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TALLYING UPDATED NDCs TO GAUGE EMISSIONS REDUCTIONS IN 2030 AND PROGRESS TOWARD NET ZERO

BY DR. JAMES GLYNN, KIRSTEN NICOLE SMITH, LILLY YEJIN LEE, JORDAN SHENHAR, PEKUN BAKARE, AND DR. MELISSA C. LOTT

MARCH 2022

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Dr. Glynn's research interests focus on developing and applying integrated techno-economic energy systems models and their interactions with the climate, economy, and society to find resilient pathways to future sustainable development goals. He is an expert developer and user of the International Energy Agency's Energy Technology Systems Analysis Programmes' (IEA-ETSAP) TIMES framework. He has led and actively contributes to the global ETSAP-TIAM developer's group exploring novel developments in TIMES energy systems modeling. His national and global model applications have provided insights into Irish, European, and International energy policy, legislation, and investment decisions in collaboration with a broad range of stakeholders.

He is an EU-commission invited expert in energy systems modeling and a reviewer of the EU Commission's DG-ENER new energy systems model METIS. He has given expert witness testimony to government committees on carbon capture and storage (CCS), carbon budgets, and net-zero carbon energy systems transition. He has served on the scientific advisory boards for multiple national and European research projects, such as the German DLR BEAM-ME project on high-performance optimization algorithms. He collaborates on numerous international energy-climate networks, including the Integrated Assessment Modeling Consortium (IAMC) and JPI-Climate. He is an affiliate invited member of the IEA-ETSAP executive committee. He has successfully led multiple national and international research & consulting project consortia.

Dr. Glynn's recent publications include;

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2. improving the technical realism of the power sector in integrated assessment models,
3. the impact of future climate on the technical operation of the energy system,
4. the role of direct air carbon capture and storage in global mitigation scenarios,
5. the impact of local air pollution on equitable global decarbonization,
6. as well as the development of the first zero-carbon energy system pathways for Ireland consistent with the Paris Agreement.

He holds two masters degrees (NUIG, Strathclyde) and a PhD (UCC) in areas related to energy systems analysis across engineering, science, and economics. He has affiliations with the Science Foundation Ireland MaREI Centre in University College Cork (UCC) and the engineering faculty in Imperial College London.

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Dr. Melissa C. Lott is a Senior Research Scholar and the Director of Research at the Center on Global Energy Policy, where she co-leads the Power Sector and Renewables Research Initiative. She has worked as an engineer and advisor for more than 15 years in the United States, Europe, and Asia. While her work has spanned the entire energy system, Dr. Lott is internationally recognized for her work in the electricity and transportation sectors. For her research and contributions to global energy sector dialogues, Dr. Lott has been featured as a *Solar 100* Thought Leader, an IEEE *Women in Power*, and a Forbes *30 under 30 in Energy*.

Dr. Lott specializes in technology and policy research, working to increase our understanding of the impacts of our energy systems on air pollution and public health. She directly applies this understanding to help decision-makers mobilize technology and policy solutions to support the transition to low-carbon energy systems. She has authored more than 350 scientific articles, columns, op-eds, journal publications, and reports. Dr. Lott was previously a founding author on Scientific American's *Plugged In*. An active public speaker, she has been featured in interviews with international news organizations including the BBC World Service, ABC News PM in Australia, and Scientific American magazine's French edition.

Prior to joining the Center for Global Energy Policy, Dr. Lott served as the Assistant Vice President of the Asia Pacific Energy Research Centre (APERC), where she led the development of the flagship *APEC Energy Demand and Supply Outlook*. Dr. Lott has also held roles at the International Energy Agency, where she served as the primary author of the IEA's technology roadmap on energy storage. In 2011, Dr. Lott was selected as a U.S. Presidential Management Fellow (PMF). She went on to work as the Lead of Energy Modeling and Simulation for the Program Analysis and Evaluation Office at the U.S. Department of Energy. Dr. Lott has also served as an advisory board member for Alstom and GE and contributed as an expert advisor for government organizations including the London Sustainable Development Commission under Mayor Boris Johnson. Throughout her career, Dr. Lott has worked as a Principal Engineer at YarCom Inc., providing her clients with a practical engineering understanding of the relationships between our energy sources, our energy uses, and the impacts of our choices on the environment.

Dr. Lott holds degrees from the University of California, Davis (Bachelor of Science - Engineering), the University of Texas at Austin (Master of Science – Engineering and Master of Public Affairs), and University College London (Ph.D. in Sustainable Energy Resources and Engineering). While in university, Dr. Lott completed internships at the White House Council on Environmental Quality under President Obama, the U.S. Energy Information Administration, and Sandia National Laboratories in Albuquerque, New Mexico.

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EXECUTIVE SUMMARY

The Paris Agreement included two particularly crucial innovations for supporting greenhouse gas emissions reductions: a voluntary, bottom-up nationally determined contribution (NDC) and a ratchet mechanism. The latter change meant that, in the run-up to the 26th Conference of the Parties (COP26) to the United Nations Framework Convention on Climate Change in Glasgow last fall, countries prepared updated NDCs—specific commitments to reduce emissions by 2030—that outlined their increased ambition. After the adoption of the Glasgow Climate Pact, many observers have focused on what these NDCs, as well as countries' pledges to reach net-zero greenhouse gas emissions by certain dates, could mean for the world's ability to limit global temperature rise to well below 2° Celsius—the central goal of the Paris Agreement. But another critical question remains: how would these targets and ambitions drive near-term emissions reductions. Understanding the answer can provide insights to investors, utilities, or others with decision time horizons of 10–15 years and that wish to align with net-zero ambitions.

This report, part of the energy systems modeling program at Columbia University's Center on Global Energy Policy, aims to assess the alignment between updated NDCs and current net-zero pledges for policy makers and industry leaders to gain insight into their own national and corporate decarbonization outlooks. It considers all classes of NDCs, including: 1) percentage reduction in emissions relative to a historical base year level, 2) percentage reduction compared to a 2030 business-as-usual scenario, and 3) reduction in emissions intensity of gross domestic product. It presents an estimate of the percentage reduction in greenhouse gases (GHGs) from 2015 to 2030 for all commitments outlined in NDCs for countries that also have a net-zero target.

Overall, this analysis finds that the NDCs of economies with 2050 net-zero pledges would lead to a 27 percent reduction in GHG emissions by 2030, relative to 2015. However, countries with post-2050 net-zero pledges are projected to increase their emissions by 10 percent between 2015 and 2030, lowering the net global emission reduction to 9 percent over this period.

Other findings from the report include the following:

- Of the 65 percent of countries with net-zero targets before 2050, the majority are still in the discussion stage; only 14 countries have signed net-zero targets into law. And the range of approaches to what constitutes "net-zero" (some do not specify which GHGs are included, others refer simply to climate neutrality and carbon neutrality) makes comprehensive estimations difficult without further scrutiny and definition.
- A group of G20 countries with net-zero targets *after* 2050, including China, India, and other large GHG emitters, accounted for about 42 percent of all GHG emissions in 2018. Collectively these countries will dominate the uncertainty in global mitigation efforts, because as their emissions continue to grow their share of global emissions will rise even faster as emissions decline in other economies.

- Emissions pathways vary widely. EU, Japan, and US NDCs are projected to lead to a 42–46 percent reduction in emissions by 2030. In India and China, stated ambitions result in an increase in emissions to 2030, followed by decreasing emissions until these countries achieve their net-zero goals after midcentury.
- Pulling together the combined NDCs of countries with any net-zero target, this analysis also highlights the gap in the ambition of NDCs and the trajectory necessary to meet net-zero emissions by 2050.

A workbook accompanying this report includes further details on the NDCs of the 100 largest-emitting economies.

INTRODUCTION

Prior to the Paris Agreement in December 2015, the United Nations Framework Convention on Climate Change (UNFCCC) was primarily structured as a global organization aiming to implement top-down agreement on climate change mitigation and adaptation policy. Previous top-down policy instruments aimed to guide nations and parties to the UNFCCC with collective global mitigation action at the national or local level. This policy structure was slow and led to multiple challenging conferences of the parties (COP), ending in poor or failed policy outcomes in the few years prior to 2015. The Paris Agreement was pivotal in acknowledging that the top-down policy methods were failing to mobilize climate mitigation and adaptation action at the pace and scale that climate science outlines is necessary to limit the most severe impacts of climate change. The agreement included two particularly crucial innovations: a voluntary, bottom-up nationally determined contribution (NDC) structure and a ratchet mechanism.

The architects of the Paris Agreement, Christiana Figures and Laurence Tubiana, led the reinvention of the UNFCCC agreements. In the two years prior to the 21st Conference of the Parties (COP21), the French foreign service was mobilized with a climate action mission. Each party to the UNFCCC volunteered its intended most ambitious NDC—which specifies a commitment to reduce emissions by a certain amount by 2030—to the global climate change mitigation effort. This voluntary bottom-up contribution structure enabled national autonomy concerning the level of ambition of climate action each economy would pledge to the UNFCCC. The Paris Agreement outlines an international consensus where parties that ratified the text agree to document and share their most ambitious plans to reduce greenhouse gases (GHGs) among other commitments on finance and adaptation.

