Appendix Chapter 3. The emissions gap [only on-line]

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Appendix A.1 Methodology National and Global studies

Appendix A.1 gives an overview of the national and global studies that are used for the calculation of the emission projections resulting from the current policies scenario and NDC scenario.

Table A.1 Overview of global NDC studies included in the Gap assessment (in alphabetical order), and their main characteristics. Source: Updated from Rogelj et al. (2016) and UNEP (2016)

Reference	Date of Analysis	Scenario coverage	GWPs	Historical emissions based on National GHG Inventories	Harmonisation of historical emissions (2010 emissions)
Climate Action Tracker (CAT, 2018)	August 2017	Current policy trajectory, NDC	IPCC SAR	Yes	Yes
Climate & Energy College/ University of Melbourne (Meinshausen, 2016)	November 2016	NDC	IPCC AR4 and IPCC SAR (used here)	Partly	No
Climate Interactive (Climate Interactive, 2017)	October 2017	NDC (only unconditional)	IPCC AR4	No	No
Danish Energy Agency (Dockweiler, 2015)	8 December 2015	NDC (only unconditional) [b]	IPCC SAR	No	No
International Energy Agency - World Energy Outlook (IEA, 2017) [a]	November 2016	Current policy trajectory, NDC (only unconditional)	IPCC AR5	No	No
Joint Research Centre (JRC) (Kitous et al., 2017; Vandyck et al., 2016)	August 2017	Current policy trajectory, NDC	IPCC SAR	No	No
London School of Economics and Political Science (LSE) (Boyd et al., 2015)	Mid-October 2015	NDC	IPCC SAR	No	No
Pacific Northwest National Laboratory (PNNL) (Fawcett et al., 2015)	Mid-October 2015	NDC (only unconditional)	IPCC AR4	No	No
PBL Netherlands Environmental Assessment Agency (den Elzen et al., 2016; Kuramochi et al., 2016; PBL, 2017)	August 2017	Current policy trajectory, NDC	IPCC SAR	Yes	Yes
UNFCCC (UNFCCC, 2016)	4 April 2016	NDC	IPCC AR4, AR5 and IPCC SAR (used here)	Yes	No
New studies compared to UNEP's Emissions Gap Report 2017					
Fondazione Eni Enrico Mattei (FEEM) (Vrontisi et al., 2018)	April 2018	NDC (only conditional)	IPCC AR4 and IPCC SAR (used here)	No	No
International Institute for	June 2017	NDC	IPCC AR4 and	Yes	Yes

Applied Systems Analysis (IIASA) (Rogelj et al., 2017)			IPCC SAR (used here)		
National Institute for Environmental Studies (NIES) (Vrontisi et al., 2018)	April 2018	NDC (only conditional)	IPCC AR4 and IPCC SAR (used here)	No	No
Potsdam Institute for Climate Impact Research (PIK) (Vrontisi et al., 2018)	April 2018	NDC (only conditional)	IPCC AR4 and IPCC SAR (used here)	No	No
Universite Pierre et Marie Curie (CNRS), Paris (Benveniste et al., 2018)	December 2017	NDC (only unconditional) [b]	IPCC SAR	No	No

[a] Only available at the global level, see http://www.worldenergyoutlook.org/media/news/WEO2015_COP21Briefing.pdf. Here the IEA current policies scenario is used.

[b]. The study does not separate unconditional from conditional NDCs, but the calculations do consider the conditional NDCs as well.

Table A.2 The historical emissions databases used in the global NDC studies included in the Gap assessment (in alphabetical order). Source: Updated from Rogelj et al. *(2016) and UNEP (2016)*

Reference	Global GHG 2010 emissions, incl. LULUCF (GtCO2e)	Global 2010 LULUCF CO_2 emissions (GtCO2e)	Source LULUCF emissions of countries	Source: LULUCF emissions of world
Climate Action Tracker (CAT, 2017)	47.5	About 3	National inventories, if available	Harmonised, to match estimates in climate model
Climate & Energy College / University of Melbourne dataset (Meinshausen, 2016)	47.0	About 3.5	National inventories	Harmonised, to match estimates in climate model
Climate Interactive (Climate Interactive, 2017)	51.0	Not reported, but likely high (IPCC RCP scenario)	CROADS model	Harmonised, to match estimates in climate model
Danish Energy Agency (Dockweiler, 2015)	48.0	Not reported, but likely high due to IIASA	IIASA land use model	IIASA land use model
IIASA (Rogelj et al., 2017)*	51.0	Not reported	Various data-sources	Various data-sources
International Energy Agency - World Energy Outlook (IEA, 2016)	45.7	About 0.8	FAO with national estimates	FAO with national estimates
Joint Research Centre (JRC) (Kitous et al., 2017; Vandyck et al., 2016)	44.5	About 1.0	Harmonised, to match national inventories and FAO	Harmonised, to match national inventories and FAO
London School of Economics and Political Science (LSE) (Boyd et al., 2015)	49.8	Not reported, but likely high due to IIASA	IIASA land use GLOBIOM model	IIASA land use GLOBIOM model
Pacific Northwest National Laboratory (PNNL) (Fawcett et al., 2015)	48.6	Not reported	GCAM model	GCAM model
PBL Netherlands Environmental Assessment Agency (den Elzen et al., 2016; Kuramochi et al., 2016; PBL, 2017)	45.8	2-3 (estimated)	National inventories, if available	Harmonised, to match estimates in climate model
UNFCCC Synthesis Report on the Aggregate Effect of NDCs (UNFCCC, 2016)	47.0	Not reported	Emissions excl. LULUCF (national inventories)	Harmonised, to match estimates in climate model
New studies compared to UNEP's Emissions Gap Report 2017				
Fondazione Eni EnricoMattei	45.9	2.6	IIASA land use	IIASA land use

