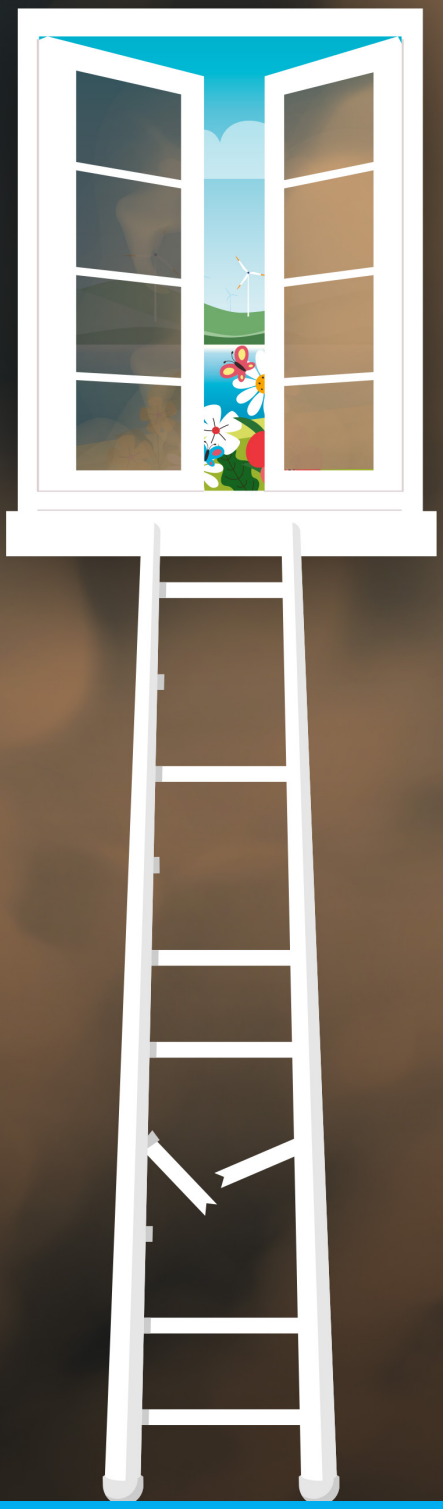
UN environment programme

# The Closing Window

## Climate crisis calls for rapid transformation of societies



Executive Summary

Emissions Gap Report 2022

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## Climate crisis calls for rapid transformation of societies

### Executive Summary

# Emissions Gap Report 2022

# Executive summary

## 1. Testimony to inadequate action on the climate crisis and the need for transformation

This thirteenth edition of the Emissions Gap Report is testimony to inadequate action on the global climate crisis, and is a call for the rapid transformation of societies. Since the twenty-sixth United Nations Climate Change Conference of the Parties (COP 26), there has been very limited progress in reducing the immense emissions gap for 2030, the gap between the emissions reductions promised and the emissions reductions needed to achieve the temperature goal of the Paris Agreement, illustrated in the following:

- Countries' new and updated nationally determined contributions (NDCs) submitted since COP 26 reduce projected global greenhouse gas (GHG) emissions in 2030 by only 0.5 gigatons of $CO_2$ equivalent ($GtCO_2e$), compared with emissions projections based on mitigation pledges at the time of COP 26.

- Countries are off track to achieve even the globally highly insufficient NDCs. Global GHG emissions in 2030 based on current policies are estimated at 58 $GtCO_2e$. The implementation gap in 2030 between this number and NDCs is about 3 $GtCO_2e$ for the unconditional NDCs, and 6 $GtCO_2e$ for the conditional NDCs.

- The emissions gap in 2030 is 15 $GtCO_2e$ annually for a 2°C pathway and 23 $GtCO_2e$ for a 1.5°C pathway. This assumes full implementation of the unconditional NDCs, and is for a 66 per cent chance of staying below the stated temperature limit. If, in addition, the conditional NDCs are fully implemented, each of these gaps is reduced by about 3 $GtCO_2e$.

- Policies currently in place with no additional action are projected to result in global warming of 2.8°C over the twenty-first century. Implementation of unconditional and conditional NDC scenarios reduce this to 2.6°C and 2.4°C respectively.

- To get on track for limiting global warming to 1.5°C, global annual GHG emissions must be reduced by 45 per cent compared with emissions projections under policies currently in place in just eight years, and they must continue to decline rapidly after 2030, to avoid exhausting the limited remaining atmospheric carbon budget.

As these headline findings illustrate, incremental change is no longer an option: broad-based economy-wide transformations are required to avoid closing the window of opportunity to limit global warming to well below 2°C, preferably 1.5°C. Every fraction of a degree matters.

At COP 26 last year, this dire situation was recognized, and countries were called upon to "revisit and strengthen" their 2030 targets by the end of 2022. Consequently, a key question for this edition of the Emissions Gap Report is, what progress has been made in ambition and action since COP 26, and how can the necessary transformations be initiated and accelerated?

The report considers transformations required in the sectors of electricity supply, industry, transport and buildings. It furthermore investigates cross-cutting systemic transformations of food systems and the financial system, illustrating that there is immense potential to reduce emissions beyond current mitigation pledges.

The climate crisis is part of the triple planetary crisis of climate change, pollution and biodiversity loss. This year, the world is witnessing compounding energy, food and cost of living crises, exacerbated by the war in Ukraine, all of which are causing immense human suffering.

Several methodological improvements and updates have been made this year to improve the estimates and ensure consistency across the chapters of this report. These changes, along with their implications for the interpretation of the report results, are described in detail in the report chapters and online appendices. However, it is important to note that these improvements imply that the estimates presented are not directly comparable to those of previous reports.

## 2. Global GHG emissions could set a new record in 2021

Estimates of land use, land-use change and forestry (LULUCF) are currently only available up to 2020, limiting our analysis of total global GHG emissions for 2021. However, global GHG emissions for 2021, **excluding** LULUCF, are preliminarily estimated at 52.8 $GtCO_2e$, a slight increase compared to 2019, suggesting that **total** global GHG emissions in 2021 will be similar to or even break the record 2019 levels (figure ES.1).

This confirms earlier findings that the global response to the COVID-19 pandemic led to an unprecedented but short-lived reduction in global emissions. Total global GHG emissions dropped 4.7 per cent from 2019 to 2020. This decline was driven by a sharp decline in $CO_2$ emissions from fossil fuels and industry of 5.6 per cent in 2020. However, $CO_2$ emissions rebounded to 2019 levels in 2021, with global coal emissions exceeding 2019 levels. Methane and nitrous oxide emissions remained steady from 2019 to 2021, and fluorinated gases continued to surge.