The Paris Agreement text includes a second crucial innovation: a ratchet mechanism. Each party agreed to a global stock take of mitigation plans every five years after the Paris Agreement (UNFCCC 2015). The ratchet mechanism aims to increase the mitigation ambition of each successive NDC, pursuing a goal of 1.5°C temperature stabilization by 2100. The second round of NDC submissions was due to be submitted by 2020 at the 26th Conference of the Parties (COP26). However, as a result of the COVID-19 pandemic, COP26 was delayed by one year and was held in November 2021 in Glasgow, Scotland. It is well documented that the window for opportunity to achieve the Paris Agreement goals is closing rapidly due to a dwindling remaining carbon budget, which makes this ratcheting mechanism even more critical to achieving climate mitigation goals (Rogelj et al. 2018; International Energy Agency 2021).

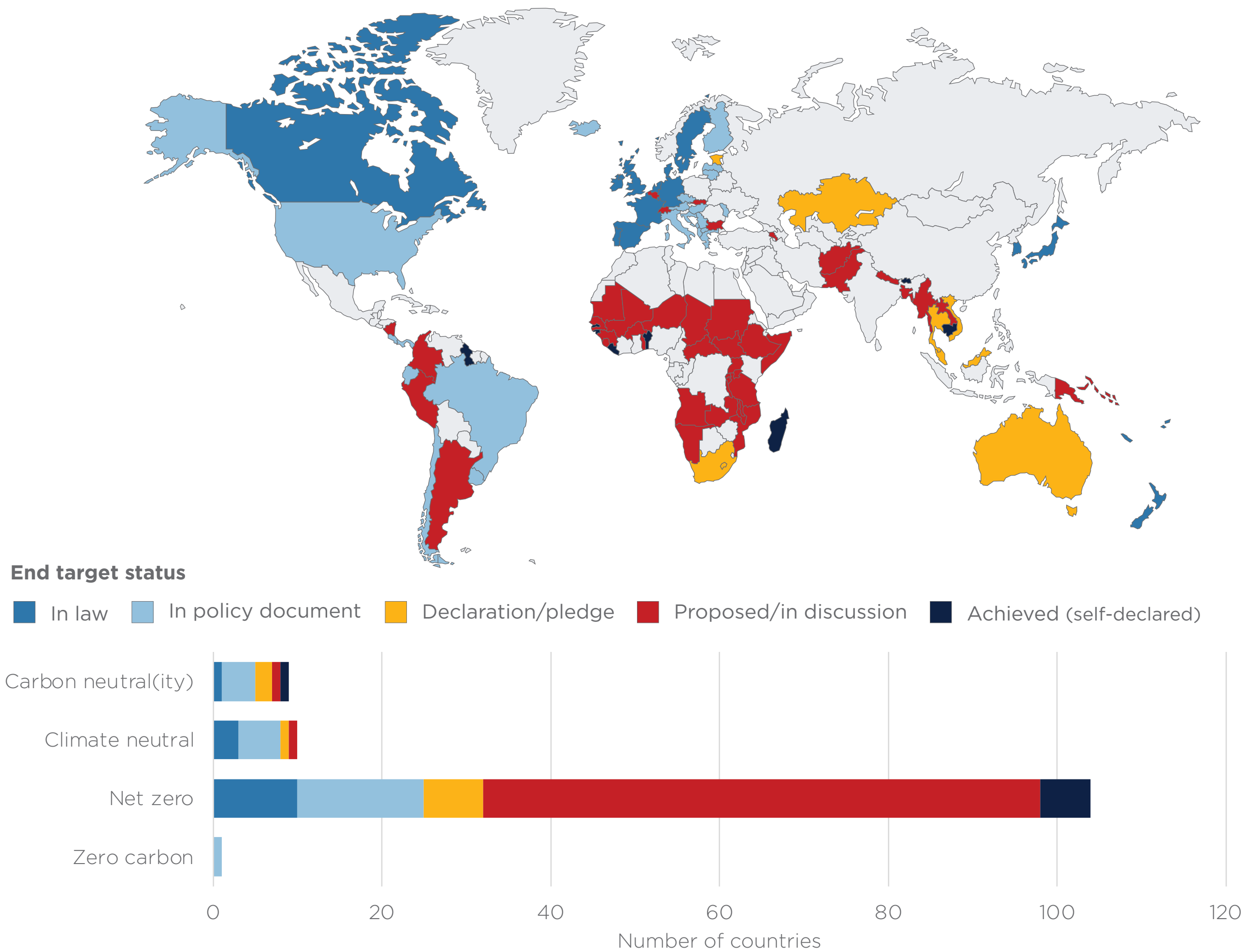
A few items related to these emissions projections are worth noting.

- Of the 65 percent of economies with net-zero targets before 2050, the majority are in the discussion stage, which precludes countries making a pledge or policy document. Furthermore, only 14 economies have signed net-zero targets into law (see Figure 1).

- There is uncertainty resulting from the range of terms to denote “net zero” and what this implies for atmospheric radiative warming by 2050. Some targets refer to “net zero” without specifying which GHGs they relate to or include. Other targets refer to climate neutrality and carbon neutrality. These terms are only starting to be defined in the scientific literature (Rogelj et al. 2015) and often are difficult to quantify within the wording of policy documents without further scrutiny and definition.
- A subset of the Group of Twenty (G20) countries with net-zero targets after 2050, including China, India, and other large GHG emitters, accounted for ~42 percent of all GHG emissions in 2018. Collectively, these countries will dominate the uncertainty in global mitigation efforts because as their emissions continue to grow, their share of global emissions will rise even faster as emissions decline in other economies. (See Figure 2)
- The range of base years used, economic outlooks, and ambiguity in the NDCs’ language mean there is uncertainty in their quantification even to 2030 as discussed below.

The NDCs of the 100 largest emitting economies are reviewed in the accompanying Excel workbook.

Figure 1: Countries with net-zero targets prior to 2050 by net-zero pledge type and policy implementation status

