



TURNING POINTS: TRENDS IN COUNTRIES' REACHING PEAK GREENHOUSE GAS EMISSIONS OVER TIME

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EXECUTIVE SUMMARY

Highlights

- This paper assesses each of the world's countries in terms of whether the country's emissions have peaked, when they have peaked, and whether the country has a commitment that implies an emissions peak in the future. While the timing of when global greenhouse gas (GHG) emissions need to peak to limit dangerous climate change is well-documented, this paper provides a country-level analysis.
- As this paper finds, an encouraging trend is emerging: the number of countries—and the percentage of global emissions covered by those countries—that have either already reached peak GHG emissions levels or have a commitment that implies a peak in emissions in the future has increased as follows:
 - The number of countries that have already peaked their emissions grew from 19 in 1990, to 33 in 2000, to 49 in 2010. By 2020, the number of countries that have already peaked or have a commitment that implies an emissions peak grows to 53 and by 2030 to 57.
 - The percentage of global emissions covered by countries that have already peaked was 21 percent by 1990, 18 percent by 2000, and 36 percent by 2010. The percentage of global emissions covered by countries that have already peaked or have a commitment that implies an emissions peak by 2020 increases to 40 percent and, by 2030, to 60

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percent (using 2010 GHG emissions data as the basis for the percentage calculation, rather than 2020 and 2030 projections).

- The large majority of developed countries as well as some developing countries have already peaked, and we are also witnessing a turning point with several developing countries taking on emissions reduction commitments that imply emissions peaks by 2020 or 2030.
- Nevertheless, the number of countries peaking and the emissions level at which they are peaking is insufficient to meet the Paris Agreement's temperature goals to limit warming to well below 2°C, with an effort to limit warming to 1.5°C.
- The world's ability to limit warming to 1.5–2°C depends not only on the number of countries that have peaked over time but also the global share of emissions represented by those countries, their emissions levels at peaking, the timing of peaking, and the rate of emissions reductions after peaking. As a result, it will be critically important for countries to make and achieve commitments to peak their emissions as soon as possible, per the Paris Agreement; to peak at lower emissions levels; and to commit to a significant rate of emissions decline after peaking. This is especially true for major emitting countries that will play a significant role in determining when and at what level global emissions peak.

Background

The science is clear that the longer we delay the peak in emissions—the point when global emissions reach a maximum level and decline thereafter—it will be more difficult, if not impossible, to limit dangerous levels of warming. Global GHG emissions have continued to rise in recent decades (WRI 2017). Peaking emissions by 2020 at the latest, with a steep decline of emissions thereafter, will still give us a chance of limiting warming between 1.5 and 2°C in time to transform the economy (Figueres et al. 2017).¹ The Paris Agreement suggests that Parties should collectively aim to reach global peaking “as soon as possible” but does not, however, identify a date by which countries should commit to peak. The Agreement recognizes that “peaking will take longer for developing country Parties,” considering equity and the principle of common but differentiated

responsibilities and respective capabilities. The timing of when individual countries' emissions and global emissions peak is of critical importance in determining whether we will be able to avoid dangerous climate impacts.

Objectives

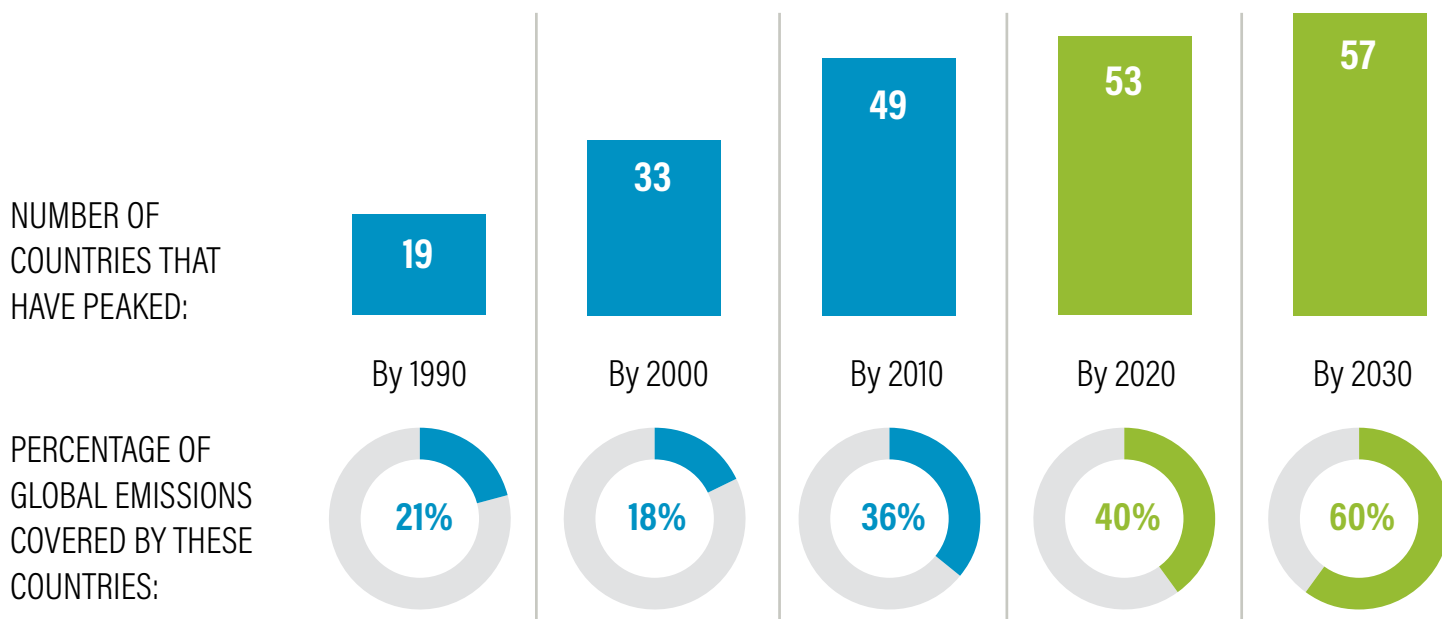
The objective of this paper is to analyze trends in the historical peaking of individual countries' emissions as well as in countries' emissions reduction commitments that imply peaking in the future. While the timing of when global GHG emissions need to peak is well-documented, and there is some research on the peaking of G20 countries and specific regions,² there has been little research to date on the timing of all of the world's individual countries' peaking. If the world's emissions are to peak in the next few years, the global community will need this information to identify which countries still need to peak and which countries may be in a position to peak at lower emissions levels or peak and reduce emissions more quickly. Ideally, financial assistance and technical expertise can be targeted to countries in need to help facilitate emissions peaking and reduction.

This paper aims to advance the understanding of which countries have already peaked their emissions and which countries have adopted emissions reduction commitments that imply an emissions peak in the future. It then discusses how this collectively affects the peaking of global emissions and the ability to meet the Paris Agreement's temperature targets. The intended audience includes decision makers setting climate change commitments, as well as the research community, nongovernmental organizations (NGOs), and the wider public interested in trends in countries' peaking and reducing emissions over time.

Key Findings

The number of countries peaking and the share of global GHG emissions covered by countries peaking has increased over time. As shown in Figure ES-1, the number of countries that have already peaked emissions grew from 19 in 1990, to 33 in 2000, to 49 in 2010. By 2020, the number of countries that have already peaked or have a commitment that implies an emissions peak by 2020 grows to 53. By 2030, this group is joined by several more countries with commitments that imply a peak by 2030, bringing the number of countries to 57.

Figure ES-1 | **Number of Countries That Peaked or Have a Commitment That Implies Emissions Peak, by Decade (Cumulative) and Percentage of Global Emissions Covered by Those Countries (Cumulative)**



Notes: Blue bars represent historical peaking, while green bars represent future commitments that imply an emissions peak by that date. While the number of countries peaking grew between 1990 and 2000, the percentage of global emissions covered by these countries did not grow because global emissions (including from countries that had not yet peaked) grew at a faster rate than emissions from countries that had peaked. The 1990, 2000, and 2010 results use 1990, 2000, and 2010 emissions data, respectively, for the calculations. The 2020 and 2030 results use 2010 emissions data for the calculations because reliable country-specific projections data for 2020 and 2030 are not available. Therefore, 2020 and 2030 results are not projections of the share of global emissions covered by countries expected to peak in those years because they use the global share of GHG emissions emitted by different countries in 2010, and the relative share of emissions coming from different countries is expected to change by 2020 and 2030. The results include the United States as having peaked by 2010 (despite U.S. plans to withdraw from the Paris Agreement, which calls into question whether its intended nationally determined contribution (INDC) will be achieved) and include China as peaking by 2030 (even though China's peaking commitment is for CO₂ only). Results for 2030 include China's CO₂ emissions (from 2010) in the numerator and China's total GHG emissions (from 2010) in the denominator since China's peaking target is for CO₂ only. Excludes INDCs that are conditional.

Whether the world is on track to peak global GHG emissions in the near term and achieve GHG reductions needed to limit warming to well below 2°C, with an effort to limit warming to 1.5°C, depends not on the number of individual countries peaking, but on the share of global emissions covered by those countries. Figure ES-1 shows the growing percentage of global emissions covered by countries peaking over time. In 1990, the percentage of global emissions covered by countries that had peaked was 21 percent. In 2000, the percentage was 18 percent (cumulative), and in 2010, the percentage was 36 percent (cumulative). While the number of countries grew in each decade, the percentage of global emissions covered by these countries did not grow from 1990 to 2000 because global GHG emissions (including from countries that had

not yet peaked) grew at a faster rate than emissions from countries that had peaked.

Looking forward, the percentage of global emissions covered by countries that have already peaked or have a commitment that implies an emissions peak by 2020 increases to 40 percent (using 2010 GHG emissions data as the basis for the percentage calculation, rather than 2020 projections). The percentage of global emissions covered by countries that have peaked or have a commitment that implies an emissions peak by 2030 increases further to 60 percent, largely as a result of China's peaking target for carbon dioxide (CO₂) emissions (again, using 2010 GHG emissions data as the basis for the percentage calculation, rather than 2030 projections).

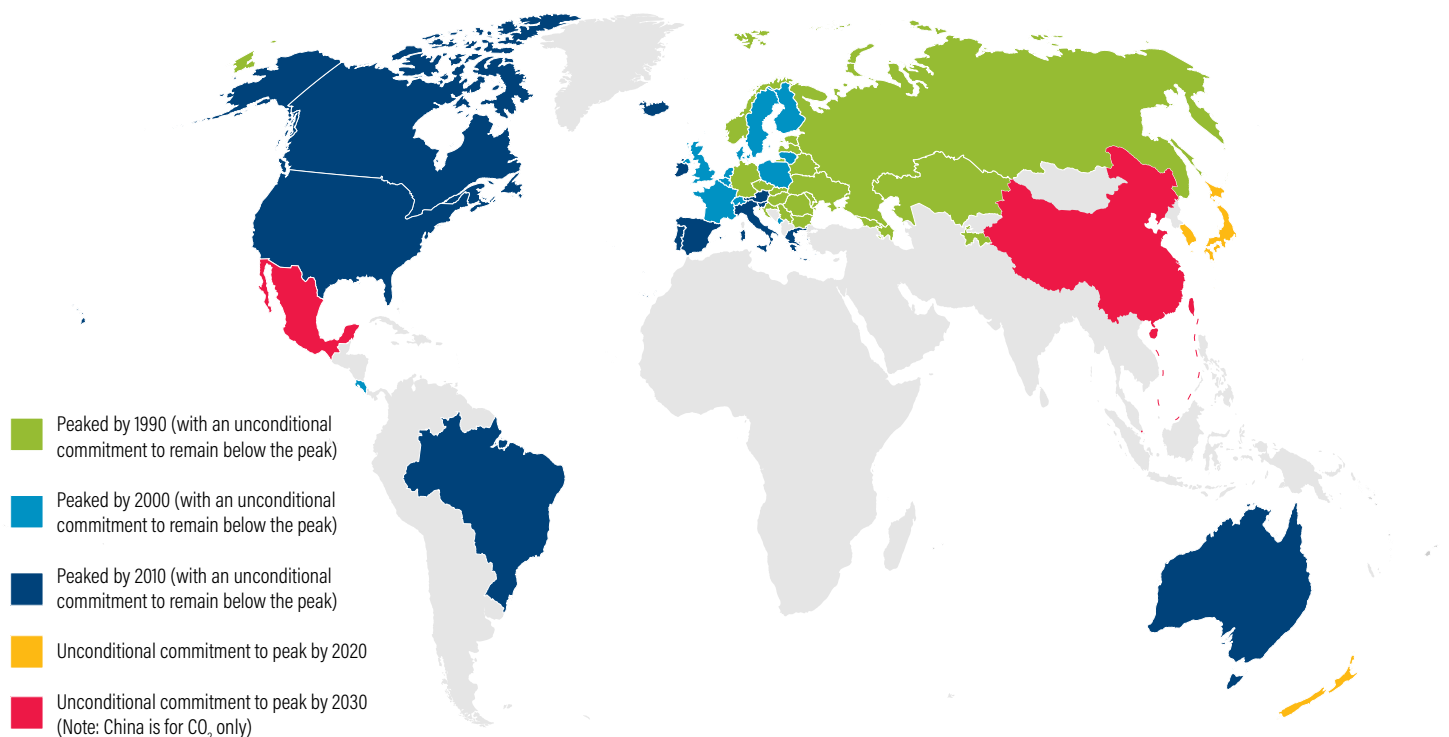
The large majority of developed countries have already peaked, and we are also witnessing a turning point with several developing countries taking on emissions reduction commitments that imply emissions peaks by 2020 or 2030. Figure ES-2

illustrates which countries have peaked or have commitments to peak over time. The Paris Agreement recognizes that it will take longer for developing country Parties to reach a peak in greenhouse gas emissions. Accordingly, developed countries must lead in both peaking and taking rapid reductions thereafter in line with the best available science. Prior to the intended nationally determined contributions (INDCs) submitted in the lead-up to the Paris Agreement, developed countries largely had targets to reduce total national GHG emissions relative to their historical emissions, while developing countries adopted goals that allowed overall national emissions to increase, although at a more moderate pace, such as emissions reductions relative to business-as-usual scenarios or

emissions intensity or a pledge to implement individual actions. With the INDCs to be achieved by 2030, 16 developing countries have taken on commitments to peak and then reduce absolute emissions, including China (for CO₂ only), Brazil, Mexico, Costa Rica, the Republic of Korea, and several others listed in Section 3 and Appendix A.

However, the world's ability to peak emissions in time to limit warming to 1.5–2 °C will not be determined only by which countries have peaked and which have not. For example, steeper reductions in some countries could offset later peaks in other countries. All countries' emissions trajectories will help determine the global peak in emissions and the ability to limit warming to safe levels. While major emitters will play a larger role in that determination, it is important for all countries to show leadership, contribute to the Paris Agreement's global goals, and embrace the shift toward low-carbon technologies and production and consumption patterns.

Figure ES-2 | **Countries That Peaked or Have a Commitment That Implies Emissions Peak, by Decade**



While these new commitments mark significant progress, we are still falling short of the need to peak global emissions by 2020 for a least-cost, likely (greater than 66 percent probability) chance of limiting warming well below 2°C or to limit warming to 1.5°C.³ Global emissions are projected to continue to rise between now and 2030 even if countries achieve new commitments (Levin and Fransen 2015a, UNEP 2015, UNEP 2016). The number of countries peaking and the timing and emissions level at which they are peaking remain insufficient to achieve a near-term peak in global GHG emissions, which threatens to place the Paris Agreement temperature goals out of reach.

Recommendations for Future Peaking Commitments

Global peaking will be determined by the cumulative emissions of all countries, which depends on three factors: the timing of countries' emissions peaking, the level at which emissions peak, and rate of emissions reductions thereafter. This is especially true for major emitting countries that will play a significant role in determining when and at what level global emissions peak. This paper makes the following general recommendations regarding each factor:

- *Timing of countries' emissions peaking:* Countries that have not yet peaked and do not yet have a commitment to peak should consider how soon their emissions can peak and decline thereafter and make a commitment to do so aligned with that timing. Countries that have a commitment that implies a peak in the future (e.g., in 2020 or 2030) should consider whether they can peak earlier.
- *Level at which emissions peak:* Countries that have a commitment that implies a peak in the future (e.g., in 2020 or 2030) should consider whether they can peak at a lower emissions level. Countries that have not yet peaked or have not established a commitment that implies a future emissions peak should set a target to peak emissions. All countries should be transparent about the emissions level at which they commit to peaking so that the research community can assess how far off the world is from the 1.5–2°C goal.
- *Rate of emissions reductions after peaking:* All countries should commit to a significant rate of emissions reductions after peaking in line with the Paris Agreement aim for countries to “undertake rapid reductions [after peaking] in accordance with best available science, so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century.”

Countries can make the above commitments when communicating or updating their NDCs⁴ under the Paris Agreement in 2020. Countries may also do so sooner because, under the Agreement, countries may at any time adjust their existing NDCs with a view to enhancing the level of ambition.

Cities, subnational governments, businesses, and other actors, many of which have already embraced emissions reduction commitments, can contribute significantly to countries' ability to peak emissions more quickly and lower levels and decarbonize thereafter by pursuing ambitious climate action. In doing so, they can allow countries to be more ambitious in their commitments as well. These nonstate and subnational actors should also act to peak and reduce emissions as soon as possible alongside national governments to help meet the goals of the Paris Agreement and avoid the worst impacts of climate change.

The global community should also take regular stock of when individual countries' emissions and global emissions have peaked or are expected to peak—for example, through the global stocktake under the Paris Agreement. Based on the findings, financial assistance and technical expertise should be provided to countries that need it to help them in their effort to peak as soon as possible and at lower emissions levels to help reach global temperature goals. Such assistance could, for example, help countries transition to clean technologies that avoid lock-in of carbon-intensive technologies such as coal-fired power plants, thus promoting low-carbon economic development.