Global GHG emissions have continued to grow in the past 10 years, but the rate of growth has slowed compared to the previous decade. Between 2010 and 2019, average annual growth was 1.1 per cent per year, compared to 2.6 per cent per year between 2000 and 2009. Thirty-five countries accounting for about 10 per cent of global emissions have peaked in $CO_2$ and other GHG emissions, but their reductions have been outweighed by global emissions growth elsewhere.

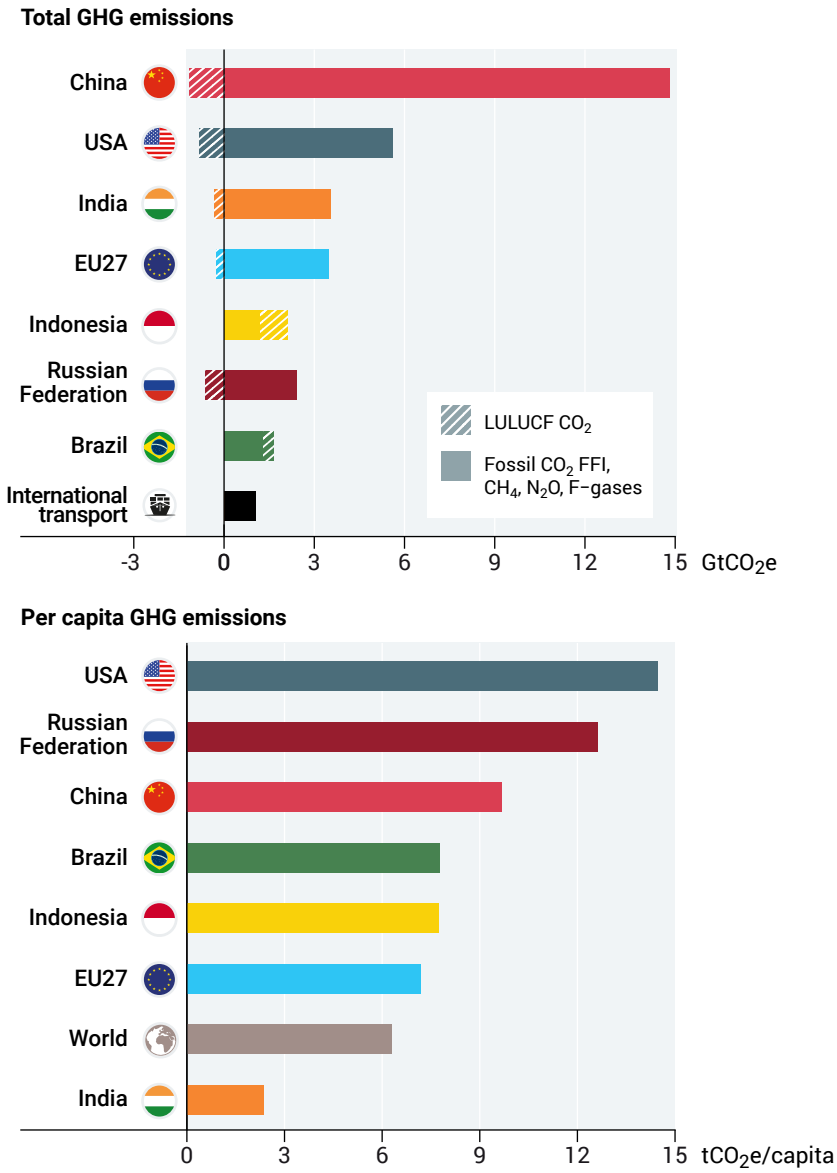
Estimates of LULUCF emissions and sinks are substantial, but also deeply uncertain. Based on national inventories, the LULUCF sector was a net sink in 17 of the G20 member States in 2020, including in China, the United States of America, India, the EU27 and the Russian Federation. GHG emissions excluding LULUCF in these countries are therefore higher, by as much as 33 per cent in the Russian Federation, 17 per cent in the United States of America, 9 per cent in India, and about 8 per cent in China and in the EU27. By contrast, the LULUCF sector is a net emitter in Indonesia and Brazil, accounting for 44 per cent and 22 per cent of their emissions respectively.

## 3. GHG emissions are highly uneven across regions, countries and households

The top seven emitters (China, the EU27, India, Indonesia, Brazil, the Russian Federation and the United States of America) plus international transport accounted for 55 per cent of global GHG emissions in 2020 (figure ES.1). Collectively, G20 members are responsible for 75 per cent of global GHG emissions.

Per capita emissions vary greatly across countries (figure ES.1). World average per capita GHG emissions (including LULUCF) were 6.3 tons of $CO_2$ equivalent ($tCO_2e$) in 2020. The United States of America remains far above this level at 14 $tCO_2e$, followed by 13 $tCO_2e$ in the Russian Federation, 9.7 $tCO_2e$ in China, about 7.5 $tCO_2e$ in Brazil and Indonesia, and 7.2 $tCO_2e$ in the European Union. India remains far below the world average at 2.4 $tCO_2e$. On average, least developed countries emit 2.3 $tCO_2e$ per capita annually.

