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Implications of Paris Agreement on the national emissions reduction efforts

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Implications of Paris Agreement on the national emissions reduction efforts

Final report

by

Andrzej Ancygier
Climate Analytics, Berlin

Matthias Duwe
Ecologic, Berlin

Jakob Wachsmuth
Fraunhofer ISI, Karlsruhe

Hanna Fekete, Niklas Höhne
NewClimate Institute, Berlin

On behalf of the German Environment Agency

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Publisher
Umweltbundesamt
Wörlitzer Platz 1
06844 Dessau-Roßlau
Tel: +49 340-2103-0
Fax: +49 340-2103-2285
buergerservice@uba.de
Internet: www.umweltbundesamt.de

/umweltbundesamt.de
/umweltbundesamt

Report performed by:
Climate Analytics
Ritterstrasse 3
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Guido Knoche

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Abstract: Implications of the Paris Agreement on the climate mitigation effort

The adoption of the Paris Agreement with the long-term temperature limit has important repercussions for the distribution of effort between its signatories. The application of the equity and least-cost approaches to the distribution effort leads to different outcomes. The disparity of the results from the equity and cost-effectiveness approaches can be closed by granting support to those countries for which least cost approach indicates much deeper emissions reduction than equity approaches.

Since the transformation away from fossil fuels towards renewables can contribute to meeting a number of Sustainable Development Goals (SDGs), the specific socio-economic and political circumstances need to be taken into consideration when distributing emissions reduction effort and supporting. Contrary to the socio-economic framework which with few exception changes only slowly, the political environmental within which climate mitigation is taking place may change rapidly. These changes – positive and negative – have a spillover effect on other countries. This effect takes place even if the external impacts of a policy are not the explicit objective of certain policies (or lack thereof). But it can be considerably strengthened if domestic climate mitigation effort is accompanied with active leadership and support of transfer agents.

The spillover effect creates an opportunity for the EU to influence emissions reductions well above those targeted by its own measures. Thus, it is essential for the EU to further specify its emissions reduction goal for 2050, adopt an ambitious emissions reduction goal for 2030, and create a robust policy framework to reach these goals.

Kurzbeschreibung: Auswirkungen des Pariser Abkommens auf die Klimaschutzbemühungen

Die Verabschiedung des Pariser Abkommens mit dem Ziel der langfristigen Temperaturbegrenzung hat bedeutende Auswirkungen auf die Verteilung der Anstrengungen zwischen den Vertragsstaaten. Die Anwendung des Equity- und des Least-Cost-Ansatzes auf die Verteilungsanstrengungen führt zu unterschiedlichen Ergebnissen. Die Diskrepanz zwischen den Ergebnissen kann geschlossen werden, indem den Ländern eine Unterstützung gewährt wird, für die sich aus dem Least-Cost-Ansatzes eine viel tiefere Emissionsreduktion ergibt als aus dem Equity-Ansatz.

Die Transformation weg von fossilen Brennstoffen hin zu erneuerbaren Energien kann zur Erreichung einer Reihe von Sustainable Development Goals (SDGs) beitragen. Aus diesem Grund müssen die spezifischen sozioökonomischen und politischen Umstände bei der Verteilung der Anstrengungen zur Emissionsreduzierung und deren Unterstützung berücksichtigt werden. Im Gegensatz zu den sozioökonomischen Rahmenbedingungen, die sich mit wenigen Ausnahmen nur langsam ändern, kann sich das politische Umfeld, in dem die Klimaschutzmaßnahmen eingeführt werden, rasch verändern. Diese Veränderungen - positive wie negative - haben einen Spillover-Effekt auf andere Länder. Dieser Effekt tritt auch dann ein, wenn die externen Auswirkungen einer Politik nicht das ausdrückliche Ziel bestimmter Klimamaßnahmen sind. Er kann jedoch erheblich verstärkt werden, wenn die nationalen Klimaschutzbemühungen mit *Active Leadership* und der Unterstützung von *Transfer Agents* einhergehen.

Der Spillover-Effekt bietet der EU die Möglichkeit, auf Emissionsminderungen Einfluss zu nehmen, die weit über die mit ihren eigenen Maßnahmen angestrebten Ziele hinausgehen. Daher ist es für die EU von entscheidender Bedeutung, ihr Emissionsreduktionsziel für 2050 weiter zu spezifizieren, ein ehrgeiziges Emissionsreduktionsziel für 2030 zu verabschieden und einen robusten politischen Rahmen zu schaffen, um diese Ziele zu erreichen.

