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NOTES

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Simon Black, Ian Parry, and Karlygash Zhunussova

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Sleepwalking to the Cliff Edge? A Wake-up Call for Global Climate Action

Simon Black, Ian Parry, and Karlygash Zhunussova
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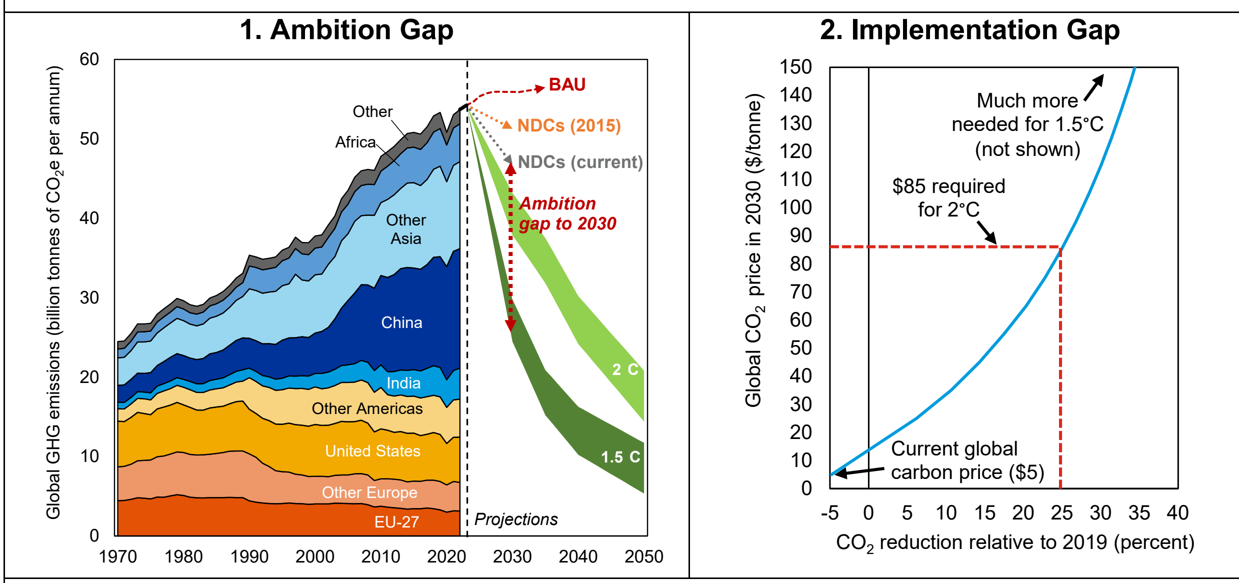
Summary

Urgent action to cut greenhouse gas (GHG) emissions is needed now. Early next year, all countries will set new emissions targets for 2035 while revising their 2030 targets. Global GHGs must be cut by 25 and 50 percent below 2019 levels by 2030 to limit global warming to 2°C and 1.5°C, respectively. However, current targets would only cut emissions by 12 percent, so global ambition needs to be doubled to quadrupled. Further delay will lead to an "emissions cliff edge," implying implausible cuts in GHGs after 2030 and putting 1.5°C beyond reach. This Note provides IMF staff's annual assessment of global climate mitigation policy. It illustrates options for equitably aligning country targets with the Paris Agreement's temperature goals. It also provides guidance on the modeling needed to set emissions targets and quantify climate mitigation policy impacts.

Introduction

Limiting global warming to 1.5°C to 2°C requires cutting greenhouse gas (GHG) emissions by 25 to 50 percent by 2030 versus 2019. However, gaps in climate ambition and implementation persist (Figure 1). Countries have raised their ambition since 2015, but even if 2030 emissions targets in nationally determined contributions (NDCs) were achieved, global GHGs would fall by just 12 percent from 2019 levels (panel 1) versus a needed 25 to 50 percent cut. Worse still, in a business-as-usual (BAU) scenario, emissions are projected to *increase* by 5 percent. Indeed, a global carbon price of $85 per tonne by 2030 would get emissions on track to 2°C and much more would be needed for 1.5°C (panel 2). But the current global carbon price is just $5 per tonne.

Figure 1. Global GHG Emissions and Targets (in NDCs) and Temperature Goals (Panel 1) and the Global Mitigation Implementation Gap Expressed as a Carbon Price (Panel 2)



Sources: Intergovernmental Panel on Climate Change 2022; and IMF staff calculations using the IMF-World Bank Climate Policy Assessment Tool (CPAT). Note: Includes land use and land-use change emissions. In panel 1, NDCs (2015) shows the needed trajectory from current emissions levels to 2030 emissions targets that countries had set during the Paris Agreement. NDCs (current) show the trajectory that countries would need to take to achieve their current 2030 targets. The gap between the two is the increase in global climate mitigation ambition since 2015 as countries have since revised their 2030 targets. In panel 2, calculations are for energy-related CO_2 but the functional relationship in the figure would be similar for total GHGs. BAU = business as usual; CO_2e = carbon dioxide equivalent; GHG = greenhouse gas; NDC = nationally determined contribution.

In 2023, countries recognized "the window to keep warming to 1.5 C within reach is closing rapidly… now is the time to rapidly accelerate action."[1] Countries are due to set new emissions targets for 2035 while enhancing 2030 targets well ahead of COP30, that is, early next year. If 2030 targets are not strengthened and achieved, the 1.5°C goal will become permanently beyond reach.

This Note aims to provide the following: (1) IMF staff's annual assessment of global climate mitigation policy; (2) options for equitably aligning 2030 and 2035 emissions targets with global temperature goals; and (3) guidance for policymakers on modeling to set and achieve emissions targets. The Note builds on earlier assessments (Black and others 2021, 2022a, 2023c)[2] by updating data sources and providing illustrative scenarios for getting global emissions on track equitably. It also provides practical guidance on the modeling required for setting emissions targets while assessing impacts of mitigation policies, providing illustrative results for Group of Twenty (G20) countries. The Note uses the IMF-World Bank Climate Policy Assessment Tool (CPAT), which is a model unique in allowing for comprehensive assessments of climate mitigation for around 200 countries.[3]

Key messages from the analysis include:

- **Two major gaps in global climate policy persist**. Global mitigation ambition and implementation remain well below what is needed.
- **Mitigation ambition for 2030 needs to be doubled to quadrupled.** Emissions growth since 2020 means GHG now need to be cut faster, by 25 and 50 percent by 2030 versus 2019 for 2°C and 1.5°C, respectively (up from 21 and 43 percent, identified by the Intergovernmental Panel on Climate Change [IPCC]). Current targets would cut emissions by just 12 percent.
- **Collectively, the world is approaching an "emissions cliff edge."** If 2030 targets are not enhanced, emissions cuts needed thereafter are implausible, **putting 1.5°C out of reach.**
- **We present illustrative targets for ratcheting up climate ambition equitably by income level for all countries.** These would align global emissions with 1.5°C or 2°C, with richer countries cutting emissions faster. However, the rate of decarbonization required for 1.5°C is rapid for all countries and it remains to be seen if such a rate is feasible technologically, economically, and politically.
- **Current mitigation policies vary considerably**. There is substantial variation in mitigation policies across countries and different sectors. Globally however, policies fall well short of what is needed for 2°C, let alone 1.5°C, indicating a large implementation gap.
- **The current estimated abatement costs of aligning global emissions in 2030 with 2°C are manageable** (around 0.4 percent of GDP). These costs, which are broadly the welfare costs of inducing households and firms to adopt cleaner but more expensive technologies, can be progressively distributed globally, and for many countries (especially developing ones) are offset mostly or fully by domestic environmental co-benefits (excluding climate benefits). The costs of 1.5°C are much less certain.
- **Stronger international coordination can help close the global mitigation ambition and implementation gap**. Given the concentration of global GHGs and political influence, plurilateral agreements between a small number of players could accelerate ambition and action. This could include coordination over policies (for example, minimum carbon prices) or emissions targets.
- **Modeling is critical for setting emissions targets and assessing policy impacts.** However, governments often lack modeling capacity and data. We provide guidance, including on setting emissions forecasts, aligning near-term targets with long-term goals (for example, net zero by 2050), and quantifying the impacts of mitigation.

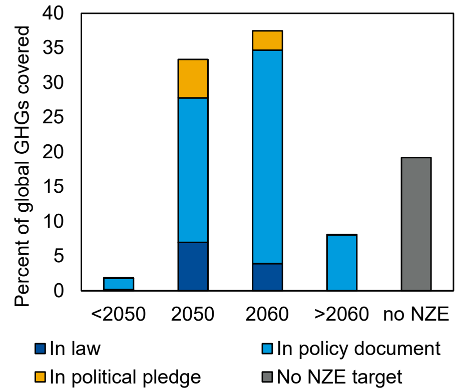
[1] See https://unfccc.int/documents?f%5B0%5D=symboldoc%3AFCCC/SB/2023/9.
[2] See also UNEP (2023) and UNFCCC (2023) for similar findings on global mitigation ambition gaps.
[3] The model that is available to government officials and is briefly described in Annex 1 and in detail in Black and others (2023a). See also www.imf.org/cpat for further information.

Equitably Aligning Global Emissions with Temperature Goals

Global Emission Reductions Needed

Long-term net zero goals are vital but should not distract from the need for stronger, temperature-aligned mitigation targets and policies in the near term. As of December 2024, 147 countries, accounting for about 70 percent of 2020 GHG emissions, have committed to net zero emissions by 2050 or 2060, while some have made earlier or later commitments (for example, India in 2070).[4] Only 11 percent of these targets are enshrined in law; however, most are in policy documents and some in political pledges—see Figure 2 for a global summary. Even if there were a reasonable prospect for ultimately meeting these targets, the path to net zero also matters, as global warming depends on cumulative stock of GHGs in the atmosphere. If emissions reductions are delayed until later in the transition, atmospheric GHG accumulations and global warming will increase. Further, delaying action will slow down the pace at which low-carbon technologies are developed and improved through innovation and learning-by-doing, raising the costs of clean energy transitions.[5] In addition, three trends create risks that even current 2030 targets could be missed: (1) recent geoeconomic fragmentation, such as rising tariffs on low-carbon technologies; (2) continued investment in fossil fuels which could lead to "carbon lock-in"[6]; and (3) growing climate-induced physical hazards as the world warms which could reduce resources available for mitigation as opposed to, for example, reconstruction.[7] Even 1.5°C would have significant consequences for human and natural systems, losses and risks which increase with warming (Intergovernmental Panel on Climate Change, IPCC 2018).

Figure 2. Net Zero Emissions (NZE) Targets by Target Year, Legal Status, and GHG Coverage



Sources: Net Zero Tracker; and IMF staff calculations.
Note: GHG = greenhouse gas.

The 2015 Paris Agreement was predicated on the need to ratchet up climate ambition over time. Since then, ambition has increased but falls well short of what is needed. During the Paris Agreement negotiations, it was known that countries' emissions targets (in NDCs) would not be sufficient to keep global warming "well below" 2°C above pre-industrial levels, ideally to 1.5°C.[8] It was envisioned that countries would ratchet up ambition on a five-year basis (the first at COP26 in 2021), supported by periodic progress reviews (the "Global Stock Take," first concluded at COP28 in 2023).[9] NDCs set in 2015 would have cut emissions in 2030 by just 2 percent versus 2019 levels, whereas current NDCs would cut emissions by about 12 percent—a step in the right direction, but well short of 25 to 50 percent cuts needed (Figure 1).

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[4] Net zero allows positive emissions from some (hard-to-abate sectors) like agriculture so long as they are offset by negative emissions elsewhere, for example, through forest carbon sequestration or direct air capture.

[5] Whether temperatures rise above target levels temporarily ("overshoot") is also determined by the historical stock of emissions. Note that, given the uncertainty in the relationship between emissions and global warming responsiveness ("climate sensitivity"), temperature goals are expressed probabilistically. In this Note, aligned with the Intergovernmental Panel on Climate Change's scenarios, the 1.5°C target is assumed to be achieved with 50-percent probability with "no or limited overshoot" while 2°C is achieved with 67-percent probability.

[6] "Carbon lock-in" conceptualizes the idea that investments in high-carbon assets, such as oil distribution infrastructure, today can lead to future emissions since it becomes cheaper to continue polluting than to decarbonize.

[7] Refer to Gardes-Landolfin and others (2023).

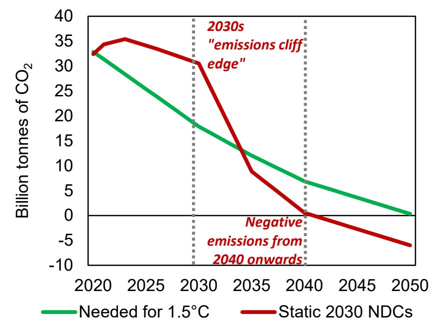
[8] See https://unfccc.int/process-and-meetings/the-paris-agreement.

[9] In addition, at COP28, countries committed to accelerating the "phase-down on unabated coal power," scaling up "net zero emission energy systems," and "transitioning away from fossil fuels in energy systems, in a just, orderly and equitable manner, accelerating action in this critical decade, so as to achieve net zero by 2050 in keeping with the science." See https://unfccc.int/documents?f%5B0%5D=symboldoc%3AFCCC/SB/2023/9.

Since 2015, countries have increasingly emphasized the need to keep warming at 1.5°C. At COP28, countries set a collective goal of cutting global GHG emissions by 43 percent (48 percent in CO_2) by 2030 and 60 percent (65 percent in CO_2) by 2035 versus 2019 levels, but this is already insufficient. These goals represent emissions cuts in the midpoint of scenarios aligned with 1.5°C identified by the IPCC.[10] This scenario, however, envisioned rapid emissions reductions from 2019 onward, whereas after an initial drop in 2020 (because of the coronavirus pandemic) emissions have continued to grow. In 2023, global GHG emissions were 10.8 billion tonnes (25 percent) higher than what the IPCC suggested was needed for 1.5°C. Accounting for this, IMF staff calculations suggest the new target would need to be an even larger 49-percent reduction in GHGs (53 percent in CO_2) for 2030 and 66-percent reduction in GHGs (72 percent in CO_2) for 2035.[11] These are drastic cuts and may not be technically (let alone politically) feasible.

If 1.5°C is to be kept alive and the world is to avoid an "emissions cliff edge" in the 2030s, it is critical that global emissions are cut rapidly in the next five years (Figure 3). If current targets for 2030 remain (and are achieved on linear emission reduction trajectories), keeping 1.5°C alive would require (1) cutting 2035 emissions by 75 percent, (2) achieving net zero emissions in 2040, and (3) net removals of CO_2 from the atmosphere after 2040, implying widescale use of costly technologies like direct air capture. The rate of decarbonization under this cliff edge scenario is dramatic—global CO_2 emissions would need to decline over 7 percent each year from 2030 to 2040.[12] For comparison, the once-in-a-generation annual fall in global CO_2 emissions in 2020 because of the coronavirus pandemic was just 5.8 percent (after which emissions rose).[13] If, instead, countries continue emitting at current levels, the remaining carbon budget to 1.5°C (the allowable amount of cumulative CO_2 implied by the temperature goal) would be fully exhausted by 2035—at that point, global emissions would need to go immediately and permanently to zero.

Figure 3. Countries Are Setting up an "Emissions Cliff Edge" in the 2030s



Sources: Intergovernmental Panel on Climate Change 2022 and IMF staff calculations.
Note: CO_2 = carbon dioxide; NDC = nationally determined contribution.

Current Emissions and Mitigation Targets by Country Income Group

Climate mitigation and international equity are intrinsically linked. The issue of equity (known as "common but differentiated responsibilities and respective capabilities") has historically divided countries into two camps in the United Nations Framework Convention on Climate Change. Under the precursor to the Paris Agreement, the Kyoto Protocol, "Annex I" (mostly developed) countries were required to cut emissions, whereas "non-Annex I" countries (mostly developing countries) were not. Given that developing countries already accounted for a majority of annual emissions, and nearly half of historical emissions, when the Protocol came into force in 2012—and they account for two-thirds of annual CO_2 emissions now (see Figure 4)—achieving a global emissions trajectory aligned with 1.5°C–2°C would have been infeasible. Under the Paris Agreement, all countries are committed to cutting emissions, with high-income countries (HICs) going faster while providing financial and technological assistance to developing countries.

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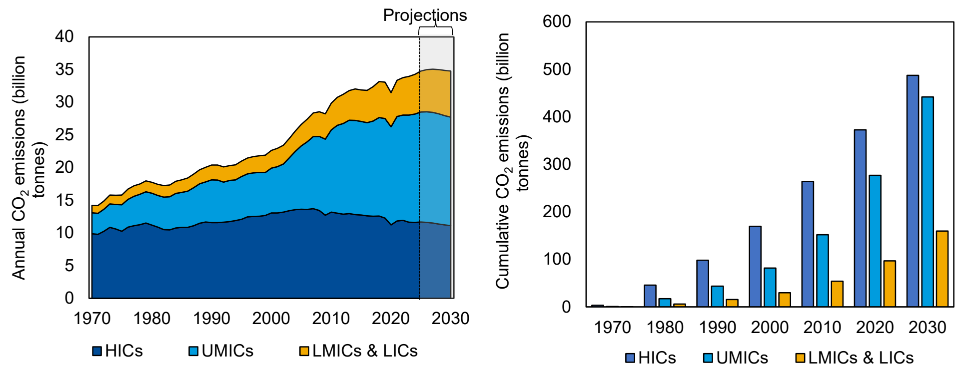
[10] Allowing for some risk of overshoot, where the temperature goal is temporarily exceeded before returning to that level at some future point. Countries noted "Limiting global warming to 1.5°C (>50-percent probability) with limited or no overshoot implies a reduction of around 43, 60, and 84 percent in global GHG emissions below the 2019 level by 2030, 2035 and 2050, respectively, as assessed by the IPCC." Refer also to table SPM.1 in https://www.ipcc.ch/report/ar6/wg3/.

[11] This assumes a fixed carbon budget out to 2050 and that emissions cuts catch up with the IPCC's "C1" ("Below 1.4°C with no or limited overshoot," also known as SSP1-1.5) scenario linearly from 2024 to 2040.

[12] Under the 1.5°C scenario, CO_2 emissions would fall from estimated current levels in 2023 by an annual average rate of 4 percent every year to 2030 and then 3.5 percent to 2050.

[13] See https://www.iea.org/reports/global-energy-review-2021/co2-emissions.

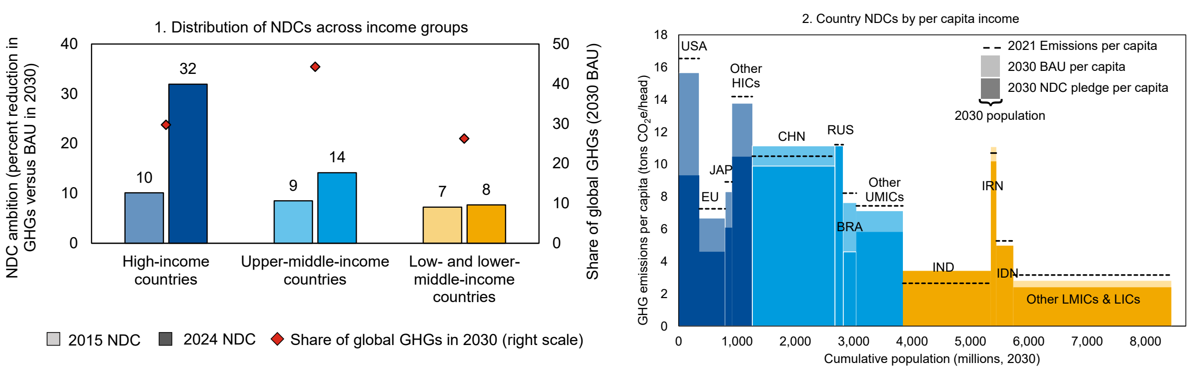
Figure 4. Historical and Projected BAU Annual (Panel 1) and Cumulative (Panel 2) CO_2 Emissions for High-, Middle-, and Low-Income Countries, 1960–2030



Source: IMF staff calculations using CPAT.
Note: BAU = business as usual; bn = billion; HICs = high-income countries; LICs = low-income countries; LMICs = lower-middle-income countries; UMICs = upper-middle-income countries.