1. INTRODUCTION

The Paris Agreement marked a historic turning point for combating climate change. Under the Agreement, countries agreed to keep temperature rise to well below 2°C above preindustrial levels and pursue efforts to limit temperature rise to 1.5°C above preindustrial levels to avoid the worst climate impacts. One of the Agreement's key goals is to peak global emissions as soon as possible and reduce them rapidly thereafter.

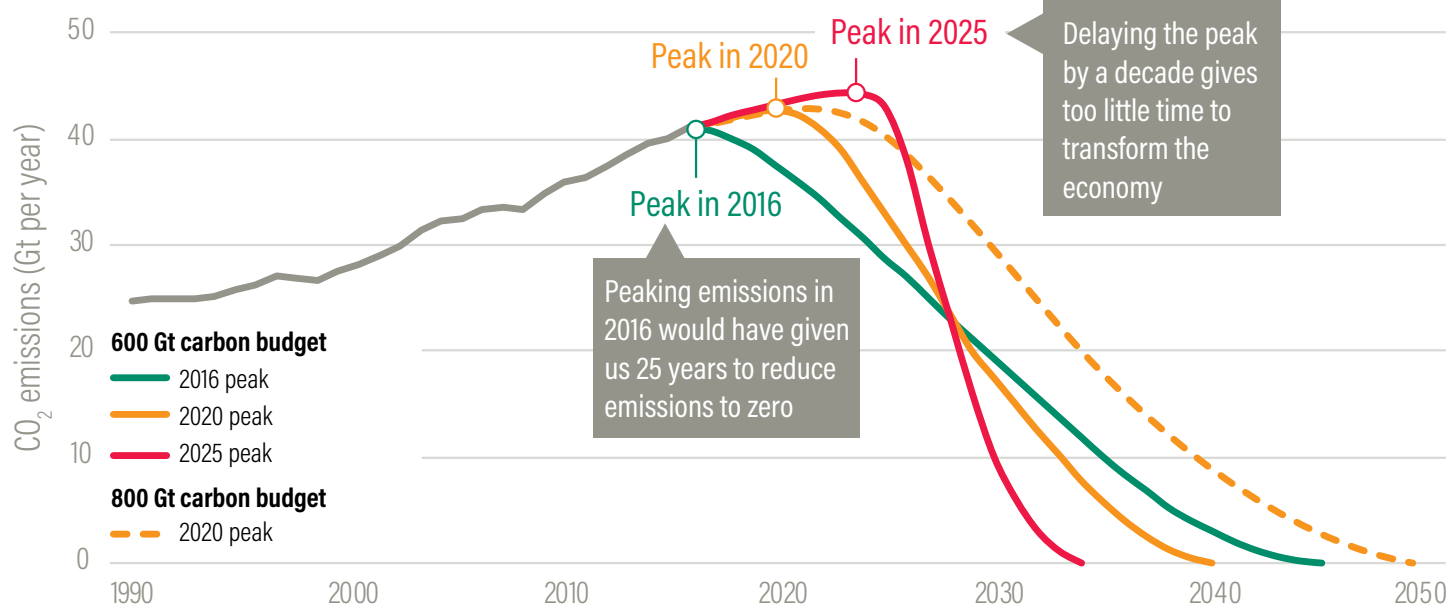
This paper assesses each country in the world in terms of whether its emissions have reached a critical turning point of peaking and then declining thereafter; if so, in what year, and if not, whether it has a commitment that implies an emissions peak in the future. While the scientific literature has dedicated considerable attention to examining when global emissions need to peak to meet various temperature targets, less research has been dedicated to when all individual countries across the globe have peaked or have commitments to peak.⁵

This paper finds that a significant number of countries' emissions have already peaked and that additional countries have committed to peak and reduce their emissions

by 2020 or 2030. These future peaking commitments are largely a result of developing countries' latest climate commitments, which represent a significant departure from previous pledges, as several countries such as Brazil, China (for CO₂ only), Costa Rica, Mexico, the Republic of Korea, and several others are committing to not only curb the growth of their emissions, but also to peak total emissions and reduce them thereafter. The experience of both developed and developing countries that have peaked already shows that many countries have continued to grow their economies while reducing their emissions.⁶

Although this is encouraging, global emissions are still not projected to peak in time to have a likely (greater than 66 percent), least-cost chance to limit warming to 1.5–2°C. In order to have a chance of staying within the 2°C limit with a likely probability for the least cost, scientific research has found that global GHG emissions need to peak by 2020 at the latest (UNEP 2014, UNEP 2015, UNEP 2016, Figueres et al. 2017).⁷ (See Figure 1.) However, projections show that, even with countries' INDCs achieved, GHG emissions are expected to continue to increase between 2020 and 2030, indicating that we are not on track for a global emissions peak in 2020 (Levin and Fransen 2015b, UNEP 2015, UNEP 2016). Box 1 provides further information.

Figure 1 | **Implications of Delay in Global Emissions Peaking on Future Decarbonization Rates Needed to Stay within 1.5–2°C Goal**



Source: Reproduced from Figueres et al. (2017).

Note: The emissions pathways (solid lines) limit the mean carbon budget to 600 Gt CO₂, which Figueres et al. (2017) suggest is consistent with limiting warming to 1.5–2°C. They note that increasing the budget to 800 Gt CO₂, while still peaking emissions at 2020, would reduce the need for such high decarbonization rates post-peak, but provides a greater risk for overshooting the 1.5–2°C goal.

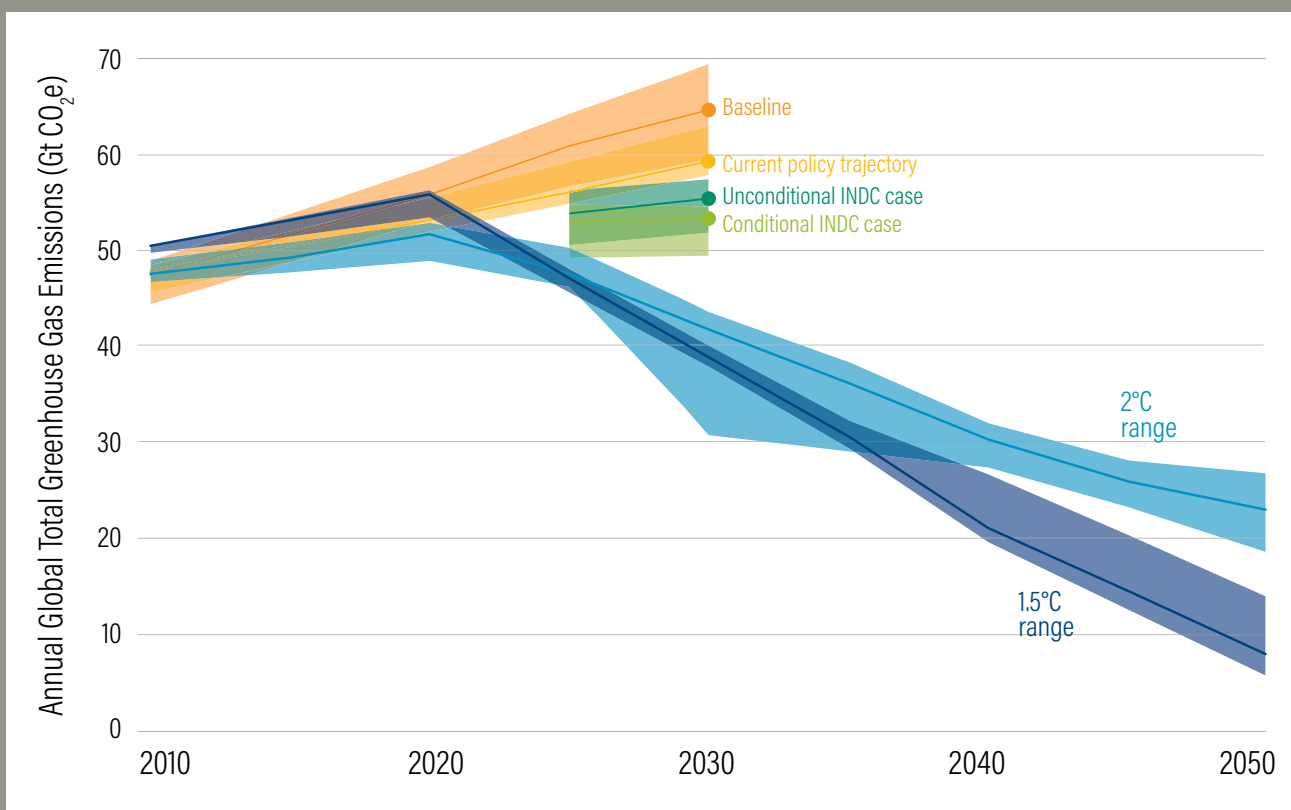
Box 1 | Current and Future Emissions Levels

The *UNEP Emissions Gap Report* summarizes a range of modeling results and finds that global emissions will be on average 52 Gt CO₂e in 2020, 48 Gt CO₂e in 2025, and 42 Gt CO₂e in 2030 for least-cost emissions pathways that are consistent with a likely chance (greater than 66 percent) of limiting warming to 2°C. Accordingly, in these scenarios, emissions peak before 2020. For a 50 percent chance of limiting warming to 1.5°C, emissions will be on average 56 Gt CO₂e in 2020, 47 Gt CO₂e in 2025 and 39 Gt CO₂e in 2030. For comparison, emissions in 2014 were already 52.7 Gt CO₂e (UNEP 2016).

The emissions assessment across a range of studies suggests that emissions will still be on average 53 Gt CO₂e (conditional INDCs) to 53.9 Gt CO₂e (unconditional INDCs) in 2025 and on average 53.4 Gt CO₂e (conditional INDCs) to 55.5 Gt CO₂e (unconditional INDCs) in 2030, implying a continuous growth, on average, in emissions between 2025 and 2030 (UNEP 2016). Note that these studies documented below were before the United States announced plans to withdraw from the Paris Agreement and reverse, revise, or review domestic policies to reduce emissions, with implications for the United States' ability to meet its INDC.

Figure B-1 shows median values for various studies' assessments of anticipated emissions levels in 2025 and 2030, given the INDCs, contrasted with what the science suggests is necessary for limiting warming to 1.5°C or 2°C. (While many INDCs have been converted to NDCs, this research assessed the INDCs submitted prior to the Paris Agreement).

Figure B-1 | Anticipated Emissions Levels in 2025 and 2030 with INDCs Compared to a 1.5°C or 2°C Emissions Trajectory



Source: Reproduced from *UNEP Emissions Gap Report* (2016).

Note: The dark blue area shows pathways limiting global temperature increase to below 1.5°C by 2100 with >50% chance. The light blue area shows pathways limiting global temperature increase to below 2°C by 2100 with >66% chance. The pathways for 1.5°C and 2°C are not directly comparable, even though plotted together, because they operate with different probabilities. At the time of publishing the *UNEP Emissions Gap Report* (2016), there were no published scenarios that meet the 1.5°C temperature target with a >66% probability.

Delaying the peak date beyond 2020 will result in higher temperatures than the temperature goals of the Paris Agreement, increasing risks of lock-in of high-carbon technologies and infrastructure, higher costs of action to reduce emissions and avoid climate impacts, and the loss of options for achieving emissions reductions adapting to some climate impacts. In addition, a later peak date will require unprecedented rates of decarbonization and reliance on unproven technologies at scale, such as bioenergy combined with carbon capture and storage, to compensate for the delay (Fay et al. 2015, Rogelj et al. 2016), with the resultant risk of overshooting temperature targets.

The rest of the paper is organized as follows: Section 2 explains our methodology and the assumptions used. Section 3.1 presents an overview of global peaking trends, while Section 3.2 provides more detail at the country level. In Section 3.3, we analyze how the types of pledges countries have made for 2020 under the Copenhagen and Cancun Agreements differ from the recently submitted INDCs, or post-2020 commitments, and which of these pledges imply a peak by 2020 or 2030. Section 3.4 explores alternative scenarios in which the United States and China do not maintain or achieve their emissions peaks as expected, given both countries' special circumstances surrounding their peaking commitments. Section 4 concludes with reflections on what current trends mean for global emissions and our ability to meet the Paris Agreement's long-term temperature goals.

We hope this paper advances the understanding of countries' emissions peaking over time and informs dialogues on how to encourage countries to reach peak emissions as soon as possible and to achieve ambitious rates of emissions decline thereafter, as well as the need to provide financial and technical support to countries in need so as to advance mitigation efforts to peak as soon as possible.

2. METHODOLOGY AND ASSUMPTIONS

This section explains the methodology and assumptions used to

- determine which countries' emissions have peaked historically;
- determine which countries have commitments to peak emissions in the future; and
- calculate the percentage of global emissions covered by countries that peaked or have a commitment to peak in each decade.

The section also explains country-specific assumptions for China and the United States, data sources for historical emissions data, limitations, and areas for possible future research.

2.1 Determining Which Countries' Emissions Have Peaked Historically

We reviewed all countries' historical emissions and future emissions reduction pledges and considered a country as having peaked in the past if it met two criteria:

1. Its emissions reached their maximum level at least five years⁸ before the most recent GHG inventory year.
2. The country has unconditionally committed to continue to lower its emissions below the peak emissions level in the future.

Regarding the first criterion, we use a five-year period because, if the peak is very recent, it could be due to short-term fluctuations such as an economic downturn rather than longer-term trends, and we have less confidence that the apparent peak will not be reversed. As a result, this paper may underestimate the number of countries that have peaked at a given point in time. For example, Japan's highest emissions in the available dataset occurred in 2013, followed by declining emissions in 2014 and 2015. Japan's emissions may have peaked in 2013, but given the available data, it is too early to say. In our results, Japan is classified as peaking by 2020, given its 2020 emissions reduction commitment.

Also, in some countries that we have classified as having peaked, emissions declined after the initial peak year then increased again almost to peak levels before declining again, rather than having a steady decline after the initial peak year. This is the case in Croatia, Finland, Italy, Kazakhstan, Latvia, Luxembourg, Micronesia, and Serbia. Despite these fluctuations, the initial peak year is still counted as the peak because emissions never surpassed the previous maximum emission level.

Regarding the second criterion, if a country does not have a commitment to reduce absolute emissions below historical levels in the future, we do not count this country's emissions as having peaked, even if it appears to have done so historically. Examples include Albania, Chad, Fiji, Kyrgyzstan, and Zimbabwe. We have not counted such countries as peaking because there is no guarantee that emissions will continue to decline in the future. We also only consider unconditional commitments, rather than conditional ones (explained further below).

2.2 Determining Which Countries Have Commitments to Peak Emissions in the Future

For the 2020 and 2030 results, we analyzed the pledges that all countries put forward under the Copenhagen Accord and Cancun Agreements (for 2020) and the INDCs that countries submitted to the United Nations Framework Convention on Climate Change (UNFCCC) (for 2025 or 2030) to determine which countries have commitments to peak and reduce emissions in the future.

Types of targets: To be counted as a peaking country, a country can either explicitly have a target to “peak emissions” or have a commitment that implies an emissions trajectory in which future emissions levels are reduced below historical levels, implying a peak and decline of emissions. For example, if a country has a base year emissions target (to reduce emissions X percent below base year emissions) or a fixed-level target (to limit GHG emissions to X tons in a certain year) where target year emissions are below historical emissions, we consider this country to have a commitment to peak emissions by a certain year (such as 2020 or 2030). This is the case even though the exact timing and level of the peak is not known. Targets that imply an emissions peak include base year emissions targets,⁹ fixed-level targets,¹⁰ and trajectory targets.¹¹ In most cases, commitments that do not imply an emissions peak include baseline scenario targets,¹² intensity targets,¹³ and sectoral non-GHG targets and/or

actions. However, in two cases, Mexico and the Republic of Korea, we have included countries with baseline scenario targets as having peaking commitments since they explicitly provided information that demonstrates an implied peak.¹⁴

Conditionality: We only consider countries with unconditional targets or pledges among those that have commitments to peak emissions in the future. If a country does not specify any conditions in its INDC, we assume the commitment is unconditional. Some countries have conditional INDCs that imply an emissions peak by 2030, such as Bhutan, Botswana, Ethiopia, Grenada, and South Africa. As a conservative assumption, we do not consider them as having a firm commitment to peak because there is no guarantee that the conditions upon which they have made their pledges will be met. If the underlying conditions are met and these countries achieve their targets, the share of global emissions covered by peaking countries in 2030 would be higher than those presented in Section 3. For example, including Bhutan, Botswana, Ethiopia, Grenada, and South Africa would increase the global percentage of emissions covered by peaking countries in 2030 from 60 to 61 percent. Future research could focus on assessing the impact of conditional pledges in greater depth.

2.3 Assumptions Regarding Specific Countries

We also made the following assumptions regarding specific countries:

China

China's INDC commits to peaking its carbon dioxide (CO₂) emissions around 2030 and making best efforts to peak early. Because the INDC only covers CO₂ emissions rather than total GHG emissions, China's overall economy-wide emissions may or may not peak by 2030, depending on the growth of non-CO₂ gases. China's CO₂ emissions accounted for 78 percent of its total GHG emissions in 2010 (based on the PIK PRIMAP database) and 82 percent in 2012 (based on China's most recent Biennial Update Report submitted to the UNFCCC), including net emissions from land use, land use change, and forestry (LULUCF). Research has shown that China's non-CO₂ emissions could nearly double by 2030 relative to 2005 levels (Yao et al. 2016). At the same time, China recently announced that efforts will be made to ensure that certain non-CO₂ emissions peak by 2020, namely methane (CH₄) emissions from energy activities and nitrous oxide (N₂O) emissions from industrial processes and croplands peak

(China 2016), which is likely to slow the growth in total non-CO₂ emissions.