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CAT	Climate Action Tracker
COP	Conference of the Parties
EU	European Union
GDP	Gross Domestic Product
HDI	Human Development Index
MACCs	Marginal Abatement Cost Curves
NDC	Nationally Determined Contributions
RES	Renewable Enegy Sources
SDGs	Sustainable Development Goals
UNFCCC	United Nations Convention on Climate Change

Summary

The adoption of the Paris Agreement with the long-term goal of reducing temperature increase to “well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels” has important repercussions for the distribution of effort between the Parties to the Agreement. In the framework of the project “Implications of Paris Agreement on the national emissions reduction efforts,” implemented between 2017 and 2020 we contributed to the discussion about the distribution of effort between the major emitters by assessing their specific circumstances, including the socio-economic ramifications and political contexts. We also looked at how the rapidly decreasing costs of mitigation technologies and spillover effect of domestic action across the border can motivate an increase in climate mitigation ambition. Finally, we contributed to the discussion concerning EU’ climate neutrality by 2050 goal.

The project was implemented by a consortium of four organizations: Fraunhofer ISI, NewClimate Institute, Ecologic Institute and Climate Analytics. In addition to leading the consortium, Climate Analytics contributed its expertise in the assessment of emissions pathways of Paris scenario development and jointly with New Climate Institute focused on the assessment of the equity approaches. It also looked into the question how domestic action can drive emissions reduction well beyond the borders of a particular country. Fraunhofer ISI focused on the assessment of the least cost emissions pathways compatible with the Paris Agreement temperature limit and contributed, jointly with New Climate Institute, to the quantification of the emissions reduction potentials reflecting a projected decrease in the costs of renewables. Ecologic Institute played a leading role in the assessment of the European policies, especially the proposal of the European Climate Law and was instrumental in developing a communication strategy and dissemination of the project’s results.

The project assessment was conducted mainly for eight countries. The focus was laid on the European Union, in addition Germany and six further countries were selected e.g. based on their importance for development of the climate negotiations, strategic importance from the EU's point of view, and relevance due to the size of the emissions. Based on these criteria China, USA, India, Brazil, Japan, and Canada were selected as the main focus countries. At the same time, it was agreed that the assessment may also concern other countries if such a focus will be justified with contribution to the project’s purpose.

Distribution of mitigation effort according to fairness- and cost-effectiveness approaches.

To contribute to answering the question on how to close the gap between the already submitted pledges and the emissions pathway resulting in meeting the Paris Agreement temperature limit in Study “Fairness- and Cost-Effectiveness-Based Approaches to Effort-Sharing under the Paris Agreement” we looked into the repercussions of using different approaches in which this additional effort can be distributed.

The distribution of the mitigation effort between the major emitters according to the equity approaches was conducted using the methodology developed by the Climate Action Tracker (CAT). It consists of a compilation of a wide range of literature on what different researchers from many perspectives would consider a “fair” contribution to greenhouse gas reductions (for more in-depth explanation see Section 3.2 of (Wachsmuth *et al.*, 2019)).

Given the large variability of equity proposals, criteria and metrics, each country has a wide equity range. For the global emissions, emissions allowances are not derived from equity approaches, they are consistent with the benchmark pathways from the CAT pathways for 1.5°C

and 2°C. The emissions allowances compatible with the 1.5°C and 2°C temperature limits for year 2030 and year 2050 are compared to the historical values from 2005 and 2015.

The comparison between equity-based emissions allowances and historical emissions levels shows broadly two categories of countries. On the one hand India based solely on fairness considerations, could increase its emissions levels by 2030. On the other hand, all the other countries covered in this study would need to reduce substantially their emissions in 2030, compared with historical emissions levels. Indeed, fairness-based ranges show compatibility with the 1.5°C emissions reduction goal would require Germany and Japan to reach negative emissions levels in 2030.

For 2050 fairness-based emissions allowances compatible with the 1.5°C and 2°C temperature limits have still wide ranges across the countries, even wider than in 2030 in absolute terms. However, as expected, all the emissions levels for all countries are smaller in 2050 than in 2030. When compared to 2015 levels, for the 2°C-compatible emissions levels, the emissions reduction ranges from -164% for Japan to +83% for India, while for 1.5°C compatible emissions reduction, the deviation ranges from -227% for Japan to +22% for India. Based solely on equity considerations, by mid-century all the countries covered in this study (except for India and China) would need to reach negative emissions levels under the Paris Agreement fairness-based considerations.