**Figure ES.1** Total and per capita GHG emissions of major emitters in 2020, including inventory-based LULUCF



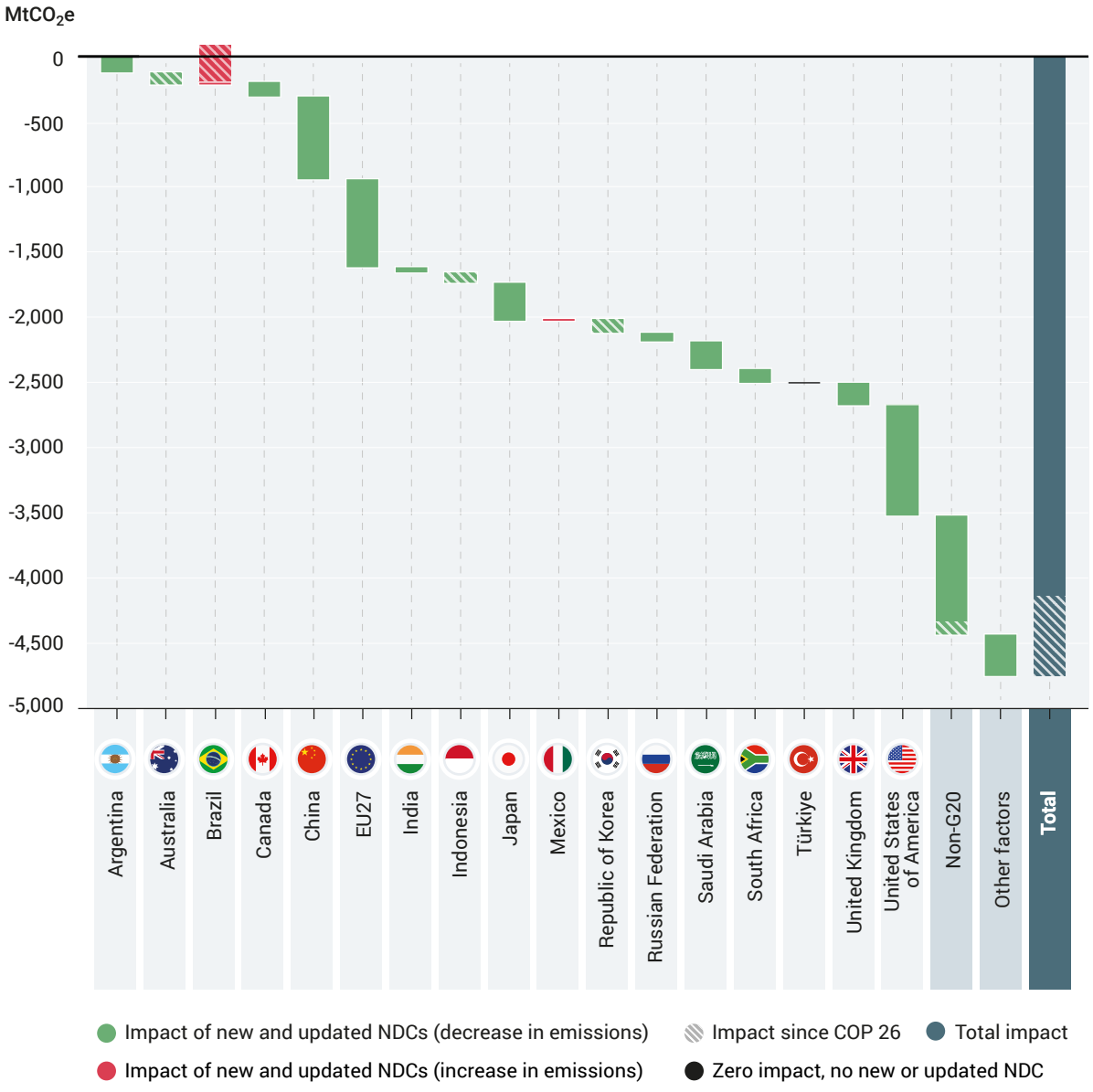
Consumption-based emissions are also highly unequal between and within countries. When emissions associated with both household consumption and public and private investments are allocated to households, and households are ranked by GHG emissions (excluding LULUCF), the bottom 50 per cent emit on average 1.6 $tCO_2e$/capita and contribute 12 per cent of the global total, whereas the top 1 per cent emit on average 110 $tCO_2e$/capita and contribute 17 per cent of the total. High-emitting households are present across all major economies, and large inequalities now exist both within and between countries.

## 4. Despite the call for countries to "revisit and strengthen" their 2030 targets, progress since COP 26 is highly inadequate

As part of the Paris Agreement's five-year ambition-raising cycle, countries were requested to submit new or updated NDCs in time for COP 26. The Glasgow Climate Pact, adopted in 2021 at COP 26, further requested countries to revisit and strengthen their 2030 mitigation targets to align with the temperature goal of the Paris Agreement. Between 1 January 2020 and 23 September 2022 (the cut-off date used for this report), 166 parties representing around 91 per cent of global GHG emissions had submitted new or updated NDCs, up from 152 parties as of COP 26. As the European Union and its 27 member States submit a single NDC, 139 new or updated NDCs have been submitted. Relative to initial NDCs, a larger share includes GHG emission targets, coverage of sectors and gases is generally greater, and more include unconditional elements.

In total and if fully implemented, the new or updated unconditional NDCs are estimated to result in an annual additional reduction of 4.8 $GtCO_2e$ by 2030 relative to the initial NDCs. Progress since COP 26 amounts to about 0.5 $GtCO_2e$, mainly resulting from new or updated NDCs from Australia, Brazil, Indonesia and the Republic of Korea (figure ES.2).

**Figure ES.2** Impact on global GHG emissions in 2030 of new and updated unconditional NDCs relative to initial NDCs



## 5. G20 members are far behind in delivering on their mitigation commitments for 2030, causing an implementation gap

Most of the G20 members that have submitted stronger NDC targets since 2020 have just started the implementation of policies and actions to meet their new targets. Those that are currently projected to meet their NDC targets are countries that have either not updated their original NDCs, or did not strengthen or only moderately strengthened their target levels in their updated NDCs. All other G20 members will need additional policies to achieve their NDCs.

The central estimate of aggregate emissions projections for G20 members in 2030 under current policies decreased by 1.3 $GtCO_2e$ compared with the 2021 assessment, mainly due to the projected emission reductions from the Inflation Reduction Act in the United States of America (about 1 $GtCO_2e$).

Collectively, the G20 members are not on track to achieve their new or updated NDCs. Based on current policies scenario projections in independent studies, there is an implementation gap, defined as the difference between projected emissions under current policies and projected emissions under full implementation of the NDCs. This implementation gap is 1.8 $GtCO_2e$ annually by 2030 for the G20 members. For two G20 members, the Russian Federation and Türkiye, the projected emissions under their NDCs have consistently been significantly above current policies projections, thereby lowering the implementation gap compared to what can reasonably be expected. If NDC projections are substituted by current policies scenario projections for these two members, the G20 members would collectively fall short of achieving their NDCs by 2.6 $GtCO_2e$ annually by 2030.

Beyond G20 members, the global implementation gap for 2030 is estimated to be around 3 $GtCO_2e$ for the unconditional NDCs and 6 $GtCO_2e$ for the conditional NDCs.

## 6. Globally, the NDCs are highly insufficient, and the emissions gap remains high

The emissions gap for 2030 is defined as the difference between the estimated total global GHG emissions resulting from the full implementation of the NDCs, and the total global GHG emissions from least-cost scenarios that keep global warming to 2°C, 1.8°C or 1.5°C, with varying levels of likelihood.

Current commitments by countries as expressed in their unconditional and conditional NDCs for 2030 are estimated to reduce global emissions by 5 and 10 per cent respectively, compared with current policies and assuming that they are fully implemented. To get on track for limiting global warming to below 2.0°C and 1.5°C, global GHG emissions must be reduced by 30 and 45 per cent respectively, compared with current policy projections.