For the main results, we consider China to be a country with a commitment to peak by 2030, given China's unique situation of having a peaking target for 2030, but one that does not apply to total national emissions, and because the size of emissions under China's CO₂ peaking target is such a large percentage of global emissions. However, while we include China as having a commitment to peak by 2030, when calculating the percentage of global emissions covered by countries that peak by 2030, we only include China's CO₂ emissions in the numerator of the calculation, while including China's total GHG emissions in the denominator, so as not to overestimate the percentage of emissions covered by peaking targets.

In Section 3.4, we also show the global results in an alternative scenario where China is not considered a peaking country by 2030 because its target is limited to CO₂.

United States

As stated above, a criterion for being considered a peaking country is that a country has committed to continue to lower its emissions below peak emissions level in the future. The Trump Administration recently announced its intention to withdraw from the Paris Agreement, calling into question its future emissions reduction commitments. Despite this, for the main results we assume that the U.S. historical emissions peak in 2007 will be maintained, given that a variety of studies¹⁵ suggest that emissions are likely to remain lower than the historical peak, despite the change in U.S. policy, due to action by states, cities, and businesses and ongoing market trends.

We treat the U.S. case differently from other countries by considering emissions projections based on current policies and trends when determining whether the country has peaked, rather than based on stated commitments alone. Although using projections for all countries as the basis for this analysis would be ideal, reliable emissions projections for every country are not available. We made this exception to give a more realistic picture of global peaking results over time based on what is most likely to occur, given the significant role of U.S. emissions in contributing to global emissions peaking.

In Section 3.4, we present an alternative scenario in which the United States is not considered a peaking country because its future commitments are in question. Indeed, in the absence of following through on the INDC commitment, there is no guarantee that U.S. emissions will stay below the historical peak.

2.4 Calculating the Percentage of Global Emissions Covered by Countries That Peaked by 1990, 2000, and 2010

We calculated the percentage of global emissions covered by countries that have historically peaked by a certain year by

1. identifying countries with historical emissions that have peaked by a certain year (1990, 2000, or 2010);
2. determining national emissions for those countries in that year (1990, 2000, or 2010), then aggregating them; and
3. dividing this aggregated total by the global emissions in that year (1990, 2000, or 2010), which yields the percentage of global GHG emissions covered by countries that peaked by a given year (1990, 2000, or 2010), using Equation 1.

EQUATION 1: CALCULATING THE PERCENTAGE OF GLOBAL EMISSIONS COVERED BY COUNTRIES THAT PEAKED BY 1990, 2000, OR 2010

$$\frac{\text{Sum of emissions in year } x \text{ from countries that peaked by year } x}{\text{Global emissions in year } x}$$

2.5 Calculating the Percentage of Global Emissions Covered by Countries That Have Peaked or Have a Commitment to Peak by 2020 and 2030

For countries that have a commitment that implies an emissions peak by 2020 or 2030, we use 2010 emissions rather than 2020 or 2030 projected emissions as the basis for the relative share of global emissions represented by each country (as shown in Equation 2). We do so because a consistent data source was not available for projected emissions in 2020 or 2030 for all countries that would have peaked in future years. While many modeling efforts have projections for individual major emitters, smaller countries are typically modeled as a bloc, and thus, projections for individual small countries were not available. Data for 2010 were used because it was the most recent year with reliable data available for all countries worldwide.

This approach reduces comparability between the 1990, 2000, and 2010 percentages figures on the one hand and the 2020 and 2030 figures on the other. The 1990, 2000, and 2010 figures are an accurate snapshot of each moment in time, while the 2020 and 2030 figures are based on the share of global emissions represented by each country in 2010, which is likely to change in 2020 and 2030. Still, the approach shows the increasing share of countries that have peaked or have a commitment to peak over time.

EQUATION 2: CALCULATING THE PERCENTAGE OF GLOBAL EMISSIONS COVERED BY COUNTRIES THAT HAVE PEAKED OR HAVE A COMMITMENT TO PEAK BY 2020 OR 2030

$$\frac{\text{Sum of emissions (using 2010 data) from countries that have peaked or have a commitment to peak by 2020}}{\text{Global emissions in 2010}}$$

$$\frac{\text{Sum of emissions (using 2010 data) from countries that have peaked or have a commitment to peak by 2030}}{\text{Global emissions in 2010}}$$

As previously mentioned, when calculating the percentage of global emissions covered by countries that have peaked, we include China's CO₂ emissions in 2010 in the numerator and China's total GHG emissions in 2010 in the denominator, since its peaking target covers CO₂ emissions only, to avoid overestimating the share of global emissions covered by peaking targets.

2.6 Data Sources for Historical Emissions

We use historical emissions data that countries have submitted to the UNFCCC, compiled on the UNFCCC's Data Interface.¹⁶ This is the case for all Annex I countries and several non-Annex I countries that provide an annual time series of emissions data from 1990 to the present. For non-Annex I countries without a complete annual time series available from the UNFCCC (such as China, Costa Rica, the Marshall Islands, and Singapore, among others) we use the PIK PRIMAP database, which estimates annual emissions for all countries (Gütschow et al. 2017).¹⁷

Data used to determine whether and when countries' emissions have peaked include net emissions from LULUCF. The inclusion of LULUCF affects the timing of some countries' peaking dates, as a result of whether mitigation efforts have been taken in the land sector versus other sectors, as well as significant annual variability in net emissions from the land sector in some countries. For example, Brazil peaked in 2004 when LULUCF is included, but has not yet peaked when LULUCF is excluded.

2.7 Limitations

There are several limitations to our analysis:

Taking countries' commitments at face value: We take countries' commitments at face value by assuming they will be achieved by the target date. We do not take into account whether the targets will be underachieved or overachieved. If countries fail to meet their peaking targets, then our conclusions are too optimistic. We also assume that if a target implies a peak by 2030, emissions will decline thereafter. However, in the absence of longer-term targets, there is no guarantee that they will.

Focusing on peaking date but not level of peaking or rate of decarbonization after peaking: A target that implies an emissions peak does not necessarily translate to a high level of ambition because emissions may peak at very high emissions levels or may first climb significantly before they decline. Even if a country has a future commitment to peak emissions, this could mean that emissions continue to grow for many years and at a high rate for years to come before they are reduced. For countries that have already peaked, this paper does not examine their decarbonization rates after peaking. Countries that have historically peaked still have a critical role to play in determining whether global emissions peak by 2020 and whether the Paris Agreement's temperature goals are achieved. The global emissions and temperature goals will be determined by the cumulative emissions of all countries, which are dependent not only on the timing and level of emissions peaks, but also on the rates of decarbonization thereafter.

Absence of forecasts or projections: Our paper is not based on projections or forecasts of where countries' emissions are likely to be headed in the future, based on current policies and trends. Instead, our analysis of when countries are expected to peak in the future is based only on commitments that countries have made. Had this study focused on future emissions projections based on current policies that countries have adopted, the results would likely differ, as some countries are likely to exceed their INDC targets while others may not meet them. For more information, see UNEP (2016) and Kuramochi et al. (2016), which further analyze current policies scenarios for an array of countries.

Data limitations: Based on the data available, we analyze the period starting in 1990 and ending in 2010–15, depending on the last year of available GHG inventory data for each country. Some countries' emissions peaked earlier than 1990, but based on the available data we classify them as peaking by 1990.

Some countries classified as not peaking yet may have peaked if data were available through the present rather than only through, for example, 2012 or 2014. Historical GHG inventory data are also sometimes recalculated, such that the historical peaking year for a given country may change in the future if data are recalculated.

As described above, a key limitation is that the percentage of global emissions covered by countries that have peaked or have a commitment to peak by 2020 and 2030 are calculated using 2010 data because reliable projections for every country in 2020 and 2030 are not available. Therefore, the percentages for 2020 and 2030 do not reflect what percentage of global emissions *in* 2020 or 2030 are expected to come from countries that will have peaked by then. Still, the figure shows the increasing share of emissions covered by countries that have peaked over time, compared to the percentage in 2010, as additional countries peak in each decade.

Another data limitation is that we use economy-wide emissions data that cover all sectors and gases for all countries, regardless of the specific coverage of each country's target. The only exception is China, where we separately consider China's CO₂ emissions because the peaking pledge covers CO₂ only, and given the scale of the country's emissions. Also, because not all countries have specified how they will account for the land sector in their NDCs, we do not consider the impact of special accounting rules for the land sector (such as for exclusion of natural disturbances) in the calculation of target year emissions.

2.8 Areas for Possible Future Research

The following questions are outside the scope of the current analysis and could be subjects for future research:

- **Underlying drivers for why countries have peaked:** This paper does not assess *why* emissions have peaked in some countries at certain points in time. Instead, the paper focuses on providing a snapshot of which countries have peaked at each point in time.
- **Which countries need to peak, by when, to achieve the Paris Agreement's goals:** This paper does not examine which countries need to peak by certain dates if we are to meet the Paris Agreement's long-term temperature targets. Such a question should consider equity and the principle of common but differentiated responsibilities and respective capabilities, in light of different national circumstances, when determining which countries should peak when and at what levels. Further research is needed to assess the impact on global emissions of various countries' peaking by certain dates and at various emissions levels and how that relates to global temperature goals.

3. OVERVIEW OF TRENDS IN EMISSIONS PEAKING

3.1 Which Countries Have Peaked over Time?

This section shows which countries have peaked or have a commitment to peak in the decades from 1990 to 2030. Table 1 lists the countries that have peaked or have a commitment to peak in each decade, the share of global emissions represented by those countries, and the number of countries that have peaked in each decade.

The percentage of global emissions covered by countries that have already peaked was 21 percent in 1990, 18 percent in 2000, and 36 percent in 2010. This corresponds to an increasing number of countries peaking over time: Nineteen countries peaked by 1990, 33 countries (cumulatively) peaked by 2000, and 49 countries (cumulatively) peaked by 2010. While the number of countries grew over time, the percentage of global emissions covered by these countries did not grow from 1990 to 2000 because global emissions (including from countries that had not yet peaked) grew at a faster rate than emissions from countries that had peaked.

Based on countries' commitments for 2020 and 2030, four more countries are expected to peak by 2020, and another four are expected to peak by 2030, bringing the total number to 57 countries peaking already or having a commitment to peak by 2030. Using 2010 as a common base year for the 2020 and 2030 results, the share of emissions covered by peaking countries grows to 40 percent in 2020 and to 60 percent in 2030.

For more detailed information, see Appendix A, which provides each country's emissions level at the peak, the percentage of global emissions each country accounts for, and each country's 2030 emissions reduction commitment. Appendix B provides peaking information for the top 10 emitting countries because the timing and level of the global emissions peak depends heavily on when and at what level major emitting countries peak.

Figure 2 illustrates which countries peaked, or have a commitment to peak, in each decade. The results are also summarized in Figure 3. Figure 4 illustrates the emissions trends of all countries that have peaked or have commitments that imply a peak.

Figure 2 | Countries That Peaked or Have a Commitment That Implies Emissions Peak, by Decade

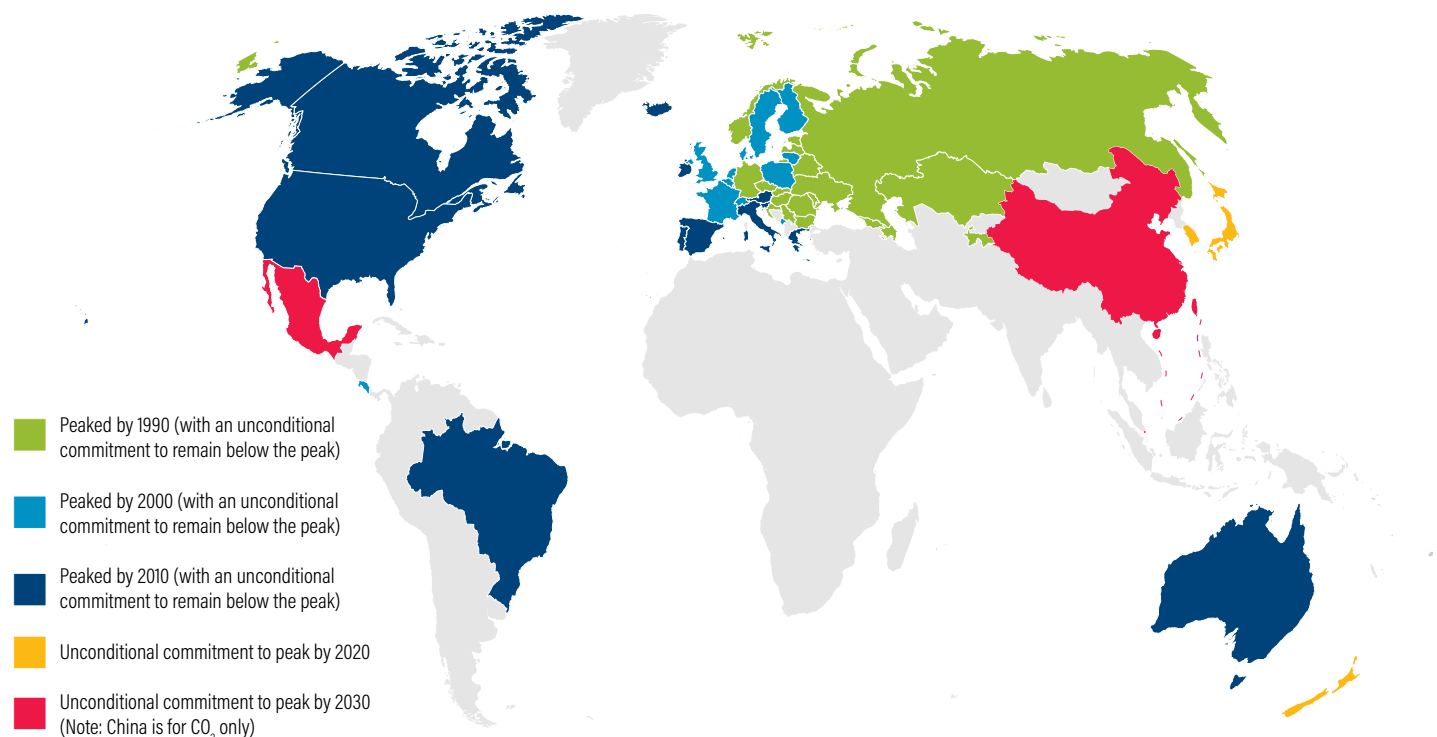
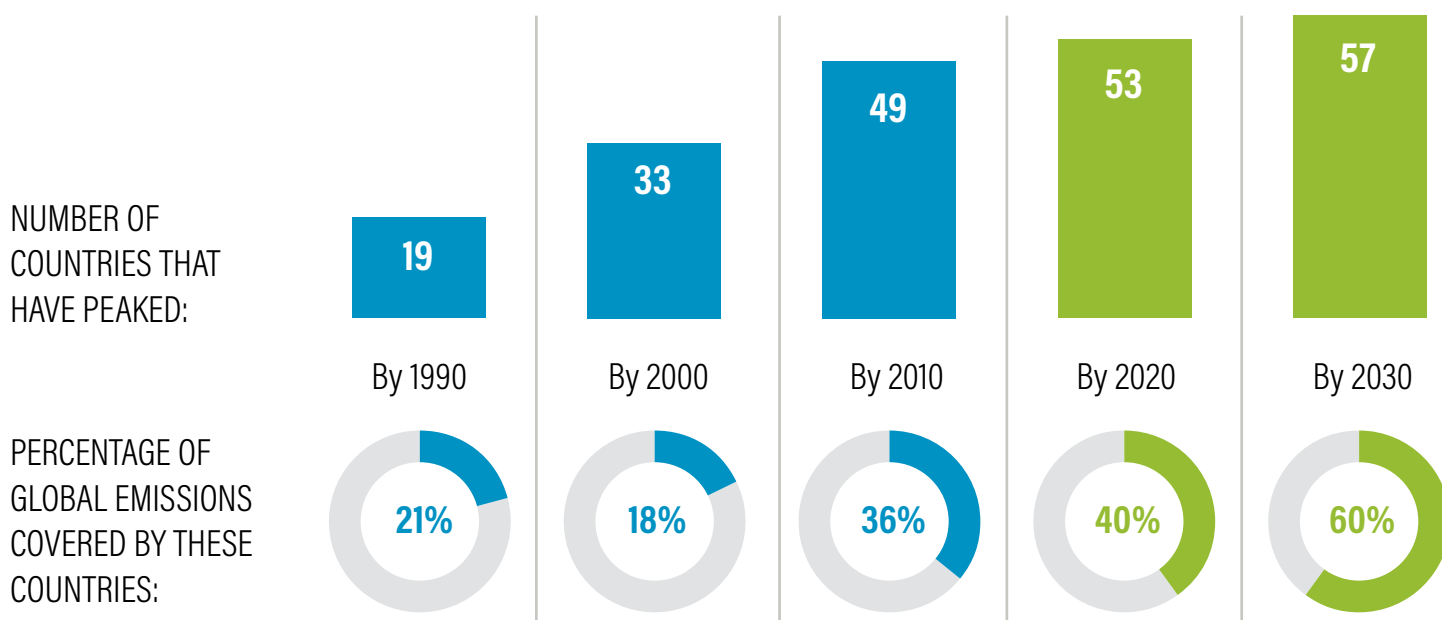


Table 1 | List of Countries That Peaked or Have a Commitment That Implies a Peak and the Percentage of Global Emissions Covered by Peaking Countries, by Decade

DECADE	COUNTRIES THAT PEAKED IN EACH DECADE		PERCENTAGE OF GLOBAL EMISSIONS COVERED BY COUNTRIES THAT PEAKED BY EACH YEAR (CUMULATIVE)	NUMBER OF COUNTRIES THAT PEAKED IN EACH DECADE (CUMULATIVE)
By 1990	Azerbaijan Belarus Bulgaria Croatia Czech Republic Estonia Georgia Germany Hungary Kazakhstan	Latvia Moldova Norway Romania Russian Federation Serbia Slovakia Tajikistan Ukraine	21% (of 1990 emissions)	19
By 2000	France (1991) Lithuania (1991) Luxembourg (1991) Montenegro (1991) United Kingdom (1991) Poland (1992) Sweden (1993)	Finland (1994) Belgium (1996) Denmark (1996) Netherlands (1996) Costa Rica (1999) Monaco (2000) Switzerland (2000)	18% (of 2000 emissions)	33
By 2010	Ireland (2001) Micronesia (2001) Austria (2003) Brazil (2004) Portugal (2005) Australia (2006) Canada (2007) Greece (2007)	Italy (2007) San Marino (2007) Spain (2007) United States (2007) Cyprus (2008) Iceland (2008) Liechtenstein (2008) Slovenia (2008)	36% (of 2010 emissions)	49
DECADE	COUNTRIES THAT HAVE A COMMITMENT THAT IMPLIES A PEAK IN EACH DECADE		PERCENTAGE OF GLOBAL EMISSIONS COVERED BY COUNTRIES THAT HAVE PEAKED OR HAVE A COMMITMENT THAT IMPLIES A PEAK BY EACH YEAR (CUMULATIVE)	NUMBER OF COUNTRIES THAT HAVE PEAKED OR HAVE A COMMITMENT THAT IMPLIES A PEAK IN EACH DECADE (CUMULATIVE)
By 2020	Japan Malta New Zealand Republic of Korea		40% (of 2010 emissions)	53
By 2030	China (CO ₂ only) Marshall Islands Mexico Singapore		60% (of 2010 emissions)	57

Notes: The 1990, 2000, and 2010 results use 1990, 2000, and 2010 emissions data, respectively, for the calculations. The 2020 and 2030 results use 2010 emissions data for the calculations because reliable country-specific projections data for 2020 and 2030 are not available. Therefore, 2020 and 2030 results are not projections of the share of global emissions covered by countries expected to peak in those years because they use the global share of GHG emissions emitted by different countries in 2010, and the relative share of emissions coming from different countries is expected to change by 2020 and 2030. The results include the United States as having peaked by 2010 (despite U.S. plans to withdraw from the Paris Agreement, which calls into question whether the INDC will be achieved) and include China as peaking by 2030 (even though China's peaking commitment is for CO₂ only). Results for 2030 include China's CO₂ emissions (from 2010) in the numerator and China's total GHG emissions (from 2010) in the denominator since China's peaking target is for CO₂ only. Excludes INDCs that are conditional.