Emissions cuts implied by current NDCs vary substantially across income groups (Figure 5). CPAT allows for quantification and comparison of mitigation ambition in NDCs for over 150 countries. By estimating countries' emissions in the BAU and comparing to that implied by NDCs, countries can be compared in a transparent and consistent manner.[14] HICs,[15] as a group, have more than tripled their ambition (from 10 to 32 percentage points [ppts] versus 2030 BAU) since 2015. Upper-middle-income countries (UMICs) have increased ambition from 9 to 14 ppts, while ambition among lower-middle-income (LMICs) and low-income countries (LICs) as a group is largely unchanged (at 7 to 8 ppts).

Figure 5. Distribution of NDC Ambition across Income Groups (2015 versus 2024, Panel 1) and Emissions per Capita across Key Countries in 2030 (Panel 2)



Source: IMF staff calculations using CPAT.
Note: For developing countries, unconditional and conditional NDCs are averaged. Where BAU and NDC are equal, the target is either nonquantifiable or nonbinding; that is, it is assumed to be achieved in the baseline. Data labels use International Organization for Standardization (ISO) country codes. BAU = business as usual; HICs = high-income countries; LICs = low-income countries; UMICs = upper-middle-income countries; LMICs = lower-middle-income countries; NDC = nationally determined contribution; [1] Of 220 countries analyzed, 63 had nonquantifiable NDCs, that is, do not have any targets or have targets that are not economy-wide. [2] Of the 157 countries with quantifiable NDCs, 36 were considered nonbinding, that is, the target is met in the business-as-usual (BAU) scenario. These countries account for 20 percent of global GHGs. [3] We do not assume that countries raise emissions above BAU by, for example, reversing current mitigation policies.

[14] Comparing targets relative to business-as-usual (BAU) levels is a fairer measure of country ambition compared with absolute cuts, as for example, low-income countries could have targets implying emissions cuts versus BAU even while raising absolute emissions. BAU emissions projections by country authorities (using their own methodologies) may differ from those in the CPAT.
[15] World Bank classifications are used – https://datahelpdesk.worldbank.org/knowledgebase/topics/19280-country-classification.

Lastly, climate finance and technology transfer to developing countries is a critical aspect of global climate policy and interlinked with ambition. At COP29, countries will set a new collective quantified goal to replace the $100-billion target, previously set for 2020, but achieved late in 2022. Private finance is especially lagging, indeed the private share of climate finance in developing countries needs to rise from current from about 50 percent to 80 to 90 percent. Our last annual update made suggestions for this goal, including setting the target based on needs (in total and with respect to mitigation and adaptation separately) and—given the central importance of policy change for attracting private climate finance and the collaborative spirit of the Paris Agreement—framing it as a joint goal for all countries, rather than a target "for" developed countries. Alternatively, developed countries could consider making climate finance conditional on developing country policies. Also, technology transfer and research and development needs to be accelerated, including through private foreign direct investment and trade policy, and could include a new global agreement on lowering tariffs on low-carbon technologies (Black and others 2023c).

Equitably Distributing Enhanced Mitigation Ambition: An Illustrative Example

Economists have proposed various ways to distribute the burden of global emissions cuts equitably. The various approaches (as identified by a team of researchers from developing and developed countries—see van der Berg and others 2020) can be ordered roughly from least to most "equitable" in terms of the emissions cuts versus BAU[16]:

1. **Acquired rights** ("grandfathering"): Under this approach, countries cut emissions proportionate to their historical (for example, 2010) annual emissions.
2. **Cost optimality**: Emissions are cut at their least-cost location to minimize global costs.
3. **Gradual convergence**: Per capita emissions converge linearly over time.
4. **Ability to pay**: Emissions cuts are based on annual per capita GDP, with lower reductions calculated based on the poverty of a country and considering that costs increase with larger emissions reductions.
5. **Immediate convergence**: Per capita emissions converge immediately.
6. **Greenhouse development rights (GDR)**: Emissions cuts are based on a mixed measure of historical responsibility and capability, which includes GDP per capita and carbon intensity.

These six approaches lead to markedly different impacts on emissions cuts for key countries (refer to Annex Figure 2.1). For example, acquired rights and cost-optimal paths lead to fewer emissions reductions in HICs compared with other methods, since HICs' historical per capita emissions and marginal abatement costs are both relatively high compared with middle-income countries and LICs. Gradual convergence and ability to pay lead to intermediate solutions, with all countries required to cut emissions compared with baseline and larger cuts (in absolute terms) in HICs than middle-income countries and LICs. Lastly, "immediate convergence" and "GHG development rights" lead to large cuts in HICs (for example, more than 100 percent for Japan under GDR, that is, requiring annual carbon removals) and much smaller reductions in developing countries (for example, India grows its emissions to be above even BAU in 2030 under the GDR approach).

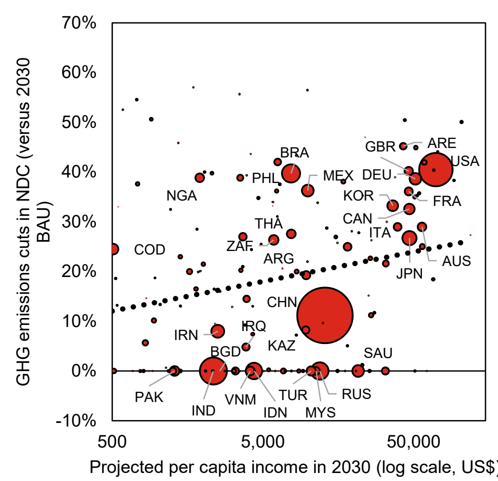
There are thus many ways to think about equity in global mitigation. However, one simplifying, illustrative way is to average across approaches and link to per capita incomes. Current NDCs and their relationship to per capita incomes are shown in Figure 6. As can be seen there is a small positive but weak relationship between current country ambition (defined in terms of emissions cuts versus BAU) and per capita income. The implied illustrative emissions reductions targets compared with BAU in 2030 can be inferred for key countries across the six different identified approaches. Then, by plotting these illustrative targets relative to per capita incomes, a linear relationship can be inferred between emissions cuts and (log) per capita income levels with the slope determining the relative level of

[16] In this narrow definition, an approach leading to more emissions cuts in developed countries is considered more "equitable."

effort required across the income distribution. Lastly, assuming countries achieve the maximum of the illustrative target (in percentage reduction versus BAU given their per capita income) and their current NDC, this line can be scaled upward or downward (in percentage points) to achieve different temperature targets (for example, 2°C, 1.8°C, or, in the case of 1.5°C).[17]

This illustrative example yields targets more equitable than current NDCs, while delivering the needed emissions reductions for 2°C or 1.5°C. Figures 7 and 8 show what enhanced, 2°C-aligned 2030 targets and 1.5°C-aligned 2030 targets, respectively, would be under the approach described in the previous section. The 2°C-aligned targets would cut global emissions by the required 25 percent and the 1.5°C-aligned targets would cut emissions by 50 percent versus the 2019 levels. In both cases, ambition would be raised substantively for a majority of countries, but the increase in the pace of emissions cuts is starker for 1.5°C. In both cases, cuts remain broadly equitable, with a sharper relationship between income and country ambition. Under the 2°C scenario some low-income countries would be able to grow emissions (albeit at a slower pace)—for example, India's emissions could grow by 21 percent from 2019 to 2030 while

Figure 6. Current Country Emissions Targets for 2030 by per Capita Income



Source: IMF staff calculations using CPAT.

Note: Bubble sizes reflect 2023 GHG emissions. Data labels are for major emitting countries and use International Organization for Standardization (ISO) codes. For countries with a nonbinding target (achieved in the BAU) it is assumed to be zero. An average is taken of conditional and unconditional targets where both are specified. A trend line is shown for all countries. BAU = business-as-usual; GHG = greenhouse gas; NDC = nationally determined contribution.

Figure 7. Illustrative 2°C-Aligned Enhanced GHG Emissions Targets for 2030

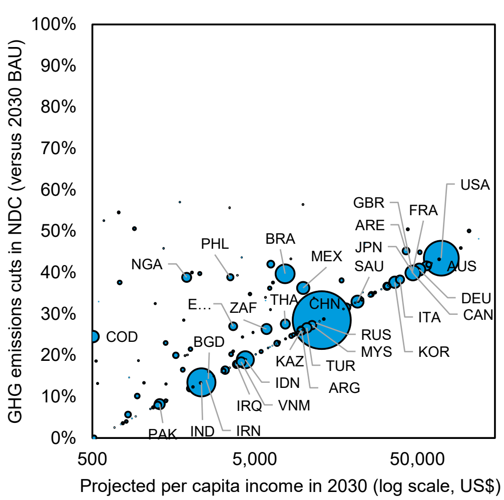
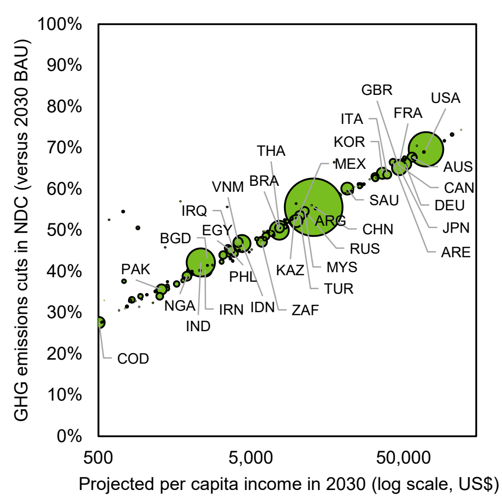


Figure 8. Illustrative 1.5°C-Aligned Enhanced GHG Emissions Targets for 2030



Source: IMF staff calculations using CPAT.

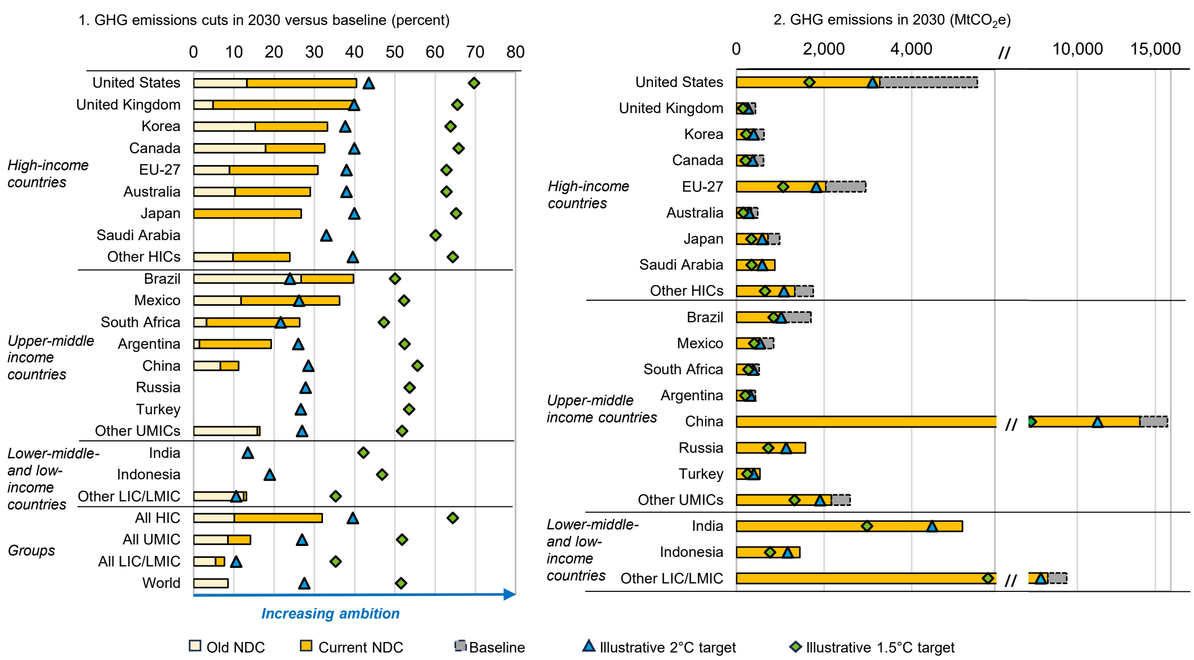
Note: Bubble sizes reflect 2021 GHG emissions. Data labels are for major emitting countries (>300 metric tons of carbon dioxide equivalent in 2030 BAU) and use International Organization for Standardization (ISO) codes. BAU = business as usual; GHG = greenhouse gas; NDC = nationally determined contribution.

[17] This approach is similar to the third most equitable approach listed ("'ability to pay'") but draws upon all approaches to determine a relationship between emissions cuts and projected per capita incomes.

the United States and China reduce their emissions 47 and 19 percent respectively. In contrast, under the 1.5°C scenario all countries would need to cut emissions in absolute terms.

Figure 9 shows gaps between current 2030 targets and illustrative targets needed for the world to be on track to 1.5°C or 2°C. Under this methodology, between income groups, shortfalls between current and illustrative targets are larger for UMICs and LIC/LMICs than for HICs. HICs as a group are about 8 ppts away from being 2°C aligned, UMICs are 16 ppts away, and LIC/LMICs are 4 ppts away. For 1.5°C, the respective distance is bigger, at 29 ppts, 37 ppts, and 25 ppts, respectively. Developed countries are generally close to being aligned with 2°C, with some exceptions. For developing countries, the NDCs of Brazil, Mexico, and South Africa are aligned with the 2°C scenario. However, the NDCs are not binding in some countries (and hence are shown without a target), although it is possible that some countries may over-achieve their existing 2030 targets with current policies (for example, India).

Figure 9. GHG Emissions Cuts for Countries under Illustrative Proposals versus Business as Usual (Panel 1) and in Absolute Values (Panel 2)

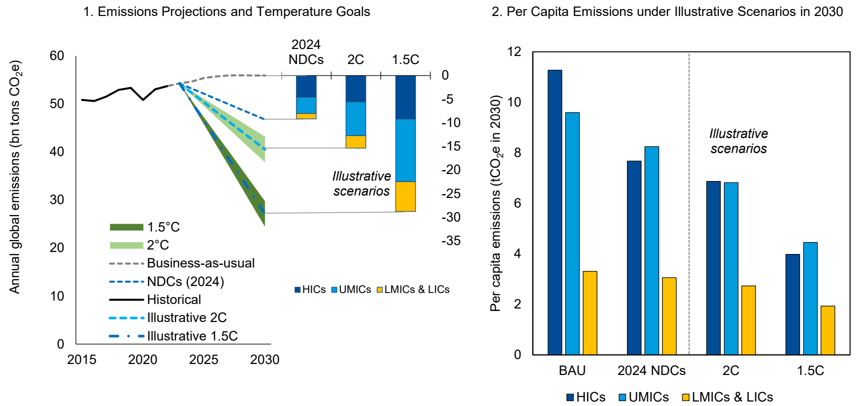


Sources: IMF staff calculations using CPAT.
Note: Where no NDC is shown, the target is nonbinding and is assumed achieved in the baseline or (for Saudi Arabia) is nonquantifiable. An average is taken of conditional and unconditional targets where both are specified. EU = European Union; GHG = greenhouse gas. Income groups use the WB classification: HICs = high-income countries; LICs = low-income countries; UMICs = upper-middle-income countries.; LMICs = lower-middle-income countries; NDC = nationally determined contribution.

Among all countries, the gap between current NDCs and illustrative temperature-aligned targets varies. Of the 179 countries with economy wide NDCs, about 40 percent have NDCs that are aligned with 2°C. But these countries account for just 18 percent of global GHG emissions. Worse, just 12 countries have targets aligned with 1.5°C, and they account for less than 2 percent of global GHGs. No major emitting country is aligned with 1.5°C on this measure. For figures showing NDC ambition levels compared with temperature-aligned targets for all countries, refer to Annex 3.

If countries enhanced their 2030 targets to be in line with the 2°C or the 1.5°C scenario, and enacted policies to achieve them, global emissions would be on track to achieve the Paris Agreement's temperature goals. Under these scenarios, emissions in 2030 would decline to their needed levels (Figure 10, panel 1).

Figure 10. Impacts of Illustrative Targets on Global and per Capita GHG Emissions



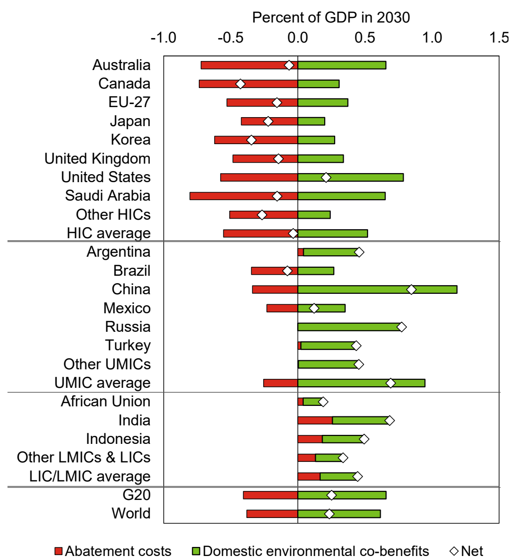
Source: IMF staff calculations using CPAT.
Note: BAU = business as usual; GHG = greenhouse gas; HICs = high-income countries; LICs = low-income countries; LMICs = lower-middle-income countries; NDC = nationally determined contribution; UMICs = upper-middle-income countries.

In addition, illustrated scenarios imply large commitments for HICs and convergence in per capita emissions (Figure 10, panel 2). In both scenarios, there is a gradual convergence of per capita emissions between HICs and UMICs LMICs/LICs maintain lower emissions per capita than HICs and UMICs but would cut by less in absolute terms.

If these targets are implemented in least-cost ways then the mitigation costs, at least for 2°C, are manageable and broadly equitable across countries (Figure 11)… Mitigation costs (see Annex 5) reflect the annualized costs of switching to cleaner but more expensive inputs and technologies, net of any savings from lower lifetime energy costs. This also includes the loss of consumer benefits from, for example, driving less than otherwise preferred. Mitigation costs depend on policy implementation. But assuming countries achieve targets in a least-cost manner, Figure 11 shows their mitigation costs under the 2°C scenario. Costs are both manageable (about 0.4 percent of GDP for the G20 as a whole) and generally equitable (higher for advanced economies and lower for low-income countries). For comparison, the abatement costs of achieving NDC targets are about 0.25 percent of GDP globally, with larger costs (0.4 percent of GDP) in HICs and almost negligible for UMICs and LICs/LMICs (0.03 percent of GDP and near zero[18], respectively). These policies can also be made equitable within countries.

…and are counteracted by domestic environmental co-benefits. Co-benefits include (most importantly) reductions in local air pollution morality from reduced

Figure 11. Abatement Costs and Domestic Environmental Benefits from Illustrative 2°C Scenario



Source: IMF staff calculations using CPAT.
Note: Domestic environmental co-benefits include reductions in local air pollution mortality and fewer road accidents and congestion from less vehicle use. They exclude climate benefits. Abatement costs are adjusted for tax interaction and revenue recycling effects. EU = European Union; HICs = high-income countries; LICs = low-income countries; LMICs = lower-middle-income countries; UMICs = upper-middle-income countries.

[18] Near zero estimates are explained by several countries achieving NDCs in the baseline.

use of fossil fuels (especially coal and diesel) and reductions in various side effects (like traffic congestion) from reduced vehicle use. For some emerging economies co-benefits can (up to a point) exceed mitigation costs implying these countries are better off on net from climate mitigation, before even counting global climate benefits. See Figure 11.[19]

Illustrative 1.5°C- and 2°C-Aligned 2035 Targets

This approach can be used to assess potential 1.5°C-aligned targets for 2035. Assuming that GHGs are cut by 50 percent by 2030 compared with 2019, emissions need to continue to fall by 66 percent by 2035 versus 2019 to stay on track to 1.5°C. Alternatively, if they are cut by 25 percent by 2030 then they would need to be but by 35 percent compared with 2019 levels to be aligned with 2°C. Recalculating based on 2035 projected emissions and per capita incomes and then scaling using the approach described in the previous sections can yield a similarly equitable allocation for this new target year. In this way, ambition can be scaled to achieve global targets while maintaining equity.