Full implementation of unconditional NDCs is estimated to result in a gap with the 1.5°C scenario of 23 $GtCO_2e$ (range: 19–25 $GtCO_2e$) (table ES.1, table ES.2 and figure ES.3). This estimate is about 5 $GtCO_2e$ smaller than in the 2021 edition of the Emissions Gap Report. However, this difference is almost entirely due to methodological updates and updates to the 1.5°C scenarios. The emissions in 2030 are higher under the updated 1.5°C scenarios, because they start their reductions from the most up-to-date historical emissions, which have increased over the past 5 years. This does not come without consequences, as on average these scenarios have a lower chance of effectively keeping warming to 1.5°C. If the conditional NDCs are also fully implemented, the 1.5°C emissions gap is reduced to 20 $GtCO_2e$ (range: 16–22 $GtCO_2e$).

The emissions gap between unconditional NDCs and below 2°C pathways is about 15 $GtCO_2e$ (range: 11–17 $GtCO_2e$), which is about 2 $GtCO_2e$ larger than that which was reported last year. The main reason for this increase is that this year's report corrects for discrepancies in historical emissions through harmonization. If the conditional NDCs are also fully implemented, the below 2°C emissions gap is reduced to 12 $GtCO_2e$ (range: 8–14 $GtCO_2e$).

Emissions under current policies are projected to reach 58 $GtCO_2e$ in 2030. This is 3 $GtCO_2e$ higher than the estimate of last year's report. About half of the increase is due to the harmonization, about one quarter to the change of global warming potentials (GWPs), and the remainder to the methodological choice of only selecting model studies that explicitly account for the most recent current polices and NDC estimates.

**Figure ES.3** Global GHG emissions under different scenarios and the emissions gap in 2030 (median estimate and tenth to ninetieth percentile range)

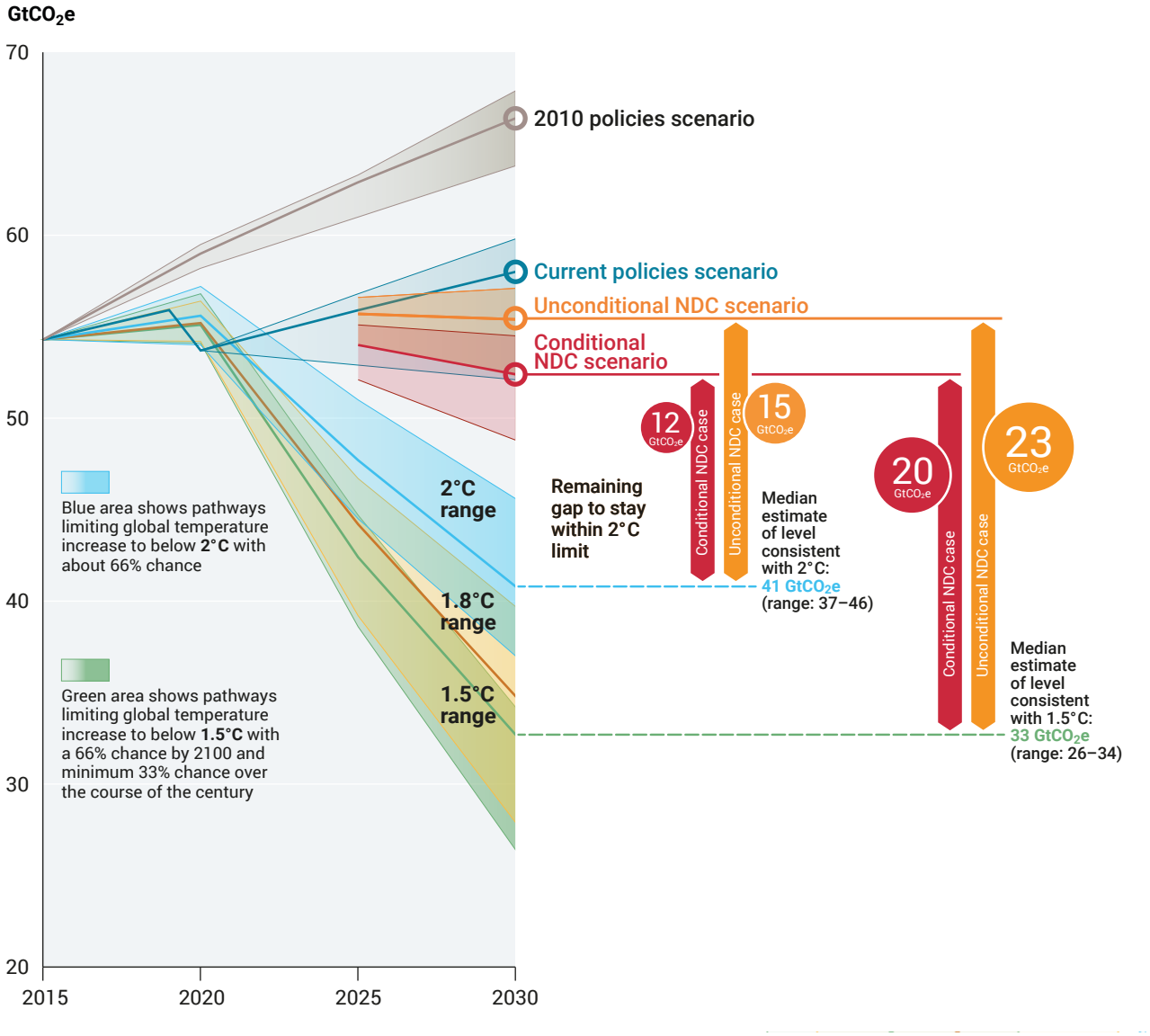



**Table ES.1** Global total GHG emissions in 2030 and the estimated emissions gap under different scenarios

| | GHG emissions in 2030 ($GtCO_2e$) Median and range | Estimated emissions gap in 2030 ($GtCO_2e$) | | |
|---|---|---|---|---|
| | | Below 2.0°C | Below 1.8°C | Below 1.5°C |
| Year 2010 policies | 66 (64–68) | - | - | - |
| Current policies | 58 (52–60) | 17 (11–19) | 23 (17–25) | 25 (19–27) |
| Unconditional NDCs | 55 (52–57) | 15 (12–16) | 21 (17–22) | 23 (20–24) |
| Conditional NDCs | 52 (49–54) | 12 (8–14) | 18 (14–20) | 20 (16–22) |

*Note:* The gap numbers and ranges are calculated based on the original numbers (without rounding), and these may differ from the rounded numbers in the table. Numbers are rounded to full $GtCO_2e$. GHG emissions have been aggregated with global warming potential over 100 years (GWP100) values of the Intergovernmental Panel on Climate Change Sixth Assessment Report (IPCC AR6).