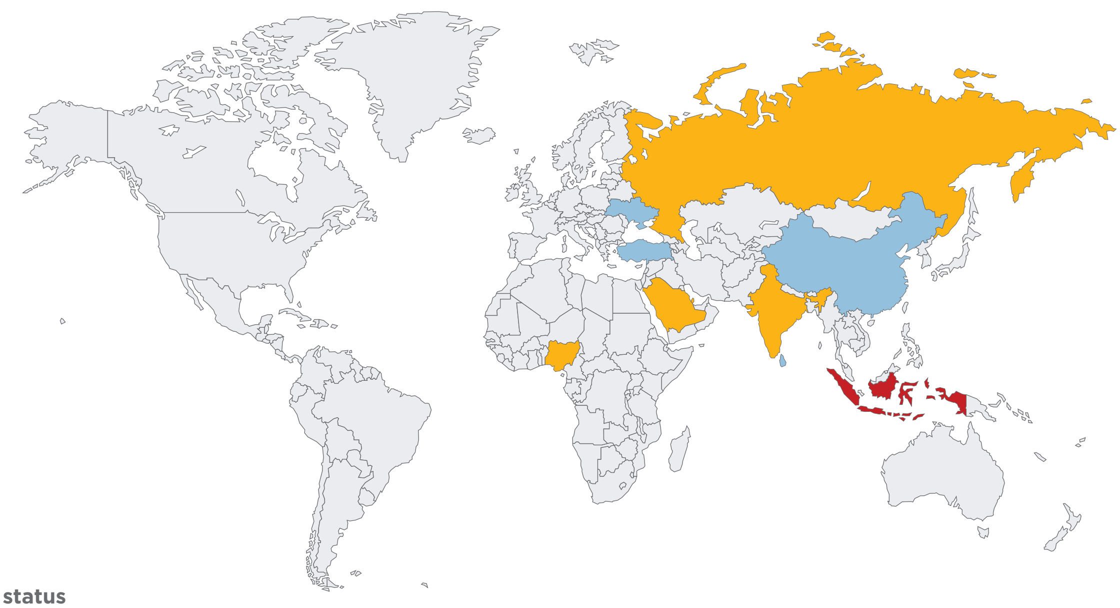


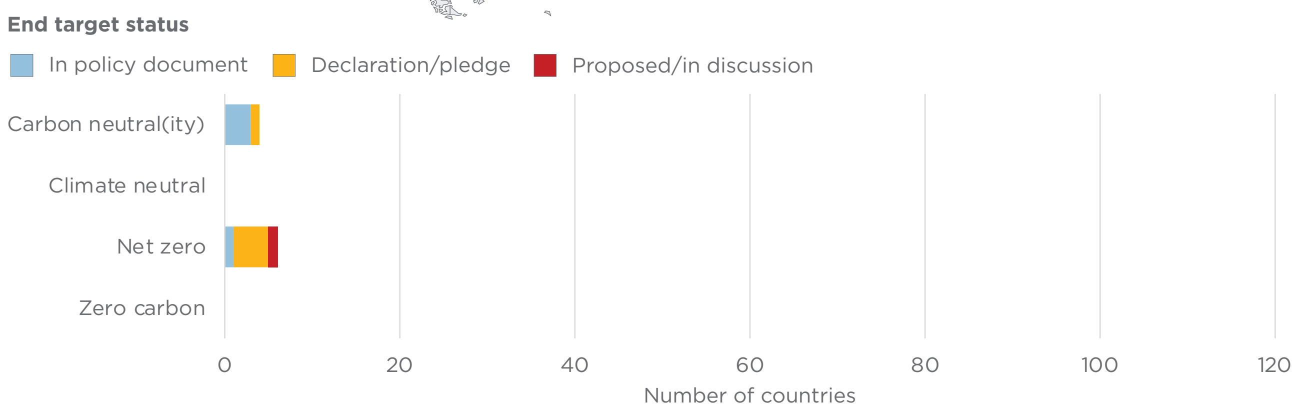
End target	In law	In policy document	Declaration/pledge	Proposed/in discussion	Achieved (self-declared)
Carbon neutral(ity)	1	4	2	1	1
Climate neutral	3	5	1	1	
Net zero	10	15	7	66	6
Zero carbon		1			

Note: Countries are colored by level of target policy implementation across the range of policy implementation levels from achieved to targets proposed and in discussion. The end target is based on language used in the relevant pledge or policy document.

Source: R. Black et al., Taking Stock: A Global Assessment of Net Zero Targets, Energy & Climate Intelligence Unit and Oxford Net Zero, March 2021, https://ca1-eci.edcdn.com/reports/ECIU-Oxford_Taking_Stock.pdf?v=1616461369.

Figure 2: Countries with net-zero targets after 2050 by net-zero pledge type and policy implementation status





End target	In policy document	Declaration/pledge	Proposed/in discussion
Carbon neutral(ity)	3	1	
Net zero	1	4	1

Note: Countries are colored by level of target policy implementation across the range of policy implementation levels from achieved to targets proposed and in discussion. The end target is based on language used in the relevant pledge or policy document.

Source: R. Black et al., Taking Stock: A Global Assessment of Net Zero Targets, Energy & Climate Intelligence Unit and Oxford Net Zero, March 2021, https://ca1-eci.edcdn.com/reports/ECIU-Oxford_Taking_Stock.pdf?v=1616461369.

Context and Related Analyses

A handful of institutions globally review the NDCs and estimate the "emissions gap" or "ambition gap" between safe mitigation pathways in the scientific literature and the projected emissions pathways resulting from the NDCs (Myles Allen [UK], Mustafa Babiker [Sudan], Yang Chen [China], Heleen de Coninck [Netherlands], Sarah Connors [UK], Renée van Diemen [Netherlands], Opha Pauline Dube [Botswana], Kris Ebi [US)], Francois Engelbrecht [South Africa], Marion Ferrat [UK/France]; Rogelj et al. 2018).

Medium-term NDC pathways and their effect on annual total global emissions are estimated with various extrapolation techniques across the integrated assessment modeling literature (Sognnaes et al. 2021). Leaders in this annual review are the *Emissions Gap Report* (United Nations Environment Programme 2021),[1] Climate Watch (the World Resources Institute),[2] Climate Action Tracker (Climate Action Tracker 2021),[3] and the PBL Global Stocktake (PBL 2021). This year, during COP26, Climate Resources[4] (Meinshausen, Lewis, Nicholls, and Burdon 2021) and the International Energy Agency provided new rapid response synthesis briefs of the NDCs' impacts.

The UNFCCC NDC synthesis report from the secretariat provides a status update on the updated NDCs. At the time of its publishing, it highlighted 164 of the latest NDCs that were submitted by the postponed COP26 deadline in 2021. Overall, 86 new or updated NDCs were submitted, representing 113 parties and covering 93.1 percent of total GHG emissions in 2019.[5]

The 2021 *Emissions Gap Report* compares the projected 2030 emissions, from the new or updated NDCs submitted ahead of COP26, with previous NDCs, concluding that the new 2030 commitments do not set G20 members on a clear path toward net-zero emissions by 2050. The aggregate impact of the new or updated unconditional NDCs led to a global reduction of 4.18 giga (billion) tons of carbon dioxide equivalent ($GtCO_2e$) of global GHG emissions compared to the previous NDCs. An addendum to the *Emissions Gap Report* issued following COP26 increased the reduction by an incremental 0.7 $GtCO_2e$ by 2030 for a total reduction of 4.8 $GtCO_2e$, primarily due to updated NDCs from China and Saudi Arabia.[6]

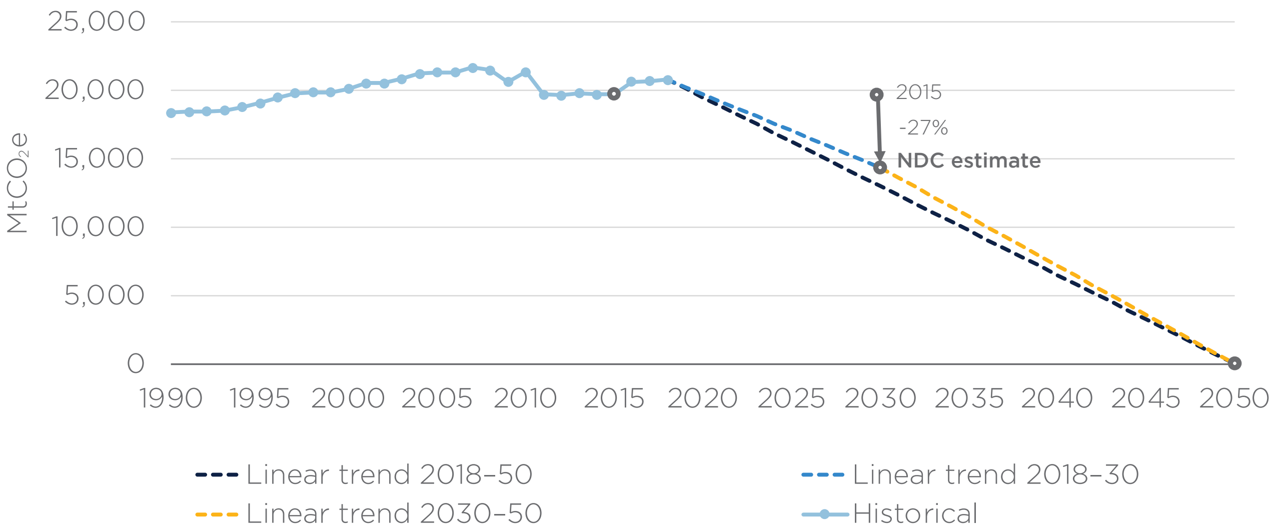
However, in the case of G20 countries alone, the currently announced GHG reduction targets for 2030 and submitted NDCs translate into a total annual reduction of 2.9 GtCO2e compared to the previous targets. According to the report, the most significant reductions come from the United States, the 27 European Union countries (EU27), the UK, Argentina, Canada, China, and Japan, and this is aligned with the analysis presented in this report. Overall, seven of the G20 economies have net-zero targets in law, five have them in policy documents, five have them in government announcements, and one does not have a net-zero target.

By grouping economies within this report's analysis into those with pre- and post-2050 net-zero targets, some interesting insights emerge that are not yet in the literature. While it is clear that developing and emerging economies have not yet peaked emissions, nor do they intend to, there is a strong division of mitigation ambition within the G20 economies. This report's analysis also adds new insights into the impact of collective NDCs of economies with pre- and post-2050 net-zero targets. While developed G20 economies need to increase their mitigation ambition to bring into line their NDCs with net-zero pledges, there is clear misalignment in the medium-term NDC targets and the long-term net-zero targets for the post-2050 group. The authors outline these misalignments in this report, highlighting the varying decarbonization rates (compound annual growth rate) required to meet both NDC and net-zero pledges.

NEAR-TERM EMISSIONS REDUCTIONS, TO 2030

Considering the medium-term International Monetary Fund (IMF) and Organisation for Economic Co-operation and Development (OECD) economic outlook, the officially submitted NDCs, and the long-run trend in GHG emissions intensity improvement, this analysis found that the unconditional updated NDCs submitted in advance of the COP26 summit in Glasgow by countries with 2050 net-zero pledges leads to a 27 percent reduction in GHG emissions by 2030 relative to 2015 (see Figure 3). In contrast, countries with post-2050 net-zero pledges are projected to increase their emissions by 10 percent between 2015 and 2030. In tandem, this analysis estimates a net global emissions reduction of 9 percent between 2015 and 2030 due to a combination of NDCs and net-zero pledges.