This yields temperature-aligned 2035 targets for all countries which would get the world on track for 2°C (Figure 12) or 1.5°C (Figure 13). Targets can be expressed versus BAU or alternatively against a historical baseline (for example, 1990, 2005, or 2010 as in many NDCs—see Annex 4 for tables with 2035 targets for all countries). For 2°C, targets are stringent but achievable, with most developed countries cutting by 40 to 45 percent versus BAU and most developing countries cutting by at least 25 percent. By contrast, for 1.5°C, cuts in emissions implied by 1.5°C-aligned targets for countries can be stark. On average, a 66-percent global cut in 2035 versus 2019 means cuts of over 80 percent versus BAU for many developed countries (e.g. US, UK, Korea, and the EU). Also, most developing countries would need to cut emissions by over 50 percent versus BAU.

Figure 12. Illustrative 2°C-Aligned Targets for 2035

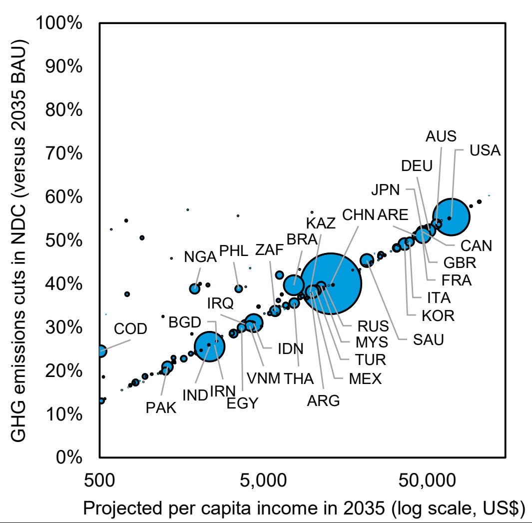
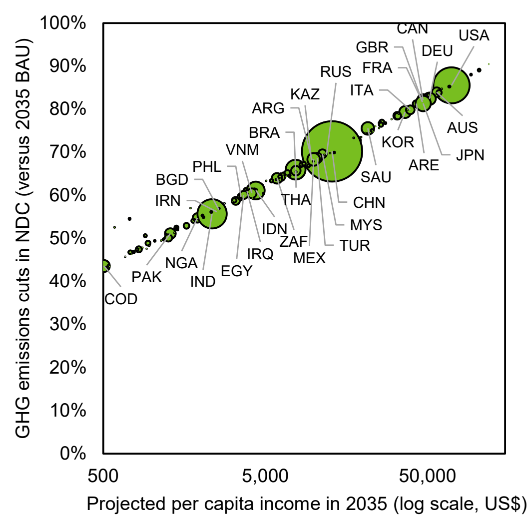


Figure 13. Illustrative 1.5°C-Aligned Targets for 2035



Source: IMF staff calculations using the CPAT.

Note: Bubble sizes reflect the 2021 GHG emissions. Data labels are for major emitting countries (>300 metric tons of carbon dioxide equivalent in 2030BAU) and use International Organization for Standardization (ISO) codes. BAU = business as usual; GHG = greenhouse gas; NDC = nationally determined contribution.

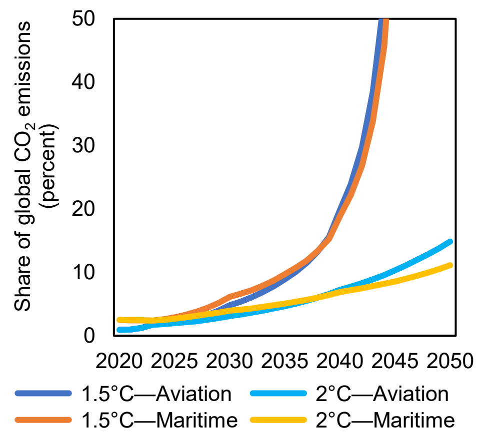
[19] For quantification of co-benefits, see Black and others (2023b). There are also unquantified co-benefits beyond these, such as soil and water quality, impacts on physical and diet, biodiversity, and energy security—see Karlsson and others (2020). Climate benefits are excluded from Figure 11. However, Rennert and others (2022) put the discounted flow of climate benefits at $185 per tonne of CO_2—under a global carbon price of $85 per tonne, this would imply climate benefits five times the global abatement costs.

While this distribution of cuts would get the world on track to 1.5°C in theory, it is questionable whether this rate of decarbonization is achievable technologically, economically, and politically. For example, the rate of turnover of energy-consuming capital goods like vehicles or buildings can be slow given their long lifetimes, while emissions from agriculture and land use can be difficult to abate. In addition, some low-carbon technologies such as green steel, green cement, and direct air capture have not reached maturity.[20] Lastly, political constraints can limit the strength of mitigation policies, especially those that have impacts on employment and equity.

International coordination mechanisms are needed to scale up global mitigation action. Additional mechanisms are needed to overcome obstacles under the Paris Agreement to negotiation (the large number of parties) and unilateral action (concerns about competitiveness and policy uncertainties in other countries). Action could be accelerated through plurilateral agreements, that is, complementary agreements among a smaller group of countries (for example, large emitters, G20) to accelerate ambition and align policies with reinforced targets. Such agreements could include concrete, monitorable actions such as an international carbon price floor agreement as proposed by the IMF staff.[21] It could also include an agreement on scaled-up, temperature-aligned, equitable emissions targets backed up by credible mitigation strategies to implement them. These additional agreements could include robust and transparent finance to encourage participation of large-emitting, lower-income countries.

In addition, action is needed on gases and sectors not previously subject to strong mitigation policies. Methane emissions—which are predominately from coal, oil, and gas extraction and agriculture—can have an outsized impact on slowing warming and require specific measures to curb them (see Annex 6). More focus is needed on the forestry and agricultural sectors, given the ongoing lack of global finance for slowing and reversing deforestation (often driven by agriculture).

Figure 14. International Aviation and Maritime's Projected Share of Global CO_2 Emissions under Different Temperature Scenarios



Source: Black and others (2024).
Note: The data assumes that the countries achieve temperature-aligned targets in 2030 and 2035 and thereafter total country emissions align with the Intergovernmental Panel on Climate Change scenarios (adjusted for higher-than-projected emissions in 2019–23) while aviation and maritime are allowed to grow in the business-as-usual case. The Intergovernmental Panel on Climate Change scenarios do not specify emissions from the sectors, so are assumed to decline by 25 and 50 percent for 2°C and 1.5°C versus business-as-usual, respectively, which are added back to the denominator.

Coordinated action in international aviation and maritime is both a necessity and an opportunity: the sectors' share of global CO_2 could rise drastically but a global carbon price could accelerate their decarbonization while doubling current climate finance. Given the need to achieve midcentury "net zero" emissions all sectors need to be decarbonized, requiring additional action now in hard-to-abate sectors like aviation and maritime, which account for a rising share of global GHGs. If no action is taken to decarbonize them then under a 1.5°C and 2°C scenario by 2035 their shares of global CO_2 emissions would grow from under 4 percent currently to 10 and 19 percent, respectively (and growing rapidly; Figure 14). But a global carbon price on fuels used in international aviation and maritime could raise revenues of over $100 billion a year by 2035, even after fully compensating affected developing countries (see Box 1). This doubling of current global climate finance could be a gamechanger for global cooperation on climate, as developing countries would feel more confident in setting and achieving more ambitious targets.

[20] Refer to Black and others (2023d) and Pigato and others (2020) for discussion of low-carbon technologies and green innovation.
[21] See Parry and others (2021).

Box 1. Decarbonizing International Aviation and Maritime

Emissions from international aviation and maritime are growing in importance for the climate. These sectors fall outside the purview of the United Nations Framework Convention on Climate Change and Paris Agreement. However, if nothing is done to decarbonize them, they will grow as a share of global CO_2 emissions, under a 2°C scenario accounting for over one-quarter of global CO_2 by 2050 (Figure 14) and much more under a 1.5°C scenario.

Carbon pricing could make a major contribution to decarbonizing both sectors while raising substantial revenues: up to $200 billion in 2035 under net zero aligned pricing. Given the highly mobile tax base, especially for maritime, a carbon price would need to be global, but could be implemented by the United Nations agencies responsible for the sectors (International Civil Aviation Organization and Internation Maritime Organization). This could raise substantial new revenues which could be used for sectors such as climate adaptation. In addition, it would level the playing field between the sectors and their competitors (for example, long-distance rail for certain flight routes), help accelerate technological development, and incentivize many behavioral changes which can improve efficiency in the sector.

The burden would mostly be borne by developed countries and the wealthy within the countries, although some compensation for developing countries would be needed. Even after fully compensating developing countries for abatement costs and losses in tourism and trade, up to $100 billion would be left for climate finance, allowing for a doubling of current total global current climate finance.

However, there are key administrative and political obstacles to overcome. Price impacts will be substantive on flight tickets, raising average ticket prices by 10 to 20 percent by 2035. Maritime costs would be more moderate at under 3 percent. However, equity impacts of this would need to be addressed as they may disproportionately affect developing countries dependent, for example, on tourism or trade. The allocation of revenues toward compensation, technological development, general government budgets, climate finance (mitigation, adaptation, or loss and damage), or other uses will be a central issue of contention.

If carbon pricing is not feasible then feebates could be an alternative but would raise less revenues. Feebates, which are also a form of pricing, are a sliding scale of fees/rebates on operators with emission rates above/below a pivot point. They can provide a strong price signal to reduce the emissions intensity of the sector (but not demand) while limiting impacts on end user prices. They can be designed to raise revenues but these are likely much lower than under a carbon price.

[1] This box draws on Black and others (2024)—for full details refer to the Note.

[2] The United Nations supervisory agencies—the International Civil Aviation Organization and International Maritime Organization—are responsible for strategies to decarbonize the industries. Both agencies have adopted (aspirational or approximate) net zero emissions targets by midcentury and the IMO has set intermediate targets for emissions and zero-emissions ships.

For governments, setting new national targets requires an increase in technical capacity to estimate future emissions, quantify potential targets, and estimate the impacts of policies to achieve these targets. **The next section provides a modeling framework for country analysts informing the development of new 2035 targets and revision of 2030 targets.**

Modeling Frameworks to Guide Setting and Implementation of NDCs: A Primer

To evaluate scenarios for enhancing emissions commitments in NDCs, and policy options for achieving them, policymakers need flexible modeling frameworks, ideally with several key features including:

- *Midrange projections of BAU emissions*: Emissions projections should be based on midrange values for key underlying parameters—if not, emissions reductions needed for NDCs, policies to achieve them, and the costs and other impacts of these policies are likely over- or under-estimated.
- *Midrange projections of the emissions impacts of mitigation policies*: The model needs to capture how mitigation policies work, for example, in raising energy prices and reducing fuel use again with midrange assumptions for parameters underlying behavioral responses.
- *Full range of potential and existing mitigation policies*: The model should be able to compare commonly used mitigation approaches such as (comprehensive and partial) carbon pricing, feebates (see the following section), technology incentives, fuel pricing reforms and existing energy and climate policies, like fuel taxes and subsidies should be included in the model's baseline.
- *Full range of sectors and gases*: The model should distinguish the main emissions-generating sectors (power, industry, transport, buildings, agriculture, forestry, extractives, waste) and the different gases (mainly CO_2, methane, NO_x) so targets and policies for individual sectors and gases can be analyzed.
- *Metrics for policy evaluation*: The model should ideally capture the full range of metrics of concern to policymakers from mitigation policies including impacts on emissions, fuel use, energy prices, revenue, economic costs, domestic environmental problems, distributional incidence across household income groups, and production costs in trade-exposed industries.[22]
- *Transparency and accessibility*: The model results should be readily explainable in terms of basic economic factors familiar to policymakers and, ideally, be accessible to users at low set up costs.

This section discusses how scenarios can be developed for BAU emissions and for the impacts across key metrics of carbon pricing and other policies for implementing emission reduction targets. The discussion is timely, given parties to the Paris Agreement are expected to revise NDCs over the next 12 months and may help countries better understand, and perhaps refine, their own baseline data and modeling assumptions (indeed mitigation models are not always transparent about their underlying assumptions). The following discussion focuses on CO_2 emissions from the energy sector and illustrates results from the Climate Policy Assessment Tool (CPAT) model (which was designed to incorporate the above features on a country-by-country basis for all IMF members—Annex 1 provides more details on CPAT). Though there is inherently uncertainty in modeling, CPAT provides reasonable estimates given the current state of knowledge on key inputs (for example, responsiveness of fuel demand to income and prices and rates of technical change).

Developing BAU Emissions Scenarios

The starting point is assembling the most recent sectoral data on fuel use, emissions as well as fuel supply costs, prices, and taxes/subsidies. CPAT uses the following data:

- *Fuel use*: The main source is various aggregations from the International Energy Agency's World Energy Balances (IEA 2024), which are updated annually.
- *Emissions*: CO_2 emissions by sector and fuel use can be calculated from fuel inputs and CO_2 emissions factors (again from IEA).

[22] The last two metrics are included CPAT for many countries (see Black and others 2023b) but are beyond the scope of the discussion in the following sections.

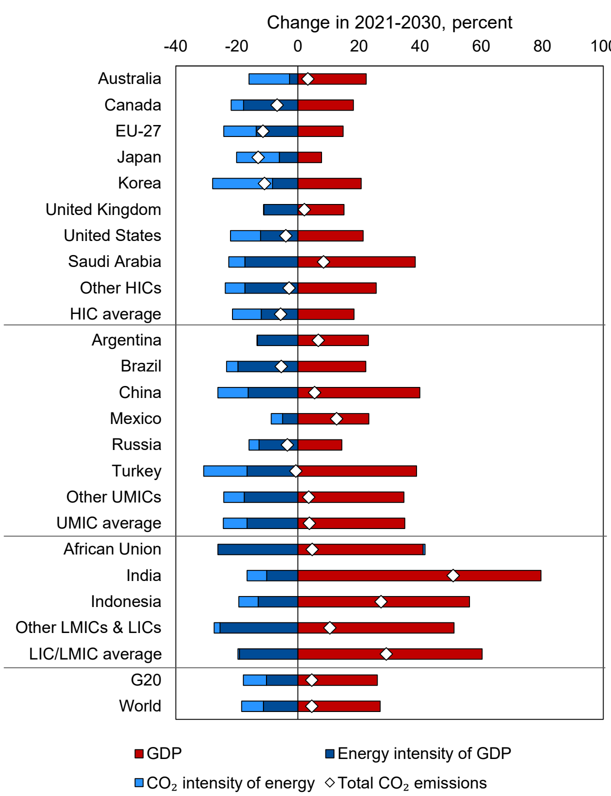
- *Fuel supply costs*: For oil (which is traded in well-integrated international markets), supply costs (the costs of consuming the product domestically rather than selling it abroad) are measured by the import/export price plus transportation/processing/distribution margins. For electricity (largely a nontraded product), the supply cost is the domestic production cost, plus margins. For coal and natural gas (where global markets are partially integrated) supply costs average over international prices and domestic production costs.
- *Energy prices and taxes/subsidies*: CPAT's comprehensive database on retail and wholesale prices by fuel product, sector, and country is compiled from IMF and World Bank country economists and other sources—fuel taxes/subsidies, including carbon pricing, are the difference between fuel prices and supply costs.

Fuel use and emissions by sector can be projected forward accounting for four main factors:

1. *GDP growth*: The IMFs World Economic Outlook provides GDP forecasts for the next five years and these can be extended assuming gradual convergence between developed and developing country growth rates.
2. *Income elasticities of energy demand*: These parameters summarize the change in demand for energy products per one percent increase in income or GDP—if income elasticities are below 1, the energy intensity of GDP falls over time (given other factors). In CPAT, income elasticities are typically around 0.5 to 0.8 across energy products and countries at different development levels, based on a database of over 250 empirical studies.
3. *Trend rates of technological change*: Improving energy efficiency (for example, as newer more efficient factories and vehicles replace older capital), also lower the energy intensity of GDP—in CPAT energy efficiency increases at 0.5 to 1 percent across sectors based on standard assumptions. CPAT also assumes modest annual improvements in the productivity of fossil generation plants and faster improvements for renewables.
4. *Future fuel prices*: International energy price projections in CPAT average over IMF and World Bank projections with all, or most, passed forward into domestic prices across fuels and countries.

For the power sector, CPAT also accounts for countries' planned investments in generation technologies and dispatch (see Annex 1).

Figure 15. Drivers of BAU CO_2 Projections, 2021–30



Source: Authors' calculations using CPAT.
Note: Countries with fossil fuel subsidies are assumed to reduce them by half to 2030, which reduces the energy intensity of GDP. BAU = business-as-usual; EU = European Union; HICs = high-income countries; LICs = low-income countries; LMICs = lower-middle-income countries; UMICs = upper-middle-income countries.

In BAU scenarios, CO_2 emissions increase moderately, or decline, across most G20 countries. Figure 15 shows projections of BAU fossil fuel CO_2 emissions growth between 2021 and 2030 for G20 countries and aggregates. The noteworthy points are as follows: *GDP* is projected to grow rapidly by 40 to 80 percent in China, India, and Indonesia, and a lower rate at 8 to 40 percent in other G20 countries.

- *Energy intensity of GDP* is projected to decrease significantly by 5 to 15 percent across countries, mainly reflecting below-unitary income elasticities and improving energy efficiency.
- *CO_2 intensity of energy* is also projected to decline about 5 to –15 percent in most cases (with expected investments in renewable generation).
- *CO_2 emissions* expand rapidly in a couple of cases (India, Indonesia) but approximately stabilize, or decline in others—averaged across the G20, emissions increase 4 percent.

Least-Cost Mitigation Scenarios and Their Impacts

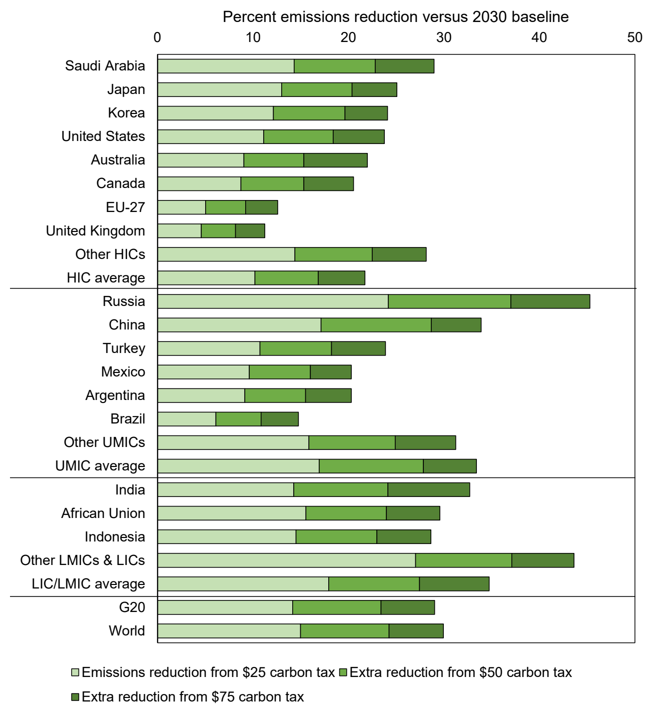
Although policymakers may prefer a combination of mitigation instruments (with or without pricing) understanding least cost with carbon pricing is important:

- For countries where pricing is the centerpiece of the mitigation strategy, understanding its impacts is critical for policy design (for example, the needed price trajectory, use of revenues);
- For countries using other instruments, a carbon pricing reference case indicates the pattern of emissions reductions across responses and sectors that, to the extent possible, would ideally be mimicked by other instruments[23]; and
- For countries choosing a balance between pricing and other instruments, understanding the trade-offs across different instruments (for example, in terms of emissions, costs, revenues, impacts on energy prices) is important.

Carbon pricing has a large impact on coal prices and intermediate impacts on natural gas, electricity, and gasoline prices. The increase in fuel prices from carbon pricing is the product of the CO_2 price, the CO_2 emissions factor, and the pass-through rate.[24] Annex 7 shows the effect of a carbon price of $25, $50, and $75 per tonne on increasing energy prices above 2030 baseline levels in G20 countries. For example, on average a $50 carbon price increases coal prices 100 percent, and prices for natural gas, electricity, and gasoline by around 25, 20, and 15 percent respectively.