Figure 3 | Number of Countries That Peaked or Have a Commitment That Implies Emissions Peak, by Decade (Cumulative) and Percentage of Global Emissions Covered by Those Countries (Cumulative)



Notes: Blue bars represent historical peaking, while green bars represent future commitments that imply an emissions peak by that date. While the number of countries peaking grew between 1990 and 2000, the percentage of global emissions covered by these countries did not grow because global emissions (including from countries that had not yet peaked) grew at a faster rate than emissions from countries that had peaked. The 1990, 2000, and 2010 results use 1990, 2000, and 2010 emissions data, respectively, for the calculations. The 2020 and 2030 results use 2010 emissions data for the calculations because reliable country-specific projections data for 2020 and 2030 are not available. Therefore, 2020 and 2030 results are not projections of the share of global emissions covered by countries expected to peak in those years because they use the global share of GHG emissions emitted by different countries in 2010, and the relative share of emissions coming from different countries is expected to change by 2020 and 2030. The results include the United States as having peaked by 2010 (despite U.S. plans to withdraw from the Paris Agreement, which calls into question whether the INDC will be achieved) and include China as peaking by 2030 (even though China's peaking commitment is for CO₂ only). Results for 2030 include China's CO₂ emissions (from 2010) in the numerator and China's total GHG emissions (from 2010) in the denominator since China's peaking target is for CO₂ only. Excludes INDCs that are conditional.

Not all countries are expected to peak national emissions at the same point in time, and the Paris Agreement notes that it will take longer for developing country Parties to reach a peak in GHG emissions than for developed country Parties. In general, developed countries have greater capacity to address climate change, as well as greater responsibility given their historical contributions to climate change. In most cases, per capita emissions of developed country Parties are also higher than those of developing countries (UNFCCC 2017).

Figure 5 shows the increasing number of Annex I (or developed) countries peaking over time and the growing share of total Annex I emissions represented by these countries in each decade. The number of Annex I countries peaking has grown significantly over time—with 14 out of 43 Annex I Parties¹⁸ peaking by 1990, growing to 26 (cumulative) by 2000, 39 (cumulative) by 2010, and

42 (cumulative) out of 43 countries by 2020. The large majority (39 of 43) of Annex I countries have peaked historically, and all but one (Turkey) are expected to peak by 2020.

Nevertheless, the results do not indicate whether the emissions level at which Annex I countries peak is adequate for meeting the Paris Agreement's temperature goals nor whether committed rates of emissions reductions after peaking are sufficient. The fact that developed countries have taken the lead in peaking also does not mean that the remaining global emissions reductions needed are the sole responsibility of countries that have yet to peak. Countries that have peaked will play a critical role in determining the timing of the global emissions peak, which will be determined in part by their decarbonization rates after their emissions peak.

Figure 4 | Emissions of Countries That Peaked or Have a Commitment That Implies Emissions Peak

COUNTRIES THAT PEAKED IN 1990 OR EARLIER (ktCO₂e)



PEAKED IN 1991-2000 (ktCO₂e)

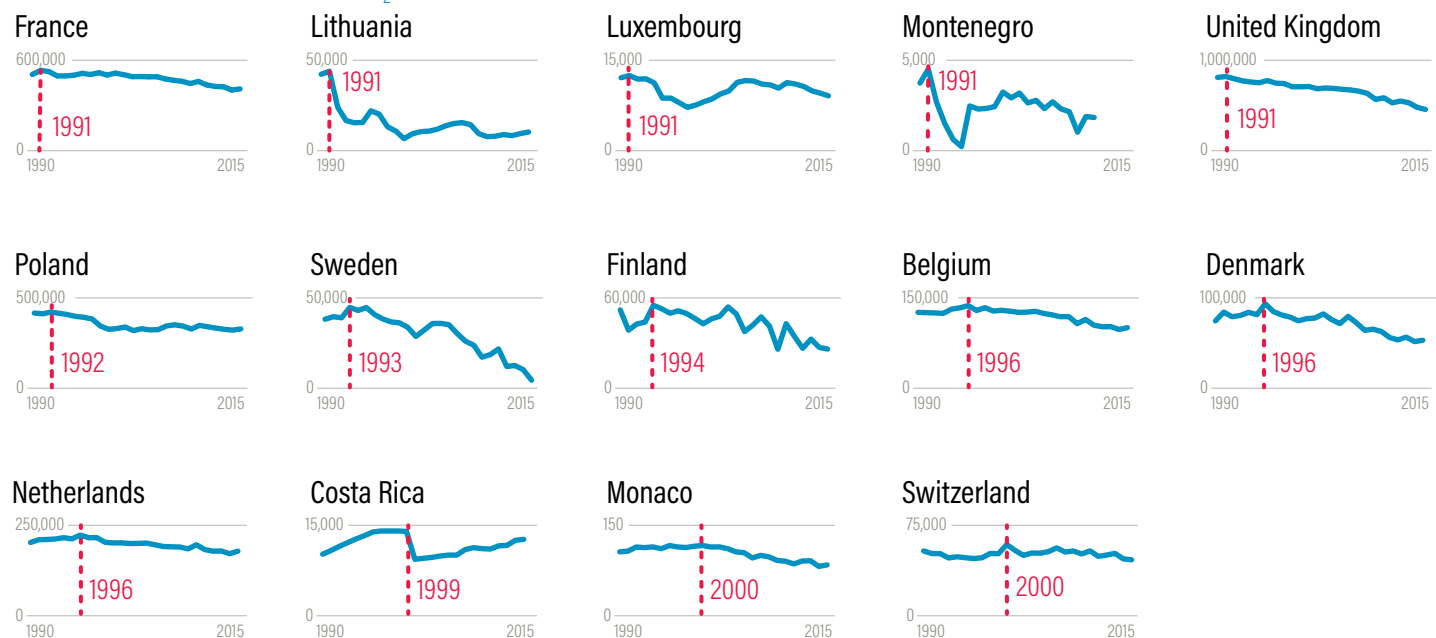
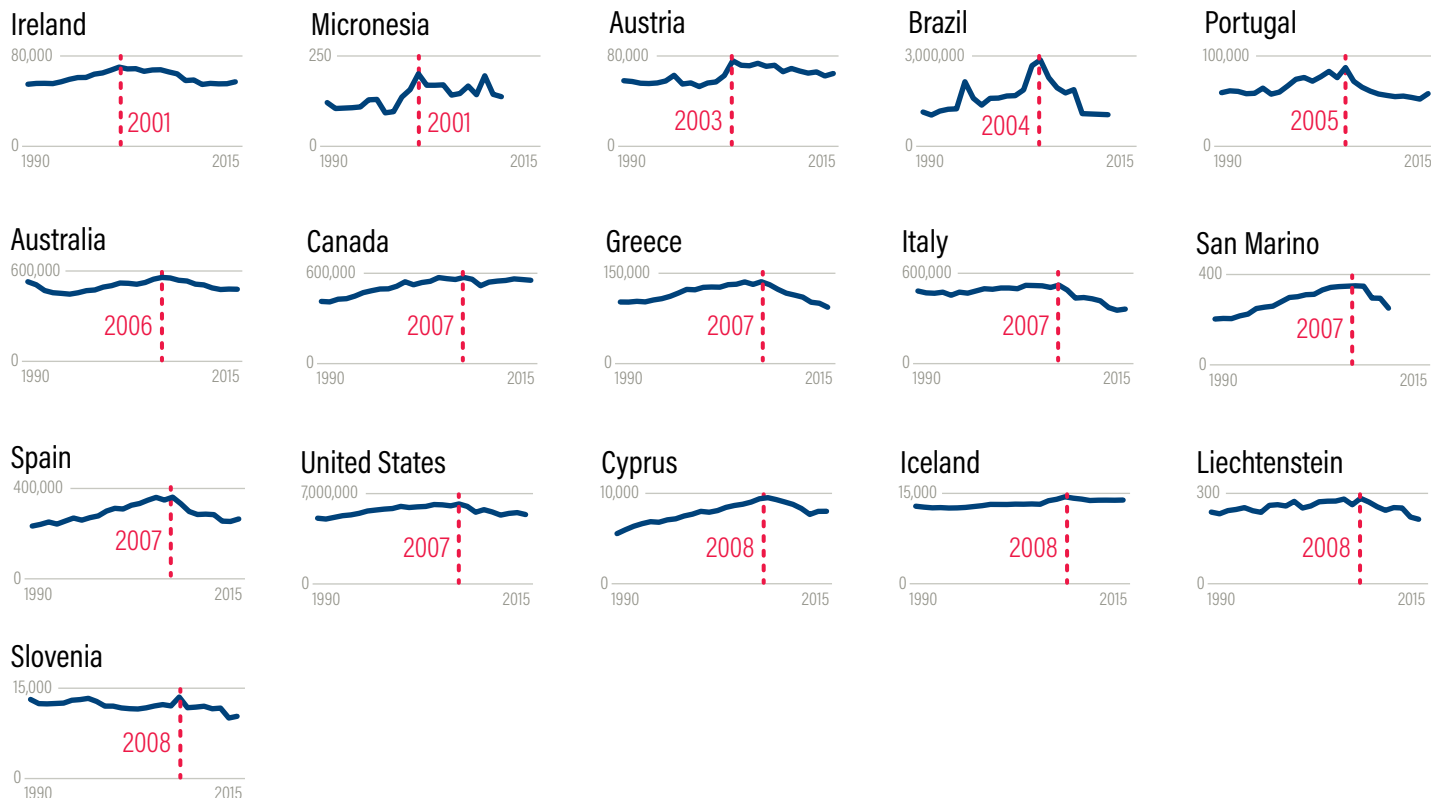
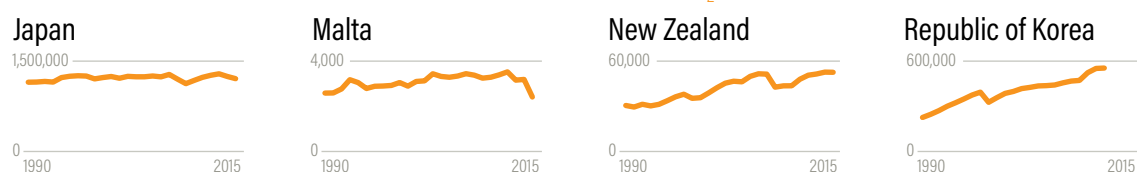


Figure 4 | Emissions of Countries That Peaked or Have a Commitment That Implies Emissions Peak (continued)

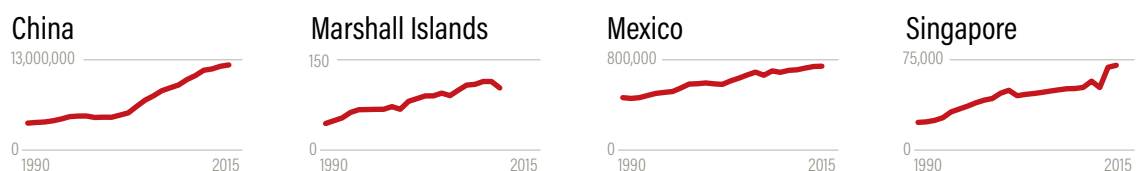
PEAKED IN 2001-2010 (ktCO₂e)



COMMITMENTS THAT IMPLY A PEAK BY 2020 (ktCO₂e)

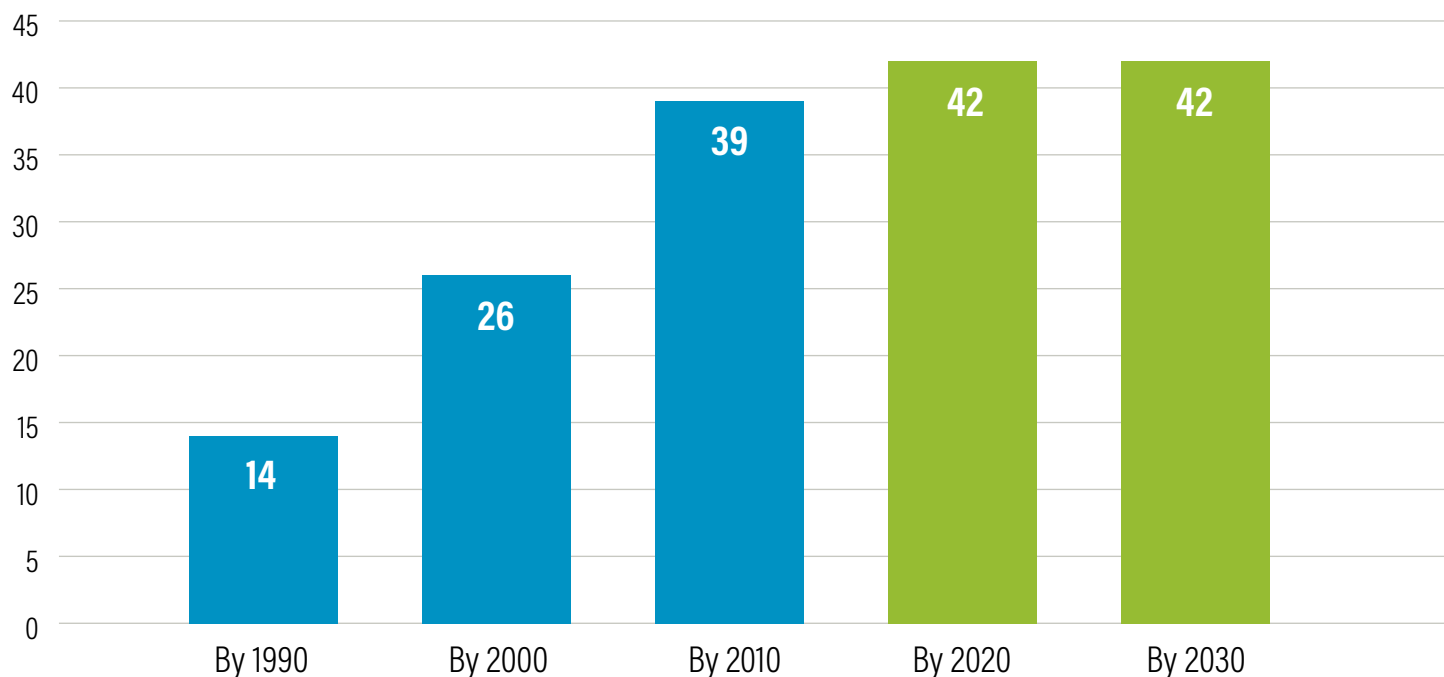


COMMITMENTS THAT IMPLY A PEAK BY 2030 (ktCO₂e)



Notes: Data are greenhouse gas emissions including LULUCF, in ktCO₂ equivalent
Source for Annex I countries and selected non-Annex I countries: UNFCCC Data Interface
Source for non-Annex I countries not included in UNFCCC Data Interface: PIK PRIMAP database

Figure 5 | **Number of Annex I Countries That Peaked or Have a Commitment That Implies a Peak, by Decade (Cumulative)**



Notes: Blue bars represent historical peaking, while green bars represent future commitments to peak. The total number of Annex I countries is 43 (not counting the EU separately). The figure includes the United States as peaking by 2010, despite U.S. plans to withdraw from the Paris Agreement, which calls into question whether the INDC will be achieved.

