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Tracking intended nationally determined contributions: what are the implications for greenhouse gas emissions in 2030?

Rodney Boyd, Joe Cranston Turner and Bob Ward

Policy paper

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The Authors

Rodney Boyd is a Policy Analyst and Research Advisor to Nicholas Stern at the Grantham Research Institute on Climate Change and the Environment and ESRC Centre for Climate Change Economics and Policy at London School of Economics and Political Science.

Joe Cranston Turner is a Visiting Fellow at the Grantham Research Institute on Climate Change and the Environment and ESRC Centre for Climate Change Economics and Policy at London School of Economics and Political Science.

Bob Ward is Policy and Communications Director at the Grantham Research Institute on Climate Change and the Environment and ESRC Centre for Climate Change Economics and Policy at London School of Economics and Political Science.

This policy paper is intended to inform decision-makers in the public, private and third sectors. It has been reviewed by at least two internal referees before publication. The views expressed in this paper represent those of the author(s) and do not necessarily represent those of the host institutions or funders.

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1. Introduction and context

Parties to the United Nations Framework Convention on Climate Change (UNFCCC) agreed at the 20th session of the Conference of the Parties (COP20) in Lima, Peru, in December 2014 to set out their “intended nationally determined contributions” (INDCs) ahead of COP21 in Paris, France, in December 2015. It was further agreed that each of these INDCs will “represent a progression beyond the current undertaking of that Party”.¹

The INDCs that were submitted by 20 July 2015 included an indication of expected annual greenhouse gas emissions beyond 2020 (many Parties provided information about their expected annual emissions in 2020 following COP15 in Copenhagen, Denmark, in December 2009²). Hence, these INDCs can be analysed to provide an indication of whether intended action by countries is collectively consistent with the decision, agreed at COP16 in Cancún, Mexico, in 2010, which states it “recognizes that deep cuts in global greenhouse gas emissions are required according to science, and as documented in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, with a view to reducing global greenhouse gas emissions so as to hold the increase in global average temperature below 2°C above preindustrial levels, and that Parties should take urgent action to meet this long-term goal, consistent with science and on the basis of equity”.³

A previous paper by Boyd *et al.* (2015) concluded that, based on announcements by the European Union, China and United States, the INDCs submitted ahead of COP21 are unlikely to be collectively consistent with the goal of having a reasonable chance of avoiding a rise in global average temperature of more than 2°C above its pre-industrial level.

The analysis presented here considers whether the INDCs that were submitted by 20 July 2015 are consistent with the 2°C limit. As of that date, 46 Parties to the UNFCCC, including the 28 Member States of the European Union, had submitted INDCs,⁴ These 46 Parties were together responsible for 58 per cent of global annual emissions of

¹ UNFCCC (2014; p.3).

² A list of the country submissions are available at:
http://unfccc.int/meetings/copenhagen_dec_2009/items/5276.php

³ UNFCCC (2011; p.3).

⁴ INDCs that have been submitted to the secretariat of the UNFCCC are published at:
<http://www4.unfccc.int/submissions/indc/Submission%20Pages/submissions.aspx>.

greenhouse gases in 2011.⁵ We compare a 'snapshot running total' in 2030 of the level of annual global emissions implied by these INDCs with pathways for both 'business as usual' (BAU) consistent with a reasonable chance of not breaching the 2°C limit.

Our conclusions are provided in the final section of this paper. Based on our analysis of the INDCs for the 46 Parties that had submitted INDCs by 20 July 2015, we conclude that, while there has been progress compared with a 'business as usual' global emissions pathway, there is a gap between the emissions pathway that would result from current ambitions and plans, including those goals outlined by the submitted INDCs, and a pathway that is consistent with a reasonable chance of limiting the rise in global average temperature to no more than 2°C above pre-industrial levels. Consequently, countries should be considering opportunities to narrow the gap before and after the COP21 summit in Paris, including (Boyd *et al.*, 2015):

- i. hard work over the next few months by all countries to find credible ways of achieving bigger emissions reductions which can be included in INDCs to be submitted to the UNFCCC secretariat, and/or achieved through additional efforts by partnerships (e.g. through specific decarbonisation initiatives among willing countries);
- ii. an intensification of efforts to increase investment and innovation, particularly in relation to the development of cities, energy systems and land use, that could help to close the gap between intentions and the goal before and after 2030;
- iii. the creation of a mechanism, to be included in the agreement emerging from COP21 in Paris in December 2015, for countries to review their efforts and to find ways of ramping up the ambition of their emissions reductions by 2030 and beyond; and
- iv. concerted efforts by all countries to build strong and transparent domestic bases for the implementation of their INDCs, setting countries on a path to decarbonisation and enabling them to ramp up their ambitions.