The emissions impact of carbon pricing in the energy sector largely depends on induced changes in fuel prices, the price responsiveness of fuel use, and the emissions intensity of fuels. Fuel price elasticities summarize the change in

Figure 16. Emissions Impacts of Carbon Pricing, 2030



Source: Authors' calculations using CPAT.
Note: EU = European Union; HICs = high-income countries; LICs = low-income countries; LMICs = lower-middle-income countries; UMICs = upper-middle-income countries.

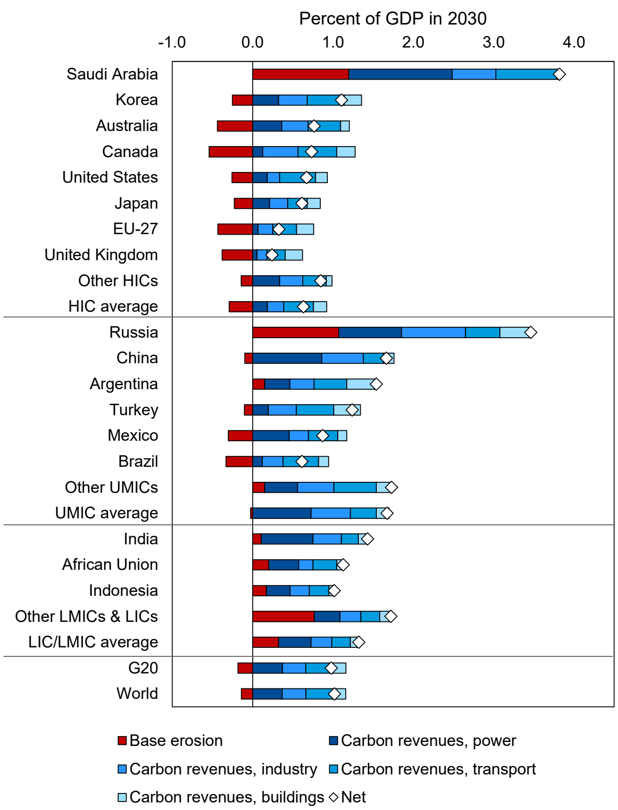
[23] Carbon pricing achieves a given emissions target at least cost as it equates the cost of the last tonne reduced across households, firms, and sectors.
[24] Pass-through rates may be limited where energy markets are subject to discretionary pricing regimes or dominated by state-owned enterprises.

demand for energy products per one percent increase in the fuel price and reflect, for example, switching from coal to other fuels in power generation, from coal to electric furnaces in steelmaking, adopting more efficient heating systems, and shifting to electric vehicles. Fuel price elasticities in CPAT are based on synthesizing hundreds of empirical studies—typical elasticity assumptions for coal are around −0.8, natural gas −0.7, gasoline −0.6, diesel −0.4, other oil products −0.6, and electricity demand −0.4.[25] Figure 16 indicates reductions in CO_2 emissions below BAU levels in 2030 for carbon prices of \$25, \$50, and \$75 per tonne (imposed on top of any preexisting mitigation policies). Some noteworthy points include:

- Carbon pricing can produce substantial emissions reductions—for example, a \$50 carbon price would cut CO_2 emissions by around 15 to 30 percent below BAU levels.
- Emissions price responsiveness varies significantly across countries—it is larger in coal-intensive countries like Australia, China, India, Indonesia while it has more modest impacts, for example, in France (where power generation has low CO_2 intensity).
- Pricing becomes progressively less effective at cutting emissions as the lower cost mitigation opportunities are exhausted—for example, the \$25 carbon price cuts emissions in Indonesia 18 percent, while raising it to \$50 or \$75 cuts emissions by an additional 7 and 6 percentage points respectively.

Across fuels, coal accounts for most of the least-cost emissions reductions in certain countries, while across sectors, power, and industry account for most emissions reductions in all G20 countries. Annex 7 also shows the breakdown of CO_2 reductions by fuel and sector under illustrative carbon pricing. Reduced coal use accounts for around 60 percent or more of the fossil fuel CO_2 reductions from carbon pricing for six G20 countries though in most other cases there is a more even balance between CO_2 reductions from coal, oil, and gas. Power and industry typically account for around 40 to 70 percent of emissions reductions across G20 countries while transport and buildings each contribute a relatively modest share. This generally reflects some combination of significant coal use in the former sectors, the relatively modest proportionate impact of carbon pricing on road fuel prices, and the relatively small share of buildings in baseline emissions. Despite this, making headway on mitigation for transport and buildings is still important, given the need to decarbonize them by the midcentury.

Figure 17. Revenues from Carbon Pricing, 2030



Source: Authors' calculations using CPAT.
Note: Estimates are for carbon prices of \$75, \$50, and \$25 per tonne of CO_2 in high-, middle-, and low-income countries respectively. EU = European Union; HICs = high-income countries; LICs = low-income countries; LMICs = lower-middle-income countries; UMICs = upper-middle-income countries.

[25] These reflect longer term responses which are appropriate for analyzing responses to permanent policy changes.

Potential revenues from carbon pricing can be calculated with reasonable confidence. Expressed relative to GDP, for carbon taxes and emissions trading systems with full allowance auctions, revenues are simply the carbon price times the emissions intensity of GDP—the latter is BAU emissions intensity scaled by the proportionate emissions reduction induced by the carbon price. Figure 17 shows calculations of revenues from carbon prices of $75/50/25 per tonne in 2030 for HICs, UMICs, and LMICs/LICs respectively. Revenues are mostly between about 0.5 and 1.5 percent of GDP, with the contribution from different sectors varying significantly across countries. Carbon mitigation also causes indirect revenue losses/gains to the extent it reduces base for preexisting energy taxes/subsidies—revenue losses are around 0.2–0.3 percent of GDP or less (though significantly more in Canada) while Saudi Arabia and Russia would gain significant revenues from reducing bases for fuel subsidies.[26]

Modeling Other Mitigation Instruments

Other mitigation instruments can be modeled by understanding which behavioral responses they promote relative to those promoted by carbon pricing.[27] For example:

- *Fuel- or sector-specific carbon pricing*: These policies are straightforward to model through limiting the scope of carbon pricing—their emissions effects can be largely anticipated from Annex 7.
- *Feebates and performance standards*: Feebates apply a sliding scale of fees/rebates to products or activities with emission rates above/below a pivot point level while performance standards require firms to meet an emission rate (or energy efficiency) standard per unit of their production or across their product sales. Both policies can cost-effectively promote all behavioral responses to reduce the emissions intensity of a sector (though performance standards require fluid credit trading markets)—they can both be modeled by a shadow price that rewards reductions in emissions intensities.
- *Incentives for clean technologies*: Subsidies or requirements for clean technologies, such as feed-in tariffs and renewable portfolio standards, promote a narrower range of behavioral responses than feebates/performance standards (for example, in power generation they do not promote shifting from coal to gas or from these fuels to nuclear, or improvements in plant efficiency) though they can be easier to administer (for example, they do not require new emissions monitoring capacity). Technology subsidies are straightforward to model, and, for example, a renewable portfolio standard can be modeled by the implicit renewable subsidy that would achieve the same renewable generation share as the standard (but with no revenue loss for the government).

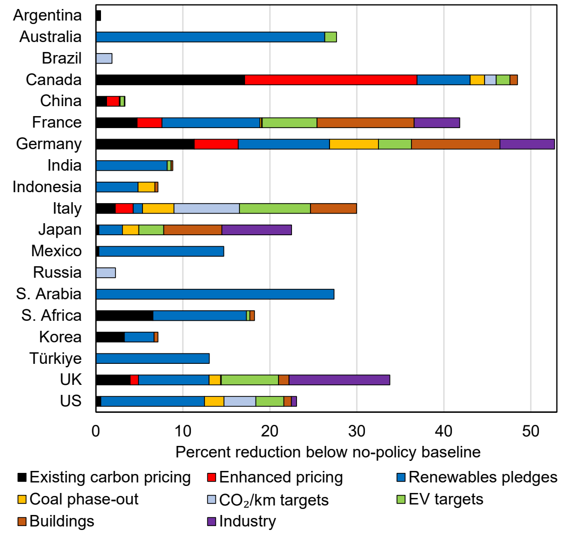
In practice, combinations of sectoral mitigation instruments, in conjunction with economy-wide instruments, are often used. For example, for G20 countries (see Annex 8):

- *Economywide*: Carbon pricing programs are operating in 12 G20 countries.
- *Power generation*: Almost all G20 countries have targets for renewables and eight have coal phase out plans. Common policies include renewable subsidies (for example, production tax credits, feed-in tariffs providing above market prices) and minimum renewable generation shares.
- *Transportation*: Aside from fuel taxes, CO_2 emission rate or fuel economy standards for vehicle sellers apply nationally in nine G20 countries and at the EU level, while 15 countries have targets for phasing in electric vehicles or phasing out internal combustion engine vehicles—feebates apply in some form in nine countries.
- *Buildings*: France, Germany, Italy, and Japan have targets for reducing energy use from the total building stock, while nine other G20 countries have targets for making all new buildings net zero emissions by 2030 or later. Multiple instruments are used to implement these goals such as building codes; incentives for insulation, heat pumps, and rooftop solar; and efficiency standards for appliances.
- *Industry*: This sector is generally subject to lighter emissions targets and policies than for other sectors—only five G20 countries have binding emissions targets for industry.

[26] For a comprehensive discussion of impacts on fiscal balances see Black and others (2024). For mitigation instruments that do not raise revenues such as regulations, the negative base erosion effect in Figure 17 would still apply but not the positive effects.
[27] Broader public investment and financial sector reforms are also needed (for example, IMF 2023; Jaumotte and others 2024).

Lastly, modeling toolkits can be used to compare mitigation effort across countries. Monitoring an agreement over emissions targets may require assessing whether implemented or planned policies are achieve emissions targets. This requires consistent methodologies for measuring emissions baselines and impacts of policies. This becomes tricky for some sectors where mitigation policies overlap and, for practical purposes, it can make sense to assume sectoral targets (for example for vehicles) are met. Figure 18 shows illustrative calculations of the emissions impacts of current and planned mitigation policies for G20 countries (as of 2022). The combined effect of specified policies and targets as of 2030 varies substantially. CO_2 reductions below a baseline are less than 20 percent in eight G20 countries and range from 20 to about 50 percent in the other 11 countries. In addition, countries vary significantly in their choice of instrument and relative contribution of sectoral targets, for example, renewables targets make a significant contribution to reductions in the policy mix for 15 cases and carbon pricing for eight cases (although, again, the relative contribution of specific policies and targets is ambiguous where they overlap, for example, for carbon pricing of power emissions and renewable generation targets).

Figure 18. CO_2 Emissions Impacts of Current and Planned Non-NDC Mitigation Policies, G20 Countries



Sources: Parry and others (2022).
Note: The no-policy counterfactual implies that countries would stop any existing carbon pricing. The figure includes sectoral and economy-wide policies outside the general economy-wide NDC targets as of beginning of 2022. EV = Electric Vehicle; NDC = nationally determined contribution.

Conclusion

To avoid an implausible "emissions cliff edge" and keep 1.5°C alive, global climate mitigation ambition and implementation must be substantially raised. The new collective quantified goal on climate finance can help, including by helping raise developing country ambition. However, the key challenge facing the world is aligning emissions targets with the Paris Agreement's temperature goals.

Getting climate ambition on track requires:

- **Revising 2030 targets in NDCs to be Paris-aligned and equitable.** For example, ambition could be enhanced by setting targets depending on countries' per capita income levels, with more ambitious emissions reduction targets for richer countries. Many options are possible, but it is critical to narrow the gap between countries' aggregated ambition and what is needed for 1.5°C and 2°C.

Getting policy implementation on track requires:

- **Adopting comprehensive policy packages needed for Paris-aligned NDCs.** Thes should ideally includes a robust and rising carbon price alongside further measures to address impediments to clean technology and investment. These reforms can be made equitable (notably using carbon pricing revenues for reducing poverty), improve fiscal balances, and yield substantial domestic welfare co-benefits, even before considering climate benefits.

- **Scaling-up and reinforcing international cooperation and coordination.** This could include new instruments such as an international carbon price floor among major emitters.

The next 12 months are critical. Will countries align both their 2030 and 2035 targets with 1.5°C and avoid an implausible global emissions' cliff edge? If they do not, then 1.5°C will be out of reach. If, on the other hand, countries align their 2030 and 2035 targets with 1.5°C along the lines discussed in this Note or another distribution, and critically implement policies to achieve them, the world can get on track to achieving the Paris Agreement's temperature goals.

Annex 1. The Climate Policy Assessment Tool (CPAT)

The IMF-World Bank Climate Policy Assessment Tool (CPAT) provides, on a country-by-country basis for around 200 countries, projections of fuel use and carbon dioxide emissions by major energy sector.[28] For key attributes of CPAT, see Annex Table 1.1.

This tool starts with the use of fossil fuels and other fuels by the power, industrial, transport, and

Annex Table 1.1. Attributes of CPAT

Desirable modelling feature	How CPAT addresses feature
Country coverage	Over 200 countries with full set of data (for example, on fuel use, emissions, energy prices) for each country. Provides consistent cross-country comparisons of baselines and policy effects.
Baseline projections and NDCs	Projections based on most recent observed emissions and projected forward by fuel/sector using latest data on GDP projections, income elasticities for energy products, trend rates of efficiency improvements, and future energy price scenarios. NDC pledges are mapped to emissions reductions below baseline/historical levels.
How mitigation policies work	Behavioral responses to mitgation policies are approximately in the mid-range of those from broader energy modelling literature and empirical evidence on fuel price/income elasticities.
Mitigation policies	Potential policies include carbon taxes, ETSs, energy efficiency/emission rate regulations, feebates, clean technology subsidies/mandates, electricity/fuel taxes, fossil fuel subsidies, energy price liberalization, removals of preferential VAT for fuels, combinations of policies. Baseline includes energy taxes/subsidies and carbon pricing regulations are implicit in observed fuel use.
Sectors and gases	Main module covers power, industry, transport, and buildings. Supplementary models cover agriculture, extractives, forestry, and waste. All GHGs are included.
Metrics for policy evaluation	Impacts on energy production/consumption, prices, trade; GHG and local emissions; GDP and economic welfare; revenue; incidence across households (income deciles, within deciles, urban/rural); incidence across industries; domestic environmental co-benefits (e.g., local air pollution mortality).
Transparency, sensitivity, accessibility	Key model parameters and inputs are easily adjusted in the dashboard. Results presented rapidly via a chart-driven interface, allowing for experimentation in designing policy reforms. Spreadhseet model has user-friendly dashboard.

Source: Authors.
Note: CPAT = Climate Policy Assessment Tool ETSs = emissions trading systems; GHG = greenhouse gas; NDC = nationally determined contributions; VAT = value-added tax.

residential sectors and then projects fuel use forward in a baseline case using (1) GDP projections, (2) assumptions about the income elasticity of demand and own-price elasticity of demand for electricity and other fuel product, (3) assumptions about the rate of technological change that affects energy efficiency and the productivity of different energy sources, and (4) future international energy prices.

In these projections, current fuel taxes/subsidies and carbon pricing are held constant in real terms. The impacts of carbon pricing on fuel use and emissions depend on (1) their proportionate impact on future fuel prices in different sectors, (2) a model of dispatch and investment in the power generation sector, and

[28] For more details on the model, its parameterization, and key caveats, see Black and others (2023b).

(3) various own-price elasticities for electricity use and fuel use in other sectors. For the most part, fuel demand curves are based on a constant elasticity specification.

The basic model is parameterized using data compiled from the International Energy Agency on recent fuel use by country and sector. GDP projections are from the latest IMF forecasts.[29] Data on energy taxes, subsidies, and prices by energy product and country is compiled from publicly available and IMF sources, with inputs from proprietary and third-party sources. International energy prices are projected forward using an average of World Bank and IMF projections for coal, oil, and natural gas prices. Assumptions for fuel price responsiveness are chosen to be broadly consistent with empirical evidence and results from energy models (fuel price elasticities are typically between about −0.5 and −0.8).

Carbon emissions factors by fuel product are from the International Energy Agency. The domestic environmental costs of fuel use are based on IMF methodologies (see Black and others 2023a).

One caveat is that the model abstracts from the possibility of mitigation actions (beyond those implicit in recently observed fuel use and price data) in the baseline, which provides a clean comparison of policy reforms to the baseline. Another caveat is that, while the assumed fuel price responses are plausible for modest fuel price changes, they may not be for dramatic price changes that might drive major technological advances, or rapid adoption of technologies like carbon capture and storage or even direct air capture, though the future viability and costs of these technologies are highly uncertain. The model does not explicitly account for full general equilibrium effects (for example, changes in relative factor prices that might have feedback effects on the energy sector), changes in international fuel prices that might result from simultaneous climate or energy price reform in large countries, or cross-country linkages through trade. Some of these effects may be of relatively minor importance however—for example, trade-sensitive sectors account for a minor portion of emissions, trade impacts depend on mitigation policies in other countries, and countries usually implement measures (like free allowance allocations) to limit the competitiveness impacts of their own mitigation policies. Moreover, parameter values in the spreadsheet are, chosen such that the results from the model are broadly consistent with those from far more detailed energy models that, to varying degrees, account for these factors.

The CPAT converts all mitigation pledges into a single, comparable metric: required emissions reductions against future business-as-usual or historical baseline emissions. It also accommodates a diverse range of mitigation policies such as carbon pricing, fossil fuel subsidy reform, energy price liberalization, electricity subsidy and tariff reform, renewable subsidies, removal of favorable VAT treatment of fuels, and combinations of these and other policies. It also has full coverage of sectors and gases, including CO_2 and non-CO_2 greenhouse gases (GHGs), as well as local air pollutants (including those with an effect on warming and others).

For each policy, CPAT assesses impacts on all the metrics noted previously and some others (household and industry incidence is available for all almost 100, but not all, countries). The model also includes a country-specific database on prices, taxes, and subsidies by fuel product/sector.

The CPAT's core is a macro-energy model distinguishing 17 fossil and non-fossil fuels and four sectors—power, industry, transport, buildings, with transport and industry split into various subsectors consistent with the classifications provided by the United Nations Framework Convention on Climate Change.

In CPAT, the user interacts with the "Dashboard," which is a chart-driven, user-friendly interface. The user selects the country, mitigation policy (for example, carbon or energy taxes), the stringency of the policy over time and its sectoral/fuel coverage, and complementary policies (for example, fossil fuel subsidy reform, energy price liberalization, and feed-in subsidies for renewables). Revenues from mitigation policies can be recycled in broader tax reductions, public spending or investment, or transfers. The user then sees the main results in key charts (for example, impacts on emissions, revenue, GDP, households by income group, local air pollution mortality, and economic welfare) and numerous more detailed charts.

[29] A modest adjustment in emissions projections is made to account for partially permanent structural shifts in the economy caused by the coronavirus pandemic.

CPAT does not require any external data, but users can adjust various inputs including data and key assumptions (such as domestic energy prices, fuel price responsiveness).

Given the importance of power generation in the early stages of decarbonization, CPAT includes a technology-based model of the sector which the user can select as an alternative to the power model based on fuel price elasticities. The technology-based model is grounded in observed generation technologies and forward-looking investments in new capacity, as well as dispatch from existing technologies, based on projections of levelized technology costs, assumptions about capital retirement rates, capacity factors, the increasing need for storing intermittent power, and possible constraints on expansion rates for renewables.[30] The technology-based model provides more accurate baseline projections of the power generation mix, though it tends to be less responsive to mitigation policies than implied by empirical evidence on the price responsiveness of generation fuels.

Lastly, it should be noted that there are many other models that can quantify and project energy consumption, emissions, and other impacts of climate mitigation policy. This includes, for example, macroeconometric models such as the Macro-Fiscal Model (Burns and others 2019), computable general equilibrium models like IMF's ENVISAGE (Chateau and others 2022), sectoral models such as the Future Technology Transformations models (Mercure and others 2012), the IMF's Fiscal Analysis of Resource Industries model (Luca and Mesa Puyo 2016), and others. Each model has varying strengths and weaknesses, and no model can provide all answers to questions relating to climate mitigation policy.

