International Institute for Applied Systems Analysis
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Why are NDC projections so uncertain and how can they be made more precise?

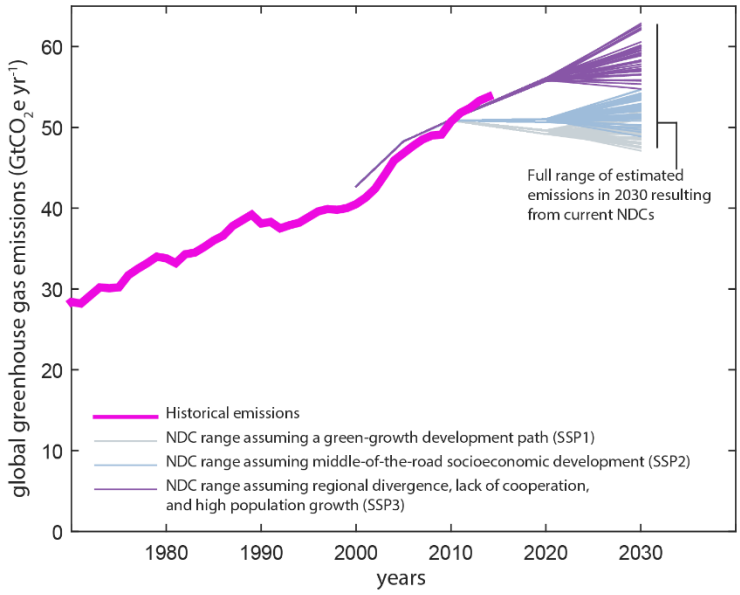
Currently, Nationally Determined Contributions (NDCs) under the Paris Agreement describe a wide variety of actions that cover both climate change adaptation and mitigation. These actions, and in particular the mitigation actions included in NDCs, intend to contribute to the achievement of the Paris Agreement's long-term temperature goal (LTTG) of holding warming well below 2°C and pursuing to limit it to 1.5°C relative to preindustrial levels. The question that immediately arises in this context is what these actions add up to collectively, and whether they set the world on track to achieve the Paris Agreement's LTTG.

Mitigation actions in NDCs are defined in a variety of ways, including emissions reductions relative to a specific reference year in the past, emissions reductions relative to a hypothetical baseline in absence of climate change impacts and climate change mitigation, emission intensity improvements, or the achievement of specific renewable energy targets, amongst other. Because many of the mitigation actions included in NDCs do not define direct emissions reductions, their effect on global emissions has to be estimated indirectly. These estimates result in a range of possible emissions outcomes, but this uncertainty can be understood and measures can be identified to reduce it.

Range of uncertainty

Exploring the various uncertainties related to the NDC mitigation actions in a structured way, allows to estimate the annual global greenhouse gas emissions in 2030 consistent with the implementation of the mitigation actions of the NDCs. These estimates range between 47 and 63 billion tonnes of CO_2-equivalent ($GtCO_2eq\ yr^{-1}$) emissions, with a median of about 52 $GtCO_2eq\ yr^{-1}$. This compares to global greenhouse gas emissions in 2010 of about 51 $GtCO_2eq\ yr^{-1}$.

Depending on the assumptions made to estimate the impact of the NDCs on global 2030 emissions, NDCs would thus result in either strongly increasing or slightly decreasing emissions. In a context where the Intergovernmental Panel on Climate Change (IPCC) Special Report on Global Warming of 1.5°C has indicated that pathways that limit warming to 1.5°C with no or limited overshoot show 2030 greenhouse gas emissions of about 25–30 $GtCO_2eq\ yr^{-1}$, it is clear that understanding this range is key. An analysis of the contributing factors allows to identify the reasons underlying the 47–63 $GtCO_2eq\ yr^{-1}$ range and measures through which it could be narrowed.



Range of 2030 emissions resulting from various interpretations of the current NDCs. Global historical GHG emissions from (Gütschow, Jeffery et al. 2016) and projected emissions under the current NDCs from (Rogelj, Fricko et al. 2017). Each line from 2010 to 2030 represents one of 144 modelled scenarios; Figure reproduced from (Rogelj, Fricko et al. 2017). Global greenhouse gases are aggregated with the AR4 GWP-100 metric.