Many other countries are expected to submit INDCs before COP21, and this analysis will be updated during 2015 based on the implications for projected global emissions in 2030.

⁵ World Resources Institute (2014a, b).

2. Evaluation of post-2020 emissions reduction pledges in INDCs

We have assessed greenhouse gas emissions in 2030 based on INDCs that were submitted by 46 Parties to the UNFCCC by 20 July 2015.⁶ We used these 2030 emissions estimates to create a ‘snapshot running total’ of annual global emissions in 2030, which was compared with two ‘business as usual’ scenarios. For those Parties that had not submitted INDCs by 20 July 2015, we made an estimate of what their emissions would be in 2030, a Reference Scenario, based on actions and plans that had been introduced by mid-2014, and as assessed by the International Energy Agency. One ‘business as usual’ scenario was originally described by the United Nations Environment Programme (UNEP, 2014) for an extrapolation of current economic, social and technological trends, and takes into account climate policies implemented up to about 2005–2010 (i.e. what would happen to emissions if planned climate mitigation policies were not implemented). The other ‘business as usual’ scenario is an aggregate of the Reference Scenarios for every Party to the UNFCCC, including those that had submitted an INDC by 20 July 2015. Details of our approach to the evaluation of post-2020 emissions reduction pledges in INDCs is described in detail in Appendix 1.

The results of our analysis, based on the 46 Parties that had submitted INDCs by 20 July 2015, are presented in Table 1. The ‘snapshot running total’ for annual global emissions in 2030 is projected to be between 56.9 GtCO₂e and 59.1 billion tonnes of carbon-dioxide-equivalent (GtCO₂e). This projected total can be expected to decrease during as more Parties submit INDCs.

Table 1: Annual global emissions in 2030 for various scenarios

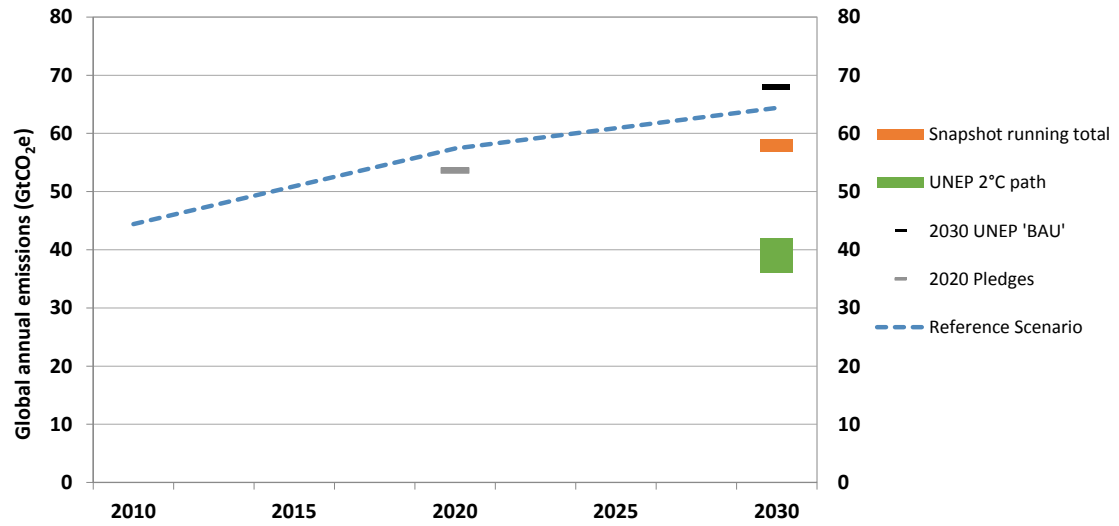
Scenario	Emissions in 2030 (GtCO ₂ e)
UNEP ‘business as usual’	68
Reference Scenario	64.4
INDC ‘snapshot running total’ (as of 20 July 2015)	56.9 – 59.1
UNEP 2°C limit (without net negative emissions from power and industry)	36
UNEP 2°C limit (with net negative emissions from power and industry)	42

Figure 1 shows the difference between the ‘snapshot running total’ and the different scenarios. Global annual emissions in 2030 would be 9–11 GtCO₂e lower than UNEP’s ‘business as usual’ (BAU) projection and 5–8 GtCO₂e lower than our Reference Scenario. However they are still 15–17 GtCO₂e higher than the emissions level that would be

⁶ We consider the basket of six anthropogenic greenhouse gases covered by the Kyoto Protocol (i.e. carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride), and express the size of emissions in terms of gigatonnes (Gt), or billions of metric tonnes, of carbon-dioxide-equivalent (CO₂e), based on 100-year global warming potentials, as published in the Second Assessment Report of the Intergovernmental Panel on Climate Change (1995). All sources from human activities, including changes to peat, of the basket of greenhouse gas emissions covered by the Kyoto Protocol are taken into account. See Appendix 1 for details on the approach taken.

consistent with the goal of avoiding global warming of more than 2°C, although the gap can be expected to decrease as more INDCs are submitted.