**Table ES.2** Global total GHG emissions in 2030 and global warming characteristics of different scenarios consistent with limiting global warming to specific temperature limits

| Scenario | Number of scenarios | Global total GHG emissions ($GtCO_2e$) | | Estimated temperature outcome | | | Closest approximate |
|---|---|---|---|---|---|---|---|
| | | In 2030 | In 2050 | 50% chance | 66% chance | 90% chance | IPCC AR6 Working Group (WG) III scenario class |
| **Below 2.0°C (66% chance)*** | 195 | 41 (37–46) | 20 (16–24) | Peak: 1.7–1.8°C In 2100: 1.4–1.7°C | Peak: 1.8–1.9°C In 2100: 1.6–1.9°C | Peak: 2.2–2.4°C In 2100: 2.0-2.4°C | C3a |
| **Below 1.8°C (66% chance)*** | 139 | 35 (28–40) | 12 (8–16) | Peak: 1.5–1.7°C In 2100: 1.3–1.6°C | Peak: 1.6–1.8°C In 2100: 1.4–1.7°C | Peak: 1.9–2.2°C In 2100: 1.8–2.2°C | N/A |
| **Below 1.5°C (66% in 2100 with no or limited overshoot)*** | 50 | 33 (26–34) | 8 (5–13) | Peak: 1.5–1.6°C In 2100: 1.1–1.3°C | Peak: 1.6–1.7°C In 2100: 1.2–1.5°C | Peak: 1.9–2.1°C In 2100: 1.6–1.9°C | C1a |

* Values represent the median and tenth to ninetieth percentile range across scenarios. Percentage chance refers to peak warming at any time during the twenty-first century for the below 1.8°C and below 2.0°C scenarios. When achieving net-negative $CO_2$ emissions in the second half of the century, global warming can be further reduced from these peak warming characteristics, as illustrated by the "Estimated temperature outcome" columns. For the below 1.5°C scenario, the chance applies to the global warming in the year 2100, while the "no or limited overshoot" characteristic is captured by ensuring projections do not exceed 1.5°C with more than 67 per cent chance over the course of the twenty-first century or, in other words, that the lowest chance of warming being limited to 1.5°C throughout the entire twenty-first century is never less than 33 per cent. This definition is identical to the C1 category definition used by the IPCC AR6 WG III report. Compared to IPCC (2022), the Emissions Gap Report analysis also selects scenarios based on whether or not they assume immediate action.

*Note:* GHG emissions in this table have been aggregated with GWP100 values of IPCC AR6.

## 7. Without additional action, current policies lead to global warming of 2.8°C over this century. Implementation of unconditional and conditional NDC scenarios reduce this to 2.6°C and 2.4°C respectively

A continuation of the level of climate change mitigation effort implied by current unconditional NDCs is estimated to limit warming over the twenty-first century to about 2.6°C (range: 1.9–3.1°C) with a 66 per cent chance, and warming is expected to increase further after 2100 as $CO_2$ emissions are not yet projected to reach net-zero levels.

Continuing the efforts of conditional NDCs lowers these projections by around 0.2°C to 2.4°C (range: 1.8–3.0°C) with a 66 per cent chance. As current policies are insufficient to meet even the unconditional of NDCs, a continuation of current policies would result in about 0.2°C higher estimates of 2.8°C (range: 1.9–3.3°C) with a 66 per cent chance.

Global warming levels only get close to the Paris Agreement temperature goal if full implementation of the highly uncertain net-zero pledges is assumed. Achieving net-zero targets in addition to unconditional NDCs results in keeping projected global warming to 1.8°C (range: 1.8–2.1°C) with a 66 per cent chance. Assuming that conditional NDCs and pledges are achieved and followed by net-zero targets, global warming is similarly projected to be kept to 1.8°C (range: 1.7–1.9°C) with a 66 per cent chance. However, in most cases, neither current policies nor NDCs currently trace a credible path from 2030 towards the achievement of national net-zero targets.

## 8. The credibility and feasibility of the net-zero emission pledges remains very uncertain

Globally, 88 parties covering approximately 79 per cent of global GHG emissions have now adopted net-zero targets,

either in law (21), in a policy document such as an NDC or a long-term strategy (47), or in an announcement by a high-level government official (20). This is up from 74 parties at COP 26. An additional eight parties covering an additional 2 per cent of global GHG emissions have another (non-net-zero) GHG mitigation target as part of their long-term strategies.

Focusing on the G20 members, 19 members have committed to achieving net-zero emissions, up from 17 at COP 26. These targets vary in a number of important respects, including their legal status; time frame; explicit consideration of fairness and equity; which sources, sectors and gases they cover; whether they will allow the use of international offsets to count towards their achievement; the level of detail they provide on the role of $CO_2$ removal; and the nature of planning, review of and reporting on target implementation.

Figure ES.4 visualizes the necessary direction for countries to move from their current emission levels to their NDC targets for 2030, and indicates the net-zero targets for each G20 member that has a net-zero target (noting that France, Germany and Italy are only assessed as part of the European Union). Those G20 members whose emissions have already peaked will need to further accelerate their emission declines to their net-zero target year, while members whose emissions will continue to increase through 2030 under the NDCs will require further policy shifts and investments – including adequate support to developing countries, where applicable – to achieve the emissions reductions implied by their national net-zero targets.

This illustration does not consider the relative merits in terms of equity or fairness of the choices countries make regarding their NDCs or their nationally determined pathways to net-zero. However, it brings to the fore the discrepancies between short-term policy implementation, midterm targets and long-term targets. It also serves as an important reminder that current evidence does not provide confidence that the nationally determined net-zero targets will be achieved.

## 9. Wide-ranging, large-scale, rapid and systemic transformation is now essential to achieve the temperature goal of the Paris Agreement

The task facing the world is immense: not just to set more ambitious targets, but also to deliver on all commitments made. This will require not just incremental sector-by-sector change, but wide-ranging, large-scale, rapid and systemic transformation. This will not be easy, given the many other pressures on policymakers at all levels. Climate action is imperative in all countries but must be achieved simultaneously with other United Nations Sustainable Development Goals.

The transformation towards zero GHG emissions in the sectors of electricity supply, industry, transportation and buildings is under way. However, increased and accelerated action is needed if these are to happen at the pace and scale required to limit global warming to well below 2°C, preferably 1.5°C.

Of these four sectors, electricity supply is the most advanced, as the costs of renewable electricity have reduced dramatically. Still, major obstacles continue to exist, including ensuring that transformations are just and deliver energy access for people who are currently not served. Furthermore, the impacts on communities and nations, and existing fossil energy companies and supply chains, must be handled, and grid integration of large shares of renewable energy must be prepared. For building operations and road transport, the most efficient technologies currently available need to be applied, while for industry, and shipping and aviation, zero-emissions technologies need to be further developed and deployed.