Breakdown of uncertainties in emission estimates consistent with the NDCs

A dedicated NDC study by the International Institute for Applied Systems Analysis (IIASA) identified six potential contributions to the overall uncertainty in NDC emission projections:

- **Potential variations in socioeconomic baseline:** These play a role, for example, when NDC mitigation actions are expressed in terms of emission intensity improvements, that is, the amount of emissions per unit of GDP. They also play a role when emission reduction targets included in the NDC would not lead to emissions in 2030 that are lower than projected baseline emission. This is the case is some reforming economies.
- **Variations in historical emission inventories:** Many NDC actions are expressed as reductions relative to a historical reference year, for example, 1990 or 2005. If the level of emissions in this year is uncertain, this also affects projected future emissions.
- **Conditionality of NDC actions:** In several cases, implementation of actions included in the NDCs are conditional, for example, on the availability of finance. Whether these conditions would be met is uncertain.
- **Range specifications:** Instead of providing a single number, some NDCs provide a range of potential emissions reductions in their NDC.
- **Alternative energy accounting methods:** Contributions of renewables and fossil energy can be compared by expressing renewables in 'primary energy equivalence'. Several methods exist to make this conversion, and this influences in turn emission estimates if NDCs aim at achieving a specific share of renewable energies in their national energy mix.
- **Attribution of non-commercial biomass:** Non-commercial biomass covers an important share of the overall energy demand in some regions, and if this non-commercial biomass is counted towards renewable energies it can influence the ease with which a country can meet an NDC target aiming at achieving a specific share of renewables in the energy mix.

The table below shows how each of these potential contributions affects the uncertainty in the projections of global greenhouse gas emissions for the year 2030 under the NDCs.

Uncertainty source	Variations in socioeconomic baseline development	Variations in historical emission inventories	Conditionality of NDC actions	Range specification of NDC targets	Alternative energy accounting methods for renewables	Variation in attribution of non-commercial biomass
Induced global variation around median	15-20%	Less than 2%	2-5%	0-5%	0-10%	Less than 2%

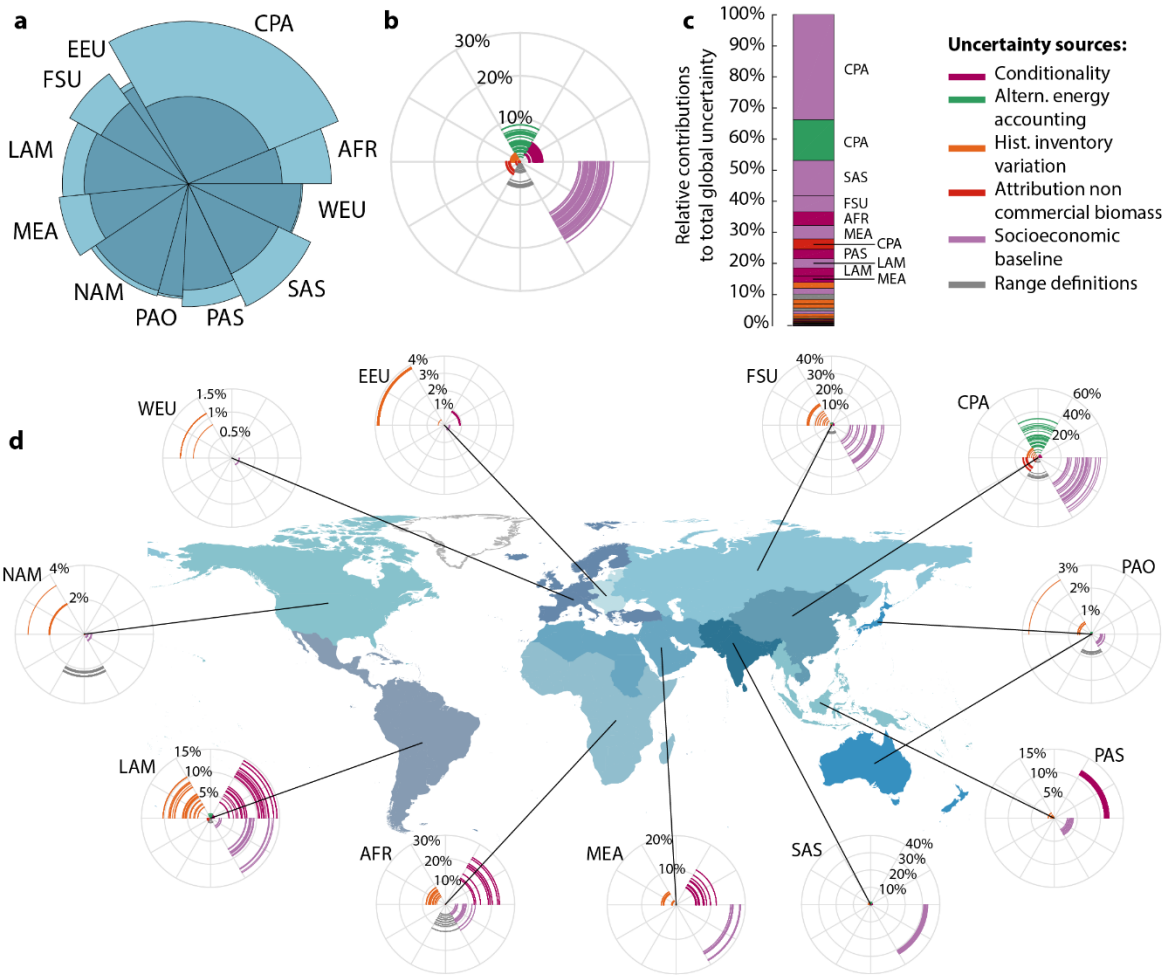
This clearly shows how variations in socioeconomic baseline development dominate the global uncertainty in NDC emission projections, followed by the impact of alternative energy accounting methods for renewables. At the regional level, however, these uncertainty can play out very differently, as illustrated in the figure on the next page.