Figure 3: Total GHG emissions for all countries with net-zero targets prior to or by 2050 and the emissions reduction between 2015 and 2030 resulting from their collective NDCs



Note: The figure includes 55 countries with net-zero targets prior to or by 2050, which account for around 42 percent of the global emissions in 2018. It does not include countries with net-zero targets after 2050, such as China, India, and Russia.

Source: Authors' analysis, as detailed in Appendix A.

A full explanation of the data sources and methods used for these calculations and those in the following sections can be found in Appendix A.

RESULTS FOR SELECT ECONOMIES WITH NET-ZERO TARGETS BY 2050

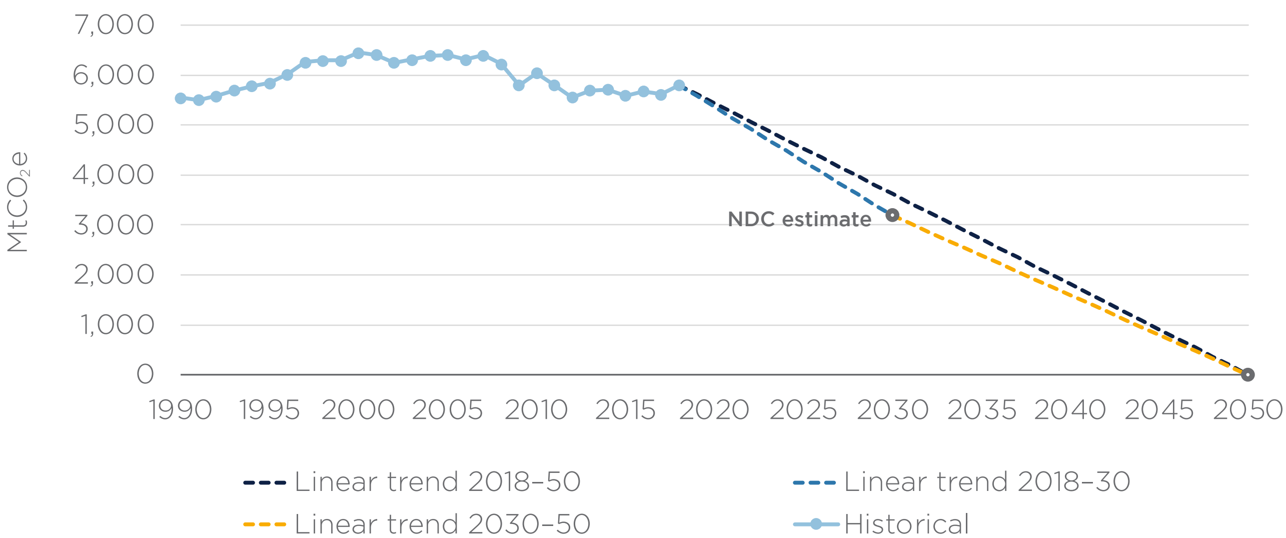
The following section describes in more detail the estimated emissions reductions for the US, EU27, and Japan, all of which have net-zero targets by 2050.

US

The latest NDC submitted by the United States before COP26 aims for a 50-52 percent net reduction in economy-wide greenhouse gas emissions by 2030, relative to a 2005 baseline of **6.635 GtCO_2e**. Achieving this objective would correspond to net economy-wide emissions of **3.185 GtCO_2e** in 2030, down from **5.794 GtCO_2e** in 2018 (i.e., a 45 percent reduction from 2018 to 2030). While net GHG emissions have declined between the baseline year and 2018, the pace of reductions will need to accelerate for the United States to meet the objectives set forth in its NDC.

Based on its NDC, the United States' emissions are estimated to decline by -4.9 percent compound annual growth rate (CAGR) from 2018 to 2030. From 2030 to 2050, this implies a -14.6 percent CAGR is necessary to hit net zero by 2050. Over the entire period from 2018 to 2050, emissions would need to decline by -10.5 percent CAGR.

Figure 4: United States's historical GHG emissions and 2030 GHG estimates resulting from its NDC



Note: Total emissions including land use, land-use change, and forestry (LULUCF).

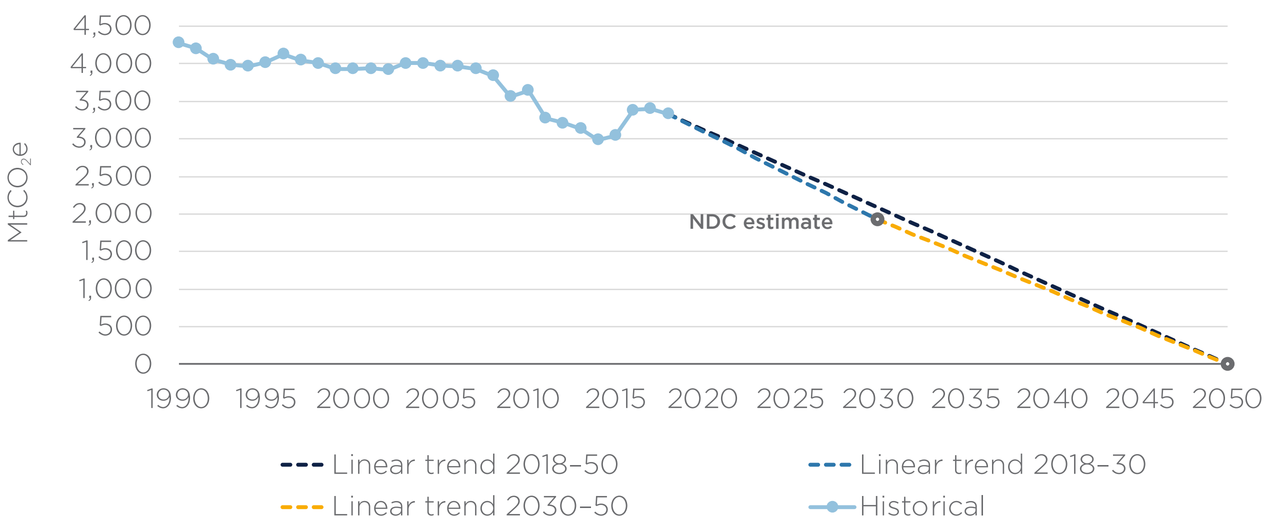
Source: Authors' analysis, as detailed in Appendix A.

EU27

The European Union has agreed to a collective binding target across the 27 member states to reduce net GHG emissions to 55 percent below 1990 levels by 2030. The 1990 reference indicator was determined by the *National Inventory Report* published by the European Environment Agency and is subject to change based on methodological improvements, but as of 2019, 1990 emissions for the EU27 is estimated at **4.27 $GtCO_2e$**. Reaching the NDC target would yield net economy-wide emissions of **1.92 $GtCO_2e$** in 2030, compared to 3.33 $GtCO_2e$ in 2018 (i.e., a 42 percent reduction from 2018 to 2030).

Based on its NDC, the EU27's emissions are estimated to decline by -4.5 percent CAGR from 2018 to 2030. From 2030 to 2050, this implies a -14.6 percent CAGR is necessary to hit net zero by 2050. Over the entire period from 2018 to 2050, emissions would need to decline by -10.6 percent CAGR.

Figure 5: EU27's historical GHG emissions and 2030 GHG estimates resulting from its NDC



Note: Total emissions including LULUCF.

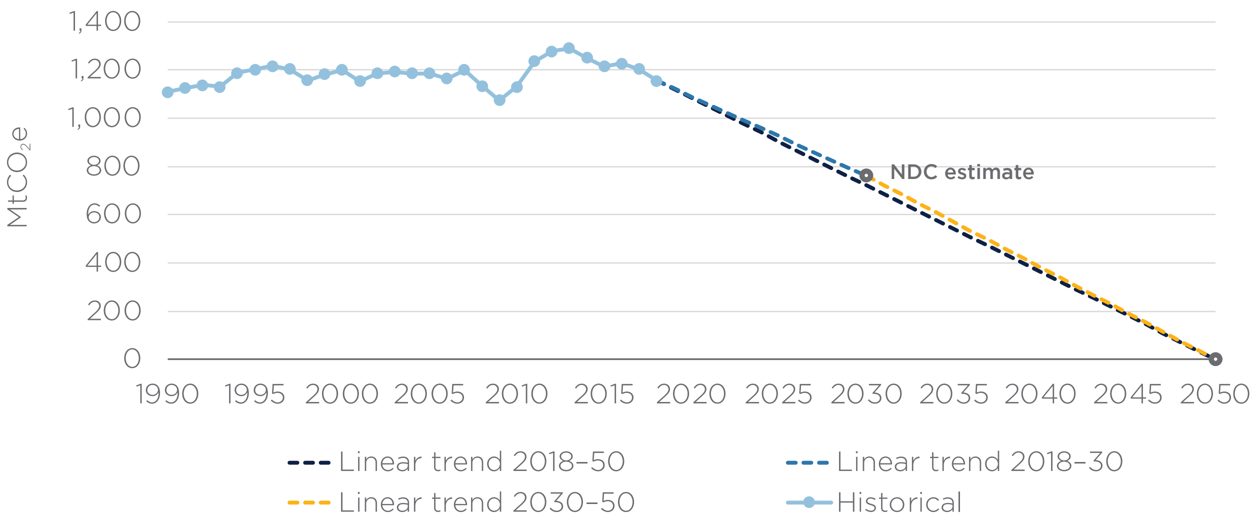
Source: Authors' analysis, as detailed in Appendix A.