Figure 1: Global annual emissions between 2010 and 2030



3. Conclusions

The results of our analysis show that the INDCs submitted by 20 July 2015 by the 46 Parties to the UNFCCC would result in a reduction in global emissions in 2030 relative to UNEP's 'business as usual' pathway and our Reference Scenario.

Nevertheless, the 'snapshot running total' of 56.9-59.1 CO₂e indicates that the INDCs that have so far been submitted are not consistent with the total of 36 GtCO₂e in 2030 calculated by UNEP (2014) as being on a global emissions pathway that would offer a 50–66 per cent chance of avoiding global warming of more than 2°C above the pre-industrial global average temperature. The 'snapshot running total' is also higher than the 42 GtCO₂e total which UNEP (2014) suggests would be consistent with a 50-66 per cent chance of not breaching the 2°C limit, assuming significant amounts of 'negative emissions' through, for instance, the utilisation of bioenergy and carbon capture and storage (BECCS).

As has been stressed by Boyd *et al.* (2015), the mismatch between the ambitions embodied by the INDCs and the overall objective of having a reasonable chance of avoiding global warming of more than 2°C means that Parties to the UNFCCC should undertake additional action, including (Boyd *et al.*, 2015):

- i. hard work over the next few months by all countries to find credible ways of achieving bigger emissions reductions which can be included in INDCs to be submitted to the UNFCCC secretariat, and/or achieved through additional efforts by partnerships (e.g. through specific decarbonisation initiatives among willing countries);
- ii. an intensification of efforts to increase investment and innovation, particularly in relation to the development of cities, energy systems and land use, that could help to close the gap between intentions and the goal before and after 2030;
- iii. the creation of a mechanism, to be included in the agreement emerging from COP21 in Paris in December 2015, for countries to review their efforts and to find ways of ramping up the ambition of their emissions reductions by 2030 and beyond; and
- iv. concerted efforts by all countries to build strong and transparent domestic bases for the implementation of their INDCs, setting countries on a path to decarbonisation and enabling them to ramp up their ambitions.

We intend to publish updated versions of this analysis on the websites of the Grantham Research Institute on Climate Change and the Environment (<http://www.lse.ac.uk/grantham>) and the ESRC Centre for Climate Change Economics and Policy (<http://www.ccepc.ac.uk>) periodically during 2015 ahead of COP21 to account for new INDCs as they are submitted.

References

- Boyd, R., N. Stern and B. Ward, 2015. *What will global annual emissions of greenhouse gases be in 2030, and will they be consistent with avoiding global warming of more than 2°C?* Policy Paper. Centre for Climate Change Economics and Policy and Grantham Research Institute on Climate Change and the Environment, London, UK. Available at: http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2015/05/Boyd_et_al_policy_paper_May_2015.pdf
- Green, F., and N. Stern, 2015. *China's "new normal": structural change, better growth, and peak emissions*. Policy Brief. ESRC Centre for Climate Change Economics and Policy and Grantham Research Institute on Climate Change and the Environment, London, UK. Available at: http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2015/06/China_new_normal_web1.pdf
- International Energy Agency [IEA], 2014. *World Energy Outlook 2014*. IEA/Organisation for Economic Cooperation and Development (OECD), Paris, France. Available at: <http://www.worldenergyoutlook.org/>
- IEA, 2015. *Emissions Database*. IEA/OECD, Paris, France. Available at: <http://data.iea.org/>
- International Monetary Fund [IMF], 2014. *World Economic Outlook Database October 2014*. Washington DC, USA. Available at: www.imf.org/external/pubs/ft/weo/2014/02/weodata/index.aspx.
- Intergovernmental Panel on Climate Change [IPCC], 1995. *Climate Change 1995: The Science of Climate Change. Contribution of Working Group I to the Second Assessment Report of the Intergovernmental Panel on Climate Change* [Houghton, J.T., L.G. Meira Filho, B.A. Callander, N. Harris, A. Kattenberg and K. Maskell (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Available at: <https://www.ipcc.ch/ipccreports/sar/wg I/ipcc sar wg I full report.pdf>
- Joosten, H., 2010. *The Global Peatland CO₂ Picture: Peatland status and drainage related emissions in all countries of the world*. Wetlands International, Wageningen, Netherlands. Available at: http://www.wetlands.org/Portals/0/publications/Report/The%20Global%20Peatland%20CO2%20Picture_web%20Aug%202010.pdf.
- Kindermann, G., Obersteiner, M., Sohngen, B., Sathaye, J., Andrasko, K., Rametsteiner, E., Schlamadinger, B., Wunder, S. and Beach, R., 2008. *Global cost estimates of reducing carbon emissions through avoided deforestation*.