The following broad portfolio of key actions to initiate and advance the transformation must be undertaken, tailored to the specific context of each of the four sectors:

- avoiding lock-in of new fossil fuel intensive infrastructure
- enabling the transition by further advancing zero-carbon technologies, market structures and plans for a just transformation
- applying zero-emissions technologies and promoting behavioural change to sustain and deepen reductions to reach zero emissions

All actors have roles to play in initiating and accelerating the transformation, including in the removal of barriers that stand in the way of progress (table ES.3). While any individual actions may not amount to significant enough change, taken together they can spur more far-reaching, durable, systemic change.

**Figure ES.4** Emissions trajectories implied by NDC and net-zero targets of G20 members. National emissions in $MtCO_2e$/year over time.

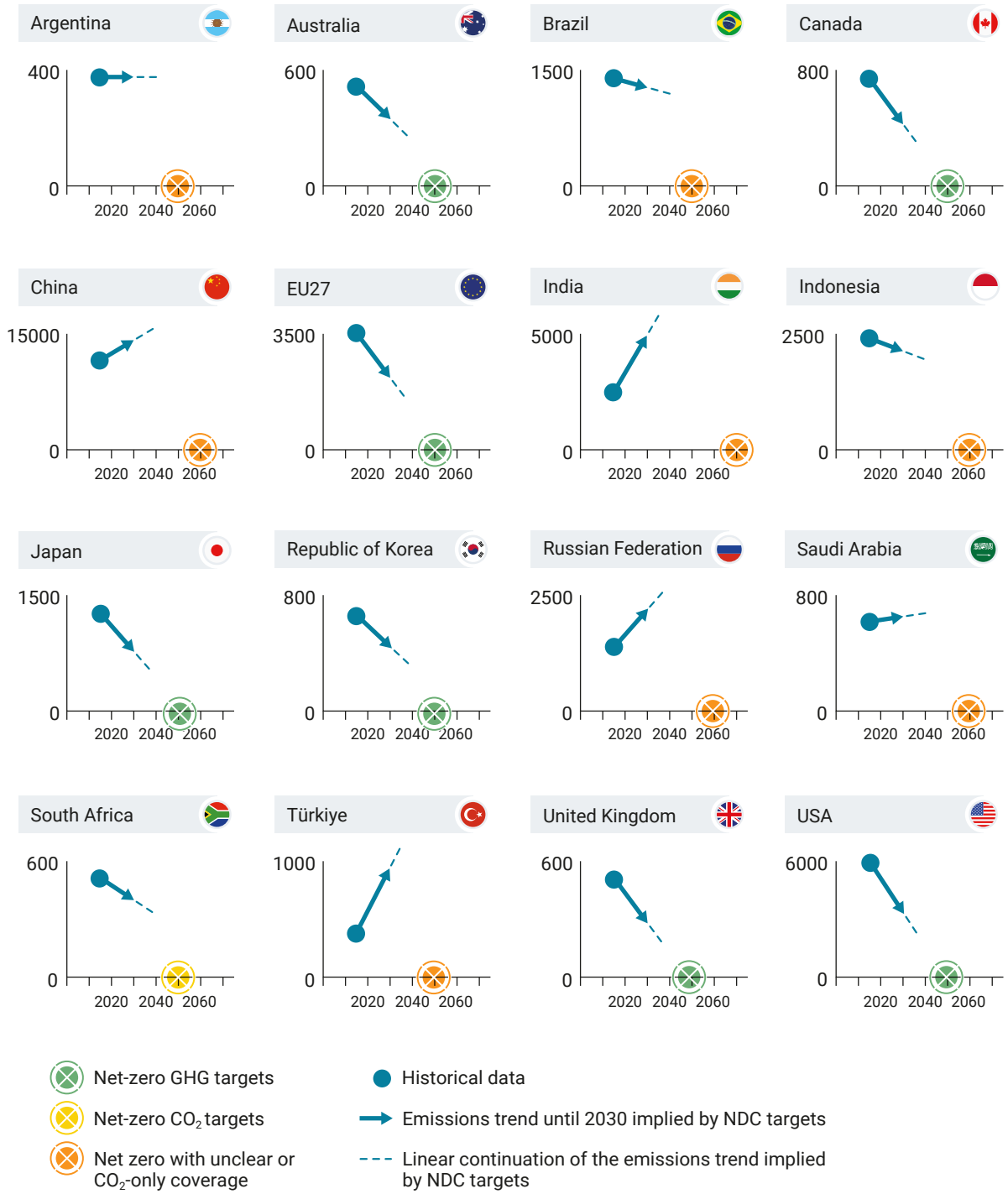


**Table ES.3** Important actions to accelerate transformations in electricity supply, industry, transportation and buildings by different actors




| | ELECTRICITY SUPPLY | INDUSTRY | TRANSPORTATION | BUILDINGS |
|---|---|---|---|---|
| National governments | › Remove fossil fuel subsidies in a socially acceptable manner<br>› Remove barriers to expansion of renewables<br>› Stop expansion of fossil fuel infrastructure<br>› Plan for a just fossil fuel phase-out<br>› Adapt market rules of electricity system for high shares of renewables | › Support zero-carbon industrial processes<br>› Promote circular material flow<br>› Promote electrification<br>› Support alternative carbon pricing mechanisms<br>› Support research and innovation<br>› Promote low-carbon products<br>› Plan for a just transformation | › Set mandates to switch to zero-emissions road vehicles by specific dates<br>› Regulate and incentivize zero-carbon fuels for aviation<br>› Adjust taxation/ pricing schemes<br>› Invest in zero-emissions transport infrastructure | › Regulate towards zero-carbon building stock<br>› Incentivize zero-carbon building stock<br>› Facilitate zero-carbon building stock |
| International cooperation | › Cooperate on a just coal phase-out<br>› Support initiatives on emissions-free electricity, power system flexibility and interconnection solutions | › Cooperate on zero-carbon basic materials<br>› Cooperate on hydrogen<br>› Share best practice | › Cooperate on financing and policy development<br>› Coordinate on target setting and standards | › Provide access and favourable conditions to finance<br>› Support skills and knowledge growth |
| Subnational governments | › Set 100 per cent renewable targets<br>› Plan for a just fossil fuel phase-out | › Engage in regional planning and regulations<br>› Cooperate with various stakeholders | › Plan infrastructure and supporting policies that reduce travel demand<br>› Adjust taxation/ pricing schemes | › Implement zero-emissions building stock plans<br>› Integrate low-emissions require-ments in urban planning<br>› Add requirements that go beyond the national level |
| Businesses | › Support a 100 per cent renewable electricity future | › Plan and implement zero-emissions transformation<br>› Design long-lived products<br>› Create circular supply chain | › Work towards zero-emissions transportation<br>› Reduce travel in operations | › Construction and building material companies review business models<br>› Achieve zero-carbon owned or rented building stock |
| Investors, private and development banks | › Engage with or divest from fossil fuel electricity utility companies<br>› Do not invest in or insure new fossil fuel infrastructure | › Engage with or divest from emissions-intensive industry<br>› Invest in low-carbon energy and process technologies<br>› Drive awareness of climate risks | › Invest in zero-emissions transport infrastructure<br>› Support zero-emissions vehicles, vessels and planes | › Adjust strategy and investment criteria for zero-carbon building stock<br>› Support building renovation |
| Citizens | › Purchase 100 per cent renewable electricity | › Consume sustainably<br>› Lobby | › Adopt active mobility practices<br>› Use public transportation<br>› Use zero-emissions vehicles<br>› Avoid long-haul flights | › Retrofit for improved carbon footprint<br>› Tenants challenge landlords<br>› Adopt energy-saving behaviour |