Japan

Japan has submitted an NDC with a target of achieving a 46 percent reduction in total greenhouse gas emissions relative to 2013 levels by 2030 (i.e., from **1.4 billion tons of carbon dioxide equivalent [$GtCO_2e$]** in 2013 to **0.76 $GtCO_2e$** in 2030) in order to support its aspiration of net zero by 2050. In 2018, total emissions in Japan had dropped to **1.2 $GtCO_2e$** (i.e., an 18 percent decrease compared to 2013).

Based on its NDC, Japan's emissions are estimated to decline by -3.4 percent CAGR from 2018 to 2030. From 2030 to 2050, this implies a -14.6 percent CAGR is necessary to hit net zero by 2050. Over the entire period from 2018 to 2050, emissions would need to decline by -10.6 percent CAGR.

Figure 6: Japan's historical GHG emissions and 2030 GHG estimates resulting from its NDC



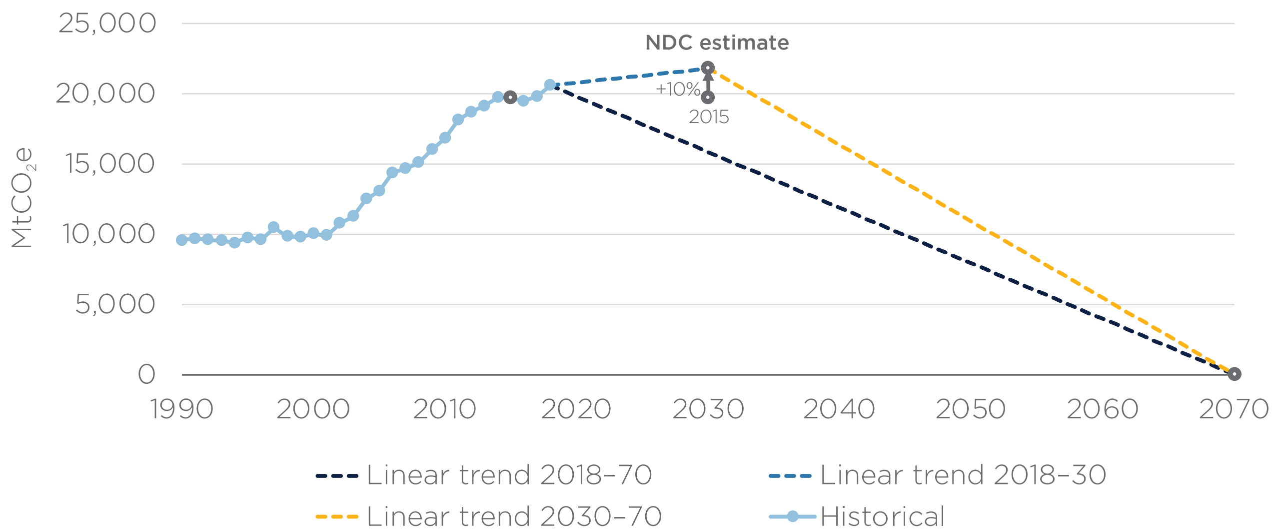
Note: Total emissions including LULUCF.

Source: Authors' analysis, as detailed in Appendix A.

RESULTS FOR SELECT ECONOMIES WITH NET-ZERO TARGETS AFTER 2050

Given that 42 percent of global emissions do not fall under a net-zero target by 2050 but do fall under a later net-zero goal (post-2050), this analysis also covers these emissions. The stark difference in historical emissions trends between pre- and post-2050 countries similarly highlights the necessity of finding solutions to address the growing emissions in these countries. Figure 7 provides an overview of the 2030 emissions estimates resulting from 10 countries' NDCs and their misalignment with net zero, with emissions estimated to increase by 10 percent from 2015 to 2030.

Figure 7: Total GHG emissions for all countries with net-zero targets after 2050 and the emissions reduction between 2015 and 2030 resulting from their collective NDC targets



Note: Total emissions including LULUCF.

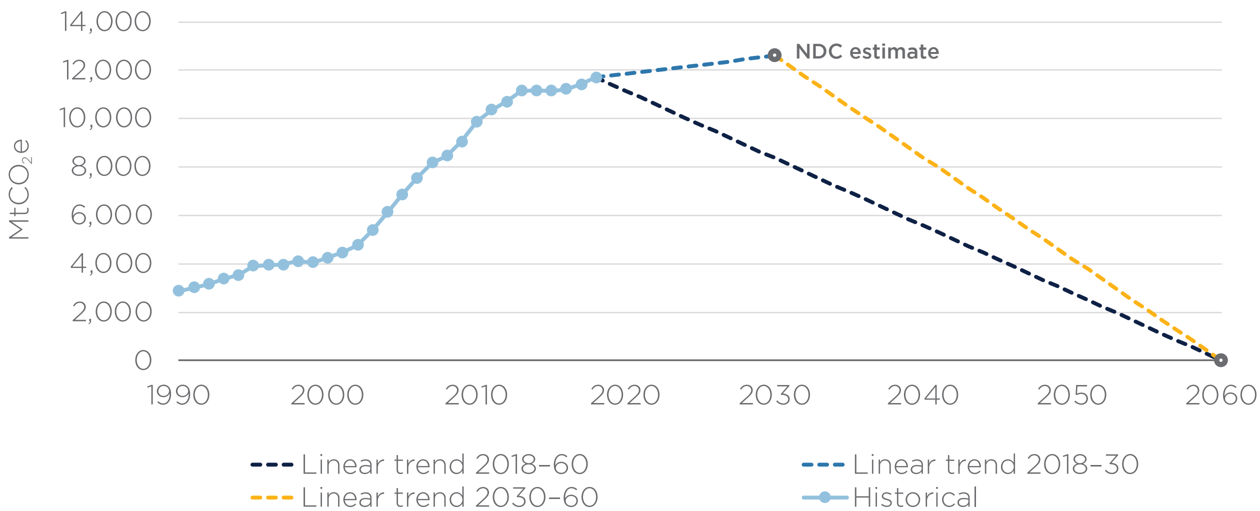
Source: Authors' analysis, as detailed in Appendix A.

China

China's latest NDC submitted before COP26 outlines its goals of reaching peak emissions before 2030 and achieving carbon neutrality before 2060. By 2030, China aims to achieve a 65 percent reduction in its carbon emissions per GDP from its 2005 level of around 5.5 $GtCO_2e$. Achieving China's 2030 target corresponds to approximately 10 $GtCO_2$ in 2030. This estimate is highly sensitive to assumptions related to GDP growth in China.[7] Since China's NDC includes only CO_2 emissions, according to the extended analysis of all greenhouse gas emissions (including methane and nitrous oxide) that was included in this report, China's GHG emissions in 2030 may reach **12.6 $GtCO_2e$**, from **6.8 $GtCO_2e$** in 2005. This is broadly similar to the greenhouse emissions level today at **11.7 $GtCO_2e$**.

Based on its NDC, China's emissions are estimated to grow by +0.6 percent CAGR from 2018 to 2030. From 2030 to 2060, this implies a -11.1 percent CAGR is necessary to hit net zero by 2060. Over the entire period from 2018 to 2060, emissions would need to decline by -8.7 percent CAGR.

Figure 8: China's historical GHG emissions and 2030 GHG estimates resulting from its NDC



Note: Total emissions including LULUCF.

Source: Authors' analysis, as detailed in Appendix A.