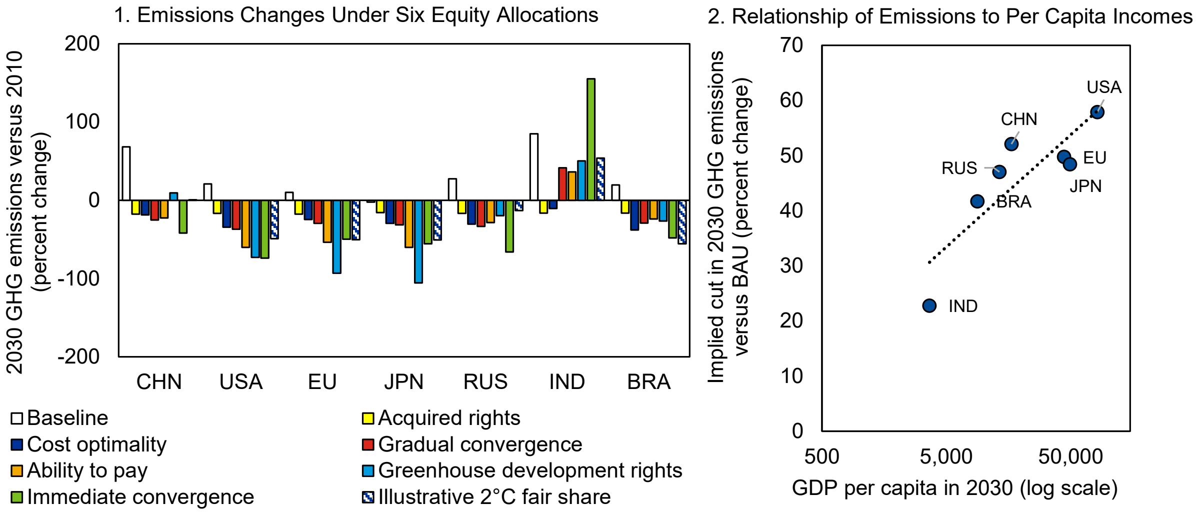
Overall, the CPAT can be a useful tool for governments setting revised and new NDC targets and assessing the policies to achieve them. It is being made available exclusively to governments.[31]

[30] In default settings, hydroelectric capacity is fixed on the assumption opportunities have already been exploited, while nuclear power can gradually ramp up in countries with fission reactors.

[31] For more details, see www.imf.org/cpat.

Annex 2. Emissions Impacts Implied by Different Allocations of Mitigation Burden

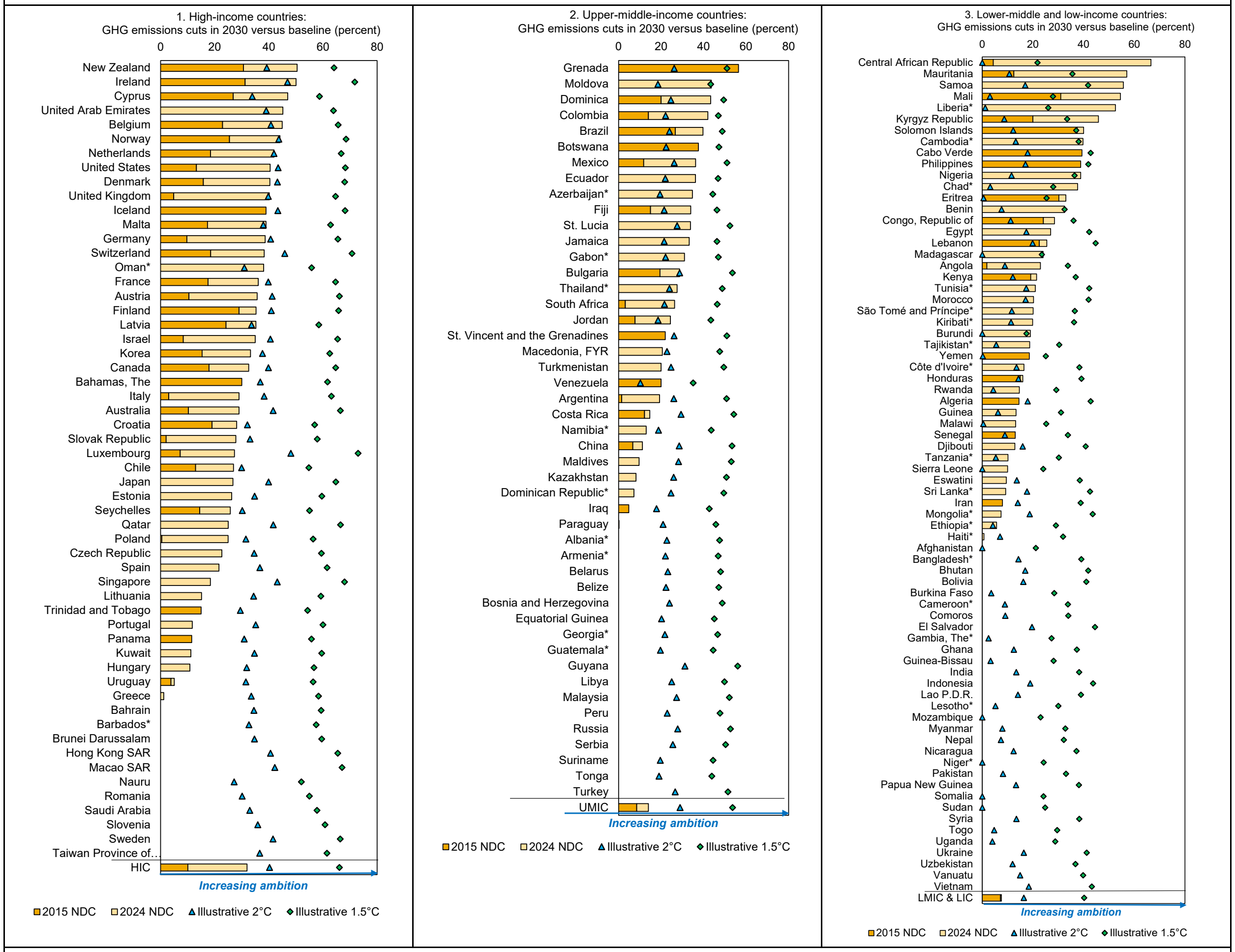
Annex Figure 2.1. Emissions Changes Under Six Equity Allocations (Panel 1) and Inferred Relationship of Emissions Cuts Versus BAU to Projected per Capita Incomes (Panel 2)



Source: van der Berg and others (2020); and IMF staff calculations using CPAT.
Note: In panel 2, dots show the average implied emissions cuts in 2030 BAU for countries/blocs taking an average of the six equity allocations from panel 2. The line-of-best fit shows the relationship between average emissions cuts implied by the six equity allocations (versus 2030 BAU from CPAT) and GDP per capita in 2030. Data labels in the figure use International Organization for Standardization (ISO) country codes. BAU = business as usual; CPAT = Climate Policy Assessment Tool; GHG = greenhouse gas.

Annex 3. Illustrative Temperature-Aligned Targets by Country (2030)

Annex Figure 3.1. Mitigation Ambition (in NDCs) and Illustrative Targets for All Countries



Source: IMF staff calculations using CPAT.
Note: Where no NDC is shown, the target is nonbinding and is assumed to have achieved in the baseline or is nonquantifiable (for example, Bahrain, Bhutan, Saudi Arabia, and others). Countries with asterisks (*) decreased ambition in 2024 NDCs relative to 2015 NDCs, so the figure shows only 2024 NDCs. NDCs for EU countries are inferred using national allocations for non-ETS sectors (in effort-sharing regulations) and an assumed similar reduction in EU ETS sectors. NDCs average over conditional and unconditional targets where both are specified. ETS = emissions trading system; EU = Euorpean Union; FYR = former Yugoslave Republic; GHG = greenhouse gas; LIC = low-income country; LMICs = lower-middle-income countries; NDC = nationally determined contribution; PDR = People's Democratic Republic; SAR = Special Administrative Region; UMICs = upper-middle-income countries.

Annex Table 3.1 Illustrative Emissions Targets Aligned with 1.5°C and 2°C in 2030

Country	Baseline GHG Emissions in 2030, $MtCO_2e$	Illustrative 2°C-Aligned Target in 2030, $MtCO_2e$	Percent Cut versus Base Years (negative = increase)			Illustrative 1.5°C-Aligned Target in 2030, $MtCO_2e$	Percent Cut versus Base Years (negative = increase)			Per Capita GHG Emissions in 2030, tCO_2/Person		
			1990	2005	2010		1990	2005	2010	Baseline	Illustrative 2°C	Illustrative 1.5°C
Afghanistan	32.1	32.1	-182.1	-75.4	-6.0	25.3	-122.4	-38.3	16.5	0.6	0.6	0.5
Albania	8.5	6.5	44.4	5.9	6.8	4.3	63.8	38.7	39.3	3.0	2.3	1.5
Algeria	286.6	235.3	-60.5	-26.5	-13.8	159.6	-8.9	14.2	22.8	5.8	4.8	3.2
Angola	113.2	87.2	-44.3	30.0	33.4	72.7	-20.2	41.7	44.5	2.6	2.0	1.6
Argentina	432.3	320.0	-3.1	27.7	27.9	206.0	33.6	53.5	53.6	9.1	6.7	4.3
Armenia	10.1	7.9	67.7	-4.3	-9.1	5.1	79.2	32.8	29.8	3.7	2.9	1.8
Australia	484.5	282.9	54.5	53.1	52.7	156.4	74.8	74.1	73.8	17.3	10.1	5.6
Austria	62.5	36.7	45.0	50.4	43.3	20.8	68.8	71.9	67.9	6.9	4.1	2.3
Azerbaijan	69.6	45.4	35.0	-1.6	3.1	37.7	46.0	15.6	19.5	6.5	4.2	3.5
The Bahamas	1.8	1.2	13.3	2.1	27.2	0.7	48.8	42.2	57.0	4.3	2.7	1.6
Bahrain	65.6	42.9	-42.0	1.8	17.0	25.5	15.7	41.8	50.7	41.8	27.4	16.2
Bangladesh	347.4	297.7	-88.3	-50.6	-26.9	197.3	-24.8	0.2	15.9	1.9	1.6	1.1
Barbados	0.9	0.6	28.7	30.8	40.5	0.4	56.5	57.9	63.8	3.2	2.2	1.3
Belarus	43.4	33.3	71.3	36.5	27.2	22.2	80.9	57.7	51.5	4.7	3.6	2.4
Belgium	110.2	60.7	57.5	57.7	54.4	37.0	74.1	74.2	72.2	9.3	5.1	3.1
Belize	5.6	4.3	38.7	-11.3	-5.6	2.9	59.6	26.6	30.4	12.5	9.7	6.4
Benin	34.8	23.5	-18.7	-19.2	-1.7	22.2	-12.4	-12.8	3.7	2.1	1.5	1.4
Bhutan	2.3	1.9				1.3				2.8	2.3	1.6
Bolivia	118.7	99.4	13.0	0.6	21.1	68.4	40.2	31.7	45.7	8.8	7.3	5.1
Bosnia and Herzegovina	16.4	12.4	62.1	47.4	56.9	8.1	75.4	65.9	72.0	5.2	4.0	2.6
Botswana	46.8	29.2	42.0	42.9	43.0	23.6	53.2	54.0	54.1	15.9	9.9	8.0
Brazil	1701.0	1025.7	41.3	53.1	55.4	850.5	51.3	61.1	63.0	7.6	4.6	3.8
Brunei Darussalam	15.6	10.2	-6.8	19.5	33.2	6.0	36.7	52.3	60.4	33.1	21.6	12.8
Bulgaria	28.2	20.1	75.6	56.1	57.5	12.6	84.7	72.4	73.3	4.5	3.2	2.0
Burkina Faso	61.8	59.6	-145.6	-60.4	-45.3	42.3	-74.4	-13.9	-3.2	2.3	2.2	1.6
Burundi	10.7	8.7	-7.9	-26.7	-7.3	8.5	-5.7	-24.2	-5.2	0.7	0.6	0.5
Cabo Verde	1.3	0.8		0.2	16.8	0.7		10.4	25.3	2.1	1.2	1.1
Cambodia	86.8	52.3	-77.7	-38.7	-22.0	50.7	-72.4	-34.5	-18.4	4.8	2.9	2.8
Cameroon	80.7	73.4	13.7	3.3	2.2	51.2	39.9	32.6	31.8	2.4	2.2	1.5
Canada	619.5	372.4	28.9	48.8	45.5	212.0	59.6	70.8	69.0	15.2	9.1	5.2
Central African Republic	43.2	14.5	65.4	71.9	71.2	14.5	65.4	71.9	71.2	6.2	2.1	2.1
Chad	122.7	76.6	-266.8	-40.8	-17.5	76.6	-266.8	-40.8	-17.5	5.5	3.5	3.5
Chile	73.1	51.2	-15.9	14.9	28.9	32.0	27.5	46.8	55.5	3.7	2.6	1.6
China	15789.2	11290.5	-202.9	-39.3	-0.5	7012.5	-88.1	13.5	37.6	11.1	8.0	4.9
Colombia	292.2	169.4	26.9	30.9	35.3	150.3	35.2	38.7	42.6	5.4	3.1	2.8
Comoros	1.1	1.0	-138.6	-52.8	-44.4	0.7	-67.1	-7.0	-1.1	1.1	1.0	0.7
Congo, Democratic Republic of the	584.8	441.5	-3.4	-2.3	-1.0	423.4	0.8	1.9	3.2	4.7	3.5	3.4
Congo, Republic of	35.6	25.5	-25.2	13.4	20.4	22.0	-7.8	25.4	31.4	5.1	3.6	3.1
Costa Rica	10.7	7.5	39.4	36.8	44.9	4.7	62.5	60.9	65.9	2.0	1.4	0.9
Côte d'Ivoire	45.1	37.7	47.0	18.5	21.9	26.1	63.3	43.5	45.9	1.3	1.1	0.8

Country	Baseline GHG Emissions in 2030, $MtCO_2e$	Illustrative 2°C-Aligned Target in 2030, $MtCO_2e$	Percent Cut versus Base Years (negative = increase)			Illustrative 1.5°C-Aligned Target in 2030, $MtCO_2e$	Percent Cut versus Base Years (negative = increase)			Per Capita GHG Emissions in 2030, tCO_2/Person		
			1990	2005	2010		1990	2005	2010	Baseline	Illustrative 2°C	Illustrative 1.5°C
Croatia	20.9	14.2	43.5	35.2	33.3	8.7	65.6	60.5	59.3	5.4	3.7	2.2
Cyprus	8.5	4.5	16.9	50.0	51.0	3.4	38.1	62.8	63.5	6.5	3.4	2.6
Czech Republic	95.8	62.6	67.1	55.5	52.9	37.7	80.2	73.2	71.7	9.1	6.0	3.6
Denmark	47.9	27.2	65.5	63.2	60.3	14.9	81.1	79.9	78.3	7.9	4.5	2.4
Djibouti	2.6	2.2	-14.0	-9.7	-5.0	1.4	24.3	27.2	30.3	2.1	1.7	1.2
Dominica	0.1	0.1	47.4	36.3	44.9	0.1	54.9	45.4	52.7	1.8	1.0	0.9
Dominican Republic	45.6	34.4	-218.0	-18.4	-2.1	21.7	-100.3	25.4	35.7	3.8	2.9	1.8
Ecuador	99.8	63.7	15.2	25.2	34.4	52.0	30.8	39.0	46.5	5.1	3.3	2.7
Egypt	422.8	308.7	-102.2	-10.8	2.6	231.9	-51.9	16.8	26.8	3.4	2.5	1.9
El Salvador	15.1	12.2	-37.2	13.8	9.2	8.2	7.7	42.0	38.9	2.3	1.9	1.3
Equatorial Guinea	15.7	12.5	-212.6	40.0	45.5	8.6	-114.3	58.9	62.6	7.9	6.3	4.3
Eritrea	9.1	6.1	-16.0	1.7	3.5	6.1	-16.0	1.7	3.5	2.2	1.4	1.4
Estonia	11.8	7.7	78.8	52.3	50.0	4.6	87.2	71.2	69.8	9.1	6.0	3.6
Eswatini	3.8	3.3	-1.9	-1.8	-18.2	2.2	30.9	30.9	19.8	3.0	2.6	1.7
Ethiopia	250.7	236.5	-155.0	-86.8	-50.9	167.7	-80.8	-32.5	-7.0	1.7	1.6	1.1
Fiji	0.7	0.4		39.1	29.0	0.3		52.3	44.3	0.7	0.4	0.4
Finland	42.7	25.2	42.3	35.9	47.0	14.2	67.5	63.9	70.1	7.7	4.5	2.6
France	394.3	237.3	54.5	52.7	49.4	136.1	73.9	72.9	71.0	6.0	3.6	2.1
Gabon	25.7	17.7	25.8	39.7	26.8	13.2	44.6	55.0	45.4	9.3	6.4	4.8
Gambia, The	3.1	3.0	-73.3	-46.0	-17.6	2.1	-23.5	-4.0	16.2	1.0	0.9	0.7
Georgia	20.8	16.2	61.5	-109.6	-90.4	10.4	75.2	-34.8	-22.5	5.7	4.4	2.9
Germany	639.1	378.9	70.5	61.8	59.2	216.7	83.2	78.1	76.7	7.7	4.6	2.6
Ghana	37.5	32.8	-53.4	49.7	54.4	22.4	-5.0	65.6	68.8	1.0	0.9	0.6
Greece	72.0	47.9	52.9	64.1	58.6	29.3	71.2	78.0	74.7	7.1	4.7	2.9
Grenada	0.2	0.1	-4.2	17.8	40.0	0.1	-4.2	17.8	40.0	1.9	0.8	0.8
Guatemala	54.0	43.4	-41.0	-2.9	1.5	28.7	6.6	31.8	34.7	2.7	2.2	1.4
Guinea	43.7	37.9	-103.1	-52.3	-26.3	28.7	-53.9	-15.4	4.3	2.7	2.3	1.7
Guinea-Bissau	5.0	4.9	-39.2	-17.3	-6.6	3.5	0.7	16.3	24.0	2.0	2.0	1.4
Guyana	22.5	15.5	-66.1	-25.4	-20.2	7.5	19.1	38.9	41.5	26.6	18.3	8.9
Haiti	16.1	14.9	-86.7	-31.9	-14.4	10.9	-35.8	4.1	16.8	1.3	1.2	0.9
Honduras	34.7	29.1	-86.6	-27.7	-16.4	20.3	-30.0	11.0	18.9	3.0	2.5	1.7
Hong Kong SAR	28.0	16.6	58.4	65.6	65.5	9.2	77.0	81.0	80.9	3.7	2.2	1.2
Hungary	52.9	36.0	60.7	49.2	41.6	21.9	76.1	69.1	64.5	5.5	3.7	2.3
Iceland	13.1	7.4	44.3	46.0	49.0	4.0	70.1	71.0	72.6	33.6	19.0	10.2
India	5159.9	4467.3	-266.5	-102.1	-56.6	2983.8	-144.8	-35.0	-4.6	3.4	3.0	2.0
Indonesia	1449.3	1175.2	-6.1	0.1	-4.7	771.0	30.4	34.5	31.3	5.0	4.0	2.6
Iran	1026.5	882.6	-182.5	-38.1	-15.7	612.0	-95.9	4.3	19.8	11.1	9.5	6.6
Iraq	371.8	305.5	-80.2	-86.5	-45.7	205.2	-21.1	-25.3	2.1	7.1	5.8	3.9
Ireland	69.6	34.7	43.7	56.1	50.4	18.6	69.8	76.5	73.4	13.2	6.6	3.5
Israel	89.2	53.0	-24.1	28.4	38.4	28.9	32.2	60.9	66.3	8.9	5.3	2.9
Italy	372.4	229.8	55.6	58.8	52.3	135.9	73.7	75.7	71.8	6.5	4.0	2.4
Jamaica	7.9	5.3	45.5	48.2	22.7	4.2	57.0	59.1	39.0	2.8	1.9	1.5