## 10. The food system accounts for one third of all emissions, and must make a large reduction

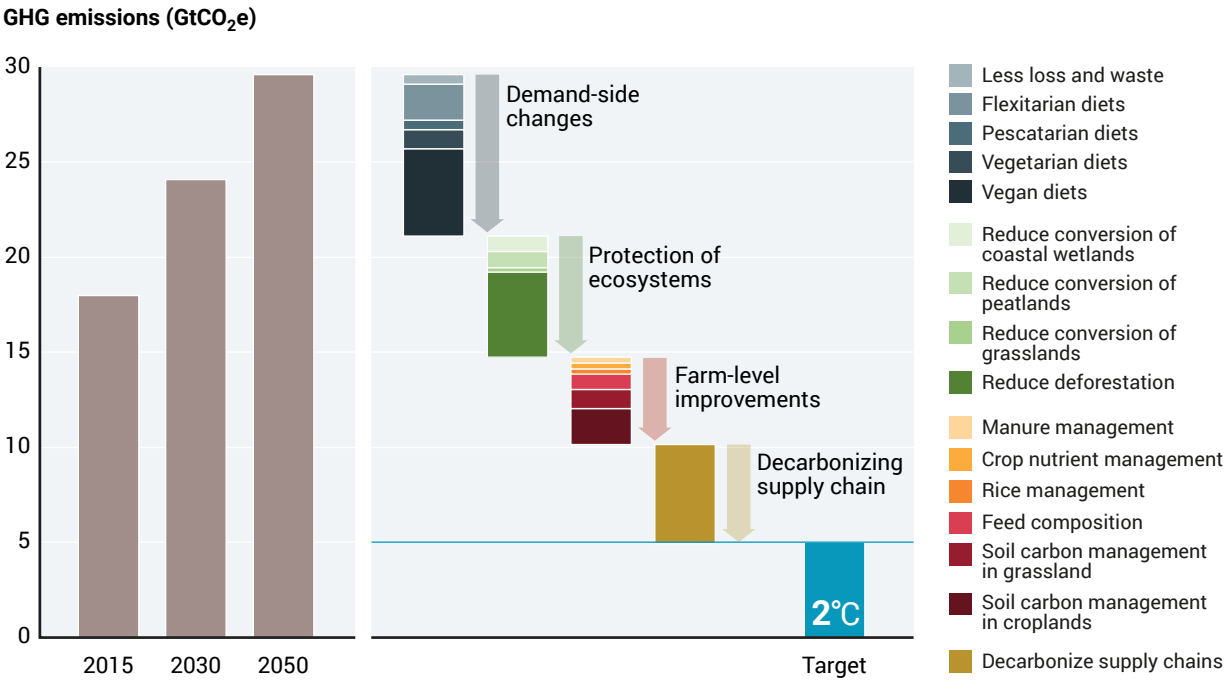
Food systems are major contributors not only to climate change, but also to land-use change and biodiversity loss, depletion of freshwater resources, and pollution of aquatic and terrestrial ecosystems. Adopting a food systems lens implies a cross-sectoral approach that explicitly connects supply and demand sides, and all actors of the food supply chain. It facilitates identifying synergies and trade-offs across interconnected environmental, health and economic dimensions, but the inclusion of several sectors makes computation of emissions more difficult, and increases risks of double counting.

The food system is currently responsible for about a third of total GHG emissions, or 18 $GtCO_2e$/year (range: 14–22 $GtCO_2e$). The largest contribution stems from agricultural production (7.1 $GtCO_2e$, 39 per cent) including the production of inputs such as fertilizers, followed by changes in land use (5.7 $GtCO_2e$, 32 per cent), and supply chain activities (5.2 $GtCO_2e$, 29 per cent). The latter includes retail, transport, consumption, fuel production, waste management, industrial processes and packaging.

Projections indicate that food system emissions could reach ca 30 $GtCO_2e$/year by 2050. To get on an emissions pathway aligned with the Paris Agreement temperature goal, food systems will have to be rapidly transformed across multiple domains. Required transformations include shifting diets, protecting natural ecosystems, improving food production and decarbonizing the food value chain. Each transformation domain includes several mitigation measures. The potential to reduce GHG emissions is up to 24.7 $GtCO_2e$/year in 2050 (figure ES.5).

Transforming food systems is not only important for addressing climate change and environmental degradation, but also essential for ensuring healthy diets and food security for all. Actions by all major groups of actors is required to drive transformations forward and to overcome barriers.

**Figure ES.5** Food systems emissions trajectory and mitigation potentials by transformation domain



## 11. Realignment of the financial system is a critical enabler of the transformations needed

A realignment of the financial system is vitally important to enable the transformations needed are to be achieved. The financial system is a network of private and public institutions such as banks, institutional investors and public institutions that regulate the safety and soundness of the system, but also co-lend or finance directly. A global transformation from a heavily fossil fuel- and unsustainable land use-dependent economy to a low-carbon economy is expected to require investments of at least US$4–6 trillion a year, a relatively small (1.5–2 per cent) share of total financial assets managed, but significant (20–28 per cent) in terms of the additional annual resources to be allocated. The IPCC assesses that global mitigation investments need to increase by a factor of three to six, and even more for developing countries (figure ES.6). Financial systems change is required to enable such a global transformation.