India

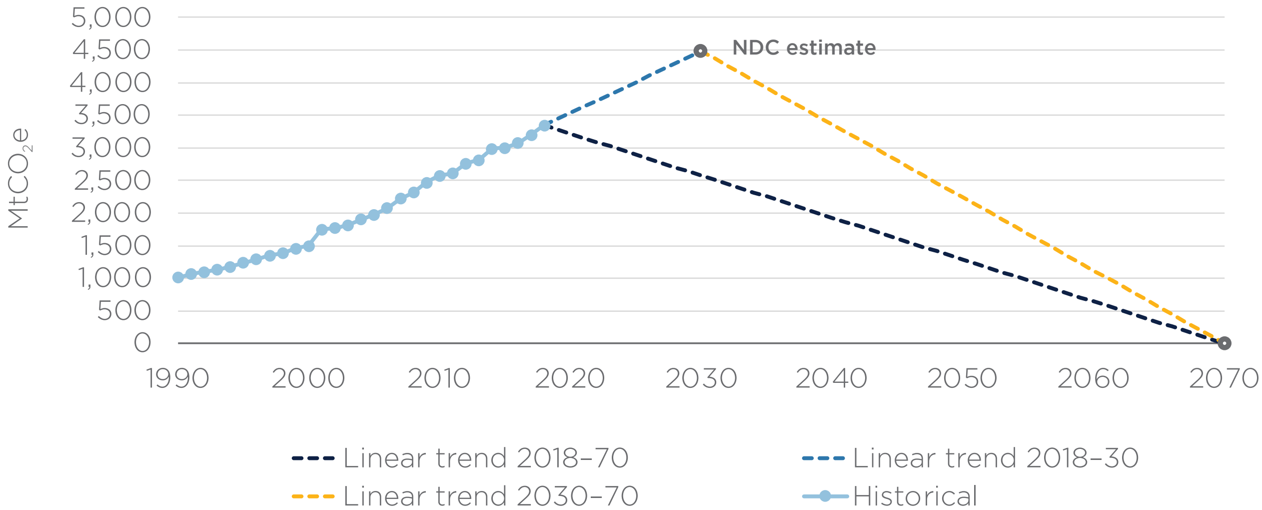
Since India's initial NDC in 2016, the country has yet to submit an updated NDC beyond a pledge made by President Modi at COP26 on November 2, 2021,[8] that declared the following:

1. Achieve net-zero emissions by 2070.
2. Reduce emissions intensity of GDP by 45 percent in 2030 from 2005 levels.
3. Reduce emissions by one billion tons by 2030.
4. Generate 50 percent of energy from renewable resources by 2030.

Thus far, the emissions intensity of India's GDP has decreased by 12 percent between 2005 and 2010. Overall, estimates produced in this analysis show India's emissions increasing from **3.4 $GtCO_2e$** in 2018 to **4.5 $GtCO_2e$** in 2030 (i.e., a 32 percent increase).

Based on its NDC, India's emissions are estimated to increase by +2.5 percent CAGR from 2018 to 2030. From 2030 to 2070, this implies a -9.0 percent CAGR is necessary to hit net zero by 2070. Over the entire period from 2018 to 2070, emissions would need to decline by -7.5 percent CAGR.

Figure 9: India's historical GHG emissions and 2030 GHG estimates resulting from its NDC



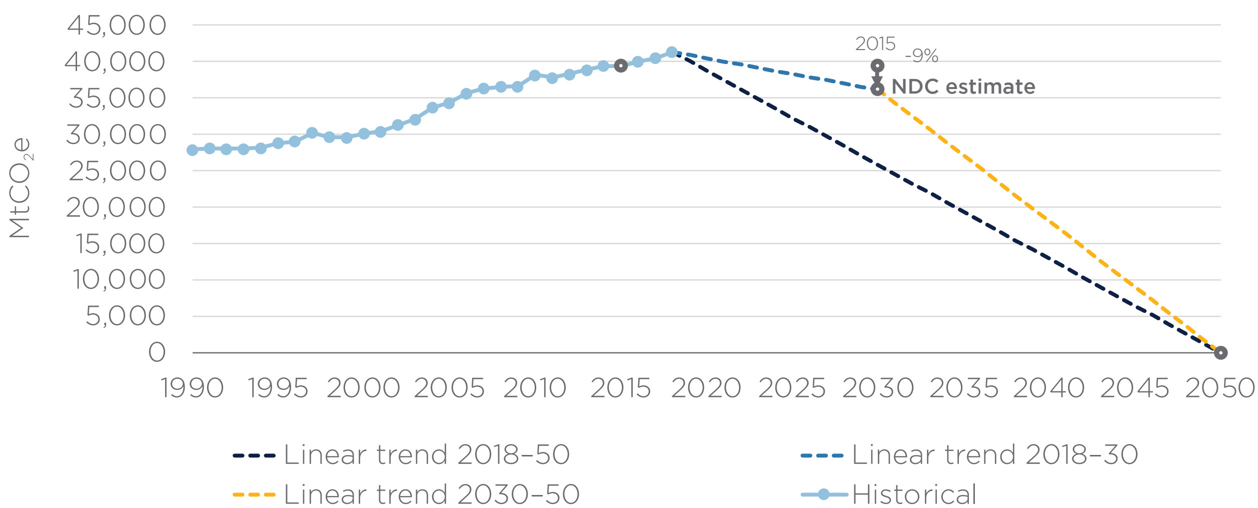
Note: Total emissions including LULUCF.

Source: Authors' analysis, as detailed in Appendix A.

NDC AMBITION AND ALIGNMENT WITH NET ZERO

Pulling together the combined NDCs of countries with any net-zero targets, this analysis highlights the gap between the ambition of the NDCs and the trajectory necessary to meet net-zero emissions by 2050 (see Figure 10). Although a substantial portion of global emissions (84 percent of emissions in 2018) are currently included under a net-zero target, this misalignment of NDCs and longer-term net-zero targets is a worrying sign of where emissions could be headed if more aggressive near-term actions are not taken by governments, businesses, and consumers.

Figure 10: Total GHG emissions for all countries with net-zero targets and the 2030 GHG estimates resulting from their collective NDCs



Note: The figure includes 65 countries with net-zero targets, which account for around 84 percent of the global emissions in 2018.

Source: Authors' analysis, as detailed in Appendix A.

CONCLUSION

In the run-up to COP26 in Glasgow, countries prepared updated NDCs that outlined their increased ambition for reducing emissions. After the adoption of the Glasgow Climate Pact, many organizations have focused on what these NDCs and net-zero ambitions could mean for the world's ability to limit global temperature rise to well below 2°C. But this analysis sought to answer another critical question, specifically, how these targets and ambitions could potentially drive near-term emissions reductions (i.e., over the next decade).

Understanding the answer to this question can help decision makers understand what their own emissions profiles might look like if they wish to align themselves with the NDCs of countries with net-zero targets. Moreover, it provides insights into which near-term reductions could successfully align organizations with their country-level ambitions. This alignment could help to alleviate tensions and risks associated with decisions that result in delayed emissions reductions at an organization level. For example, organizations with emissions that rise or stay flat in the face of declining national-level emissions could find themselves subject to increased scrutiny.

Overall, this analysis revealed that the unconditional NDCs of economies with 2050 net-zero pledges could lead to a 27 percent reduction in GHG emissions by 2030 relative to 2015. In contrast, countries with post-2050 net-zero pledges are projected to increase their emissions by 10 percent between 2015 and 2030, resulting in a net global emissions reduction of 9 percent during this period.

The emissions pathways vary widely between countries and regions. In the US, the EU27, and Japan, NDCs are projected to lead to a 42–46 percent reduction in emissions by 2030. In India and China, the stated ambitions result in an increase in emissions to 2030, followed by decreasing emissions until these countries achieve their net-zero goals after midcentury. Additional emissions pathways for individual countries can be found in the Excel workbook associated with this report.

Future analysis could explore the implications of these emissions trajectories on investment and infrastructure.

APPENDIX A: DATA SOURCES AND METHODS

This appendix includes discussion of the data sources and methodologies that were used in the analysis presented in this report. In addition to this appendix, a workbook including a database and methodology accompany this report. This workbook includes a log and notes about the review of the NDC texts of the largest 100 emitting economies.[9] Historical GHG emissions inventories, historical macroeconomic data, future macroeconomic outlooks, and a current database of net-zero policies are also archived within this same workbook. The workbook enables the estimation of national GHG emissions in 2030 as a function of the emissions reduction objectives outlined in each NDC. National 2030 GHG emissions are then aggregated by either conditional or unconditional NDCs, as well as the status of a party's net-zero target compared to total group estimates. This workbook provides GHG estimates for 2030 NDCs grouped by economies with pre- and post-2050 net-zero targets.

Data Sources

The full range of data sources used in this analysis are outlined in this section and the sections below. The data requirements begin with a qualitative review of NDCs, prioritizing the 100 largest emitting parties to the UNFCCC. This approach captured roughly 98 percent of all CO_2 emissions in 2018, with the top 10 accounting for 68 percent of global emissions in the same year.[10] The officially submitted NDC documents were reviewed in English, searching for crucial parameters and phrases to quantify the critical metrics that define the binding constraints within each 'party's overall NDC emissions pathway. The NDC review is synthesized in detail in the workbook accompanying this report. A summary table in Appendix B outlines a sample of economies, their NDC typology, and notes synthesizing their NDC text used to quantify their resulting emissions trajectory. The quantification of constraining metrics with the NDC text results in a range of NDC typologies, which are broadly captured as long-term *Emissions Caps, Intensity Targets, and Conditional and Unconditional Targets*. The range of base years used, economic outlooks, and ambiguity in an NDC's language mean there is uncertainty in their quantification even to 2030.