Proceedings of the National Academy of Sciences of the United States of America, 105(30), pp.10302-10307.

Lucas, P.L., van Vuuren, D.P., Olivier, J.G.J. and den Elzen, M.G.J., 2007. *Long-term reduction potential of non-CO₂ greenhouse gases*. Environmental Science & Policy, 10(2), pp.85-103.

National Climate Strategy Centre [NCSC], 2015. Commentary on the Chinese INDC. NCSC/National Development and Reform Commission, Beijing, China. Available at [in Chinese]:
<http://files.ncsc.org.cn/www/201507/20150702114814244.pdf>.

Organisation for Economic Cooperation and Development [OECD], 2014. *OECD Economic Outlook: Long-term Baseline Projections (No. 95, Edition 2014)*. Paris, France. Available at: http://www.oecd-ilibrary.org/economics/data/oecd-economic-outlook-statistics-and-projections/long-term-baseline-projections-no-95_data-00690-en.

People's Republic of China, 2012. *Second National Communication on Climate Change*. National Development and Reform Commission, Beijing, China. Available at: <http://unfccc.int/resource/docs/natc/chnnc2e.pdf>.

Republic of Korea, 2008. Third National Communication under the United Nations Framework Convention on Climate Change. Korea. Available at: <http://unfccc.int/resource/docs/natc/kornc3.pdf>.

Stern, N. & C. Taylor, 2010. What do the Appendices to the Copenhagen Accord tell us about global greenhouse gas emissions and the prospects for avoiding a rise in global average temperature of more than 2°C? Policy Paper. Centre for Climate Change Economics and Policy and Grantham Research Institute on Climate Change and the Environment, London, UK. Available at: <http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2014/02/PPCOPAccordSternTaylorMarch10.pdf>

United Nations Environment Programme [UNEP], 2013. *The Emissions Gap Report 2013*. UNEP, Nairobi, Kenya. Available at:
http://www.unep.org/pdf/UNEP_EmissionsGapReport2013.pdf

UNEP, 2014. *The Emissions Gap Report 2014*. UNEP, Nairobi, Kenya. Available at:
http://www.unep.org/publications/ebooks/emissionsgapreport2014/portals/50268/pdf/EGR2014_LOWRES.pdf

United Nations Framework Convention on Climate Change [UNFCCC], 2011. Report of the Conference of the Parties on its sixteenth session, held in Cancún from 29 November to 10 December 2010—Addendum Part Two: Action taken by the Conference of the Parties at its sixteenth session. Bonn,

Germany. Available at:

<http://unfccc.int/resource/docs/2010/cop16/eng/07a01.pdf>

UNFCCC, 2014. Report of the Conference of the Parties on its twentieth session, held in Lima from 1 to 14 December 2014—Addendum Part Two: Action taken by the Conference of the Parties at its twentieth session. Bonn, Germany. Available at:

<http://unfccc.int/resource/docs/2014/cop20/eng/10a01.pdf>

World Resources Institute [WRI], 2014a. *Climate Analysis Indicators Tool (CAIT Version 2.0): Climate Data Explorer, Country Emissions*. World Resources Institute, Washington, DC. Available at:

<http://www.wri.org/resources/data-sets/unfccc-annex-i-ghg-emissions-0>

WRI, 2014b. *Climate Analysis Indicators Tool (CAIT Version 2.0): UNFCCC Annex I GHG Emissions Data*. World Resources Institute, Washington, DC. Available at: <http://www.wri.org/resources/data-sets/unfccc-annex-i-ghg-emissions-0>

Appendix 1: Approach to evaluating post-2020 emissions reduction pledges in INDCs

Our approach to evaluating post-2020 emissions reduction pledges in INDCs consists of four main steps:

- i. estimating annual emissions of greenhouse gases in 2030 from the INDCs that had been submitted by 46 Parties to the UNFCCC by 20 July 2015;
- ii. estimating a Reference Scenario for each Party based on policies that had been implemented by mid-2014;
- iii. calculating a 'snapshot running total' for the projected annual global emissions of greenhouse gases in 2030, based on submitted INDCs; and
- iv. quantifying the gaps between the 'snapshot running total' and
 - a. a UNEP 'business as usual' pathway and an aggregate of the Reference Scenarios; and
 - b. an aggregate total for global emissions in 2030 that is projected to be consistent with a reasonable chance of avoiding global warming of more than 2°C above pre-industrial levels.