Country	Baseline GHG Emissions in 2030, $MtCO_2e$	Illustrative 2°C-Aligned Target in 2030, $MtCO_2e$	Percent Cut versus Base Years (negative = increase)			Illustrative 1.5°C-Aligned Target in 2030, $MtCO_2e$	Percent Cut versus Base Years (negative = increase)			Per Capita GHG Emissions in 2030, tCO_2/Person		
			1990	2005	2010		1990	2005	2010	Baseline	Illustrative 2°C	Illustrative 1.5°C
Japan	987.5	593.4	50.8	53.9	51.7	344.1	71.4	73.3	72.0	8.3	5.0	2.9
Jordan	40.1	30.3	-141.5	-18.4	-11.6	22.0	-75.1	14.2	19.1	3.4	2.6	1.8
Kazakhstan	331.4	245.6	35.4	33.7	35.6	157.0	58.7	57.6	58.8	15.8	11.7	7.5
Kenya	123.8	97.2	-153.2	-29.6	4.6	74.2	-93.3	1.1	27.2	2.0	1.6	1.2
Kiribati	0.1	0.1	-180.5	-8.4	-9.1	0.1	-116.8	16.2	15.7	0.8	0.7	0.5
Korea	633.0	394.7	-37.1	24.5	35.6	229.1	20.4	56.1	62.6	12.3	7.7	4.5
Kuwait	158.2	103.3	-107.2	12.1	16.8	61.9	-24.2	47.3	50.1	34.8	22.7	13.6
Kyrgyz Republic	19.3	10.4	69.0	13.2	27.2	10.4	69.0	13.2	27.2	2.6	1.4	1.4
Lao P.D.R.	57.0	48.9	-131.7	-82.1	-51.4	33.3	-57.8	-24.0	-3.1	6.9	5.9	4.0
Latvia	12.4	8.0	38.9	-77.0	13.7	5.0	62.1	-9.6	46.5	7.3	4.7	2.9
Lebanon	31.6	23.5	-191.4	-12.1	8.1	17.5	-116.2	16.8	31.8	6.7	5.0	3.7
Lesotho	3.3	3.1	-40.2	-10.4	-8.1	2.3	-1.5	20.1	21.8	1.3	1.3	0.9
Liberia	16.6	7.9	48.6	51.2	53.3	7.9	48.6	51.2	53.3	2.7	1.3	1.3
Libya	102.4	76.8	11.3	27.0	29.4	49.0	43.5	53.5	55.0	13.9	10.4	6.7
Lithuania	14.6	9.6	77.5	47.2	6.4	5.8	86.5	68.3	43.8	5.7	3.7	2.2
Luxembourg	8.1	4.2	67.0	66.2	64.9	2.1	83.7	83.3	82.6	11.7	6.0	3.0
Macao SAR	2.8	1.6	-59.0	30.2	14.6	0.8	18.7	64.3	56.4	3.7	2.1	1.1
Macedonia, FYR	10.6	8.2	43.2	33.9	30.5	5.3	63.0	57.0	54.8	5.1	4.0	2.6
Madagascar	49.1	37.3	30.5	25.4	29.2	36.2	32.6	27.7	31.3	1.4	1.1	1.0
Malawi	30.6	26.6	-80.7	-45.2	-25.6	22.1	-50.2	-20.7	-4.4	1.2	1.1	0.9
Malaysia	416.3	302.7	-48.6	14.8	22.3	188.8	7.3	46.8	51.5	11.4	8.3	5.2
Maldives	2.7	1.9	-1165.8	-128.4	-57.2	1.2	-674.6	-39.7	3.8	5.3	3.8	2.3
Mali	58.6	26.6	-70.8	-18.8	6.3	26.6	-70.8	-18.8	6.3	2.1	0.9	0.9
Malta	2.4	1.4	44.7	51.7	51.3	0.8	68.4	72.4	72.2	4.4	2.7	1.5
Mauritania	18.2	7.8	-11.0	27.6	33.8	7.8	-11.0	27.6	33.8	3.2	1.4	1.4
Mexico	849.7	541.4	-10.3	15.9	23.0	405.9	17.4	36.9	42.3	6.3	4.0	3.0
Moldova	14.0	7.9	79.0	23.2	25.2	7.5	79.9	26.6	28.5	4.4	2.5	2.4
Mongolia	78.2	63.5	-28.3	-30.7	-2.3	41.5	16.2	14.6	33.2	21.0	17.1	11.2
Morocco	121.4	96.9	-140.0	-38.9	-20.8	68.0	-68.5	2.5	15.2	3.0	2.4	1.7
Mozambique	101.7	101.7	-33.1	-15.1	-5.3	73.8	3.4	16.5	23.6	2.5	2.5	1.8
Myanmar	291.2	268.1	-19.6	-10.3	-2.5	192.3	14.2	20.9	26.5	5.1	4.7	3.4
Namibia	23.2	18.8	-9.5	11.4	8.9	12.7	26.1	40.2	38.6	8.0	6.5	4.4
Nepal	67.9	62.9	-107.5	-87.2	-66.5	44.0	-45.2	-31.0	-16.5	2.1	1.9	1.3
Netherlands	158.4	92.0	59.7	58.3	58.1	51.2	77.6	76.8	76.7	8.8	5.1	2.9
New Zealand	56.6	28.0	36.6	50.0	41.3	19.6	55.8	65.1	59.0	10.3	5.1	3.6
Nicaragua	39.2	34.4	-13.8	11.4	13.8	23.8	21.2	38.6	40.3	5.1	4.5	3.1
Niger	56.0	56.0	-220.0	-145.4	-112.0	40.2	-129.9	-76.3	-52.3	1.6	1.6	1.2
Nigeria	492.6	301.2	10.3	32.6	27.1	301.2	10.3	32.6	27.1	1.9	1.2	1.2
Norway	32.7	18.3	55.0	46.0	40.7	10.0	75.5	70.6	67.7	5.7	3.2	1.7
Oman	148.3	91.8	-174.3	-37.7	-10.7	62.8	-87.8	5.7	24.2	29.3	18.1	12.4
Pakistan	648.4	595.3	-166.9	-66.2	-46.2	417.5	-87.1	-16.5	-2.5	2.4	2.2	1.5
Panama	23.0	15.9	-20.1	7.7	19.5	9.6	27.0	43.8	51.0	4.7	3.3	2.0

Country	Baseline GHG Emissions in 2030, $MtCO_2e$	Illustrative 2°C-Aligned Target in 2030, $MtCO_2e$	Percent Cut versus Base Years (negative = increase) 1990	2005	2010	Illustrative 1.5°C-Aligned Target in 2030, $MtCO_2e$	Percent Cut versus Base Years (negative = increase) 1990	2005	2010	Per Capita GHG Emissions in 2030, tCO_2/Person Baseline	Illustrative 2°C	Illustrative 1.5°C
Papua New Guinea	37.3	32.4	-22.5	9.1	-1.4	22.3	15.5	37.3	30.1	3.2	2.8	1.9
Paraguay	87.4	69.1	-7.5	17.5	26.4	45.5	29.2	45.7	51.5	11.8	9.4	6.2
Peru	185.7	143.2	-34.0	-8.7	3.3	94.4	11.7	28.4	36.3	5.1	3.9	2.6
Philippines	321.2	196.4	-74.9	-18.7	-9.8	174.6	-55.5	-5.5	2.4	2.5	1.5	1.4
Poland	296.6	203.0	54.5	42.4	45.8	123.7	72.3	64.9	67.0	7.7	5.2	3.2
Portugal	52.3	33.9	48.6	62.0	45.5	20.3	69.2	77.2	67.4	5.2	3.4	2.0
Qatar	216.7	126.4	-334.7	-51.5	7.9	67.9	-133.4	18.6	50.5	76.2	44.4	23.9
Romania	67.5	47.1	79.4	60.0	47.3	28.9	87.3	75.5	67.7	3.5	2.5	1.5
Russia	1577.9	1139.3	63.0	19.5	13.0	731.9	76.2	48.3	44.1	11.1	8.0	5.2
Rwanda	11.9	10.2	-17.2	-30.7	-13.9	7.9	8.7	-1.8	11.3	0.7	0.6	0.5
Samoa	0.7	0.3	24.3	43.3	47.8	0.3	24.3	43.3	47.8	2.8	1.3	1.3
São Tomé and Príncipe	0.4	0.3	-260.9	-104.9	-62.8	0.3	-177.5	-57.5	-25.1	1.6	1.3	1.0
Saudi Arabia	879.2	589.3	-147.2	-26.3	4.9	350.7	-47.1	24.8	43.4	21.9	14.7	8.7
Senegal	42.3	36.8	-132.1	-57.0	-36.6	26.4	-66.7	-12.8	1.9	2.0	1.8	1.3
Serbia	49.6	37.0	56.8	0.8	49.1	23.4	72.6	37.1	67.7	7.2	5.4	3.4
Seychelles	1.1	0.8	-133.3	26.7	23.7	0.5	-43.0	55.1	53.2	9.9	6.9	4.3
Sierra Leone	10.7	9.7	-29.2	-15.2	-6.7	7.9	-5.1	6.3	13.2	1.1	1.0	0.8
Singapore	73.6	41.8	-22.5	18.2	29.3	22.5	34.2	56.1	62.0	11.8	6.7	3.6
Slovak Republic	35.8	24.0	62.7	47.8	40.9	14.5	77.4	68.4	64.2	6.4	4.3	2.6
Slovenia	10.5	6.7	53.0	49.5	46.4	4.0	72.4	70.4	68.5	5.0	3.2	1.9
Solomon Islands	37.0	22.2	-430.4	-916.3	-882.9	22.2	-430.4	-916.3	-882.9	43.6	26.2	26.2
Somalia	53.8	53.8	-26.1	-12.9	-15.7	39.5	7.5	17.2	15.2	2.4	2.4	1.8
South Africa	522.7	385.0	8.1	31.5	35.3	275.9	34.1	50.9	53.6	8.1	6.0	4.3
Spain	266.2	168.5	33.5	57.2	45.7	99.5	60.7	74.7	67.9	5.7	3.6	2.1
Sri Lanka	36.1	29.7	-7.7	14.4	17.2	20.7	24.8	40.2	42.2	1.6	1.3	0.9
St. Lucia	0.3	0.2	-617.7	-53.7	-1.9	0.1	-405.1	-8.2	28.3	1.5	1.0	0.7
St. Vincent and the Grenadines	0.2	0.1	-225.4	-4.6	17.4	0.1	-107.3	33.4	47.4	1.7	1.3	0.8
Sudan	181.9	181.9	-115.8	-31.2	-22.0	132.2	-56.9	4.6	11.3	3.2	3.2	2.3
Suriname	12.0	9.6	-92.6	-49.1	-43.7	6.4	-28.7	0.4	3.9	18.3	14.7	9.8
Sweden	0.4	0.3	99.0	98.9	98.1	0.1	99.4	99.4	98.9	0.0	0.0	0.0
Switzerland	43.0	23.3	56.2	56.2	55.6	12.2	77.1	77.1	76.8	4.7	2.6	1.3
Syria	58.4	50.6	20.3	43.2	45.2	34.8	45.1	60.9	62.3	2.0	1.7	1.2
Taiwan Province of China	293.7	186.0	-32.3	44.0	38.6	108.8	22.6	67.3	64.1	12.2	7.7	4.5
Tajikistan	24.4	19.8	11.1	-69.2	-67.9	16.3	27.0	-38.9	-37.9	2.2	1.8	1.4
Tanzania	164.9	148.1	-64.7	-28.9	-22.7	108.8	-21.0	5.3	9.9	2.0	1.8	1.3
Thailand	512.8	371.5	-57.2	-6.1	6.1	253.5	-7.3	27.6	35.9	7.1	5.2	3.5
Togo	13.8	13.1	-109.0	-85.9	-46.3	9.3	-47.3	-31.0	-3.1	1.3	1.3	0.9
Tonga	0.3	0.2	-28.9	-2.5	-2.0	0.2	12.2	30.1	30.5	2.6	2.1	1.5
Trinidad and Tobago	45.6	32.1	-75.8	38.2	48.3	20.2	-10.3	61.2	67.5	29.4	20.8	13.0
Tunisia	45.6	36.0	-56.7	-2.4	11.8	25.9	-12.7	26.3	36.6	3.5	2.8	2.0

Country	Baseline GHG Emissions in 2030, $MtCO_2e$	Illustra-tive 2°C-Aligned Target in 2030, $MtCO_2e$	Percent Cut versus Base Years (negative = increase)			Illustra-tive 1.5°C-Aligned Target in 2030, $MtCO_2e$	Percent Cut versus Base Years (negative = increase)			Per Capita GHG Emissions in 2030, tCO_2/Person		
			1990	2005	2010		1990	2005	2010	Baseline	Illustrative 2°C	Illustrative 1.5°C
Turkey	540.7	396.8	-159.4	-49.3	-21.4	251.4	-64.4	5.4	23.1	6.1	4.5	2.8
Turkmenistan	131.8	99.3	-14.6	0.8	3.2	64.7	25.3	35.3	36.9	18.8	14.2	9.2
Uganda	79.6	76.4	-131.7	-78.0	-38.2	53.4	-62.1	-24.5	3.4	1.4	1.3	0.9
Ukraine	277.4	231.9	74.5	46.5	41.8	155.4	82.9	64.1	61.0	7.2	6.0	4.0
United Arab Emirates	332.1	182.0	-114.7	-7.3	19.1	111.3	-31.3	34.4	50.5	33.3	18.2	11.2
United Kingdom	436.3	261.0	68.0	62.8	57.6	150.5	81.5	78.5	75.6	6.3	3.8	2.2
United States	5503.0	3110.7	44.5	53.5	50.6	1671.1	70.2	75.0	73.5	15.7	8.9	4.8
Uruguay	40.7	27.9	-69.4	1.1	6.7	17.1	-4.0	39.3	42.7	11.9	8.1	5.0
Uzbekistan	244.7	215.5	-21.6	-19.7	-9.7	146.7	17.2	18.5	25.3	6.4	5.7	3.8
Vanuatu	0.7	0.6	-25.2	-6.0	14.3	0.4	14.0	27.1	41.1	1.8	1.6	1.1
Venezuela	209.2	167.3	46.3	50.0	52.0	131.8	57.7	60.6	62.2	6.6	5.3	4.1
Vietnam	559.7	456.7	-1060.7	-76.6	-39.6	296.2	-652.8	-14.6	9.5	5.5	4.5	2.9
Yemen	49.8	40.5	-122.1	10.7	28.5	36.0	-97.3	20.7	36.5	1.3	1.0	0.9
Zambia	79.4	39.2	25.5	28.5	36.0	39.2	25.5	28.5	36.0	3.3	1.6	1.6
Zimbabwe	98.6	82.3	-79.5	-107.3	-105.1	61.3	-33.7	-54.4	-52.7	5.2	4.3	3.2

Source: IMF staff calculations using CPAT.
Note: The terms "country" and "economy" do not in all cases refer to a territorial entity that is a state as understood by international law and practice. The terms also cover some territorial entities that are not states. GHG = greenhouse gas; $MtCO_2e$ = million tonnes of CO_2 equivalent; tCO_2 = tonnes of CO_2

Annex 4. Illustrative Temperature-Aligned Targets by Country (2035)

Annex Table 4.1 Illustrative Emissions Targets Aligned with 1.5°C and 2°C in 2035

Country	Baseline GHG Emissions in 2035, $MtCO_2e$	Illustrative 2°C-Aligned Target in 2035, $MtCO_2e$	Percent Cut versus (negative = increase)			Illustrative 1.5°C-Aligned Target in 2035, $MtCO_2e$	Percent Cut versus (negative = increase)			Per capita GHG Emissions in 2035, tCO_2/Person		
			1990	2005	2010		1990	2005	2010	Baseline	Illustrative 2°C	Illustrative 1.5°C
Afghanistan	29.4	29.1	-155.4	-58.8	4.1	17.7	-55.6	3.2	41.5	0.5	0.5	0.3
Albania	7.7	5.6	52.6	19.8	20.6	2.7	76.6	60.5	60.9	2.8	2.0	1.0
Algeria	283.4	199.8	-36.3	-7.4	3.4	112.0	23.5	39.8	45.8	5.4	3.8	2.2
Angola	113.5	87.2	-44.3	30.0	33.4	53.9	10.8	56.8	58.9	2.2	1.7	1.1
Argentina	416.5	268.4	13.5	39.3	39.5	132.9	57.2	70.0	70.0	8.5	5.5	2.7
Armenia	9.4	6.7	72.5	11.1	7.1	3.4	86.0	54.8	52.8	3.4	2.5	1.3
Australia	473.7	224.0	64.0	62.9	62.5	76.1	87.8	87.4	87.3	16.2	7.7	2.6
Austria	60.3	29.4	55.9	60.3	54.6	10.2	84.7	86.2	84.3	6.7	3.2	1.1
Azerbaijan	68.0	45.4	35.0	-1.6	3.1	26.2	62.5	41.4	44.1	6.3	4.2	2.4
Bahamas, The	1.9	0.9	29.7	20.7	41.0	0.4	70.1	66.2	74.9	4.3	2.1	0.9
Bahrain	74.4	35.0	-15.8	20.0	32.3	17.3	42.9	60.5	66.6	45.6	21.5	10.6
Bangladesh	301.7	255.5	-61.6	-29.2	-8.9	130.9	17.2	33.8	44.2	1.6	1.3	0.7
Barbados	0.9	0.5	41.0	42.8	50.8	0.2	72.9	73.8	77.4	3.2	1.8	0.8
Belarus	45.2	28.4	75.5	45.8	37.9	16.0	86.2	69.5	65.1	5.0	3.2	1.8
Belgium	100.4	52.3	63.4	63.5	60.7	17.4	87.8	87.9	86.9	8.4	4.4	1.5
Belize	6.4	3.6	48.5	6.5	11.3	2.3	68.1	42.0	44.9	13.6	7.7	4.8
Benin	30.9	23.5	-18.7	-19.2	-1.7	15.1	23.5	23.3	34.5	1.7	1.3	0.8
Bhutan	2.0	1.6				0.8				2.3	2.0	1.0
Bolivia	127.8	84.7	26.0	15.4	32.8	52.6	54.0	47.4	58.2	8.9	5.9	3.7
Bosnia and Herzegovina	27.0	10.6	67.7	55.3	63.3	9.3	71.6	60.6	67.7	8.9	3.5	3.1
Botswana	52.9	29.2	42.0	42.9	43.0	18.5	63.4	64.0	64.0	16.8	9.3	5.9
Brazil	1730.3	1025.7	41.3	53.1	55.4	589.0	66.3	73.1	74.4	7.6	4.5	2.6
Brunei Darussalam	15.8	8.3	12.8	34.3	45.5	3.6	61.8	71.2	76.1	32.6	17.2	7.5
Bulgaria	39.9	17.0	79.4	62.9	64.1	12.0	85.4	73.8	74.6	6.6	2.8	2.0
Burkina Faso	59.9	51.5	-112.3	-38.6	-25.6	31.9	-31.3	14.3	22.3	2.0	1.7	1.0
Burundi	10.4	8.7	-7.9	-26.7	-7.3	6.7	17.1	2.7	17.6	0.6	0.5	0.4
Cabo Verde	1.2	0.8		0.2	16.8	0.5		39.3	49.4	1.8	1.2	0.7
Cambodia	83.1	52.3	-77.7	-38.7	-22.0	36.9	-25.6	2.0	13.8	4.4	2.8	2.0
Cameroon	80.1	62.8	26.2	17.2	16.3	38.3	55.1	49.6	49.1	2.1	1.7	1.0
Canada	657.5	297.5	43.2	59.1	56.5	117.4	77.6	83.8	82.8	15.5	7.0	2.8
Central African Republic	45.0	14.5	65.4	71.9	71.2	15.0	64.0	70.8	70.1	5.6	1.8	1.9
Chad	111.9	76.6	-266.8	-40.8	-17.5	59.6	-185.3	-9.5	8.6	4.4	3.0	2.3
Chile	77.9	42.7	3.4	29.1	40.8	21.9	50.3	63.5	69.5	3.8	2.1	1.1
China	15421.0	9469.9	-154.1	-16.9	15.7	4597.4	-23.3	43.3	59.1	11.0	6.8	3.3
Colombia	296.1	169.4	26.9	30.9	35.3	106.0	54.3	56.8	59.5	5.4	3.1	1.9
Comoros	1.0	0.8	-105.4	-31.6	-24.3	0.5	-15.4	26.1	30.2	0.9	0.8	0.5
Congo, Democratic Republic of the	682.4	441.5	-3.4	-2.3	-1.0	385.0	9.8	10.8	11.9	4.7	3.0	2.6
Congo, Republic of	36.4	25.5	-25.2	13.4	20.4	16.6	18.3	43.4	48.0	4.7	3.3	2.1
Costa Rica	9.2	6.3	49.6	47.5	54.2	2.6	78.9	78.0	80.8	1.7	1.1	0.5