(FEEM) (Vrontisi et al., 2018)			GLOBIOM model	GLOBIOM model
International Institute for Applied Systems Analysis (IIASA) (Rogelj et al., 2017)*	50.3	6.9	IIASA land use GLOBIOM model	IIASA land use GLOBIOM model
National Institute for Environmental Studies (NIES) (Vrontisi et al., 2018)	49.7	5.5	AIM/CGE model	AIM/CGE model
Potsdam Institute for Climate Impact Research (PIK) (Vrontisi et al., 2018)	50.8	6.9	REMIND model	REMIND model
Universite Pierre et Marie Curie/CNRS, Paris (Benveniste et al., 2018)	50.6	6.3	Emissions of Integrated Assessment models	Emissions of Integrated Assessment models

[a] Only available at the global level. Here the IEA current policies scenario is used.

Appendix A.2 The impact of uncertainties

Additional research is necessary, as the uncertainty ranges of global emissions projections resulting from full implementation of the NDCs and current policies overlap and since the number of studies available for the current policy trajectory case and the NDC cases vary significantly. There is no literature on systematically analysing the impact of key uncertainties on the current policies projections. Rogelj et al. (2017) and Benveniste et al. (2018) analysed the key uncertainties in the emissions outcomes of NDCs. These compromise in Rogelj et al.: (i) variations in overall socioeconomic conditions, such as GDP and population growth, (ii) uncertainties in historical emission inventories, (iii) the conditionality of certain NDCs, (iv) the definition of NDC targets as ranges instead of single values, (v) the way in which renewable energy targets are expressed, and (vi) the way in which traditional biomass use is accounted for, as renewable energy or otherwise. Rogelj et al. concluded (2017) that the uncertainties in socioeconomic developments are the dominant driver, accounting for more than half of the uncertainty, followed by uncertainties in the way renewable energy targets are expressed. These uncertainties are not fully accounted for in the NDC emissions range of this study, as this is based on the central estimates of all studies that individually make implicit or explicit assumptions on the above-mentioned uncertainties.

In addition, there is (vii) uncertainties around the estimation and accounting of *land-use-related mitigation* (Forsell et al., 2016; Grassi et al., 2017). Land-use options play a key role in many country NDCs (up to a quarter of planned global emission reduction in 2030 (Grassi et al., 2017). Land-use options play a key role in many country NDCs (up to a quarter of planned global emission reduction in 2030 (Grassi et al., 2017). However, most of the global analyses on NDCs do not directly use country estimates on land-use emissions in their global estimates (Appendix A.1), but use the estimates from integrated assessment models or global carbon models, mainly because of the large difference in estimating the "anthropogenic" forest sink between countries and models (Grassi et al. 2017). Grassi *et al.* found a 3 $GtCO_2e\ yr^{-1}$ difference for the 2000s in global LULUCF net emissions between country reports (data submitted to UNFCCC, such as GHG inventories and national communications) and integrated assessment models (that are used here, Appendix A.1). Grassi et al. (2018), using updated model and country GHG estimates, reassessed this gap to be about 4 $GtCO_2\ yr^{-1}$ for the period 2005-2014. They also identified different approaches to estimate the anthropogenic forest CO_2 sink as the main reason for this discrepancy.

Another issue is that model teams apply different estimates of *historical emissions* in their NDC analyses. Firstly, there is a group of model teams that calculate emissions estimates of NDCs using historical emissions data based on national inventories such as the GHG emissions data submitted via the Common Reporting Format 2017 (UNFCCC, 2017a) or Biennial Update Reports (UNFCCC, 2017b) (see Table 3.1, like Climate Action Tracker or PBL follow this approach). The global emissions by 2010 for these studies are typically around 44 ± 3 $GtCO_2e\ yr^{-1}$, which is lower than the 2010 emissions of the 1.5°C and 2°C scenarios from the IPCC AR5 scenario database. The discrepancy mainly arises from the difference in global LULUCF net emissions between country reports and model studies underlying the 1.5°C and 2°C scenarios. Therefore, most of these modelling teams (with the exception of JRC) harmonise or correct for these discrepancies, by using land use emissions estimates from global models (see earlier), and their variation increases the uncertainty surrounding NDC estimates. Secondly, there is another group of model teams, which calculate emission estimates using IAMs and based on their own historical emissions data. The country-level NDC emissions estimates of these model studies can be quite different from the emission estimates as reported from the official NDC data and independent analysis of Chapter 2, and therefore these studies were only included for a few G20 members in the country assessment of Chapter 2. The global emissions by 2010 for these studies are typically around 47.5 ± 3 $GtCO_2e\ yr^{-1}$, which is similar to the levels as assumed in the 1.5°C and 2°C scenarios, and therefore no harmonisation is needed.

Finally, some uncertainty is due to the inconsistent use of *Global Warming Potentials (GWPs)*. Both for historical data and future projections studies vary in their use of GWPs (Table 3.1), but the majority of all underlying studies reports CO_2-equivalent emissions as calculated by means of the 100-year GWPs reported in IPCC SAR (similar to Annex I emissions inventory reports until 2015). In this report (and in the earlier gap reports) the NDC projections are also based on the 100-year GWPs reported in IPCC SAR, and therefore, the NDC projections of some underlying studies were converted towards GWP values reported in IPCC SAR (if the data was available), to ensure consistency across the studies. The UNFCCC NDC Synthesis report (UNFCCC, 2016) shows that depending on whether GWP-100 values from the SAR, AR4, or AR5 are used, global NDC estimates vary in the order of 1-2 $GtCO_2e$/yr in 2030, which is much less than the variation between the various estimates due to other factors.

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