We consider the basket of six anthropogenic greenhouse gases covered by the Kyoto Protocol (i.e. carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride), and express the size of emissions in terms of gigatonnes (Gt), or billions of metric tonnes, of carbon-dioxide-equivalent (CO₂e), based on 100-year global warming potentials, as published in the Second Assessment Report of the Intergovernmental Panel on Climate Change (1995). All sources from human activities, including changes to peat, of the basket of greenhouse gas emissions covered by the Kyoto Protocol are taken into account.

Estimating 2030 emissions from INDCs

We have based our calculations on INDCs that have been posted on the website of the UNFCCC.⁷ Details of how emissions in 2030 are calculated from each INDC are listed in Appendix 2. The INDCs for the 28 Member States of the European Union are considered together. In some cases, the INDCs imply a range within which emissions will lie in 2030. In these cases we have calculated the upper and lower limits to the ranges and therefore created two INDC scenarios: INDC Low Ambition and INDC High Ambition. This range does not include the conditional offers submitted by some Parties; only the unconditional parts of targets have been included in our analysis.

We use the total for annual emissions of greenhouse gases in 2030 where it is explicitly stated in an INDC. Where it is implied, we have undertaken a calculation based on information provided by the Party that submitted the INDC. Our general approach has been to take INDCs and other information at face value. We have not conducted a detailed assessment of the different approaches to accounting for emissions from the land sector that have been adopted by Parties.

⁷ See: <http://www4.unfccc.int/submissions/indc/Submission%20Pages/submissions.aspx>.

Where, for instance, an INDC expresses emissions in 2030 as a percentage of an earlier year's emissions (e.g. 40 per cent below 1990 levels), we calculate the total based on the emissions data submitted by that Party to the UNFCCC.⁸ Where the INDC for a Party is less specific about emissions in 2030, we make simple and reasonable assumptions to estimate the total, with details provided in Appendix 2.

For INDCs that do not explicitly state a level of emissions in 2030, we calculate the total based on the most up-to-date and reliable information about past and future emissions, as well as relevant data about other relevant factors, such as economic growth rates. In some cases this included referring to published analyses. Were any INDCs to include a target measured as a reduction compared with 'business as usual', but without specifying a 'business as usual' projection, we would use the Reference Scenario outlined below. However, so far all INDCs that have included a 'business as usual' target have also included a 'business as usual' projection.

In addition to the analysis of emissions in 2030 based on INDCs, we provide projections of annual emissions in 2020 for the 13 individual countries and 11 regional blocs, based on submissions by Parties to the secretariat of the UNFCCC after COP15, including both conditional and unconditional pledges.⁹ These totals are updates on the figures first published by Stern and Taylor (2010), and subsequent submissions by the Grantham Research Institute on Climate Change and the Environment to the United Nations Environment Programme for its annual reports on the gap between emissions commitments and targets (e.g. UNEP, 2013). The totals allow a comparison between projected emissions in 2020 and 2030.

Reference Scenario emissions for countries without INDCs

The UNEP 'Emissions Gap Report 2014' presented a 'business as usual' pathway based on an extrapolation of current economic, social and technological trends. This scenario only takes into account climate policies implemented up to around 2005–2010 and therefore serves as a reference point for what would happen to emissions without more recent pledges and policies. In this scenario, global annual emissions of greenhouse gases would rise from 54 GtCO₂e in 2012 to 68 GtCO₂e in 2030.

While this provides one benchmark against which to judge the progress represented by the INDCs, we have also sought to determine a Reference Scenario pathway based on policies that had been implemented by mid-2014. This provides a better estimate of what emissions would be as a result of current policies without additional action. The Reference Scenario emissions for countries that have not submitted INDCs are also used to calculate the 'snapshot running total'.

The Reference Scenario draws on the following data sources:

⁸ For Annex I countries: National Communication Reports submitted to the UNFCCC by Parties, compiled by the World Resources Institute (WRI, 2014b). For non-Annex I countries: data from the World Resources Institute's CAIT 2.0 dataset (WRI, 2014a).

⁹ A list of the country submissions are available at:
http://unfccc.int/meetings/copenhagen_dec_2009/items/5276.php

- i. emissions of carbon dioxide from all sources other than land use, land-use change and forestry (LULUCF), provided by Enerdata, using the POLES model calibrated for the data from the Current Policies Scenario in the World Energy Outlook (2014) published by the International Energy Agency;¹⁰
- ii. emissions of carbon dioxide from LULUCF, from the International Institute for Applied Systems Analysis (IIASA);¹¹ and
- iii. emissions of greenhouse gases covered by the Kyoto Protocol, other than carbon dioxide, from the Netherlands Environmental assessment Agency (PBL)¹².