3.2 Results by Decade

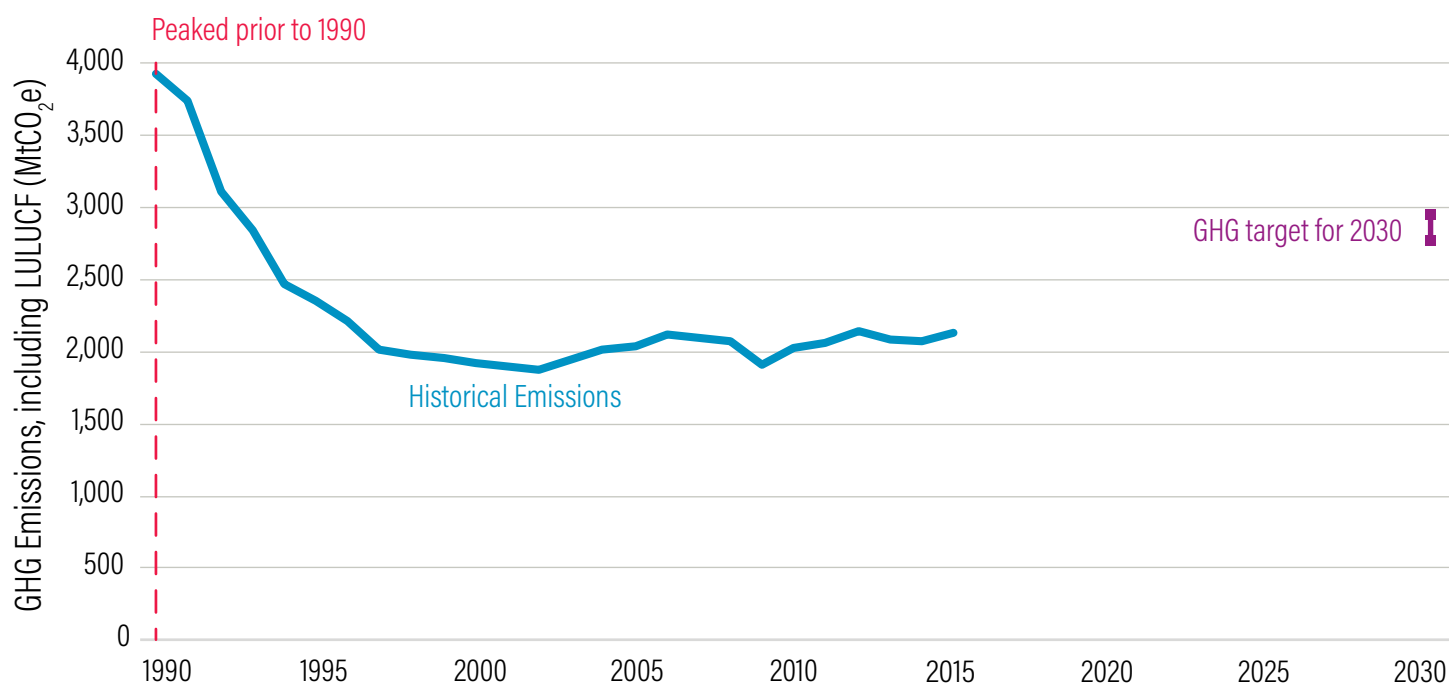
This section focuses on how countries' peaking evolves over time, organized by decade.

By 1990

In 1990, 21 percent of global emissions came from countries that had peaked. Sixteen of the 19 countries with emissions that peaked in or prior to 1990 were former Soviet republics and/or economies in transition under the UNFCCC.¹⁹ The economic collapse after the breakup of the Soviet Union resulted in several former Soviet republics' emissions declining sharply. The other countries that

peaked by 1990 are Germany, Norway, and Serbia. The EU's emissions as a whole also peaked by 1990, as nine of the countries peaking by 1990 are EU member states, including Germany, which is the EU member state with the largest emissions.

As an example, Russia's emissions peaked prior to 1990. While Russia's commitments for 2020 and 2030 indicate an intended increase from recent emissions levels, Russia's future commitments do not propose to surpass 1990 emissions levels (see Figure 6).

Figure 6 | Russia's Historical Emissions and Estimated Future Emissions Associated with GHG Target

Source: Emissions data, including data used to calculate GHG target levels, are from the UNFCCC Data Interface.

Notes: The calculation of GHG targets does not account for land sector accounting approaches or the use of internationally transferred mitigation outcomes.

By 2000

In 2000, 18 percent of global emissions came from countries that had peaked. This included 33 countries—those that peaked by 1990 plus additional European countries (such as Belgium, Denmark, Finland, France, the Netherlands, Sweden, Switzerland, and the United Kingdom) and Costa Rica. Of the 33 countries that had peaked by 2000, 30 are Annex I countries or former Soviet republics—all except for Costa Rica, Serbia, and Montenegro.

By 2010

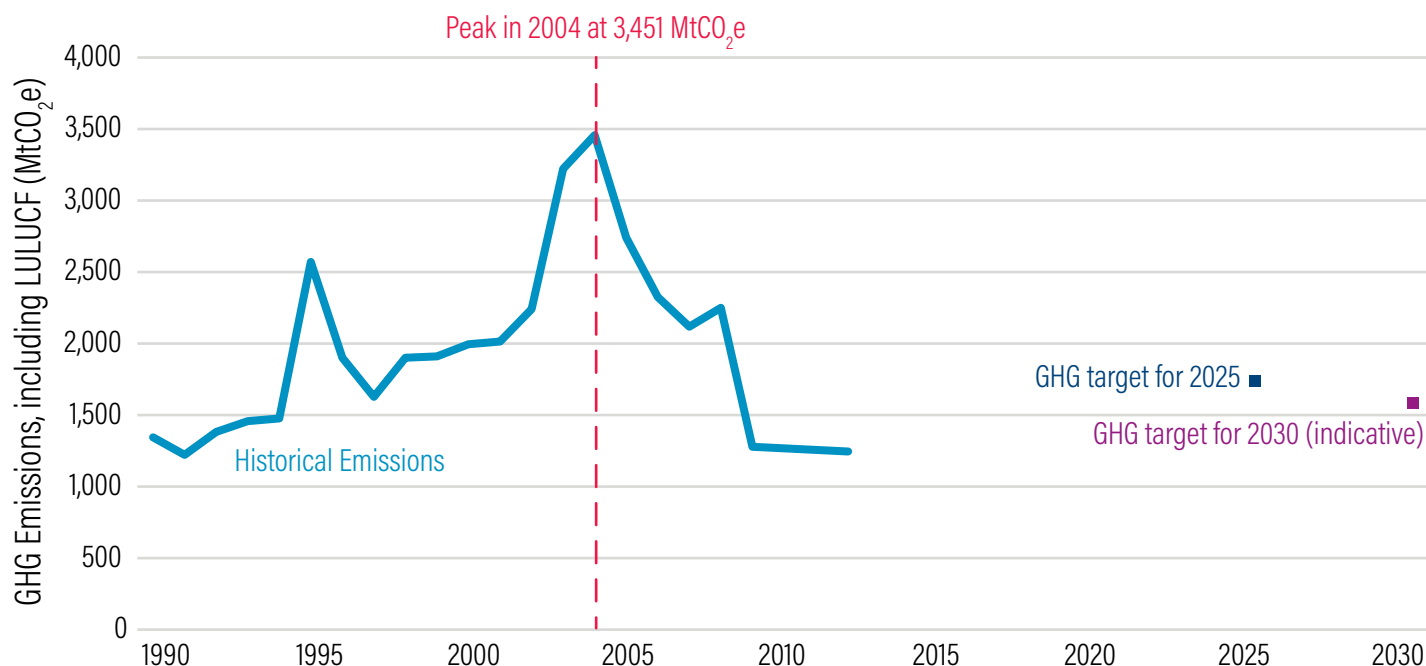
In 2010, 36 percent of global emissions came from countries that had peaked and have a commitment to keep emissions below the peak level. This includes 49 countries—those already mentioned plus additional European countries (such as Austria, Iceland, Ireland, Spain, Portugal), as well as Australia, Brazil, Canada, Micronesia, and the United States.

Many of the countries that peaked by 2010 are Annex I countries with Kyoto Protocol targets. By 2010, 39 of

43 Annex I countries had peaked (all except for Japan, Malta, New Zealand, and Turkey). By 2010, 27 of the 28 EU member states had peaked (all except for Malta). Of the 48 countries that peaked by 2010, 42 are either European countries, former Soviet republics, or both. The other 6 are the United States, Canada, Australia, Costa Rica, Micronesia, and Brazil. Non-Annex I countries that peaked by 2010 or earlier include Azerbaijan, Brazil, Costa Rica, Georgia, Micronesia, Moldova, Montenegro, San Marino, Serbia, and Tajikistan.

Brazil is the first major emitting developing country with emissions to peak, reaching a maximum level in 2004, as shown in Figure 7. Brazil's commitments for 2025 and 2030 indicate that the country does not intend to surpass peak emissions levels in the future. Brazil's peak and subsequent emissions reduction is primarily a result of actions to reduce deforestation in the Amazon region (Observatório do Clima 2014). Brazil's emissions, excluding LULUCF, have not yet peaked.

Figure 7 | **Brazil's Historical Emissions and Estimated Future Emissions Associated with GHG Targets**



Source: Emissions data, including data used to calculate GHG target levels, are from the UNFCCC Data Interface.

Notes: Historical emissions data use GWP values from the IPCC Second Assessment Report, which are the same used to calculate GHG target levels using the base year of 2005. However, in its INDC, Brazil included absolute GHG emissions levels in 2025 (1,300 MtCO₂e) and 2030 (1,200 MtCO₂e) calculated based on GWP values from the IPCC Fifth Assessment Report. We include 2025 and 2030 values based on Second Assessment Report GWP values for consistency with the historical data. The calculation of the GHG targets does not account for land sector accounting approaches or the use of internationally transferred mitigation outcomes.

By 2020

By 2020, 40 percent of global emissions (using 2010 emissions data rather than 2020 projected emissions) are expected to come from countries that have already peaked or have a commitment to peak by 2020. This includes 53 countries—those already mentioned, plus Japan, the Republic of Korea, Malta,²⁰ and New Zealand. These four countries have commitments that imply an emissions peak by 2020 as a result of their pledges associated with the Copenhagen Accord. By 2020, 42 of 43 Annex I countries are expected to peak, all except for Turkey.

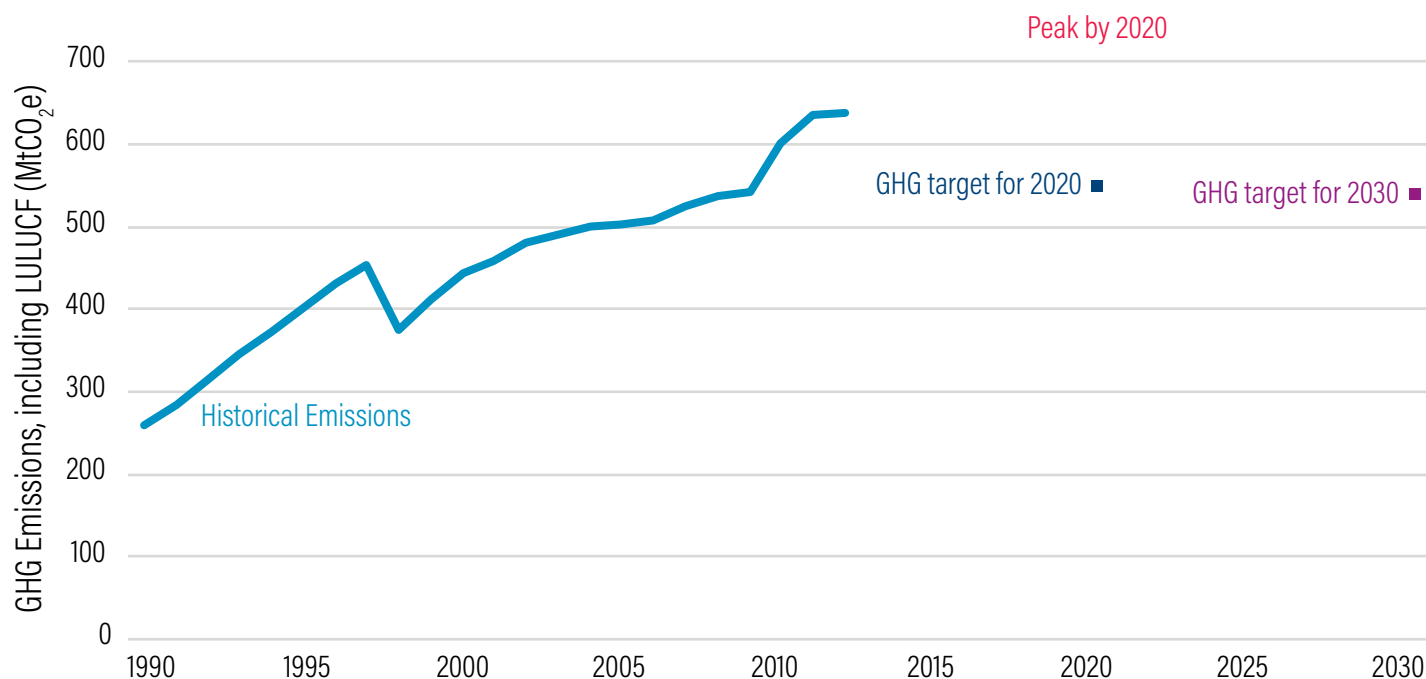
The Republic of Korea is an example of a non-Annex I country with a Copenhagen pledge to reduce emissions in 2020 below recent levels, indicating an intent for emissions to peak prior to 2020 and remain below the peak in 2030, as shown in Figure 8.

By 2030

By 2030, 60 percent of global emissions (using 2010 emissions data rather than 2030 projected emissions) are expected to come from countries that have already peaked or have a commitment to peak by 2030. This includes 57 countries—those already mentioned plus four non-Annex I countries: China (CO₂ only), the Marshall Islands, Mexico, and Singapore.

Countries' commitments for 2030—INDCs under the Paris Agreement—represent a shift with more developing countries adopting economy-wide emissions reduction commitments, including a commitment for emissions to peak or decline. For example, China's INDC includes a commitment for CO₂ emissions to peak around 2030. In previous decades, primarily developed countries adopted targets that implied a peak and decline of emissions. With the INDCs, developing countries have increasingly adopted targets that imply a peak. This trend is described further in the next section.

Figure 8 | The Republic of Korea's Historical Emissions and Estimated Future Emissions Associated with GHG Targets



Source: Emissions data are from the UNFCCC Data Interface.

Notes: Data include LULUCF emissions, but the Republic of Korea notes "a decision on whether to include land use, land-use change and forestry (LULUCF) will be made at a later stage." The calculation of the GHG targets does not account for land sector accounting approaches or the use of internationally transferred mitigation outcomes.

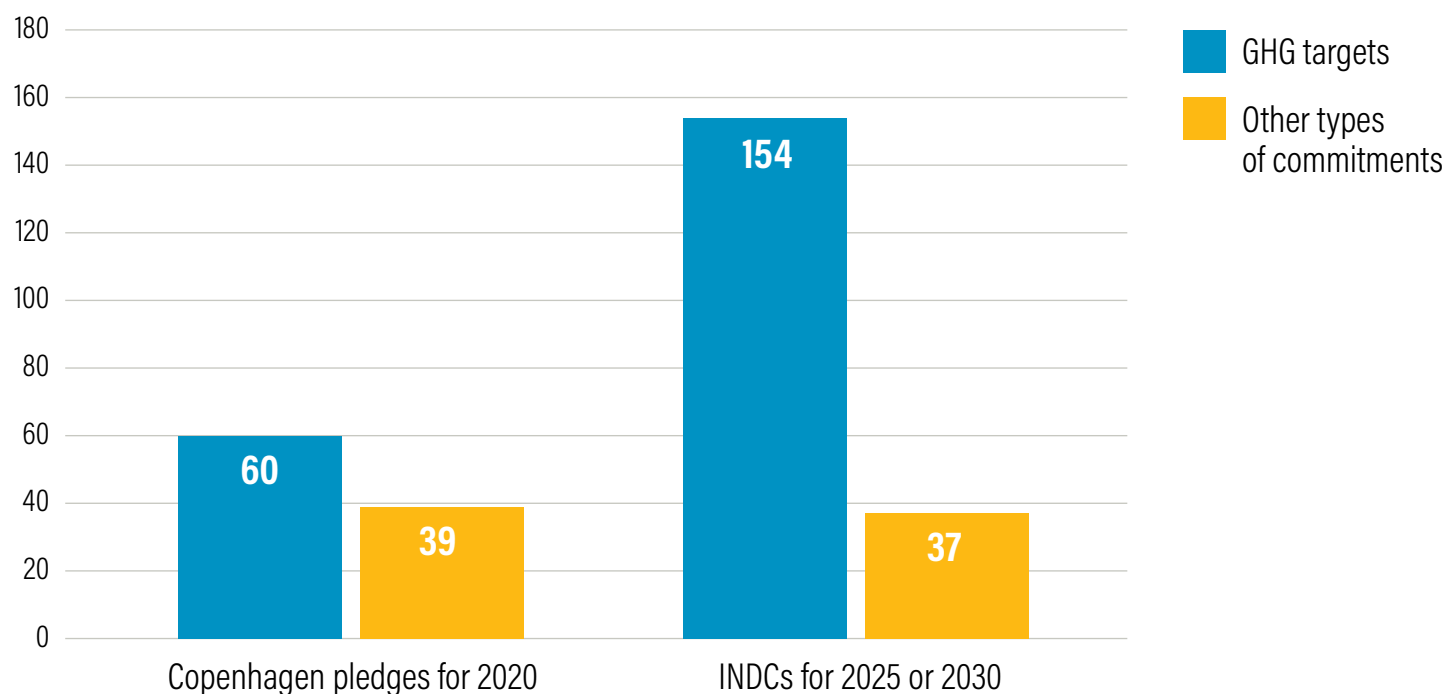
3.3 Trends in Countries' Mitigation Commitments over Time

In 2009 and 2010, 99 countries put forward pledges for 2020 under the Copenhagen and Cancun Agreements. These pledges included quantified economy-wide emissions reduction targets from 41 developed countries (separately counting the member states of the EU), as well as nationally appropriate mitigation actions (NAMAs) from 58 developing countries. Of these 99 pledges, 60 are GHG targets, while 39 are sectoral non-GHG targets and/or actions (WRI 2017). Table 2 provides a further breakdown by type of GHG target.