Many data sets are required in order to estimate national emissions trajectories once the binding constraining metrics are quantified. This includes national economic projections and the outlook for emissions intensity improvements based on recent historical trends and energy technology stock turnover. With these factors in mind, the medium-term economic outlook from the IMF and the long-term macroeconomic outlook to 2060 from the OECD were used as estimates for GDP for each country to 2030.[11] This data is contained within the accompanying workbook.

Furthermore, a range of global GHG emissions databases was reviewed for completeness across the full range of GHGs and for the lag between the real-time year and the most recent year of a data set. The Global Climate Project (Friedlingstein et al. 2020) is the most prompt in estimating global GHG emissions, producing annual estimates before the COP each winter. However, the range of GHGs it includes is not complete. Similarly, the UNFCCC database, Emissions Database for Global Atmospheric Research (EDGAR), and Potsdam Institute on Climate Impact Research–Paris Reality Check data set (PIK-PRIMAP) are based on official global and national inventories. However, there are data gaps and time lags in their publishing, with the UNFCCC and PIK-PRIMAP data subject to a two to three year lag between the end of the data collection period and the data publication date. The UNFCCC data is further subject to different reporting methodologies between Annex I and Annex II countries. Ultimately, with the purpose of this report being to estimate emissions reduction from 2015 to 2030, real-time timeliness was not a constraining factor. So the more complete Climate Analysis Indicators Tool (CAIT)[12] database from the World Resources Institute was used as a complete GHG inventory basis, including all GHG emissions on a country level, measured in CO_2 equivalents assuming a 100-year global warming potential.

Data sources used in this analysis:

1. UNFCCC—all NDC official submissions repository: https://www4.unfccc.int/sites/NDCStaging/Pages/All.aspx#
2. Climate Action Tracker: https://climateactiontracker.org/
3. World Resources Institute's Climate Watch: http://cait.wri.org/ and https://www.wri.org/initiatives/climate-watch
4. Climate NDC policy tool from PBL, the Netherlands Environmental Assessment Agency: https://themasites.pbl.nl/o/climate-ndc-policies-tool/
5. EDGAR—global GHG emissions database: https://edgar.jrc.ec.europa.eu/country_profile
6. PIK-PRIMAP: https://www.pik-potsdam.de/paris-reality-check/primap-hist/
7. International Energy Agency—energy balances: https://www.oecd-ilibrary.org/energy/data/iea-world-energy-statistics-and-balances/extended-world-energy-balances_data-00513-en
8. OECD macroeconomic projections: https://data.oecd.org/gdp/real-gdp-long-term-forecast.htm
9. IMF's *World Economic Outlook* macroeconomic projections: https://www.imf.org/en/Publications/WEO
10. United Nations Demographic Division for population projections: https://population.un.org/wpp/

Methods

This section summarizes the methods contained within the accompanying workbook. It outlines the estimates for the total greenhouse gas emissions for all sectors, including land-use change in 2030 for the top 100 emitting countries, covering around 98 percent of the total CO_2 emissions in 2018. Four global emissions estimates by 2030 were calculated as a result of filtering the core analysis database to include or exclude conditional or unconditional NDCs and filtering countries by their net-zero 2050 target statuses.

NDC Submission Review

Most regions express their emissions reduction targets as a percentage reduction based on a clear baseline year. If a reference value is given for the baseline year, this number is used directly. If not, the greenhouse gas emissions data (covering all sectors including land-use change) from CAIT for the baseline year is incorporated. The percentage reduction targets are applied to the CAIT data set for that country. Instead of having a historical baseline year, some countries (e.g., Indonesia, Turkey, etc.) had their targets referenced against a business-as-usual scenario in 2030 or 2035 based on their projections. In these cases, the national numbers according to their NDCs are used directly to calculate the absolute 2030 emissions numbers.

For countries with targets expressed as an emissions intensity (i.e., GHG per unit of GDP), a historical coefficient between GHG and GDP was estimated in combination with an elasticity to represent autonomous efficiency improvements. This historical relationship and rate of efficiency improvement were then used in conjunction with future real GDP baseline long-term growth projections from the OECD and IMF, benchmarked to 2010 US dollars and purchasing power parities, to estimate future gross GHG emissions in 2030. For instance, China's NDC target is expressed in reduction of CO_2 emissions per GDP. In turn, this analysis applied China's CO_2 emissions reduction target to CO_2 emissions but assumed the current rate of increase in other greenhouse gases (e.g., methane and nitrous oxide) based on its GDP growth, in the absence of targets covering these gases.

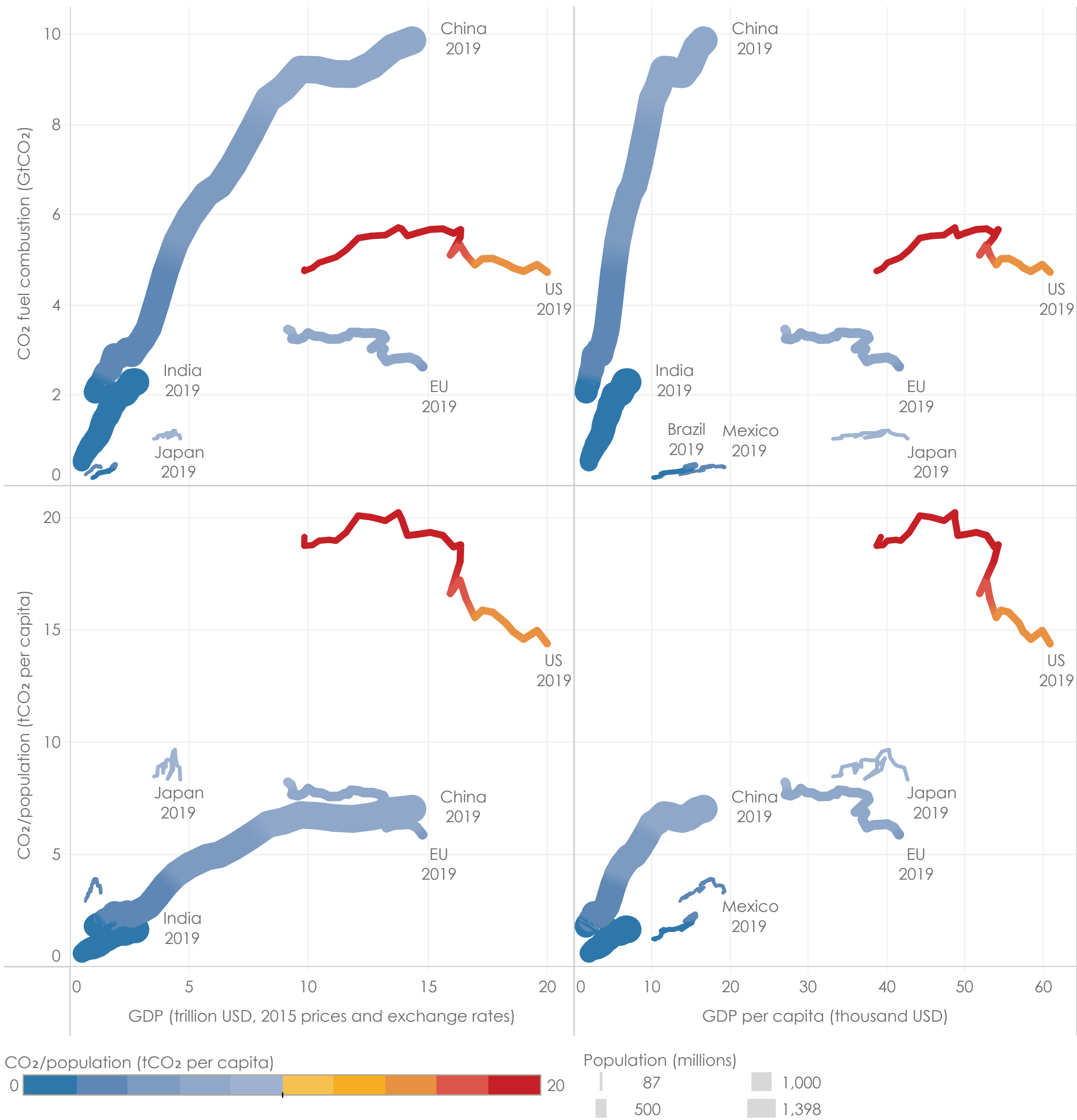
It should be noted that for countries in the EU, this analysis used the 2030 target set by the EU as a region, not the targets set by individual countries. Furthermore, the global emissions number does not include international bunkers (e.g., aviation and navigation) because this report only focuses on emissions covered by NDCs.