The Reference Scenario totals are calculated for 26 separate blocs:

- 13 individual countries (Brazil, Canada, China, India, Indonesia, Japan, Mexico, Russia, South Africa, South Korea, Turkey, Ukraine, United States);
- 11 regional blocs (European Union, Middle East, Oceania, Northern Africa, Rest of Central America, Rest of Europe, Rest of the Former Soviet Union, Rest of South America, Rest of South Asia, Rest of South East Asia, Rest of Sub-Saharan Africa); and
- two international fuel bunkers (aviation and maritime) which cannot be assigned to any individual countries or regional blocks so are treated as regions in their own right.

To project the level of emissions of smaller countries in the regional blocs that have not submitted INDCs, we assume that the percentage of emissions produced by a country within each region stays the same between 2010 and 2030 (even if the total absolute emissions for the bloc changes). This is a simplifying assumption; in reality, each country's share of emissions may change over time due to differences in economic growth rates, climate policies, and so on. However, the impact of these trends is likely to be small relative to the global emissions level reported in the results¹³.

In addition, we considered that the aggregate sum of annual emissions for the 13 individual countries, 11 regional blocs and 2 international bunkers was likely to underestimate global emissions by not fully including carbon dioxide emissions from peat. We have taken into account emissions from peat in the final total for the Reference Scenario by adding a further 1.5 GtCO₂e per year¹⁴. The data used for the Reference Scenario was procured through open tender by the UK Government's Department of Energy and Climate Change (DECC) for use in its Global Carbon Finance Model (GLOCAF).

¹⁰ IEA (2014).

¹¹ Kindermann *et al.* (2008).

¹² Lucas *et al.* (2007).

¹³ We conducted a sensitivity analysis around this assumption, using the alternative assumption that each country's share of its region's emissions changes at the same rate as that between 2000 and 2010. This alternative assumption increases projected global emissions by around 0.01 GtCO₂e, a difference which is too small to show up in the results presented here.

¹⁴ Research suggests global emissions from drained peatland were 1.3 GtCO₂e in 2008, although this does include emissions caused by peat fires (for which conservative estimates are at least 400 MtCO₂e) (Joosten, 2010). We have increased the total annual emission from peat to 1.5 GtCO₂e to account for these additional emissions.

The Reference Scenario provides a useful indication of the likely level of emissions in 2030, based on the assessment of the International Energy Agency of current policies and socio-economic trends. Nonetheless, projecting economic growth, demographic changes and technological development 15 years into the future inherently results in a significant level of uncertainty. The Reference Scenario should, therefore, be regarded as a reasonable estimate of what emissions will be, based on current evidence and expectations.

For comparison purposes, alongside the estimates of future emissions for each bloc, we also provide the details of annual emissions in 1990, 2005 and 2010. These data are for illustration purposes and were not used in the projections of future emissions. In most cases, these figures are based on official national inventory submissions of emissions from Annex I Parties to the UNFCCC, and the WRI CAIT database¹⁵ for other parties (i.e. Non-Annex I Parties to the UNFCCC).

Snapshot running totals

In order to assess the overall impact of the INDCs on global annual emissions in 2030, we create a 'snapshot running total'. This is calculated by starting with the Reference Scenario and replacing the emissions total for each Party that has made a submission to the UNFCCC with an estimate based on its INDC. Two 'snapshot running total' scenarios (INDC High Ambition and INDC Low Ambition) are provided to take account of the target ranges implied by some INDCs. We only include unconditional contributions from INDCs. The 'snapshot running totals' can be compared with:

- i. The UNEP (2014) 'business as usual' global total, to assess what progress will be made by existing climate policies and the delivery of the INDCs;
- ii. The Reference Scenario, to assess the additional impact of INDCs on top of policies implemented since mid-2014; and
- iii. The UNEP estimates of the pathway for annual global emissions that is consistent with a 50–66 per cent chance of limiting the rise in global average temperature to no more than 2°C above pre-industrial level.

As UNEP (2014) makes clear, there is significant uncertainty around both what 'business as usual' emissions would be, and what level of emissions would be consistent with the 2°C warming limit. We follow the UNEP approach of using a median value from its ranges for emissions in order to make comparisons.

This paper will be updated throughout 2015 as new INDCs are submitted by Parties to the UNFCCC. In addition, UNEP is currently updating its analysis of what level of emissions would be consistent with the 2°C limit which, once published, will be used to update the comparative analysis in this paper.

¹⁵ A previous paper, Boyd *et al.* (2015), employs the IEA Emissions Dataset for historic emissions (IEA, 2015). However the regional bloc country breakdowns differ from those used to generate the Reference Scenario, with no official sources available from one source such as the UNFCCC. We thus used WRI CAIT database to ensure a high level of consistency and accuracy (WRI, 2014a).