To assess the distribution of effort according to the cost-effectiveness criteria, we used an approach based on marginal abatement cost curves (MACCs) that measure the total additional cost of reducing emissions MACCs. One of the limitations of this method is that the MACCs applied in the global cost-effectiveness approach to the distribution of emissions reductions to the countries under study do not cover GHG emissions from the agriculture and the waste sector, which are included in the fairness-based approaches described earlier. To enable a comparison of the results from both approaches, we hence expand the cost-effective distribution to those sectors.

Due to the lack of MACCs for those two sectors, we use country-specific data on the current emissions of the sectors and the sectoral emissions trends as well as the globally necessary emissions reductions in the sectors. For the latter, we assume that the relative reduction with regard to the emissions trend is the same across countries and – in order to ensure consistency – apply the same global data we used to derive the energy- and process-related emissions from the global CAT pathways. For the current emissions and the emissions trends, we use the official data reported under the UNFCCC protocol for all countries under study, except for China and India, where we had to collect additional data from Ding et al. (2017) and Dhingra & Mehta (2017). We assume that current emissions trends flatten until 2030 in order not to overrate the current trends.

For all countries, the relative emissions reductions with regard to 2005 and 2015 are lower after including agricultural and waste emissions because the mitigation potential is substantially lower in these sectors. This effect is increased for those countries with a rising emissions trend in these sectors (Brazil, China and India). The change in relative emissions reductions is particularly large for Brazil because more than one third of its emissions in 2015 are from these sectors. For all other countries under study here, the change is smaller than in the global average, as is the share of agriculture and waste emissions in the total GHG emissions.

For the majority of countries under study, the cost-effectiveness-based reduction of emissions is less stringent than it would have to be according to the fairness-based distribution in 2030 and 2050 both for a 2°C-consistent and a 1.5°C-consistent pathways. The main exceptions here are China and India, for which the fairness-based ranges of GHG emissions are substantially higher than the emissions based on a cost-effectiveness approach both in 2030 and 2050. For the United States and Brazil, this is also the case either in 2030 or in 2050, but only with regard to compatibility with the pre-Paris 2°C temperature goal.

In a more recent study, we investigated how the disparity of the results from the equity and cost-effectiveness approaches can be closed (Höhne and Wachsmuth, 2020). If the national potential is not substantial enough to represent a fair contribution (likely for most developed countries), these countries should support other countries to make the transition. If the highest possible ambition leads to faster reductions than the fair contribution (likely for many developing countries), these countries would receive financial support.

Such support should not finance the cheapest reductions in developing countries as such reductions are to be implemented by the countries themselves in order to set and meet their stringent domestic emission targets. The financial support should, in particular, help to avoid sectoral lock-ins which usually require much higher efforts compared to current NDC pathways, most of which were designed to be in line with the now outdated below-2°C limit. The difference between cost-effective 2°C and 1.5°C pathways can help identify the difficult steps that could be supported, although some caution is required in the interpretation due to uncertainties about future cost developments.

Assessment of the potentials to reduce emissions

The potential distribution of the emissions reduction efforts between different Parties taking into consideration specific circumstances, was the focus of a report published in the framework of Work Package 4 (Fekete *et al.*, 2019). For each country, the report drew conclusions to what extent mitigation targets could be strengthened, based on the socioeconomic and political context, greenhouse gas emissions and energy profiles, and emissions reduction potential.

The countries selected for the assessment differ significantly in terms of their socio-economic context. Whereas Brazil, China, and India can be classified as developing countries, Canada, Germany, Japan, and the United States belong to the highly industrialized countries. This is also reflected in the Human Development Index (HDI) measuring life expectancy, access to education, and per capita income indicators, with the latter four scoring above 0.9, Brazil and China on par at 0.76 and 0.75, respectively, and India scoring the least at 0.64. The GINI index measuring inequality, presents a much more diverse picture. The higher the value of the index, the biggest the inequality. While Brazil is the country with the largest inequalities of all selected countries, the United States is the country with the largest inequality among developed countries. In Germany and Japan, the income is comparatively the more equally distributed

The differences in the GDP per capita to some degree correlate with the GHG emissions per capita. The highest emissions at around 19-20 tCO_2/capita have been recorded in the United States and Canada, per capita emissions in India and Brazil were the lowest of the selected countries, with 2.1 and 4.8 tCO_2, respectively. China, Germany, and Japan were in between with emissions per capita between 9-11 tCO_2. Different picture shows when looking at emissions intensity of the economy. In this case China and Japan record the highest emissions per unit of GDP, whereas emissions intensity of the economy in Japan and Germany is the lowest, mostly due to the high share of services in the GDP generation.