Country	Baseline GHG Emissions in 2035, $MtCO_2e$	Illustrative 2°C-Aligned Target in 2035, $MtCO_2e$	Percent Cut versus (negative = increase)			Illustrative 1.5°C-Aligned Target in 2035, $MtCO_2e$	Percent Cut versus (negative = increase)			Per capita GHG Emissions in 2035, tCO_2/Person		
			1990	2005	2010		1990	2005	2010	Baseline	Illustrative 2°C	Illustrative 1.5°C
Côte d'Ivoire	36.1	33.1	53.5	28.4	31.4	15.6	78.1	66.3	67.7	1.0	0.9	0.4
Croatia	19.1	11.8	52.9	45.9	44.3	5.1	79.9	76.9	76.2	5.1	3.2	1.4
Cyprus	8.5	4.5	16.9	50.0	51.0	2.0	62.5	77.4	77.9	6.3	3.4	1.5
Czech Republic	120.1	51.5	72.9	63.4	61.3	28.4	85.1	79.8	78.7	11.4	4.9	2.7
Denmark	45.3	21.5	72.7	70.9	68.6	6.7	91.5	91.0	90.2	7.3	3.5	1.1
Djibouti	2.2	1.8	2.8	6.5	10.5	0.9	51.7	53.6	55.5	1.7	1.4	0.7
Dominica	0.1	0.1	47.4	36.3	44.9	0.0	68.8	62.2	67.3	1.8	1.0	0.6
Dominican Republic	39.8	28.9	-167.0	0.6	14.2	13.2	-22.0	54.6	60.8	3.2	2.3	1.1
Ecuador	101.9	63.7	15.2	25.2	34.4	36.3	51.6	57.3	62.6	5.0	3.1	1.8
Egypt	373.2	296.3	-94.2	-6.3	6.5	149.0	2.4	46.5	53.0	2.8	2.2	1.1
El Salvador	14.1	10.4	-17.0	26.5	22.6	5.4	39.0	61.7	59.6	2.1	1.6	0.8
Equatorial Guinea	17.0	10.5	-161.8	49.7	54.3	6.2	-55.3	70.2	72.9	7.8	4.8	2.9
Eritrea	9.7	6.1	-16.0	1.7	3.5	5.5	-4.2	11.7	13.4	2.1	1.3	1.2
Estonia	12.5	6.4	82.5	60.6	58.7	3.0	91.8	81.6	80.7	9.9	5.0	2.4
Eswatini	3.3	2.8	12.6	12.6	-1.4	1.4	56.1	56.1	49.0	2.3	2.0	1.0
Ethiopia	224.0	207.4	-123.5	-63.8	-32.3	117.7	-26.8	7.0	24.9	1.4	1.3	0.7
Fiji	0.4	0.4		39.1	29.0	0.1		80.7	77.4	0.4	0.4	0.1
Finland	42.8	20.3	53.7	48.5	57.5	7.4	83.1	81.2	84.5	7.7	3.6	1.3
France	383.6	191.1	63.3	61.9	59.2	70.3	86.5	86.0	85.0	5.8	2.9	1.1
Gabon	25.9	16.7	29.9	43.0	30.8	9.1	62.1	69.2	62.6	8.6	5.6	3.0
Gambia, The	2.9	2.6	-50.1	-26.5	-1.9	1.6	9.8	24.0	38.8	0.8	0.7	0.4
Georgia	17.9	13.9	67.1	-79.0	-62.6	6.6	84.4	15.4	23.2	5.0	3.9	1.8
Germany	713.8	305.2	76.3	69.2	67.1	125.6	90.2	87.3	86.5	8.7	3.7	1.5
Ghana	29.1	28.0	-31.1	57.0	61.0	13.0	39.3	80.1	82.0	0.7	0.7	0.3
Greece	72.9	39.7	61.0	70.2	65.7	18.2	82.1	86.3	84.3	7.4	4.0	1.8
Grenada	0.3	0.1	-4.2	17.8	40.0	0.1	5.9	25.8	45.7	2.3	0.8	0.7
Guatemala	48.7	36.7	-19.1	13.1	16.8	18.3	40.4	56.5	58.4	2.3	1.7	0.9
Guinea	40.6	35.3	-89.3	-42.0	-17.7	20.6	-10.3	17.3	31.4	2.2	1.9	1.1
Guinea-Bissau	5.0	4.2	-20.7	-1.7	7.6	2.7	24.0	35.9	41.8	1.8	1.6	1.0
Guyana	23.9	12.8	-37.3	-3.6	0.7	6.4	31.6	48.3	50.5	27.7	14.8	7.4
Haiti	16.8	13.0	-62.0	-14.4	0.7	8.5	-6.1	25.1	35.0	1.3	1.0	0.6
Honduras	31.2	25.4	-62.6	-11.3	-1.4	13.4	14.0	41.1	46.3	2.5	2.0	1.1
Hong Kong SAR	39.0	13.4	66.5	72.4	72.2	6.9	82.8	85.8	85.7	5.3	1.8	0.9
Hungary	51.0	30.2	67.1	57.5	51.1	13.7	85.0	80.7	77.8	5.4	3.2	1.4
Iceland	14.3	5.8	56.1	57.3	59.7	2.1	84.4	84.8	85.7	35.9	14.7	5.2
India	4170.0	3842.3	-215.3	-73.9	-34.7	1847.3	-51.6	16.4	35.2	2.7	2.5	1.2
Indonesia	1414.3	1000.6	9.6	15.0	10.8	549.8	50.3	53.3	51.0	4.7	3.3	1.8
Iran	988.3	759.8	-143.2	-18.8	0.4	433.4	-38.7	32.2	43.2	10.4	8.0	4.6
Iraq	373.7	257.5	-51.9	-57.2	-22.8	146.1	13.8	10.8	30.3	6.5	4.5	2.5
Ireland	70.7	28.6	53.6	63.9	59.2	7.7	87.5	90.2	89.0	13.1	5.3	1.4
Israel	92.0	41.8	1.9	43.4	51.3	15.4	63.9	79.2	82.1	8.6	3.9	1.4
Italy	377.1	187.4	63.8	66.4	61.1	76.0	85.3	86.4	84.2	6.7	3.3	1.3
Jamaica	7.7	5.3	45.5	48.2	22.7	2.8	70.6	72.0	58.3	2.8	1.9	1.0

Country	Baseline GHG Emissions in 2035, $MtCO_2e$	Illustrative 2°C-Aligned Target in 2035, $MtCO_2e$	Percent Cut versus (negative = increase) 1990	2005	2010	Illustrative 1.5°C-Aligned Target in 2035, $MtCO_2e$	Percent Cut versus (negative = increase) 1990	2005	2010	Per capita GHG Emissions in 2035, tCO_2/Person Baseline	Illustrative 2°C	Illustrative 1.5°C
Japan	1074.3	482.4	60.0	62.5	60.7	200.7	83.3	84.4	83.7	9.3	4.2	1.7
Jordan	35.4	27.8	-121.8	-8.7	-2.5	13.9	-10.7	45.8	48.9	2.8	2.2	1.1
Kazakhstan	346.2	205.0	46.1	44.7	46.3	109.7	71.1	70.4	71.2	15.7	9.3	5.0
Kenya	108.8	93.1	-142.3	-24.0	8.7	49.0	-27.5	34.7	51.9	1.6	1.4	0.7
Kiribati	0.1	0.1	-166.3	-2.9	-3.5	0.1	-43.7	44.5	44.1	0.7	0.6	0.3
Korea	685.6	321.8	-11.8	38.4	47.5	141.7	50.8	72.9	76.9	13.5	6.4	2.8
Kuwait	173.0	84.1	-68.8	28.4	32.2	39.8	20.1	66.1	67.9	36.6	17.8	8.4
Kyrgyz Republic	18.5	10.4	69.0	13.2	27.2	9.0	73.3	25.3	37.4	2.3	1.3	1.1
Lao P.D.R.	54.1	41.9	-98.4	-55.9	-29.6	23.5	-11.2	12.6	27.4	6.2	4.8	2.7
Latvia	12.3	6.9	47.7	-51.5	26.1	3.1	76.4	31.7	66.7	7.5	4.2	1.9
Lebanon	32.7	22.0	-172.7	-4.9	14.0	13.0	-60.5	38.3	49.4	7.1	4.7	2.8
Lesotho	3.0	2.7	-22.2	3.8	5.8	1.6	28.6	43.8	44.9	1.2	1.0	0.6
Liberia	18.4	7.9	48.6	51.2	53.3	8.7	43.0	45.8	48.1	2.7	1.1	1.3
Libya	93.0	64.3	25.8	38.9	40.9	30.4	64.9	71.1	72.1	12.1	8.3	3.9
Lithuania	13.2	8.0	81.3	56.1	22.2	3.2	92.4	82.2	68.5	5.4	3.2	1.3
Luxembourg	7.4	3.2	74.8	74.1	73.1	0.7	94.4	94.3	94.1	10.3	4.5	1.0
Macao SAR	2.4	1.3	-25.1	45.1	32.8	0.4	63.5	84.0	80.4	3.0	1.6	0.5
Macedonia, FYR	11.0	7.0	51.7	43.8	40.8	3.9	73.0	68.6	66.9	5.4	3.4	1.9
Madagascar	46.1	37.3	30.5	25.4	29.2	26.8	50.1	46.4	49.2	1.2	1.0	0.7
Malawi	28.9	26.5	-79.9	-44.6	-25.1	16.3	-10.5	11.2	23.2	1.0	1.0	0.6
Malaysia	411.1	252.0	-23.7	29.0	35.3	124.8	38.7	64.8	67.9	10.8	6.6	3.3
Maldives	2.4	1.6	-964.7	-92.1	-32.2	0.7	-378.5	13.7	40.6	4.6	3.1	1.4
Mali	49.0	26.6	-70.8	-18.8	6.3	22.3	-42.9	0.6	21.6	1.5	0.8	0.7
Malta	2.3	1.2	54.4	60.2	59.9	0.5	82.4	84.6	84.5	4.2	2.2	0.8
Mauritania	15.8	7.8	-11.0	27.6	33.8	6.8	3.9	37.3	42.8	2.4	1.2	1.0
Mexico	819.8	525.3	-7.0	18.4	25.3	259.6	47.1	59.7	63.1	5.9	3.8	1.9
Moldova	12.4	7.9	79.0	23.2	25.2	5.0	86.6	50.8	52.1	3.9	2.5	1.6
Mongolia	84.2	53.9	-8.9	-10.9	13.2	32.7	34.1	32.8	47.4	21.6	13.8	8.4
Morocco	110.1	85.9	-112.8	-23.2	-7.1	44.6	-10.6	36.0	44.3	2.6	2.1	1.1
Mozambique	105.9	90.1	-17.9	-1.9	6.7	61.9	19.0	30.0	35.9	2.3	2.0	1.4
Myanmar	307.0	233.2	-4.0	4.1	10.8	153.2	31.6	37.0	41.4	5.3	4.0	2.6
Namibia	23.5	15.9	7.4	25.1	23.0	9.0	47.5	57.5	56.3	7.5	5.1	2.9
Nepal	60.4	54.6	-80.1	-62.5	-44.5	30.4	-0.2	9.6	19.6	1.8	1.6	0.9
Netherlands	158.7	73.4	67.8	66.7	66.5	25.7	88.7	88.4	88.3	8.8	4.1	1.4
New Zealand	54.9	27.5	37.7	50.9	42.3	10.2	77.0	81.9	78.7	9.7	4.9	1.8
Nicaragua	40.5	29.5	2.3	23.9	26.0	18.3	39.5	52.9	54.2	5.0	3.7	2.3
Niger	44.7	48.6	-177.6	-112.9	-83.9	25.3	-44.6	-10.9	4.2	1.1	1.2	0.6
Nigeria	459.2	301.2	10.3	32.6	27.1	207.8	38.1	53.5	49.7	1.6	1.0	0.7
Norway	30.5	14.5	64.4	57.3	53.0	4.3	89.4	87.3	86.1	5.2	2.5	0.7
Oman	142.5	83.9	-150.8	-25.9	-1.2	37.7	-12.6	43.5	54.6	26.6	15.7	7.0
Pakistan	556.9	512.7	-129.8	-43.1	-25.9	272.3	-22.1	24.0	33.1	1.9	1.7	0.9
Panama	22.5	13.0	1.4	24.2	33.9	6.0	54.8	65.3	69.7	4.4	2.6	1.2
Papua New Guinea	42.1	27.6	-4.7	22.3	13.4	18.5	30.1	48.1	42.1	3.4	2.2	1.5

Country	Baseline GHG Emissions in 2035, $MtCO_2e$	Illustrative 2°C-Aligned Target in 2035, $MtCO_2e$	Percent Cut versus (negative = increase)			Illustrative 1.5°C-Aligned Target in 2035, $MtCO_2e$	Percent Cut versus (negative = increase)			Per capita GHG Emissions in 2035, tCO_2/Person		
			1990	2005	2010		1990	2005	2010	Baseline	Illustrative 2°C	Illustrative 1.5°C
Paraguay	90.8	58.4	9.2	30.4	37.9	33.3	48.2	60.3	64.5	11.7	7.5	4.3
Peru	191.5	120.6	-12.8	8.5	18.6	66.6	37.7	49.4	55.0	5.0	3.2	1.7
Philippines	271.0	196.4	-74.9	-18.7	-9.8	109.3	2.7	33.9	38.9	2.0	1.4	0.8
Poland	354.3	170.4	61.8	51.7	54.5	96.7	78.3	72.6	74.2	9.3	4.5	2.5
Portugal	51.1	27.9	57.7	68.7	55.1	11.9	82.0	86.7	80.9	5.2	2.8	1.2
Qatar	206.8	100.4	-245.1	-20.3	26.9	33.4	-14.9	60.0	75.7	70.1	34.0	11.3
Romania	62.2	39.6	82.7	66.4	55.7	17.7	92.2	85.0	80.2	3.3	2.1	0.9
Russia	1668.8	959.5	68.8	32.2	26.7	511.3	83.4	63.9	61.0	12.0	6.9	3.7
Rwanda	10.5	9.9	-13.6	-26.6	-10.4	5.5	36.4	29.1	38.2	0.6	0.6	0.3
Samoa	0.7	0.3	24.3	43.3	47.8	0.3	33.8	50.5	54.4	2.5	1.2	1.0
São Tomé and Príncipe	0.5	0.3	-241.3	-93.7	-53.9	0.2	-120.7	-25.3	0.5	1.6	1.1	0.7
Saudi Arabia	840.5	480.3	-101.5	-3.0	22.5	205.6	13.7	55.9	66.8	19.8	11.3	4.8
Senegal	34.8	33.0	-107.9	-40.6	-22.4	16.6	-4.9	29.1	38.3	1.5	1.4	0.7
Serbia	70.7	31.4	63.3	15.7	56.8	23.4	72.6	37.1	67.8	10.7	4.8	3.5
Seychelles	1.2	0.6	-93.5	39.2	36.7	0.3	1.9	69.2	67.9	10.3	5.7	2.9
Sierra Leone	10.4	9.4	-26.2	-12.5	-4.2	6.0	19.4	28.1	33.5	1.0	0.9	0.6
Singapore	71.6	33.1	3.2	35.4	44.1	10.6	69.0	79.3	82.1	11.3	5.2	1.7
Slovak Republic	32.9	20.0	68.9	56.5	50.7	8.4	86.9	81.6	79.2	6.0	3.6	1.5
Slovenia	12.3	5.5	61.5	58.6	56.1	2.7	80.9	79.5	78.2	5.9	2.6	1.3
Solomon Islands	44.9	22.2	-430.4	-916.3	-882.9	20.1	-379.5	-818.8	-788.6	48.0	23.7	21.5
Somalia	51.2	47.0	-10.0	1.5	-0.9	29.2	31.5	38.7	37.2	2.0	1.9	1.2
South Africa	533.6	346.2	17.3	38.4	41.8	192.5	54.0	65.8	67.6	8.0	5.2	2.9
Spain	253.5	137.8	45.6	65.0	55.6	54.8	78.4	86.1	82.3	5.4	3.0	1.2
Sri Lanka	40.2	25.5	7.6	26.6	29.0	16.3	41.1	53.2	54.7	1.8	1.1	0.7
St. Lucia	0.3	0.2	-558.9	-41.2	6.4	0.1	-234.2	28.4	52.6	1.5	0.9	0.5
St. Vincent and the Grenadines	0.2	0.1	-174.4	11.8	30.4	0.1	-79.0	42.5	54.6	2.2	1.1	0.7
Sudan	166.7	158.1	-87.6	-14.1	-6.0	94.6	-12.3	31.7	36.5	2.7	2.5	1.5
Suriname	13.5	8.2	-63.6	-26.6	-22.1	5.1	-2.4	20.8	23.6	19.8	12.0	7.5
Sweden	-2.2	0.2	99.2	99.1	98.5	-0.4	101.5	101.6	102.7	-0.2	0.0	0.0
Switzerland	41.3	18.1	65.9	65.9	65.4	5.0	90.7	90.7	90.6	4.4	1.9	0.5
Syria	49.4	42.4	33.1	52.3	54.0	21.0	67.0	76.4	77.3	1.5	1.3	0.6
Taiwan Province of China	308.1	151.9	-8.0	54.3	49.9	66.4	52.8	80.0	78.1	12.9	6.3	2.8
Tajikistan	22.8	19.8	11.1	-69.2	-67.9	11.8	47.4	-0.2	0.6	1.9	1.6	1.0
Tanzania	157.8	134.0	-49.0	-16.7	-11.0	80.7	10.3	29.8	33.2	1.7	1.5	0.9
Thailand	480.9	330.5	-39.9	5.6	16.4	164.8	30.2	52.9	58.3	6.7	4.6	2.3
Togo	11.9	11.3	-80.6	-60.6	-26.4	6.2	1.5	12.4	31.1	1.0	1.0	0.5
Tonga	0.3	0.2	-9.5	12.8	13.3	0.1	41.9	53.8	54.0	2.4	1.8	0.9
Trinidad and Tobago	45.0	26.8	-46.7	48.4	56.8	12.9	29.3	75.1	79.2	29.1	17.4	8.4
Tunisia	45.3	32.2	-39.9	8.5	21.3	18.3	20.5	48.0	55.2	3.4	2.4	1.4
Turkey	526.4	332.4	-117.3	-25.1	-1.7	164.8	-7.7	38.0	49.6	5.8	3.7	1.8
Turkmenistan	131.6	83.1	4.1	17.0	19.0	43.3	50.0	56.8	57.8	17.9	11.3	5.9

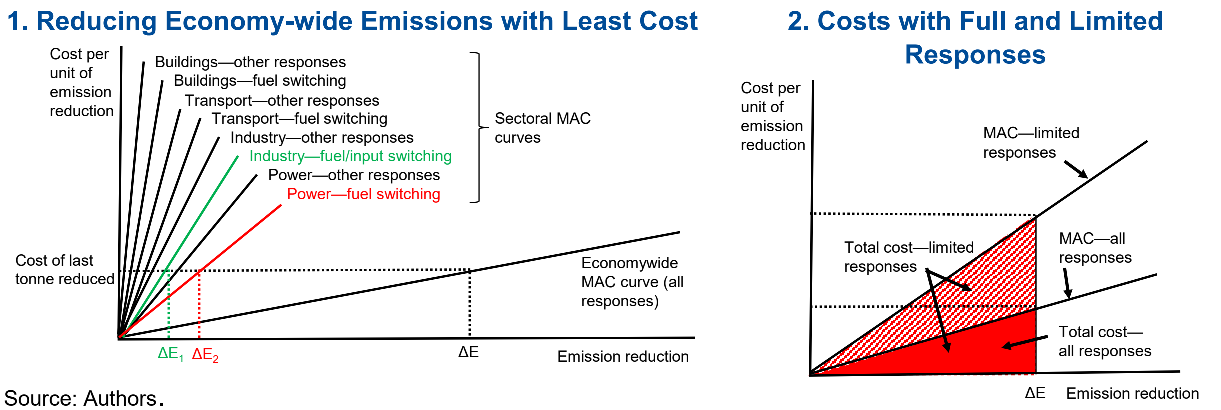
Country	Baseline GHG Emissions in 2035, $MtCO_2e$	Illustrative 2°C-Aligned Target in 2035, $MtCO_2e$	Percent Cut versus (negative = increase)			Illustrative 1.5°C-Aligned Target in 2035, $MtCO_2e$	Percent Cut versus (negative = increase)			Per capita GHG Emissions in 2035, tCO_2/Person		
			1990	2005	2010		1990	2005	2010	Baseline	Illustrative 2°C	Illustrative 1.5°C
Uganda	71.1	65.9	-99.8	-53.5	-19.1	37.4	-13.5	12.8	32.3	1.1	1.0	0.6
Ukraine	270.5	198.2	78.2	54.2	50.2	111.7	87.7	74.2	72.0	7.3	5.3	3.0
United Arab Emirates	305.5	162.4	-91.5	4.3	27.8	57.2	32.5	66.3	74.6	29.7	15.8	5.6
United Kingdom	419.8	211.2	74.1	69.9	65.7	76.6	90.6	89.1	87.6	6.0	3.0	1.1
United States	5622.0	2455.8	56.2	63.3	61.0	813.1	85.5	87.8	87.1	15.6	6.8	2.3
Uruguay	40.5	23.2	-40.7	17.9	22.5	10.8	34.2	61.6	63.8	11.9	6.8	3.2
Uzbekistan	221.3	185.2	-4.5	-2.9	5.7	100.7	43.1	44.0	48.7	5.5	4.6	2.5
Vanuatu	0.6	0.5	-6.1	10.2	27.4	0.3	45.2	53.6	62.5	1.5	1.2	0.6
Venezuela	209.5	161.5	48.2	51.7	53.6	98.6	68.4	70.5	71.7	6.3	4.9	3.0
Vietnam	478.3	389.9	-890.9	-50.8	-19.2	189.0	-380.2	26.9	42.2	4.6	3.7	1.8
Yemen	49.5	40.5	-122.1	10.7	28.5	28.1	-53.8	38.2	50.5	1.1	0.9	0.6
Zambia	80.6	39.2	25.5	28.5	36.0	39.8	24.3	27.4	35.0	2.9	1.4	1.5
Zimbabwe	115.3	75.0	-63.6	-88.9	-86.8	52.9	-15.5	-33.3	-31.9	5.5	3.6	2.5

Source: IMF staff calculations using CPAT.
Note: The terms "country" and "economy" do not in all cases refer to a territorial entity that is a state as understood by international law and practice. The terms also cover some territorial entities that are not states. GHG = greenhouse gas; $MtCO_2e$ = million tonnes of CO_2 equivalent; tCO_2 = tonnes of CO_2.