Beginning in 2015, 192 countries put forward INDCs, which included emissions reduction commitments for 2025 or 2030. (This includes 28 EU member states as separate countries, even though the EU submitted a single INDC). Of the 192 countries, 155 countries (or 81 percent) have GHG targets, while 37 countries (or 19 percent) have mitigation contributions in the form of actions and/or sectoral non-GHG targets, rather than GHG targets (WRI 2017). Table 2 provides a further breakdown by type of GHG target.

The increasing number of GHG targets from 60 countries (adopted in 2009–10) to 154 countries (adopted in 2015) represents significant progress in countries taking on targets that aim to limit overall emissions (see Figure 9). Many of these GHG targets imply a peak of emissions by 2030, such as those with base year emissions targets, fixed-level targets, and trajectory targets. However, not all GHG targets imply a future emissions peak. Baseline scenario targets, intensity targets, and sectoral non-GHG targets and/or actions generally do not aim to peak and reduce total emissions. Among the INDCs, the majority of GHG targets are baseline scenario targets, which limit emissions relative to a business-as-usual (BAU) emissions projection but in general allow for growth in absolute emissions over time. As countries prepare to update or communicate new NDCs by 2020, countries with targets that allow for growth in absolute emissions should consider taking on transparent GHG targets that specify when absolute emissions are expected to peak and then decline and state the intended level of emissions in future years.

Figure 9 | Increasing Number of GHG Targets in INDCs Compared to Copenhagen Pledges



Source: WRI (2017).

Table 2 | Changes in Mitigation Targets between the Copenhagen Pledges and INDCs

TYPES OF MITIGATION COMMITMENTS	COPENHAGEN PLEDGES FOR 2020: NUMBER (AND PERCENTAGE) OF MITIGATION PLEDGES OF EACH TYPE, OUT OF 99 TOTAL COUNTRIES	INDCs FOR 2025 OR 2030: NUMBER (AND PERCENTAGE) OF MITIGATION PLEDGES OF EACH TYPE, OUT OF 192 TOTAL COUNTRIES
GHG Targets	60 (61%)	155 (81%)
Base year targets (which imply a peak of emissions)	44 (44%)	60 (31%)
Fixed-level targets (which imply a peak of emissions)	3 (3%)	5 (3%)
Trajectory targets (which imply a peak of emissions)	0 (0%)	4 (2%)
Baseline scenario targets	11 (11%)	78 (41%)
Intensity targets	2 (2%)	8 (4%)
Sectoral Non-GHG Targets and/or Actions (without a GHG Target)	39 (39%)	37 (19%)

Source: WRI (2017).

Notes: Some of the targets in the table are conditional while others are unconditional. The results in this paper only consider countries with unconditional targets as having a commitment for emissions to peak (described in Section 2). Some countries have multiple types of GHG targets. China and Singapore both have trajectory targets that aim to peak emissions by 2030 as well as intensity targets that aim to reduce emissions intensity per unit of GDP for the same period. In order not to count both countries twice, for the purposes of this table we count them as having a trajectory target that implies a peak and consider the intensity target as a means of achieving the peaking target. Mexico has a baseline scenario target but also notes that the target implies a net emissions peak starting from 2026. In this table, we count Mexico as having a baseline scenario target (based on Mexico's classification of its own target as such), while also counting Mexico as having a peaking commitment for 2030 in the main results.

3.4 Alternative Scenarios for the United States and China

The main results presented in Sections 3.1 and 3.2 use a set of assumptions for which countries have peaked or have a commitment to peak and show the United States as having peaked in 2007 and China as having a commitment to peak by 2030. This section shows how the results would change if different assumptions are used for each case. China and the United States are the two highest emitting countries in the world, and both have special circumstances surrounding their peaking commitments.

Alternative scenario #1: assuming the United States does not peak due to plans to withdraw from the Paris Agreement

The main results consider the United States to be a country that peaked (in 2007) with a commitment to keep emissions below the peak. The Trump Administration recently announced plans to withdraw from the Paris Agreement, which calls into question whether the INDC will be achieved—a commitment to reduce emissions 26 to 28 percent below 2005 levels by 2025. The United States also has a target in the range of a 17 percent emissions reduction by 2020, compared with 2005 levels. However, even without federal effort taken to achieve the INDC, it is unlikely that U.S. emissions will increase beyond the maximum emissions level in 2007, due to market trends in the energy sector (such as low natural gas prices leading to the displacement of coal by natural gas in the electricity sector) and ongoing climate and renewable energy policies by states, cities, and businesses.

Table 3 provides results if the United States is not considered a peaking country, using the assumption that a country should only be considered a peaking country if it has a commitment to remain below the peak. Table 3 (Scenario 1) shows that, under this scenario, the percentage of global emissions represented by peaking countries is reduced (compared to the main results) from 36 percent to 22 percent in 2010, 40 percent to 26 percent in 2020, and 60 percent to 46 percent in 2030. The main results would apply if the United States adopts the emissions targets in the INDC again in the future.

Alternative scenario #2: assuming China is not considered a country with a peaking commitment

The main results consider China to be a country with a commitment to peak by 2030. The peaking target covers CO₂ emissions only, rather than all GHG emissions. China's CO₂ emissions accounted for 78 percent of its total GHG emissions in 2010 (based on the PIK PRIMAP database) and 82 percent in 2012 (based on China's most recent Biennial Update Report submitted to the UNFCCC), including net emissions from LULUCF. Without China considered as a peaking country, based on the assumption that the peaking target must cover all GHG emissions in order to be counted as a peaking country, the global percentage numbers for 2030 are reduced from 60 percent to 42 percent, as shown in Table 3 (Scenario 2). While this scenario is not likely to occur, since China has a commitment to peak its CO₂ emissions around 2030, it shows the importance of China's achieving its CO₂ peaking target to enable global emissions to peak.

Alternative scenario #3: assuming both China and the United States do not peak

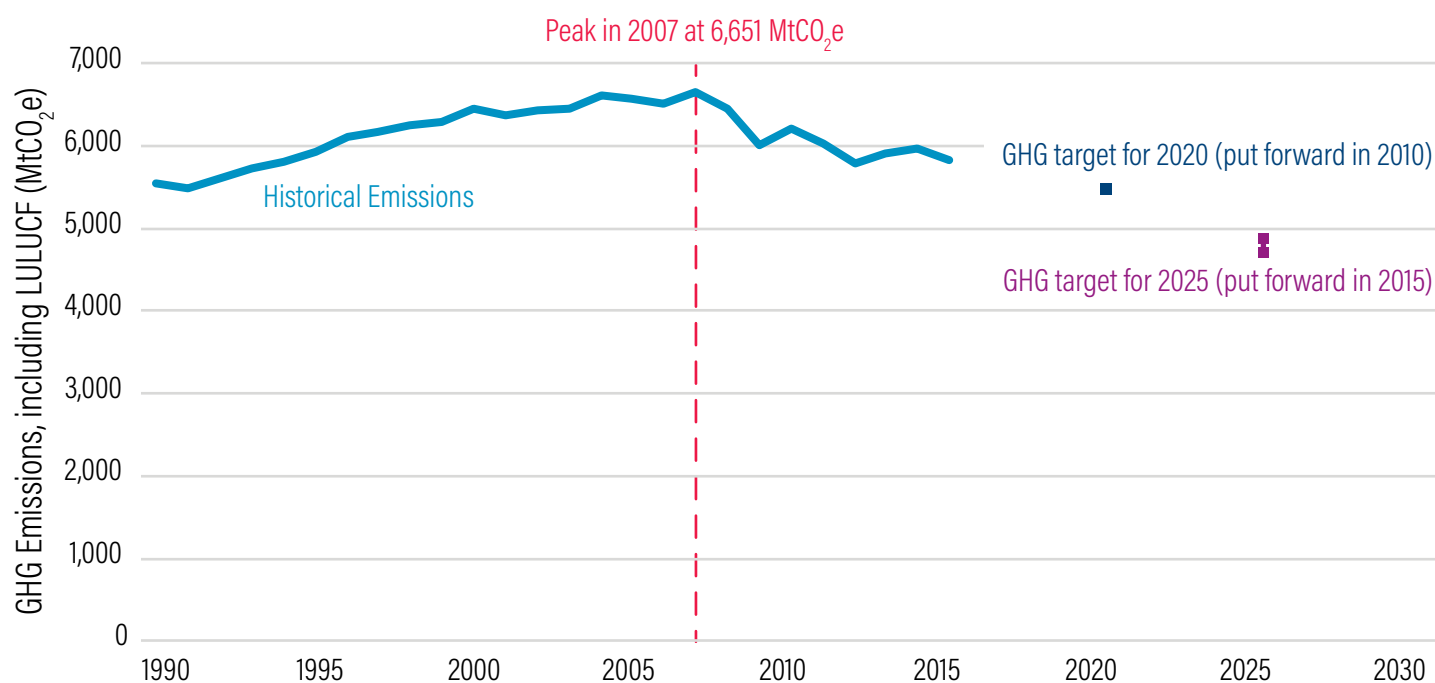
If neither the United States nor China is considered as a peaking country, the global percentage numbers for 2030 are reduced from 60 percent to 28 percent, as shown in Table 3 (Scenario 3). If this unlikely scenario occurs, where the United States and China—the world's two highest emitters, together accounting for 37 percent of global emissions in 2010—do not peak, then the ability for global emissions to peak in the near term is significantly compromised.

Table 3 | **Results If the United States and/or China Are Not Counted as Peaking Countries**

DECADE	PERCENTAGE OF GLOBAL EMISSIONS COVERED BY COUNTRIES THAT HAVE PEAKED, BY DECADE (CUMULATIVE)			
	MAIN RESULTS PRESENTED IN SECTION 3: THE UNITED STATES AND CHINA ARE BOTH COUNTED AS PEAKING COUNTRIES	ALTERNATIVE SCENARIO #1: THE UNITED STATES IS NOT COUNTED AS A PEAKING COUNTRY (BUT CHINA IS INCLUDED)	ALTERNATIVE SCENARIO #2: CHINA IS NOT COUNTED AS A PEAKING COUNTRY (BUT THE U.S. IS INCLUDED)	ALTERNATIVE SCENARIO #3: NEITHER THE UNITED STATES NOR CHINA IS COUNTED AS A PEAKING COUNTRY
1990	21%	21%	21%	21%
2000	18%	18%	18%	18%
2010	36%	22%	36%	22%
DECADE	PERCENTAGE OF GLOBAL EMISSIONS COVERED BY COUNTRIES THAT HAVE PEAKED OR HAVE A COMMITMENT THAT IMPLIES A PEAK, BY DECADE (CUMULATIVE)			
	MAIN RESULTS PRESENTED IN SECTION 3: THE UNITED STATES AND CHINA ARE BOTH COUNTED AS PEAKING COUNTRIES	ALTERNATIVE SCENARIO #1: THE UNITED STATES IS NOT COUNTED AS A PEAKING COUNTRY (BUT CHINA IS INCLUDED)	ALTERNATIVE SCENARIO #2: CHINA IS NOT COUNTED AS A PEAKING COUNTRY (BUT THE U.S. IS INCLUDED)	ALTERNATIVE SCENARIO #3: NEITHER THE UNITED STATES NOR CHINA IS COUNTED AS A PEAKING COUNTRY
2020	40%	26%	40%	26%
2030	60%	46%	42%	28%

Notes: The 1990, 2000, and 2010 results use 1990, 2000, and 2010 emissions data, respectively, for the calculations. The 2020 and 2030 results use 2010 emissions data for the calculations because reliable country-specific projections data for 2020 and 2030 are not available. Therefore, 2020 and 2030 results are not projections of the share of global emissions covered by countries expected to peak in those years because they use the global share of GHG emissions emitted by different countries in 2010, and the relative share of emissions coming from different countries is expected to change by 2020 and 2030. The results for 2030 include China's CO₂ emissions (from 2010) in the numerator and China's total GHG emissions (from 2010) in the denominator because China's peaking target is for CO₂ only.

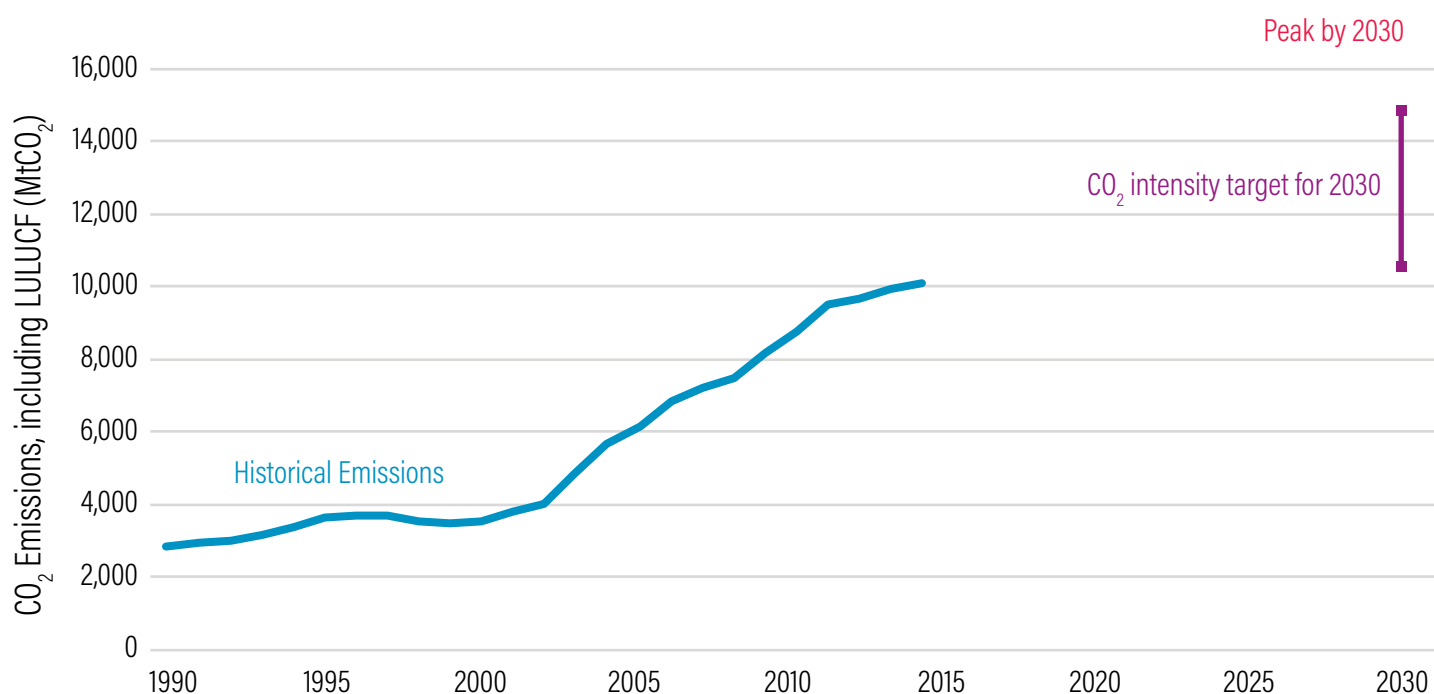
Figure 10 | **United States' Historical Emissions and Estimated Future Emissions Associated with GHG Targets**



Source: Emissions data, including data used to calculate GHG target levels, is from the UNFCCC Data Interface.

Notes: The United States recently announced plans to withdraw from the Paris Agreement, which calls into question whether its NDC will be achieved. The calculation of GHG targets does not account for land sector accounting approaches or the use of internationally transferred mitigation outcomes.

Figure 11 | China's Historical Emissions and Estimated Future Emissions Associated with GHG Target



Source: Emissions data are from the PIK PRIMAP database. Estimated CO₂ target levels for 2030 are based on a range of likely GDP values from Ross et al. (2016), based on China's target to reduce CO₂ emissions intensity (per unit of GDP) by 60–65% by 2030.

Notes: The graph includes CO₂ emissions only, rather than total GHG emissions, since China's peaking target is limited to CO₂ only. China has not stated an intended peak level of CO₂ emissions by 2030, therefore the peaking target cannot be represented in the graph based on the information the government has provided. The CO₂ target range for 2030 is not a projection of where emissions are likely to be in 2030, but instead the estimated emissions range associated with China's CO₂ intensity target for 2030. The range is a result of the 60–65% range in China's intensity target as well as a range of likely GDP growth projections for 2030. For more information, see Ross et al. (2016). The calculation of GHG targets does not account for land sector accounting approaches or the use of internationally transferred mitigation outcomes.

4. CONCLUSIONS AND RECOMMENDATIONS

This paper demonstrates that we are seeing an increase in the number of countries that have peaked their emissions or pledged to do so in the future. Peaking represents a critical turning point; no longer are emissions rising, but they are falling, and steep declines in GHG emissions are necessary for our ability to avoid the most dangerous climate impacts. Many countries are accepting a future in which economic development proceeds while GHG emissions decline.