Appendix 2: Details of calculation of 2030 emissions from each INDC as of 20 July 2015.¹⁶

	Announced INDCs Low	Announced INDCs High
OECD		
Canada	Headline 30% reduction on 2005 target (on an excluding LULUCF baseline) translates to 28% reduction compared to an including LULUCF baseline.	
European Union	Headline 40% reductions against 1990 level (on an excluding LULUCF 1990 baseline) translates to 41% compared to 1990 including LULUCF baseline.	
Japan	<p>26% reduction against 2013 baseline excluding LULUCF, translating to 20.3% reduction on 2005 level with an including LULUCF baseline.</p> <p>Further technical information: Japan's target emissions level expressed in the INDC includes removals from LULUCF; the 26% reduction is expressed against a baseline excluding LULUCF.</p> <p>Japan's INDC target emissions level uses the latest global warming potentials from the Fourth IPCC report. For consistency we have applied the same 20.3% reduction on 2005 to Japan's UNFCCC inventory data¹⁷.</p>	
Mexico	Unconditional 22% reduction on 2030 'business as usual'. Does not count 'black carbon' as GHGs. 'Business as usual' in INDC for 2030 is 987 million tonnes (Mt) CO ₂ e. INDC target emissions 770 MtCO ₂ e.	
Oceania	<p>Includes New Zealand's INDC of a 30% reduction by 2030 on a 2005 baseline excluding LULUCF (77 MtCO₂e), translating to 42% reduction compared to 2005 baseline including LULUCF.</p> <p>Reference Scenario used for rest of the region as no other INDCs have been submitted.</p>	

¹⁶ Unless otherwise stated, source of baseline emissions used in calculations are explained under Appendix 1.

¹⁷ See Appendix 1 for data source.

Rest of Europe	<p>Includes INDCs from Norway, Iceland, Serbia and Switzerland, Reference Scenario for others.</p> <p>Norway: 40% reduction on 1990 emissions level provided in INDC (52 MtCO₂e, excluding LULUCF). This gives 31.2 MtCO₂e. Projected net removals in 2030 constitute 21.2 MtCO₂e from Norway's INDC, bringing net emissions including LULUCF to 10 MtCO₂e. Norway states that only removals beyond the level in the base year and the projected level will count towards the 40% commitment.</p> <p>Switzerland: 50% reduction of emissions against 1990 baseline. 1990 baseline provided in INDC (53.3 MtCO₂e).</p> <p>Iceland: 40% reduction of emissions against 1990 is 3 MtCO₂e by 2030.</p> <p>Serbia: 73 MtCO₂e allowed emissions, a 10% reduction against 1990 levels by 2030 incl. LULUCF.</p>	
South Korea	<p>37% reduction of emissions against 'business as usual' in 2030. 'Business as usual' given in INDC as 850.6 MtCO₂e, excluding LULUCF. LULUCF emissions in 2030 are estimated to be -23 MtCO₂e (based on 2020 LULUCF projections from the 3rd National Communications report.¹⁸</p>	
Turkey	<p>Reference Scenario as no INDC submitted.</p>	
USA	<p>2025 target of 26% reduction on 2005 baseline emissions including LULUCF. 2030 based on linear trajectory from 2020 target of 17% reduction on 2005 level, leading to 2030 emissions 35% below 2005.</p>	<p>2025 target of 28% reduction on 2005 baseline emissions including LULUCF, straight line trajectory from 2020 target of 17% reduction on 2005 level, leading to 2030 emissions 39% below 2005.</p>
<p>BASICS</p>		
Brazil	<p>Reference Scenario as no INDC submitted.</p>	

¹⁸ Republic of Korea (2008).

China ¹⁹	<p>60% reduction in emissions intensity of GDP relative to 2005 level.</p> <p>Emissions improvement and GDP projections (approximately 7% annual growth 2015–2020, 5.3% 2020–2030) based on analysis by the Chinese National Climate Strategy Centre.²⁰</p> <p>Assume target covers all CO₂ but no other GHGs.</p> <p>CO₂: 2005 baseline for all CO₂ is 5,936 MtCO₂e from China's 2nd National Communications report.²¹</p> <p>Non-CO₂: Reference Scenario projection for nonCO₂ gases: 2,706 MtCO₂e, and LULUCF of -284 MtCO₂e.</p> <p>60% improvement in emissions intensity from 2005 gives 16,256 MtCO₂e of emissions in 2030.</p>	<p>65% reduction in emissions intensity of GDP relative to 2005 level.</p> <p>Emissions improvement and GDP projections (approximately 7% annual growth 2015–2020, 5.3% 2020–2030) based on analysis by the Chinese National Climate Strategy Centre.</p> <p>Assume target covers all CO₂ but no other GHG.</p> <p>CO₂: 2005 baseline for all CO₂ is 5,936 MtCO₂e from China's 2nd National Communications report.</p> <p>Non-CO₂: Reference Scenario projections for non-CO₂ gases: 2,706 MtCO₂e, and LULUCF of -284 MtCO₂e.</p> <p>65% improvement in emissions intensity from 2005 gives 14,428 MtCO₂e of emissions in 2030.</p>
India	Reference Scenario as no INDC submitted.	
South Africa	Reference Scenario as no INDC submitted.	
Rest of the World		
Indonesia ²²	Reference Scenario as no INDC submitted.	
Russia	25% reduction on 1990 baseline emissions including LULUCF.	30% reduction on 1990 baseline emissions including LULUCF.
Ukraine	Reference Scenario as no INDC submitted.	
Middle East	Reference Scenario as no INDCs submitted.	
Northern Africa	<p>Includes Morocco's INDC only: unconditional 13% reductions on 2030 BAU gives 148 MtCO₂e.</p> <p>Reference Scenario for the rest of the region as no INDCs submitted.</p>	
Rest of Central	Reference Scenario as no INDCs submitted.	