Annex 5. Understanding Mitigation Costs

Cutting economy-wide emissions—with respect to cost—involves equating the cost of the last tonne reduced across responses and sectors. This is illustrated in Annex Figure 5.1, panel 1 where the economy-wide marginal abatement cost (MAC) curve is the envelope, or horizontal summation, of MAC curves at the sectoral level for switching to clean fuels and other responses (like improving energy efficiency, conserving on energy-using products). Reducing economy-wide emissions by ΔE at least cost involves emissions reductions of ΔE_1 and ΔE_2 from fuel/input switching in industry and power generation respectively, and so on. If instead, only a limited range of behavioral responses is exploited, total mitigation costs—the integral under the relevant MAC curve over the range of emissions reductions—will be higher for a given total emissions reduction as indicated in Annex Figure 5.1, panel 2, because the narrower policy pushes along a steeper MAC schedule.

Annex Figure 5.1. Minimizing Mitigation Costs



Source: Authors.

Note: The relative position of sectoral MAC curves will vary with country circumstances. MAC = marginal abatement cost.

Where fuels are subject to preexisting taxes this effectively causes the MAC curve for reducing the fuel to start out with a positive (rather than zero) intercept and conversely where fuels are subsidized the MAC for reducing them starts out with a negative intercept. The Climate Policy Assessment Tool takes these effects into account in calculating mitigation costs using a country-specific database of fuel taxes and subsidies.

Annex 6. Coordination Mechanisms for Methane

The discussion here draws on Black and others (2022b), which discusses policies to decarbonize methane.

Several factors are favorable in establishing an international policy coordination mechanism to cut methane emissions:

- *Participants*: Signatories to the Global Methane Pledge, or representatives from blocs of signatories, could potentially negotiate an agreement.[32]
- *Initial coverage*: An initial agreement could focus on extractives which (1) account for most low-cost opportunities for cutting methane and (2) are already covered administratively through business tax regimes.
- *Parameters*: The agreement could focus on simple parameters like a minimum methane price or emission rate standards.
- *Competitiveness*: Concerns might be addressed through implementing revenue-neutral fees for industries, or other policies like feebates that avoid new tax burdens on the average producer, though competitiveness impacts are modest anyway.
- *International equity*: Equity issues are less challenging than for CO_2 as methane mitigation costs are much smaller. Again, equity issues might be dealt with through stricter requirements for advanced economies and transfer of know-how on monitoring and mitigation technologies to developing countries.
- *Flexibility*: The choice of mitigation instrument could be left to national governments as countries should be able to agree on methodologies for mapping instruments to emissions reductions.

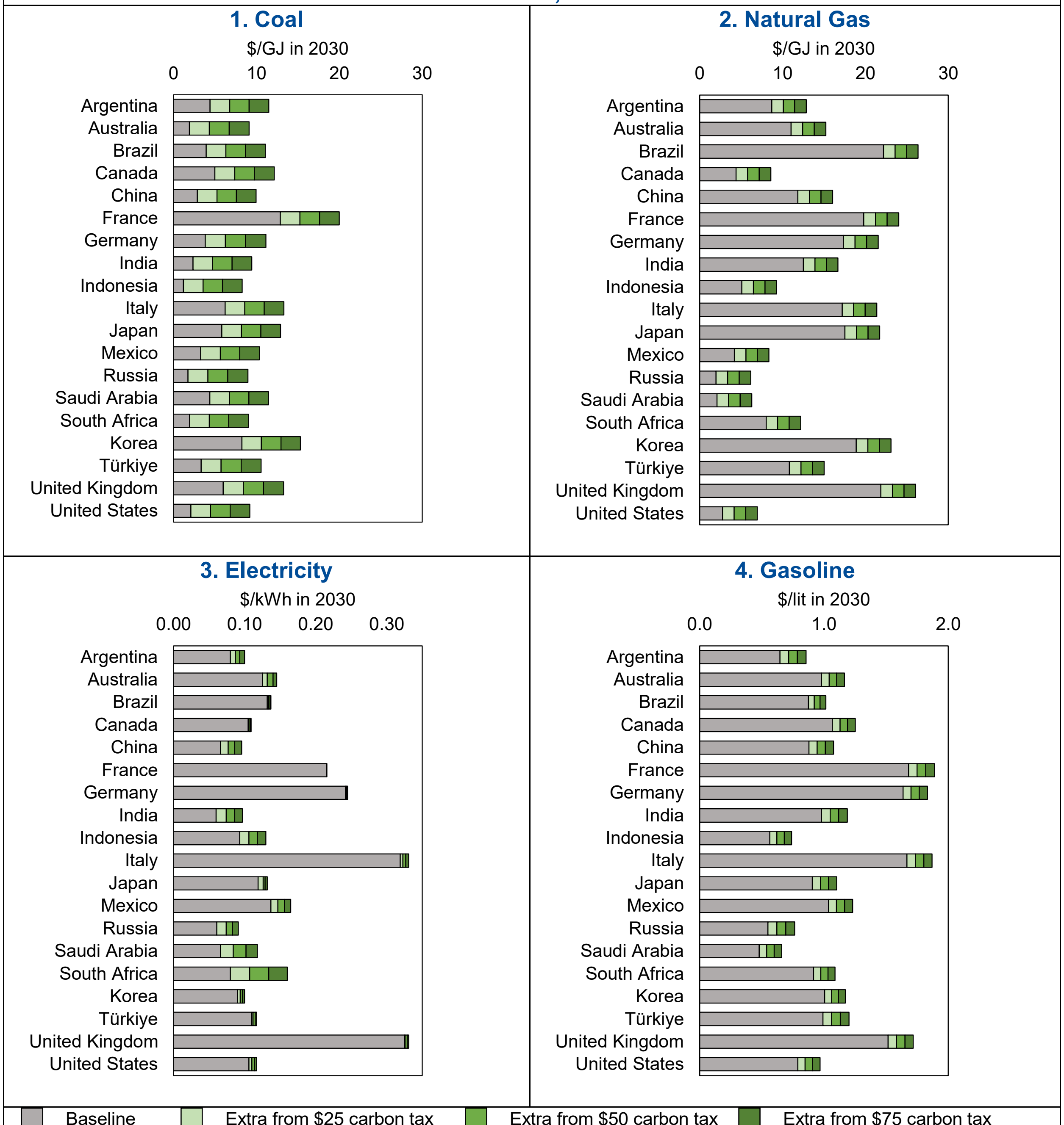
The arrangement would need to encompass mutually agreed procedures for measuring methane emissions. A tricky issue is whether the agreement should be supported by a border methane adjustment, charging for embodied methane in fuel imports from nonparticipants. This adjustment would, however, complicate the agreement's initial set up and may not be needed if competitiveness concerns are addressed through other measures (like revenue-neutral fees or regulations).

[32] The Global Methane Pledge seeks to cut global methane emissions 30 percent by 2030 relative to 2020 levels—more than 150 countries have so far signed the pledge (notable large emitting exceptions include China, India, and Russia, although China has released a national action plan to control methane emissions). See www.globalmethanepledge.org.

Annex 7. Further Impacts of Carbon Pricing

Annex Figure 7.1 shows the impacts of $25/$50/$75 carbon pricing on energy prices versus BAU in 2030.

Annex Figure 7.1. Impacts of Carbon Pricing on Raising BAU Energy Prices, G20 Countries, 2030

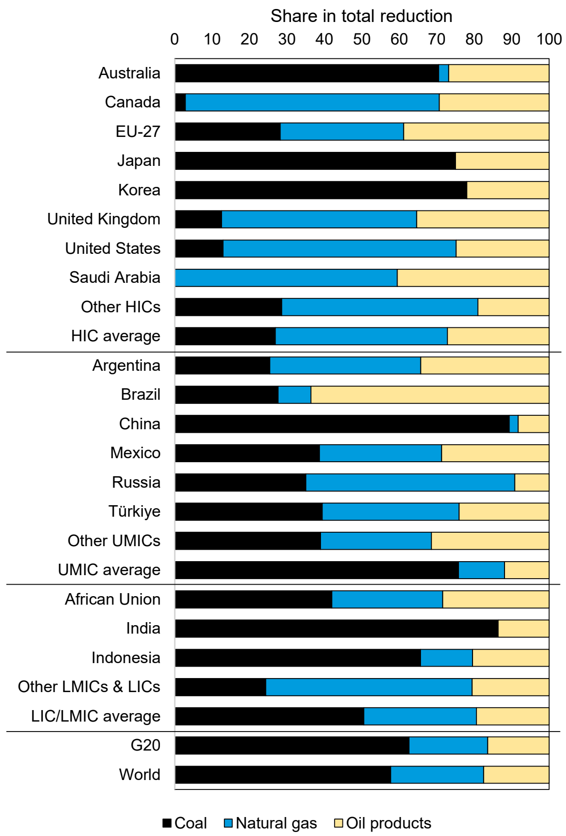


Source: Authors' calculations using CPAT. Note: For fuels, price increase is the product of the (fixed) emissions factor and the carbon price and for electricity it is the product of the new (lower) emissions rate and the carbon price plus mitigation costs from the reduction in emission rate per unit of electricity production. Pass-through rates are assumed to be 100 percent. BAU = business as usual; G20 = Group of Twenty; GJ = gigajoule; kWh = kilowatt-hour; lit = liter.

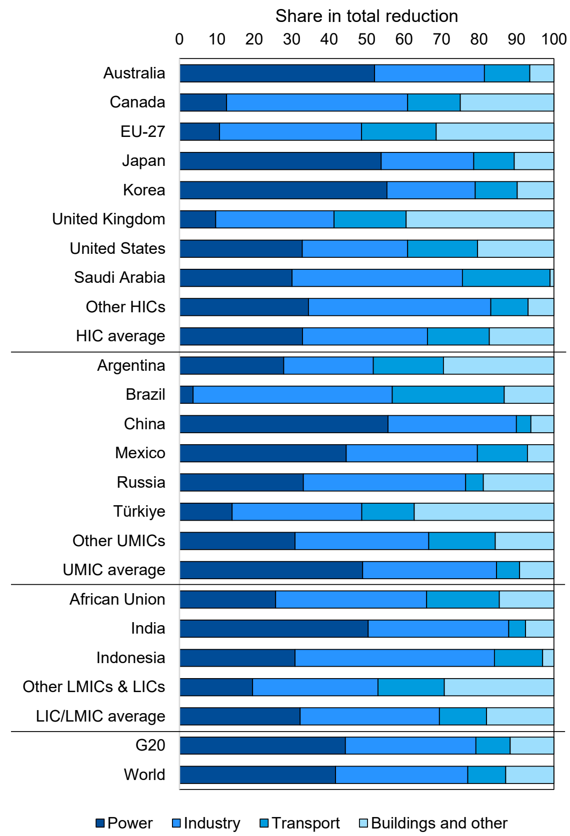
Annex Figure 7.2 illustrates the breakdown of the emissions reductions by fuel product and sector under carbon prices of $75/$50/$25 per tonne in high-/middle-/low-income G20 countries in 2030.

Annex Figure 7.2. Breakdown of CO_2 Reductions under Pricing by Fuel and Sector, 2030

1. Fuel



2. Sector



Source: Authors' calculations using the Climate Policy Assessment Tool.
Note: Estimates are for a $75/$50/$25 carbon price for high/medium/low-income countries. Increase in natural gas (replacing coal) is excluded. Buildings sector includes residential sector, services, food, and forestry. EU = European Union; G20 = Group of Twenty; HIC = high-income countries; LIC = low-income countries; LMIC = lower-middle-income countries; UMIC = upper-middle-income countries

Annex 8. Sectoral Mitigation Policies and Targets for G20 Countries (As of 2022)

Annex Table 8.1 lists key sectoral policies across sectors in G20 countries, as of 2022.

Annex Table 8.1. G20 Sectoral Mitigation Policies

	Instrument/coverage (April 2022, 2030 prices, US $/ton)[a]	Power: Generation Shares (%)				Industry	Transport				Buildings
		Renewables		Coal			CO_2/km		% EVs in Vehicle Sales		
		2021	Future Target (year)	2021	Future Target (year)		2021	Future Target (year)	2021	Future Target (year)	
Argentina	Carbon tax for all emissions (5, 5)	0	20 (2025)[d]	1							
Australia		0	68 (2030)	51		Reduce the energy intensity of industry 30 percent between 2015 and 2030.			1	30 (2030)	
Brazil		0	[e]	5			125	119 (2022)	<1		
Canada	Carbon tax/ETS for power, industry, transport, buildings (40, 140)	0	90 (2030)	4	0 (2030)		123	100 (2026)	4	100 (2035)	All new buildings net zero emissions by 2030.
China	ETS for electricity to be expanded to industry (9, 9)[b]	0	80 (2060)	56		Peak aluminium and steel CO_2 emissions by 2025, and reduce them 40 and 30 percent, respectively from that peak by 2040.	116	72 (2030)	6	100 (2035)	Green buildings to account for 50% of new urban buildings.
France	EU ETS for power/industry (87,140), domestic tax for industry/buildings/transport (49, 60)	0	40 (2030)[f]	1	0 (2022)	Reduce (all GHG) emissions from industry 37 percent by 2030 relative to 2019.	100	61 (2030)	11	100 (2030)[f]	Reduce building sector emissions 44% below 2020 emisisons by 2030; EU legislation requires all new buildings to be nearly zero energy.
Germany	EU ETS for power/industry (87,140), domestic ETS for buildings/transport (33,55)	0	80 (2030)	17	0 (2030)	Reduce CO_2 emissions 49–51 percent below 1990 levels by 2030	100	61 (2030)	14	100 (2030)[f]	Reduce building sector emissions 43% below 2020 emisisons by 2030; EU legislation requires all new buildings to be nearly zero energy.
India		0	50 (2030)	64			114	112 (2022)	<1	30 (2030)[h]	Reduce energy use for new commercial buildings 50% by 2030.
Indonesia		0	23 (2025)	61	30 (2025)				<1	numeric (2025)[i]	Reduce energy intensity ≥ 1% per year till 2025.*
Italy	EU ETS for power/industry(87,140)	0	55 (2030)	5	0 (2025)		100	61 (2030)	4	100 (2030)[f]	Reduce building sector emissions 25% below 2020 emisisons by 2030; EU legislation requires all new buildings to be nearly zero energy.
Japan	Carbon tax for all emissions (2,2), Subnational ETS schemes	0	36–38 (2030)	36	19 (2030)	Reduce CO_2 emissions 38% below 2013 levels by 2030	106	92 (2030)	<1	100(2035)	Reduce building sector CO_2 emissions 66% below 2013 levels by 2030. All new houses net zero emissions by 2030.
Mexico	Carbon tax for all emissions (0.4–4,0.4–4)[c], ETS for power/industry (4,4). Subnational carbon tax schemes	0	35 (2024)	5			114	85 (2025)	<1	n/a[j]	All new buildings net zero emissions by 2030.
Russia		0	20 (2020)	9						production (2030)[k]	Reduce energy consumption for all buildings 3.7% a year 2031–2050.
Saudi Arabia		0	50(2030)	0						30 (2030)	
South Africa	Carbon tax for all emissions (10, 10)	0	41(2030)	87		Reduce energy consumption of manufacturing 16 percent below 2015 levels by 2030.	138	n/a	<1		All new buildings net zero emissions by 2030.
South Korea	ETS for power/industry/buildings (19, 19)	0	30 (2030)	30	0 (2050)		98	84 (2030)	3	numeric (2025)[l]	All new buildings net zero emissions by 2030.
Turkey		0	60(2030)[g]	19		Reduce energy intensity by at least 10 percent in each sub-sector by 2023 (2011 baseline)				numeric (2030)[m]	
United Kingdom	ETS for power/industry (99,130), domestic tax for power (24,24)	0	100 (2035)	2	0 (2024)	Reduce CO_2 emisisons 67 percent below 2018 levels by 2035.	100	61 (2030)	11	100 (2030)	Reduce CO_2 emisisons for all new buildings 75–80% by 2030.
United States	Subnational ETS	0	28 (2030)[g]	12			123	100 (2026)	2	50 (2030)	All new buildings net zero emissions by 2030.

Source: Black and others (2022a).

Note: ETS = emissions trading system; EU = European Union; EVs = electric vehicles; G20 = Group of Twenty; GHG = greenhouse gas. [a]Where prices, or caps in ETSs, are not specified in legislation for 2030 they are based on 2022 prices or, as in Germany, the last available year where a price is specified. For the EU ETS, the 2030 price is an estimate based on CPAT. [b]China's ETS takes the form of a tradable emission rate standard. [c]Mexico's carbon price on additional CO2 emission content compared to natural gas. [d]Argentina's target excludes large hydro, which is included in its generation share. [e]Brazil's latest NDC no longer includes a renewable target. [f]EU wide target. [g]Inferred from numeric targets. [h]Target is for private cars. Target for commercial vehicles=70%, buses=40%, two and three-wheeler sales=80%. [i]Target of 2 million EVs in the passenger vehicle stock by 2025. [j]No federal target but Jalisco, Mexico committed to 100(2030). [k]Annual EV production target of 220,000 units by 2030. [l]Target of 1.13 million EVs in the passenger vehicle stock by 2025. [m]Target of 1 million EVs in the vehicle stock by 2030.

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