Projecting Medium-Term Emissions Trajectories

Based on the most recent academic literature (Sognnaes et al. 2021), this analysis used the stable long-run correlation between macroeconomic activity (GDP) and carbon intensity to extrapolate medium-term GHG emissions where necessary. This projection method is required in the absence of explicitly noted emissions caps, conditional or unconditional, within each of the NDCs that were reviewed and compiled. There is a well-documented and slowly changing historical correlation between macroeconomic activity, energy consumption, and CO_2 emissions as a function of the energy technology stock in a given country.

Figure A1 shows carbon dioxide emissions on the left vertical axis and economic activity on the horizontal axis. The trends are colored as a function of the carbon dioxide emissions per capita and the thickness of the trend lines represent the population of each country. The trend lines in each of the four panels run from 1990 to 2019. The upper left panel shows the dominant trend of gross emissions that China has relative to other large economies discussed in the report relative to their GDP. The lower left panel outlines the dominant role that the US has with relatively high carbon dioxide emissions per capita relative to the overall economic activity of the country. The upper right panel highlights the emissions per economy relative to the wealth of each citizen of each country as a function of GDP per capita. Lastly, the lower right panel highlights the differences in emerging economies' wealth per capita and emissions intensity per capita relative to developed economies'. These trends of emissions per economy on a national and per capita basis are used in conjunction with economic outlooks and population projections to estimate gross GHG emissions in 2030 for those NDCs based on emissions intensities rather than gross emissions caps.

Figure A1: Historical correlation between CO_2 emissions and macroeconomic activity on economy-wide and per capita bases



Source: International Energy Agency, 2021, "CO_2 Emissions from Fuel Combustion Statistics: Greenhouse Gas Emissions from Energy" https://doi.org/10.1787/co2-data-en.

APPENDIX B: SUMMARY OF NDC TYPOLOGIES

Country name	Reference year	Target for 2030 annually	Note
US	2005	**Typology: Emissions Cap (Unconditional)** 52% reduction from 6,635 $MtCO_2e$ emissions level in 2005	The US has focused on five main areas to achieve its 2030 targets: i) **Electricity**: install carbon-free electricity-generating systems with energy storage and retrofit power plants with carbon capture and existing nuclear. ii) **Transportation**: incentives for zero-emissions personal vehicles, funding for public charging infrastructure, and research and development (R&D) into renewable fuels for aviation. iii) **Buildings**: funding for retrofit programs, wider use of heat pumps and induction stoves, and adoption of modern energy codes for new buildings. Invest in new technologies to reduce emissions associated with construction. iv) **Industry**: R&D of zero-carbon industrial processes and products including use of green hydrogen to power industrial facilities. In addition, the US will use its procurement power to support early markets for zero-carbon industrial goods. v) **Agriculture**: support scaling of climate-smart agricultural practices (including cover crops), reforestation, rotational grazing, and nutrient management practices. Plans to invest in forest protection and management aimed toward reducing wildfires and restoring forests.
EU	1990	**Typology: Emissions Cap (Unconditional)** 55% reduction from 5,659 $MtCO_2e$ emissions level in 1990 By the end of 2019, the EU and its member states have reduced their emissions by around 26% on 1990 levels while GDP has grown by more than 64% over the same period.	The EU has implemented an EU Emission Trading System (EU ETS) that puts a price on carbon through a maximum emissions volume and the Effort Sharing Regulation, which sets individual binding targets for member states for greenhouse gas emissions not covered by the EU ETS. The efficiency of the EU's final and primary energy consumption will be improved by at least 32.5% by 2030 as compared to its historic baseline. CO_2 emissions/kilometer (km) from passenger cars sold in the EU must be reduced on average by 37.5% from 2021 levels by 2030 and from new vans on average by 31% from 2021 levels by 2030. CO_2 emissions/km for new large lorries must be reduced on average by 30% from 2019/2020 levels.

Country name	Reference year	Target for 2030 annually	Note
Canada	2005	**Typology: Emissions Cap (Unconditional)** Emissions 40%–45% below 2005 levels by 2030	Canada's Strengthened Climate Plan (SCP), released on December 2020, is built on five pillars to accelerate emissions reductions: i) Invest over $6 billion in building efficiency retrofits. ii) Require 100% electrification of new light-duty trucks by 2035 as part of a broader vehicle electrification effort. iii) Increase carbon pricing to $170/ton by 2030. iv) Build a domestic market for clean fuels to facilitate industrial decarbonization. v) Provide over $3 billion in reforestation funding.
Mexico	2030 BAU	**Typology: Emissions Cap (Conditional)** -36% Conditional Unconditional contributions: Reduction of 22% of GHG emissions and 51% of black carbon emissions by 2030 as compared to the baseline BAU scenario Conditional contributions: A reduction of up to 36% of GHG emissions and 70% of black carbon emissions by 2030 compared to the BAU scenario	Mexico has identified the following sectors as critical to its overall decarbonization strategy, although it has yet to release concrete sectoral emissions reduction targets: i) Transport ii) Power generation iii) Buildings iv) Oil and gas v) Industrial vi) Agriculture vii) Waste viii) LULUCF The adaptation component is integrated by five strategic axes: Axis A. Prevention and management of negative impacts on the human population and the territory Axis B. Resilient production systems and food security Axis C. Conservation, restoration, and sustainable use of biodiversity and ecosystem services Axis D. Comprehensive water resources management with a focus on climate change Axis E. Protection of strategic infrastructure and tangible cultural heritage Among the most relevant issues addressed in the adaptation component are synergies with mitigation. These include strategic infrastructure protection, integrated water resource management and wastewater treatment, conservation and restoration of marine ecosystems, soil restoration and conservation of blue carbon ecosystems and coral reefs, and actions to strengthen the management and conservation of forests and rainforests.

Country name	Reference year	Target for 2030 annually	Note
China	2005	**Typology: Carbon Intensity of GDP (Unconditional)** 65% reduction in carbon intensity from 2005 levels China intends to reach peak CO_2 emissions before 2030 and carbon neutrality by 2060.	China's updated NDC goals are as follows: (1) have CO_2 emissions peak before 2030 and achieve carbon neutrality before 2060, (2) lower CO_2 emissions per unit of GDP by over 65% from the 2005 level, (3) increase the share of nonfossil fuels in primary energy consumption to around 25%, (4) increase the forest stock volume by 6 billion cubic meters from the 2005 level, and (5) bring its total installed capacity of wind and solar power to over 1.2 billion kilowatts by 2030.
India	2030 BAU	**Typology: Carbon Intensity (Conditional)** 45% reduction of emissions intensity of GDP by 2030 from 2005 levels Achieve net-zero emissions by 2070, and reduce emissions by 1 billion tons by 2030 conditional upon financial support and human capacity development from advanced economies	Based on its 2016 NDC and COP26 announcements, India plans to do the following: i) Reduce the emissions intensity of its GDP by 33%–35% by 2030 from 2005 levels. ii) Generate 50% of energy from renewable resources by 2030. iii) Expand its national smart grid mission to increase energy efficiency. iv) Pursue conservation efforts to eliminate 2.5 to 3 billion tons of CO_2 equivalent by 2030 by adding forests and tree cover.

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NOTES

1. The United Nations Environmental Programme's *2021 Emissions Gap Report* can be found here: https://www.unep.org/resources/emissions-gap-report-2021.
2. The World Resources Institute's Climate Watch can be found here: https://www.climatewatchdata.org/2020-ndc-tracker.
3. The Climate Action Tracker can be found here: https://climateactiontracker.org/.
4. The Climate Resource website can be found here: https://www.climate-resource.com/our-work.
5. *Nationally Determined Contributions under the Paris Agreement*, 2021, https://unfccc.int/sites/default/files/resource/cma2021_08E.pdf.
6. United Nations Environmental Programme, "Addendum to the Emissions Gap Report," https://wedocs.unep.org/bitstream/handle/20.500.11822/37350/AddEGR21.pdf.
7. China's NDC target is expressed in CO_2 emissions per GDP reduction. We have applied China's CO_2 emissions reduction target to CO_2 emissions but assumed the current rate of increase in other greenhouse gases (e.g., methane and nitrous oxide) based on its GDP growth, in the absence of targets covering these gases.
8. "COP26: India PM Narendra Modi pledges net-zero by 2070," BBC News, November 2, 2021, https://www.bbc.com/news/world-asia-india-59125143.
9. Emissions from international bunkers are not included in this assessment as the report only focuses on emissions covered by NDCs.
10. The World Resources Institute's Climate Data Explorer can be found here: http://cait.wri.org/.
11. It should be noted that these outlooks are bound to their assumptions and sensitivity especially in regard to COVID-19. Uncertainty about the length, depth, and impacts of the pandemic may change the economic outlook and affect this analysis.
12. The World Resources Institute's Climate Data Explorer can be found here: http://cait.wri.org/.

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