¹⁹ Other research has suggested China emissions in 2030 are likely to be lower than suggested by this analysis—see, for instance, Green and Stern (2015).

²⁰ NCSC (2015).

²¹ People's Republic of China (2012).

²² A significant proportion of peat emissions are understood to come from Indonesia. These emissions are captured in the historical data, but not the *Reference Scenario*. The report on peat emissions used for this analysis suggests that 500–900 Mt of peat emission are from Indonesia, which if included bring our Reference Scenario into line with the historical data.

Table 2: Annual emissions (in MtCO₂e) showing historical emissions, Reference Scenario and ‘snapshot running totals’ for Parties that had submitted INDCs by 20 July 2015. See text for details.

	INDC submitted (as of 20 July 2015)	Historical data			Reference scenario		Pledge Scenario (Low)	Pledge Scenario (High)	INDC Scenario (Low)	INDC Scenario (High)
		1990	2005	2010	2020	2030	2020	2020	2030	2030
OECD										
Canada	YES	529	800	804	921	959	752	752	579	579
EU	YES	5,320	4,672	4,275	4,037	4,007	4,037	3,627	3,126	3,126
Japan	YES	1,197	1,263	1,182	1,283	1,242	1,283	1,283	1,006	1,006
Mexico	YES	434	657	706	839	966	672	672	770	770
Oceania	YES - partial	571	744	747	794	818	579	467	792	792
Rest of Europe	YES - partial	218	192	120	255	257	204	195	180	180
South Korea	YES	263	530	630	848	772	520	520	513	513
Turkey	NO	173	286	361	554	657	554	554	657	657
USA	YES	5,389	6,197	5,922	6,691	6,808	5,144	5,144	4,030	3,780
BASICs										
Brazil	NO	1,739	2,257	1,393	2,521	2,576	1,789	1,789	2,576	2,576
China	YES	3,047	6,966	9,387	14,645	16,588	14,426	14,426	16,256	14,428
India	NO	1,035	1,648	2,304	3,888	5,477	3,888	3,888	5,477	5,477
South Africa	NO	331	410	459	554	627	554	554	627	627
REST OF WORLD										
Indonesia	NO	1,077	1,673	2,033	1,006	1,233	1,006	1,006	1,233	1,233
Russia	YES	3,436	1,588	1,567	2,492	2,643	2,492	2,492	2,577	2,406
Ukraine	NO	860	379	345	417	432	417	417	432	432
Middle East	NO	958	1,841	2,294	2,563	3,195	2,538	2,538	3,195	3,195
Northern Africa	YES - partial	369	596	715	870	1,070	870	870	1,080	1,080
Rest of Central America	NO	271	315	354	470	488	470	470	488	488
Rest of FSU	NO	1,007	714	820	934	1,050	934	934	1,050	1,050
Rest of South America	NO	1,255	1,561	1,706	2,059	2,244	1,920	1,870	2,244	2,244
Rest of South Asia	NO	373	542	596	708	937	708	708	937	937
Rest of South East Asia	YES - partial	762	1,623	1,756	2,397	2,836	2,254	2,254	2,788	2,788
Rest of Sub Saharan Africa	YES - partial	2,411	2,649	2,826	2,861	3,339	2,861	2,861	3,314	3,314
NON-SOVEREIGN EMISSIONS										
International Aviation	N/A	248	405	440	586	796	550	550	796	796
International Maritime	N/A	286	555	639	712	915	712	712	915	915
Peat emissions	N/A	-	-	-	1,500	1,500	1,500	1,500	1,500	1,500
TOTAL		33.6	41.1	44.4	57.4	64.4	53.6	53.1	59.1	56.9