To assess the emissions reduction potential in different sectors we used models that distribute global emission pathways in line with the temperature limits to countries, assuming a most cost-efficient distribution of efforts. This means that the cheapest mitigation options are used first, regardless of which country implements them. The cost-effective reduction potentials were based on recent marginal abatement cost curves (MACC) from the POLES database (ENERDATA, 2018), which were used to derive globally cost-effective national pathways.

The calculations indicate the largest potential for emissions reduction for all countries in the energy sector. Compatibility with the 1.5°C according to the cost-effective criteria would result in emissions from this sector decreasing by over 60% between 2015 and 2030 in China, Canada, and Japan. The emissions reductions in this sector so far result in slightly lower emissions reduction potential in Germany at 42%. At the same time, Germany, next to Canada and the United States, could more than half its emissions in the buildings sector. The picture for transport is much more varied, with Brazil, China, and India, possibly even increasing their emissions. This results from comparatively low emissions from this sector in those countries. However, a temporary increase in emissions from transport would result in increasing stranded assets, as emissions from all sectors will have to decrease and in most cases these sectors have to be fully decarbonized by 2050.

The political context for emissions reduction differs significantly between the countries assessed. Starting from very negative developments in terms of climate mitigation in Brazil and the United States, to much more positive in the European Union. In remaining countries, some positive developments were often counterbalanced by negative ones, in terms of discrepancy between the ambitious actions, and emissions reduction efforts on the ground or contributing to emissions increase abroad, e.g. through funding coal-fired power plants. A clear conclusion was also that contrary to socio-economic context, which changes only steadily, the political framework within which decisions affecting climate change are taken can change rapidly.

Impact of decreasing costs of climate change mitigation on the level of ambition.

The period since the submission of the first wave of the (I)NDCs witnessed a significant decrease in the costs of climate change mitigation. Therefore, the study assessing the socio-economic and political framework for emissions reduction has been complemented with three discussion papers looking at the potential for an increase in ambition resulting merely from projected decrease in the costs of the major climate mitigation technologies.

The discussion paper by (Wachsmuth and Anatolitis, 2018) compared global cost projections for key mitigation technologies in recent reports with those that were available in the run-up to COP21. The results of the evaluation showed that the latest projections for levelized costs of energy in 2025 and 2030 were substantially lower, namely up to 51 – 52% for photovoltaics and onshore wind (ranges 17 – 52% for photovoltaics, 11 –51% for onshore wind) as well as more than 36 % for offshore wind (range 36 – 44%). For Lithium-Ion batteries used in electric vehicles, there was higher uncertainty about the reduction of costs (with an increase of the upper range in 2025), but the reductions of battery cost projections range up to 38% in 2025 and 52% in 2030 (ranges +14% – -32% in 2025 and -19% – -52%). This can be a starting point for the revision of the NDCs, which nevertheless would require a detailed analysis of a specific country's techno-economic potentials and socio-economic needs.

This applied also to the *projections* of the costs for certain key mitigation technologies, in particular for electricity from renewable energy sources (RES) and battery storage. In two studies investigating. In two studies focusing on Canada and Chile, respectively we have shown that merely reinvesting the savings resulting from the decrease in the costs of technologies in comparison to pre-COP21 projections would allow both countries to strengthen their respective NDCs. This would result in strengthening Canada's emissions reduction goal for 2030 by between 1 and 2% points. For Chile, an improvement in emissions intensity of the economy could be between 1 and 2% points stricter for the unconditional target emissions intensity target and between 3-5% for the conditional. However, the emissions reduction in the new NDCs should go significantly beyond these values to reflect the "highest possible ambition" as described in the Paris Agreement. This assessment showed how much more could be done at the same level of effort due to much speedier decrease in the costs of renewables and storage (Wachsmuth and Anatolitis, 2018; Fekete and Nascimento, 2019; Fekete, Nascimento and Lütkehermöller, 2019).