To date, most financial actors have shown limited action on climate change mitigation because of short-term interests and conflicting objectives, and because climate risks are not adequately recognized. Six approaches to bringing about a financial system that is capable of the shifting of finance flows needed for systemic transformation are identified:

- Increase the efficiency of financial markets. Key interventions include the provision of better information, including taxonomies and transparency, on climate risks. In developing country contexts, priorities will include capacity-building and strengthening institutions.

- Introduce carbon pricing. This can be done through policy instruments such as carbon taxes or cap-and-trade systems. Emissions-trading schemes and carbon taxes now cover 30 per cent of all global emissions, with a global average price of US$6 per ton of $CO_2$. Both the coverage and the price are insufficient for transforming the financial system: the International Monetary Fund has suggested a global average price of US$75 as required by 2030.

- Nudge financial behaviour. Climate finance markets are subject to deep information asymmetry, risk aversion and herd behaviour, all of which result in inefficient choices. Policy "nudges" can achieve better results, with strong public policy interventions, taxation, spending and regulations positively influencing behaviour.

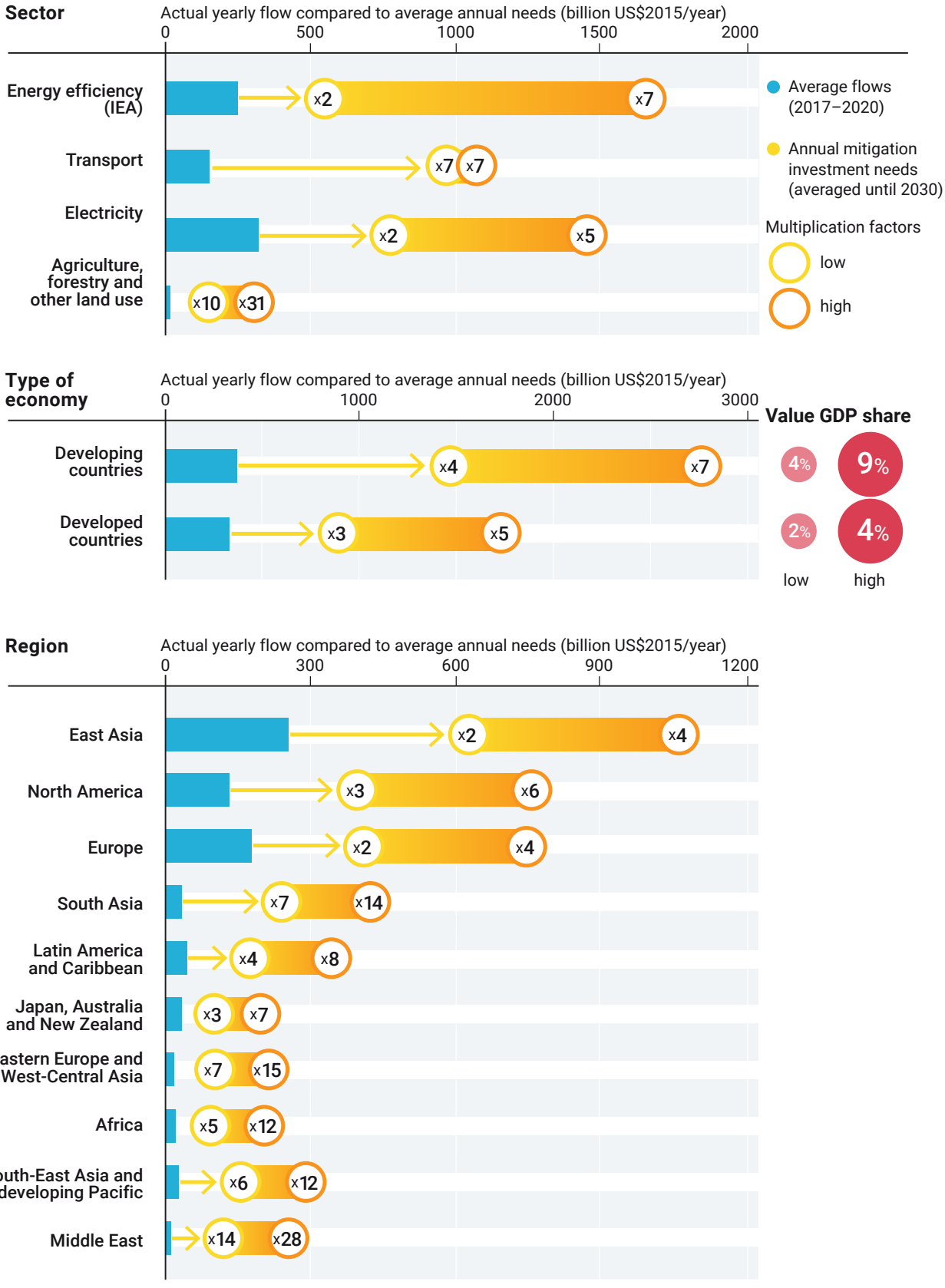
- Create markets. Public policy action can remove existing market distortions and accelerate new product markets for low-carbon technology, pushing innovation through public finance, and replacing older, inefficient and fossil fuel-based technology. Development banks, including green banks, can play a more active role to stimulate financial markets as newer product markets are being accelerated. Multilateral development banks can support market creation through shifting financial flows, stimulating innovation and helping to set standards (e.g. for fossil fuel exclusion policies, GHG accounting and climate risk disclosure).

- Mobilize central banks. Central Banks are increasingly addressing the climate crisis. In December 2017, eight central banks and supervisors established the Network for Greening the Financial System, which has now grown to 116 members and 18 observers. Mandates of central banks in developing countries are often broader than those of central banks in developed countries; more concrete action towards this approach can therefore be observed. For example, the Reserve Bank of India requires that commercial banks allocate a certain proportion of lending to a list of "priority sectors", including renewable energy, and Bangladesh Bank has introduced a minimum credit quota of 5 per cent that financial institutions must allocate to green sectors.

- Set up climate clubs and cross-border finance initiatives. These can include just transition partnerships, and can alter policy norms and change the course of finance through credible financial commitment devices on cross-border financial flows, such as sovereign guarantees.

Evidence on the effectiveness of the six approaches above suggests that there is no single "silver bullet". Instead, nested and coordinated approaches are needed, tailored to contexts, and implemented across major groups of countries, with equity and "just transition" within and between countries. The success of such coordinated and cooperative action, depend, ultimately, on public support and pressures to avert the significant risks of inaction, and the willingness of key financial system actors to take on their roles.

**Figure ES.6** Finance flows and mitigation investment needs per sector, type of economy and region (averaged until 2030)



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