Avoidable and irreducible uncertainties

Some of the factors that affect the range of greenhouse gas projections consistent with NDCs can be easily avoided, for example, by deciding on common, high-standard, and internally consistent emission inventories, by clarifying conditions attached to NDC action as well as clarifying which support would become available, and by deciding on methodological issues such as the method by which renewables are compared to other sources of energy or the inclusion of traditional biomass use in renewable energy. These clarifications could reduce de overall uncertainty range by about 10 percentage points. The remainder, and largest part of the NDC emission projection uncertainty, however, depends on government choices about how to express their NDCs and providing clarity about the assumed socioeconomic development that underlies these choices. Unless NDC actions are expressed differently, for example, as a reduction relative to a historical reference year, these uncertainties will be hard to avoid.

Implications for achieving the Paris Agreement Long-term Temperature Goal

No available interpretation of the current mitigation included in the NDCs would suggest that they are putting the world on track for limiting warming to well below 2°C, let alone 1.5°C. If NDCs would not be strengthened before 2030, a sudden increase in implied global carbon prices by a factor four to 25 would be required after 2030 to still keep warming to below 2°C. For limiting warming to 1.5°C, the window would be closed if current NDCs are not strengthened before 2030.



Contributions of uncertainty sources to regional NDC emission projection uncertainty. ***(a)*** *Regional emissions contributions to global emissions and uncertainty under the full implementation of current NDCs. Shadings show the minimum–maximum range of emissions estimates per region;* ***(b)*** *Estimates of the magnitude of uncertainty induced in 2030 per source relative to the median estimate;* ***(c)*** *Average contribution to full uncertainty range in 2030 per uncertainty source with the 10 most important contributions identified by region;* ***(d)*** *As b but per geographical region. AFR, Sub-Saharan Africa; CPA, Centrally Planned Asia and China; EEU, Central and Eastern Europe; FSU, Former Soviet Union; LAM, Latin America and the Caribbean; MEA, Middle East and North Africa; NAM, North America; PAS, Pacific OECD; SAS, South Asia; PAS, Other Pacific Asia; WEU,Western Europe. Country borders use the simplified TM World borders, provided by Bjorn Sandvik (thematicmapping.org). Figure reproduced from (Rogelj, Fricko et al. 2017).*

Publication on which this policy brief is based:

Rogelj, J., O. Fricko, M. Meinshausen, V. Krey, J. J. J. Zilliacus and K. Riahi (2017). "Understanding the origin of Paris Agreement emission uncertainties." Nature Communications ***8****: 15748. DOI: 10.1038/ncomms15748 [OPEN ACCESS]*

Other references:

Gütschow, J., L. Jeffery, R. Gieseke, R. Gebel, D. Stevens, M. Krapp and M. Rocha (2016). The PRIMAP-hist national historical emissions time series (1850-2014). http://doi.org/10.5880/PIK.2016.003, GFZ Data Services.

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IIASA's Energy Program has prepared this policy brief.

The overall objective of the Energy Program (ENE) is to understand the nature of alternative future energy transitions, their implications for human well-being and the environment, and how they might be shaped and directed by current and future decision makers.

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IIASA's Energy Program

About CD-Links:

An important question for policymakers is how individual countries meet the climate targets they agreed to under the Paris Agreement and how they can tie this in with the broader sustainable development agenda.

Linking Climate & Development Policies: Leveraging International Networks & Knowledge Sharing (CD-LINKS) is a 4-year research project funded by the European Union with 19 partners and collaborators from Brazil, China, Europe, India, Japan, Korea, Russia, and the USA. The project explores national and global transformation strategies for climate change and their linkages to a range of sustainable development objectives.

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