Spillover effect of domestic action

The decreasing costs of climate mitigation can be strengthened by domestic climate action, especially if it is accompanied active leadership at the international arena and transfer agents facilitating policy diffusion (Steinbacher, 2016). In the project, we also looked at the ways in which domestic actions could trigger emissions reductions that go significantly beyond reduction in a particular country.

In a study focusing on the spillover effect of domestic action, we looked at three mechanisms that could be used to facilitate emissions reduction in other countries even if their main goal was reducing domestic emissions. The most important of these mechanisms – policy diffusion – has already contributed to spread of some successful policy measures and learning on the mistakes of other countries concerning less successful policies. However, each of the three main drivers behind these mechanisms could be strengthened to accelerate global climate action. The second mechanism, the economies of scale, could be strengthened by creating markets for products needed for decarbonization and setting standards that manufacturers will follow also when producing for other markets. Finally, technological complementarity allows a country to facilitate global effort by contributing specific, niche solutions without which achieving net zero would not be possible (Climate Analytics, 2020).

The study argued that the spillover impact of domestic action could be strengthened at the backdrop of the current COVID-19 induced health and economic crises. While unusual times call for unusual measures, political leaders may be prone to adopt measures that have already been adopted in other countries. Greening the recovery packages in one country may significantly increase the probability that other countries will also focus on climate mitigation in their recovery packages, triggering transformative change. Countries may leverage the spillover effect of their green recovery packages by a corresponding increase in the level of ambition and timely submission in 2020 of new and updated NDCs.

European Union's path to climate leadership

The implementation of the project also accompanied the discussion around the European Union's long-term strategy and its 2050 emissions reduction goal. In December 2018, we promptly reacted to the European Commission's long-term Strategic Vision "A Clean Planet for All" and the accompanied in-Depth Assessment. In our Working Paper, we pointed out that the "hold-below-2°C" pathways used in the Assessment do not provide guidance in terms of lowering peak warming and increasing the probability of limiting warming to 1.5°C, an integral part of the Paris long-term temperature goal (Wachsmuth, Schaeffer and Hare, 2018).

Subsequently, we contributed to the discussion around the European Climate Law during stakeholder virtual workshops in March 2020 and presented the main conclusions about the ways in which the draft tabled by the Commission could be improved in an Analysis in April 2020 (Meyer-Ohlendorf, 2020). The Analysis argued that if adopted, the Commission's proposal for a European Climate Law would mark important progress. It would set a legally binding EU target of reaching climate neutrality by 2050 – a milestone in EU climate policy making. It would determine that reductions can only be achieved domestically, excluding international offsets. The proposal also contains new processes on ensuring that all EU policies are consistent with the EU's new climate neutrality target. Despite various implementation problems, the EU has a relatively strong legal framework for involving its citizens in climate policies. The European Climate Law would improve this framework further but additional strengthening of public participation is necessary.

Among the shortcomings flagged by the analysis was the fact that EU climate neutrality was at the moment of writing defined as a collective target on the EU. Thus, it would make it difficult to hold individual Member States to account. It needs to be complemented by a continuation of the EU Climate Action Regulation after 2030. Another weakness of the Commission's proposal was lacking specification of climate neutrality. The ECL only stipulate that the EU will reduce emissions to net zero but does not specify further details. Finally, the European Climate Law did not plan to establish an independent scientific advisory body. Experience from Member States shows that such a body could support consistency between long-term goals and short-term action, enhance the role of science in decision-making, help build and maintain the necessary political will to decarbonize economies and strengthen public confidence in climate policies

Outreach

The outcomes of the project have been published and distributed among the policy makers in using an Outreach Strategy developed at the beginning of the project. To maximize the uptake of the project's outputs, the Strategy identified the most important events and process at the international and European levels taking place during the project's implementation. This concerned the elements of the UNFCCC process (especially the Talanoa Dialogue) and different processes taking place simultaneously at the EU level, e.g. the EU 2050 strategy process, the European elections, and the debate about the Future of Europe. Due to the limited scope of the project, the most relevant elements and stakeholders participating in these processes were selected as the audiences for the project's outputs.