Still, the number of countries that have peaked emissions or have commitments that imply an emissions peak and the global share of emissions they represent is not large enough to enable the world's emissions to peak in the near term. In addition to the timing of peaking, the level at which countries' emissions peak, especially for major

emitters, is still insufficient to lead to peaking of global emissions before 2030, based on current projections, (Levin and Fransen 2015b, UNEP 2015, UNEP 2016) and to meet the temperature goals of the Paris Agreement.

The Paris Agreement urges that global emissions peak “as soon as possible” if we are to limit warming to between 1.5 and 2°C. The scientific literature finds that global emissions peaking by 2020 is necessary for a least-cost chance of meeting the Agreement's temperature goals (for a greater than 66 percent probability of achieving 2°C and a 50 percent probability of achieving 1.5°C) (UNEP 2014, UNEP 2015, UNEP 2016). Unfortunately, projections show that global emissions will not peak by 2020, and, looking further into the future, emissions (averaged across model runs) are expected to continue to rise through 2030, even if the INDCs are achieved (Levin and Fransen, 2015b, UNEP 2015, UNEP 2016).

Box 2 | Recommendations for Countries' Peaking Commitments

Global peaking will be determined by the cumulative emissions of all countries, which depends on three factors: the timing of countries' emissions peaking, the level at which emissions peak, and rate of emissions reductions thereafter. This is especially true for major emitting countries that will play a significant role in determining when and at what level global emissions peak. This paper makes the following general recommendations regarding each factor:

- **Timing of countries' emissions peaking:** Countries that have not yet peaked and do not yet have a commitment to peak should consider how soon their emissions can peak and decline thereafter and make a commitment to do so aligned with that timing. Countries that have a commitment that implies a peak in the future (e.g., in 2020 or 2030) should consider whether they can peak more quickly.
- **Level at which emissions peak:** Countries that have a commitment that implies a peak in the future (e.g., in 2020 or 2030) should consider whether they can peak at a lower emissions level. Countries that have not yet peaked or have not established a commitment that implies a future emissions peak should set a target to peak emissions. All countries should be transparent about the emissions level at which they commit to peaking so that the research community can assess how far off track the world is from the 1.5–2°C goal.
- **Rate of emissions reductions after peaking:** All countries should commit to a significant rate of emissions reductions after peaking in line with long-term rates of decarbonization needed to limit warming to 1.5–2°C. Countries that have historically peaked still have a critical role to play in determining the timing and level of global emissions peaking, as each country's decarbonization rate after peaking will be a defining factor in global cumulative emissions.

Countries can make these commitments when communicating or updating their NDCs under the Paris Agreement in 2020. Countries may also do so sooner, since under the Agreement, countries may at any time adjust their existing NDCs with a view to enhancing the level of ambition.

Since the Paris Agreement includes a long-term goal to reach zero net emissions in the second half of this century,²¹ and current projections forecast growing emissions rather than a global emissions peak, countries around the world need to adopt more stringent emissions reduction targets and implement more aggressive mitigation measures as soon as possible.

The more we delay necessary reductions, the greater the need for rapid reductions in subsequent decades. Not only will this pose greater risks of economic disruption, require significant technology transitions to overcome locked-in carbon-intensive technologies, and rely on unproven technologies to achieve negative emissions, it will also increase the risks of higher temperatures, which would lead to higher adaptation costs and challenges (Clarke et al., 2014). Delayed action until 2030, for example, will give us only a 50-50 chance of limiting warming to 2°C; whereas concerted action now will reduce the risks of delay, as well as reduce the risks of failing to meet the Paris Agreement's temperature targets (UNEP 2014).

Given the overwhelming evidence of the risks of significant—or even catastrophic—impacts from inaction, countries should commit to peaking their emissions as early as possible. Furthermore, it will be important for countries not only to commit to peaking, but also to peak at emissions levels that are as low as possible, peak as soon as possible, and ensure a significant rate of decline thereafter because all of these factors will determine future cumulative emissions and, in turn, our ability to limit the amount of warming and dangerous climate impacts that will occur. See Box 2 for a summary of recommendations for countries' peaking commitments.

Cities, subnational governments, businesses, and other actors, many of which have already embraced emissions reduction commitments, can contribute significantly to countries' ability to peak emissions more quickly and at lower levels and to decarbonize thereafter, by pursuing ambitious climate action. In doing so, they can allow countries to be more ambitious in their commitments as well. These nonstate and subnational actors should also act to peak and reduce emissions as soon as possible alongside national governments to help meet the goals of the Paris Agreement and avoid the worst impacts of climate change.

The global community should also take regular stock of when individual countries and global emissions have peaked or are expected to peak. Based on the findings, financial assistance and technical expertise should be provided to countries that need it to help them in their effort to peak as soon as possible and at lower emissions levels to help reach global temperature goals.

APPENDIX A. COUNTRIES THAT HAVE PEAKED OR HAVE A COMMITMENT THAT IMPLIES A PEAK IN THE FUTURE

PEAK YEAR	COUNTRY	UNFCCC GROUP	EMISSIONS IN PEAK YEAR (TOTAL GHG EMISSIONS WITH LULUCF, IN ktCO ₂ e)	PERCENT OF GLOBAL GHG EMISSIONS IN 2010 (WITH LULUCF)	GHG TARGETS INCLUDED IN THE COUNTRY'S INDC (UNCONDITIONAL ONLY)
1990 or earlier	Azerbaijan	Non-Annex I	69,696 (in 1990)	0.1%	By 2030, the Republic of Azerbaijan targets 35% reduction in the level of GHG emissions compared to 1990 base year as its contribution to the global climate change efforts.
1990 or earlier	Belarus	Annex I (EIT)	115,810 (in 1990)	0.2%	The Republic of Belarus undertakes by 2030 to reduce GHG emissions by at least 28% of the 1990 level, excluding emissions and removals in the LULUCF sector and without any additional conditions.
1990 or earlier	Bulgaria	Annex I (EIT)	88,630 (in 1990)	0.1%	The EU and its member states are committed to a binding target of an at least 40% domestic reduction in GHG emissions by 2030 compared to 1990, to be fulfilled jointly.
1990 or earlier	Croatia	Annex I (EIT)	24,564 (in 1990)	0.1%	The EU and its member states are committed to a binding target of an at least 40% domestic reduction in GHG emissions by 2030 compared to 1990, to be fulfilled jointly.
1990 or earlier	Czech Republic	Annex I (EIT)	189,339 (in 1990)	0.3%	The EU and its member states are committed to a binding target of an at least 40% domestic reduction in GHG emissions by 2030 compared to 1990, to be fulfilled jointly.
1990 or earlier	Estonia	Annex I (EIT)	38,668 (in 1990)	0.04%	The EU and its member states are committed to a binding target of an at least 40% domestic reduction in GHG emissions by 2030 compared to 1990, to be fulfilled jointly.
1990 or earlier	Georgia	Non-Annex I	39,035 (in 1990)	0.03%	Georgia plans to unconditionally reduce its GHG emissions by 15% below the BAU scenario for the year 2030, which translates to emissions of 32.66 MtCO ₂ e in 2030. Emissions in 1990 were 39.035 MtCO ₂ e.
1990 or earlier	Germany	Annex I	1,219,604 (in 1990)	1.9%	The EU and its member states are committed to a binding target of an at least 40% domestic reduction in GHG emissions by 2030 compared to 1990, to be fulfilled jointly.
1990 or earlier	Hungary	Annex I (EIT)	91,224 (in 1990)	0.1%	The EU and its member states are committed to a binding target of an at least 40% domestic reduction in GHG emissions by 2030 compared to 1990, to be fulfilled jointly.
1990 or earlier	Kazakhstan	Annex I ²²	371,831 (in 1990)	0.6%	The Republic of Kazakhstan intends to achieve an economy-wide target of 15% [unconditional target] reduction in GHG emissions by 2030 compared to 1990.
1990 or earlier	Latvia	Annex I (EIT)	17,354 (in 1990)	0.03%	The EU and its member states are committed to a binding target of an at least 40% domestic reduction in GHG emissions by 2030 compared to 1990, to be fulfilled jointly.
1990 or earlier	Moldova	Non-Annex I	37,532 (in 1990)	0.03%	The Republic of Moldova intends to achieve an economy-wide unconditional target of reducing its GHG emissions by 64–67% below its 1990 level in 2030 and to make best efforts to reduce its emissions by 67%.

PEAK YEAR	COUNTRY	UNFCCC GROUP	EMISSIONS IN PEAK YEAR (TOTAL GHG EMISSIONS WITH LULUCF, IN ktCO _{2e})	PERCENT OF GLOBAL GHG EMISSIONS IN 2010 (WITH LULUCF)	GHG TARGETS INCLUDED IN THE COUNTRY'S INDC (UNCONDITIONAL ONLY)
1990 or earlier	Norway	Annex I	41,279 (in 1990)	0.1%	Norway is committed to a target of an at least 40% reduction of GHG emissions by 2030 compared to 1990 levels.
1990 or earlier	Romania	Annex I (EIT)	226,889 (in 1990)	0.2%	The EU and its member states are committed to a binding target of an at least 40% domestic reduction in GHG emissions by 2030 compared to 1990, to be fulfilled jointly.
1990 or earlier	Russian Federation	Annex I (EIT)	3,929,756 (in 1990)	5.3%	Limiting anthropogenic GHGs in Russia to 70–75% of 1990 levels by the year 2030 might be a long-term indicator, subject to the maximum possible account of absorbing capacity of forests.
1990 or earlier	Serbia	Non-Annex I	80,800 (in 1990)	0.1%	The Republic of Serbia intends to reduce GHG emissions by 9.8% by 2030 compared to 1990 levels.
1990 or earlier	Slovakia	Annex I (EIT)	65,469 (in 1990)	0.1%	The EU and its member states are committed to a binding target of an at least 40% domestic reduction in GHG emissions by 2030 compared to 1990, to be fulfilled jointly.
1990 or earlier	Tajikistan	Non-Annex I	22,265 (in 1990)	0.01%	Without attracting new substantial international funding, Tajikistan communicates "a flexible target, not exceeding 80–90% of the 1990 level by 2030, which amounts to 1.7–2.2 tons in CO ₂ equivalent per capita."
1990 or earlier	Ukraine	Annex I (EIT)	910,319 (in 1990)	0.8%	Ukraine will not exceed 60% of 1990 GHG emissions level in 2030.
1991	France	Annex I	551,155	1.1%	The EU and its member states are committed to a binding target of an at least 40% domestic reduction in GHG emissions by 2030 compared to 1990, to be fulfilled jointly.
1991	Lithuania	Annex I (EIT)	46,146	0.04%	The EU and its member states are committed to a binding target of an at least 40% domestic reduction in GHG emissions by 2030 compared to 1990, to be fulfilled jointly.
1991	Luxembourg	Annex I	13,138	0.02%	The EU and its member states are committed to a binding target of an at least 40% domestic reduction in GHG emissions by 2030 compared to 1990, to be fulfilled jointly.
1991	Montenegro	Non-Annex I	5,031	0.004%	Montenegro's contribution to the international effort to avoid dangerous climate change is expressed [as a] 30% emission reduction by 2030 compared to the 1990 base year. The emission level of GHGs for Montenegro from sectors covered by INDC was 5,239 kilotons in 1990, and Montenegro pledges to reduce it at least by 1,572 kilotons, to the level below or at 3,667 kilotons.
1991	United Kingdom of Great Britain and Northern Ireland	Annex I	810,972	1.2%	The EU and its member states are committed to a binding target of an at least 40% domestic reduction in GHG emissions by 2030 compared to 1990, to be fulfilled jointly.
1992	Poland	Annex I (EIT)	447,233	0.8%	The EU and its member states are committed to a binding target of an at least 40% domestic reduction in GHG emissions by 2030 compared to 1990, to be fulfilled jointly.

PEAK YEAR	COUNTRY	UNFCCC GROUP	EMISSIONS IN PEAK YEAR (TOTAL GHG EMISSIONS WITH LULUCF, IN ktCO ₂ e)	PERCENT OF GLOBAL GHG EMISSIONS IN 2010 (WITH LULUCF)	GHG TARGETS INCLUDED IN THE COUNTRY'S INDC (UNCONDITIONAL ONLY)
1993	Sweden	Annex I	41,085	0.1%	The EU and its member states are committed to a binding target of an at least 40% domestic reduction in GHG emissions by 2030 compared to 1990, to be fulfilled jointly.
1994	Finland	Annex I	61,897	0.2%	The EU and its member states are committed to a binding target of an at least 40% domestic reduction in GHG emissions by 2030 compared to 1990, to be fulfilled jointly.
1996	Belgium	Annex I	155,904	0.3%	The EU and its member states are committed to a binding target of an at least 40% domestic reduction in GHG emissions by 2030 compared to 1990, to be fulfilled jointly.
1996	Denmark	Annex I	94,863	0.1%	The EU and its member states are committed to a binding target of an at least 40% domestic reduction in GHG emissions by 2030 compared to 1990, to be fulfilled jointly.
1996	Netherlands	Annex I	248,362	0.4%	The EU and its member states are committed to a binding target of an at least 40% domestic reduction in GHG emissions by 2030 compared to 1990, to be fulfilled jointly.
1999	Costa Rica	Non-Annex I	18,400	0.0%	Costa Rica is committed to a maximum of 9,374 ktCO ₂ eq net emissions by 2030. These numbers are consistent with the necessary global path to comply with 2°C goal. Costa Rica's commitment includes an emissions reduction of 25% compared to 2012 emissions.
2000	Monaco	Annex I	108	0.0003%	The Principality of Monaco wishes to contribute to the joint effort by adopting a target to reduce its emissions by 50% by 2030, compared with the reference year of 1990.
2000	Switzerland	Annex I	57,383	0.1%	Switzerland commits to reduce its GHG emissions by 50% by 2030 compared to 1990 levels, corresponding to an average reduction of GHG emissions by 35% over the period 2021–30. By 2025, a reduction of GHGs by 35% compared to 1990 levels is anticipated.
2001	Ireland	Annex I	77,844	0.1%	The EU and its member states are committed to a binding target of an at least 40% domestic reduction in GHG emissions by 2030 compared to 1990, to be fulfilled jointly.
2001	Micronesia, Federated States of	Non-Annex I	204	0.0003%	The Federated States of Micronesia commits to unconditionally reduce by 2025 28% of its GHG emissions below emissions in 2000.
2003	Austria	Annex I	87,005	0.2%	The EU and its member states are committed to a binding target of an at least 40% domestic reduction in GHG emissions by 2030 compared to 1990, to be fulfilled jointly.
2004	Brazil	Non-Annex I	3,451,210	2.6%	Brazil intends to commit to reduce GHG emissions by 37% below 2005 levels in 2025.
2005	Portugal	Annex I	87,654	0.1%	The EU and its member states are committed to a binding target of an at least 40% domestic reduction in GHG emissions by 2030 compared to 1990, to be fulfilled jointly.
2006	Australia	Annex I	610,176	1.1%	Australia will implement an economy-wide target to reduce GHG emissions by 26–28% below 2005 levels by 2030.

PEAK YEAR	COUNTRY	UNFCCC GROUP	EMISSIONS IN PEAK YEAR (TOTAL GHG EMISSIONS WITH LULUCF, IN ktCO ₂ e)	PERCENT OF GLOBAL GHG EMISSIONS IN 2010 (WITH LULUCF)	GHG TARGETS INCLUDED IN THE COUNTRY'S INDC (UNCONDITIONAL ONLY)
2007	Canada	Annex I	712,129	1.4%	Canada intends to achieve an economy-wide target to reduce its GHG emissions by 30% below 2005 levels by 2030.
2007	Greece	Annex I	133,216	0.2%	The EU and its member states are committed to a binding target of an at least 40% domestic reduction in GHG emissions by 2030 compared to 1990, to be fulfilled jointly.
2007	Italy	Annex I	555,783	1.0%	The EU and its member states are committed to a binding target of an at least 40% domestic reduction in GHG emissions by 2030 compared to 1990, to be fulfilled jointly.
2007	San Marino	Non-Annex I	397	0.001%	The Republic of San Marino commits to reduce GHG emissions to 20% below 2005 levels by 2030.
2007	Spain	Annex I	401,775	0.7%	The EU and its member states are committed to a binding target of an at least 40% domestic reduction in GHG emissions by 2030 compared to 1990, to be fulfilled jointly.
2007	United States of America	Annex I	6,650,571	14.2%	The United States intends to achieve an economy-wide target of reducing its greenhouse gas emissions by 26–28% below its 2005 level in 2025 and to make best efforts to reduce its emissions by 28%. [Note: The United States recently announced plans to withdraw from the Paris Agreement, which calls into question whether the INDC will be achieved.]
2008	Cyprus	Annex I	9,931	0.02%	The EU and its member states are committed to a binding target of an at least 40% domestic reduction in GHG emissions by 2030 compared to 1990, to be fulfilled jointly.
2008	Iceland	Annex I	15,412	0.01%	Iceland aims to be part of a collective delivery by European countries to reach a target of 40% reduction of GHG emissions by 2030 compared to 1990 levels.
2008	Liechtenstein	Annex I	281	0.0005%	Liechtenstein aims at a reduction of GHGs by 40% compared to 1990 by 2030.
2008	Slovenia	Annex I (EIT)	14,554	0.04%	The EU and its member states are committed to a binding target of an at least 40% domestic reduction in GHG emissions by 2030 compared to 1990, to be fulfilled jointly.
By 2020	Japan	Annex I	Not yet peaked (maximum emissions in the available dataset were 1,339,379 in 2013)	2.6%	Japan's INDC toward post-2020 GHG emission reductions is at the level of a reduction of 26.0% by fiscal year (FY) 2030 compared to FY 2013 (25.4% reduction compared to FY 2005) (approximately 1.042 billion tCO ₂ e as 2030 emissions).
By 2020	Korea, Republic of	Non-Annex I	Not yet peaked (maximum emissions in the available dataset were 637,494 in 2012)	1.2%	The Republic of Korea plans to reduce its GHG emissions by 37% from the BAU (850.6 MtCO ₂ eq) level by 2030 across all economic sectors. (The INDC implies an emissions level of 536 MtCO ₂ eq in 2030, while emissions in 2012 were 637 MtCO ₂ eq.)

PEAK YEAR	COUNTRY	UNFCCC GROUP	EMISSIONS IN PEAK YEAR (TOTAL GHG EMISSIONS WITH LULUCF, IN ktCO ₂ e)	PERCENT OF GLOBAL GHG EMISSIONS IN 2010 (WITH LULUCF)	GHG TARGETS INCLUDED IN THE COUNTRY'S INDC (UNCONDITIONAL ONLY)
By 2020	Malta	Annex I	Not yet peaked (maximum emissions in the available dataset were 3,236 in 2012)	0.01%	The EU and its member states are committed to a binding target of an at least 40% domestic reduction in GHG emissions by 2030 compared to 1990, to be fulfilled jointly.
By 2020	New Zealand	Annex I	Not yet peaked (maximum emissions in the available dataset were 56,472 in 2014)	0.2%	New Zealand commits to reduce GHG emissions to 30% below 2005 levels by 2030. (This responsibility target corresponds to a reduction of 11% from 1990 levels.)
By 2030 (CO ₂ only)	China	Non-Annex I	Not yet peaked (maximum emissions in the available dataset were 12,800,000 in 2014)	22.7% (Note: Includes China's total GHG emissions, while the peaking target is for CO ₂ only)	China has nationally determined its actions by 2030 as follows: <ul style="list-style-type: none"> ■ to achieve the peaking of carbon dioxide emissions around 2030 and making best efforts to peak early; ■ to lower carbon dioxide emissions per unit of GDP by 60% to 65% from the 2005 level; ■ to increase the share of nonfossil fuels in primary energy consumption to around 20%; and ■ to increase the forest stock volume by around 4.5 billion cubic meters on the 2005 level.
By 2030	Marshall Islands	Non-Annex I	Not yet peaked (maximum emissions in the available dataset were 124 in 2014)	0.0002%	The Republic of the Marshall Islands (RMI) commits to a quantified economy-wide target to reduce its emissions of GHGs to 32% below 2010 levels by 2025. RMI communicates, as an indicative target, its intention to reduce its emissions of GHGs to 45% below 2010 levels by 2030.
By 2030	Mexico	Non-Annex I	Not yet peaked (maximum emissions in the available dataset were 704,718 in 2011)	1.5%	Mexico is committed to reduce unconditionally 25% of its GHGs and short-lived climate pollutants emissions (below BAU) for the year 2030. This commitment implies a reduction of 22% of GHG and a reduction of 51% of black carbon. This commitment implies a net emissions peak starting from 2026, decoupling GHG emissions from economic growth. Emissions intensity per unit of GDP will be reduced by around 40% from 2013 to 2030.
By 2030	Singapore	Non-Annex I	Not yet peaked (maximum emissions in the available dataset were 87,400 in 2014)	0.1%	Singapore communicates that it intends to reduce its emissions intensity by 36% from 2005 levels by 2030, and stabilize its emissions with the aim of peaking around 2030.

Source for emissions data: UNFCCC Data Interface (http://di.unfccc.int/time_series and http://di.unfccc.int/ghg_profile_non_annex1), except for China, Costa Rica, Marshall Islands, Micronesia, San Marino, Serbia, and Singapore, which are from the PIK PRIMAP database because complete UNFCCC data are not available.

APPENDIX B. TOP 10 EMITTING COUNTRIES (TOGETHER ACCOUNTING FOR 64% OF GLOBAL EMISSIONS IN 2010) AND WHETHER THEY HAVE PEAKED OR HAVE A COMMITMENT THAT IMPLIES A PEAK IN THE FUTURE

EMISSIONS RANK IN 2010	COUNTRY	PERCENT OF GLOBAL GHG EMISSIONS IN 2010 (WITH LULUCF)	UNFCCC GROUP	PEAK YEAR	EMISSIONS IN PEAK YEAR (TOTAL GHG EMISSIONS WITH LULUCF, IN ktCO ₂ e)	GHG TARGETS INCLUDED IN THE COUNTRY'S INDC (UNCONDITIONAL ONLY)
1	China	22.7% (Note: Includes China's total GHG emissions, while the peaking target is for CO ₂ only)	Non-Annex I	By 2030 (CO ₂ only)	Not yet peaked (maximum emissions in the available dataset were 12,800,000 in 2014)	China has nationally determined its actions by 2030 as follows: <ul style="list-style-type: none"> ■ to achieve the peaking of carbon dioxide emissions around 2030 and making best efforts to peak early; ■ to lower carbon dioxide emissions per unit of GDP by 60% to 65% from the 2005 level; ■ to increase the share of nonfossil fuels in primary energy consumption to around 20%; and ■ to increase the forest stock volume by around 4.5 billion cubic meters on the 2005 level.
2	United States of America	14.2%	Annex I	2007	6,650,571 (in 2007)	The United States intends to achieve an economy-wide target of reducing its GHG emissions by 26–28% below its 2005 level in 2025 and to make best efforts to reduce its emissions by 28%. [Note: The United States recently announced plans to withdraw from the Paris Agreement, which calls into question whether the INDC will be achieved.]
3	India	7.8%	Non-Annex I	Has not yet peaked; no commitment to peak	Not yet peaked (maximum emissions in the available dataset were 4,480,000 in 2014)	Conditional INDC only: <ul style="list-style-type: none"> ■ To reduce the emissions intensity of its GDP by 33–35% by 2030 from 2005 level. ■ To achieve about 40% cumulative electric power installed capacity from nonfossil-fuel-based energy resources by 2030 with the help of transfer of technology and low-cost international finance including from Green Climate Fund. ■ To create an additional carbon sink of 2.5 to 3 billion tonnes of CO₂ equivalent through additional forest and tree cover by 2030.
4	Russian Federation	5.3%	Annex I (EIT)	1990 or earlier	3,929,756 (in 1990)	Limiting anthropogenic GHGs in Russia to 70–75% of 1990 levels by the year 2030 might be a long-term indicator, subject to the maximum possible account of absorbing capacity of forests.
5	Indonesia	4.2%	Non-Annex I	Has not yet peaked; no commitment to peak	Not yet peaked (maximum emissions in the available dataset were 2,220,000 in 2011)	Indonesia has committed to reduce unconditionally 26% of its GHGs against the BAU scenario by 2020. Indonesia is committed to reducing emissions by 29% compared to the BAU scenario by 2030.
6	Japan	2.6%	Annex I	By 2020	Not yet peaked (maximum emissions in the available dataset were 1,339,379 in 2013)	Japan's INDC toward post-2020 GHG emission reductions is at the level of a reduction of 26.0% by fiscal year (FY) 2030 compared to FY 2013 (25.4% reduction compared to FY 2005) (approximately 1.042 billion tCO ₂ e as 2030 emissions).
7	Brazil	2.6%	Non-Annex I	2004	3,451,210 (in 2004)	Brazil intends to commit to reduce GHG emissions by 37% below 2005 levels in 2025.
8	Germany	1.9%	Annex I	1990 or earlier	1,219,604 (in 1990)	The EU and its member states are committed to a binding target of an at least 40% domestic reduction in GHG emissions by 2030 compared to 1990, to be fulfilled jointly.

EMISSIONS RANK IN 2010	COUNTRY	PERCENT OF GLOBAL GHG EMISSIONS IN 2010 (WITH LULUCF)	UNFCCC GROUP	PEAK YEAR	EMISSIONS IN PEAK YEAR (TOTAL GHG EMISSIONS WITH LULUCF, IN ktCO ₂ e)	GHG TARGETS INCLUDED IN THE COUNTRY'S INDC (UNCONDITIONAL ONLY)
9	Iran	1.5%	Non-Annex I	Has not yet peaked; no commitment to peak	Not yet peaked (maximum emissions in the available dataset were 827,000 in 2014)	The Islamic Republic of Iran intends to participate by mitigating its GHG emissions in 2030 by 4% compared to the BAU scenario.
10	Mexico	1.5%	Non-Annex I	By 2030	Not yet peaked (maximum emissions in the available dataset were 704,718 in 2011)	Mexico is committed to reduce unconditionally 25% of its GHGs and short-lived climate pollutants emissions (below BAU) for the year 2030. This commitment implies a reduction of 22% of GHG and a reduction of 51% of black carbon. This commitment implies a net emissions peak starting from 2026, decoupling GHG emissions from economic growth: Emissions intensity per unit of GDP will be reduced by around 40% from 2013 to 2030.

Source for emissions data: UNFCCC Data Interface (http://di.unfccc.int/time_series and http://di.unfccc.int/ghg_profile_non_annex1), except for China, India, Indonesia, and Iran, which are from the PIK PRIMAP database because complete UNFCCC data are not available.

ENDNOTES

- Figueres et al. (2017) present a mean budget of around 600 gigatonnes of CO₂ that is consistent with limiting warming to 1.5–2°C. Rogelj et al. (2016) show that the 2°C target can be achieved with the INDCs and accelerated action only after 2030, but only with a lower 50–66 percent probability, and rely on rates of phase-out of fossil fuel use with “no clear historical analogue” and on carbon removal technologies at a scale that remains untested. Furthermore, no scenarios are available for delayed action until 2030 with the current INDCs and a 1.5°C warming limit with a 50 percent probability.
- See, for example, UNEP (2015), UNEP (2016), Rogelj et al. (2016), and den Elzen et al. (2016).
- Figueres et al. (2017) present a mean budget of around 600 gigatonnes of CO₂ that is consistent with limiting warming to 1.5–2°C. Rogelj et al. (2016) show that the 2°C target can be achieved with the INDCs and accelerated action only after 2030, but only with a lower 50–66 percent probability, and rely on rates of phase-out of fossil fuel use with “no clear historical analogue” and on carbon removal technologies at a scale that remains untested. Furthermore, no scenarios are available for delayed action until 2030 with the current INDCs and a 1.5°C warming limit with a 50 percent probability.
- Parties submitted intended nationally determined contributions (INDCs) in the lead-up to the Paris Agreement. These INDCs were converted to nationally determined contributions (NDCs) when a Party submits its respective instrument of ratification, acceptance, approval, or accession of the Paris Agreement. In general, this paper uses the term INDCs for simplicity.
- den Elzen et al. (2016) analyzes when G20 countries peak but does not analyze trends across all countries. UNEP (2015), UNEP (2016), Rogelj et al. (2016), and den Elzen et al. (2016) also discuss peaking of global and regional emissions.
- For more information, see: <https://www.carbonbrief.org/the-35-countries-cutting-the-link-between-economic-growth-and-emissions>.
- Figueres et al. (2017) present a mean budget of around 600 gigatonnes of CO₂ that is consistent with limiting warming to 1.5–2°C. Rogelj et al. (2016) shows that the 2°C target can be achieved with the INDCs and accelerated action only after 2030, but only with a lower 50–66 percent probability, and rely on rates of phase-out of fossil fuel use with “no clear historical analogue” and on carbon removal technologies at a scale that remains untested. Furthermore, no scenarios are available for delayed action until 2030 with the current INDCs and a 1.5°C warming limit with a 50 percent probability.
- Emissions and removals in the land sector can be highly variable. Adopting a 5- to 10-year base period for the land sector helps minimize the effects of interannual variability on GHG accounting in the land sector (WRI 2014).
- A base year target is a mitigation target that aims to reduce or control the increase of emissions relative to an emissions level in a historical base year (WRI and UNDP 2015).
- A fixed-level target is a mitigation target that aims to reduce, or limit the increase of, emissions to an absolute emissions level in a target year (WRI and UNDP 2015).

11. A trajectory target is a commitment to reduce or control the increase of emissions to specified emissions quantities in multiple target years or periods over a long time period (such as targets for 2020, 2030, and 2040 over the period 2020–50). Trajectory targets also include peak-and-decline targets, such as emissions peaking at a specified level in 2025 and declining thereafter, or a peak, plateau, and decline target, which additionally specifies that emissions will remain constant for a period after peaking and before declining (WRI and UNDP 2015).
12. A baseline scenario target is a mitigation target that aims to reduce emissions by a specified quantity relative to projected baseline scenario emissions (WRI and UNDP 2015).
13. An intensity target is a mitigation target that aims to reduce emissions intensity (emissions per unit of another variable, typically GDP) by a specified quantity relative to a historical base year (WRI and UNDP 2015).
14. The Republic of Korea provided the projected BAU emissions level in 2030 in the mitigation contribution INDC text, which enables a calculation of the intended emissions level in 2030, showing a target level of emissions that is below historical emissions levels, assuming the BAU emissions level does not change. Mexico's INDC states that the national emissions reduction target relative to a baseline scenario implies a peak of total emissions around 2026, although this is not the central commitment in the INDC. The intended peak is also confirmed by Mexico's recently released biennial update report (SEMARNAT 2015). Based on this, we consider Mexico to be a country with an INDC that implies a peak by 2030.
15. For example, see Climate Action Tracker (<https://www.climateadvisers.com/trumpbacktracker>), Climate Advisers (http://climateactiontracker.org/assets/publications/briefing_papers/CAT_2017-05-15_Briefing_India-China-USA.pdf), Climate Interactive (<https://www.climateinteractive.org/analysis/us-role-in-paris> and <https://www.climateinteractive.org/media-coverage/what-slashing-climate-rules-means-for-the-u-s-pledge-to-paris>), Resources for the Future (<http://www.rff.org/blog/2017/trump-paris-and-greenhouse-gas-emissions>), and Rhodium Group (<http://rhg.com/notes/trumps-regulatory-rollback-begins> and <http://rhg.com/reports/taking-stock-2017-adjusting-expectations-for-us-ghg-emissions>).
16. Greenhouse gas emissions data for Annex I countries are available at http://di.unfccc.int/time_series. Non-Annex I data are available at http://di.unfccc.int/ghg_profile_non_annex1. Data for this paper were accessed in October 2017.
17. Available at <http://doi.org/10.5880/PIK.2017.001>. Underlying data sources used in the PRIMAP database include UNFCCC National Communications and National Inventory Reports for developing countries: UNFCCC (2017), UNFCCC Biennial Update Reports: UNFCCC (2016), UNFCCC Common Reporting Format (CRF): UNFCCC (2013), UNFCCC (2014), BP Statistical Review of World Energy: BP (2016), CDIAC: Boden et al. (2016), EDGAR versions 4.2 and 4.2 FT2010: JRC and PBL (2011), Olivier and Janssens-Maenhout (2012), FAOSTAT database: Food and Agriculture Organization of the United Nations (2016), Houghton land use CO₂: Houghton (2008); RCP historical data: Meinshausen et al. (2011), EDGAR-HYDE 1.4: Van Aardenne et al. (2001), Olivier and Berdowski (2001), HYDE land cover data: Klein Goldewijk et al. (2010), Klein Goldewijk et al. (2011), SAGE Global Potential Vegetation Dataset: Ramankutty and Foley (1999), and FAO Country Boundaries: Food and Agriculture Organization of the United Nations (2015).
18. The total number of Annex I Parties is 44 including the European Union, but for our analysis we do not count the European Union separately, so we instead use a total of 43 Annex I countries (including individual European countries).
19. According to the UNFCCC, "Annex I Parties are the industrialized countries who have historically contributed the most to climate change. They include both the relatively wealthy countries that were members of the Organization for Economic Co-operation and Development (OECD) in 1992, and countries with "economies in transition" (known as EITs), that is, the Russian Federation and several other Central and Eastern European countries. The UNFCCC allows EITs "a certain degree of flexibility" in implementing their commitments, owing to the major economic and political upheavals that have taken place in these countries. Several EITs have invoked this clause to choose a baseline earlier than 1990, that is, before the economic changes which led to big reductions in their emissions." (UNFCCC 2017).
20. Malta is assumed to have a target to reduce emissions below 1990 levels by 2020 based on European Commission (2016).
21. The Paris Agreement, Article 4, states, "In order to achieve the long-term temperature goal set out in Article 2, Parties aim to reach global peaking of greenhouse gas emissions as soon as possible, recognizing that peaking will take longer for developing country Parties, and to undertake rapid reductions thereafter in accordance with best available science, so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century, on the basis of equity, and in the context of sustainable development and efforts to eradicate poverty."
22. Kazakhstan became an Annex I Party to the Kyoto Protocol but remains a non-Annex I Party to the Convention. In this paper, we count Kazakhstan as an Annex I country.

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ABOUT WRI

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Our Challenge

Natural resources are at the foundation of economic opportunity and human well-being. But today, we are depleting Earth's resources at rates that are not sustainable, endangering economies and people's lives. People depend on clean water, fertile land, healthy forests, and a stable climate. Livable cities and clean energy are essential for a sustainable planet. We must address these urgent, global challenges this decade.

Our Vision

We envision an equitable and prosperous planet driven by the wise management of natural resources. We aspire to create a world where the actions of government, business, and communities combine to eliminate poverty and sustain the natural environment for all people.

Our Approach

COUNT IT

We start with data. We conduct independent research and draw on the latest technology to develop new insights and recommendations. Our rigorous analysis identifies risks, unveils opportunities, and informs smart strategies. We focus our efforts on influential and emerging economies where the future of sustainability will be determined.

CHANGE IT

We use our research to influence government policies, business strategies, and civil society action. We test projects with communities, companies, and government agencies to build a strong evidence base. Then, we work with partners to deliver change on the ground that alleviates poverty and strengthens society. We hold ourselves accountable to ensure our outcomes will be bold and enduring.

SCALE IT

We don't think small. Once tested, we work with partners to adopt and expand our efforts regionally and globally. We engage with decision-makers to carry out our ideas and elevate our impact. We measure success through government and business actions that improve people's lives and sustain a healthy environment.

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