Conclusion

The adoption of the Paris Agreement with the long-term goal of reducing temperature increase to "well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels" has important repercussions for the distribution of effort between the Parties to the Agreement. The comparison between the emissions reduction levels determined according to the cost-effectiveness and equity-based criteria indicates significant differences between these two approaches. This discrepancy can be closed by countries with high emissions reductions goal according to the fairness criteria supporting countries where emissions reduction calculated according to the least-cost criteria are higher than those resulting from applying equity considerations. At the same time, it must be ensured that such support should not finance the cheapest reductions in developing countries and do not result in carbon lock-in.

The specific socio-economic circumstances need to be taken into consideration when the cooperation between countries with the high emissions reduction required by the equity criteria and high emissions reduction resulting from cost-effectiveness criteria is considered. Transformation away from fossil fuels towards renewables can also contribute to meeting a number of Sustainable Development Goals (SDGs). Due to their distributed character, rapidly decreasing cost, and employment potential, development of renewables complemented with energy efficiency measures will help to increase access to affordable and clean energy (SDG7), help to reduce of poverty and inequalities (SDG1 and SDG 10), and facilitate development of sustainable cities and communities (SDG11).

The specific political context in the respective countries is of great importance when assessing the potential for increasing climate ambition. However, contrary to the socio-economic framework which with few exception changes only slowly, the political environmental within which climate mitigation is taking place may change rapidly. This was especially the case for two of the countries assessed - Brazil and the United States. These changes – positive and negative – have a spillover effect on other countries. This effect takes place even if the external impacts of a policy are not the explicit objective of certain policies (or lack thereof). But it can be considerably strengthened if domestic climate mitigation effort is accompanied with active leadership and support of transfer agents.

The spillover effect creates an opportunity for the EU to influence emissions reductions well above those targeted by its own measures. The adoption of the goal of climate neutrality by 2050 at the latest, complemented with a more ambitious emissions reduction goal for 2030 and support for climate mitigation effort in other countries, offers the potential for accelerating global climate effort. However, at the time of writing, the European Climate Law was still under discussion and in the version proposed by the Council of Ministers was lacking important elements, such as the institutional setup within Commission, i.e. an Agency, that would oversee the achievement of the emissions reduction targets goal and suggest necessary changes, and commitment to move to negative emissions after 2050. Also, the ratcheted up 2030 goal was still not adopted. Addressing these issues is not only essential for meeting EU's climate neutrality by 2050 goal but could also help it to considerably accelerate global transformation to low-carbon economy by strengthening and potentially even leading the coalition of countries with strong climate agenda.

Zusammenfassung

Die Verabschiedung des Pariser Abkommens mit dem langfristigen Ziel, den Temperaturanstieg auf "deutlich unter 2°C über dem vorindustriellen Niveau zu senken und die Bemühungen zur Begrenzung des Temperaturanstiegs auf 1,5°C über dem vorindustriellen Niveau" zu begrenzen, hat bedeutende Auswirkungen auf die Verteilung der Anstrengungen zwischen den Vertragsparteien des Abkommens. Im Rahmen des zwischen 2017 und 2020 durchgeführten Projekts "Implications of Paris Agreement on the national emissions reduction efforts" (Implikationen des Pariser Abkommens auf die nationalen Emissionsreduktionsbemühungen) haben wir einen Beitrag zur Diskussion über die Verteilung der Anstrengungen zwischen den wichtigsten Emittenten geleistet, indem wir ihre spezifischen Umstände, einschließlich der sozioökonomischen Auswirkungen und politischen Kontexte, bewertet haben. Wir haben auch untersucht, wie die rasch sinkenden Kosten von Minderungstechnologien und die Spillover-Effekte nationaler Maßnahmen über Grenzen hinweg zu einer Steigerung der Klimaschutzziele motivieren können. Zudem haben wir im Zuge dieses Projekts einen Beitrag zur Diskussion über das Ziel der Klimaneutralität der EU bis 2050 geleistet.

Das Projekt wurde von einem Konsortium aus vier Organisationen durchgeführt: Fraunhofer ISI, NewClimate Institute, Ecologic Institute und Climate Analytics. Neben der Leitung des Konsortiums brachte Climate Analytics seine Expertise bei der Auswertung von Emissionspfaden die als kompatibel mit dem Pariser Klimaziel bewertet werden können ein und konzentrierte sich gemeinsam mit dem NewClimate Institute auf der Bewertung der Gerechtigkeitsansätze. Climate Analytics ging auch der Frage nach, wie innerstaatliche Maßnahmen die Emissionsreduktion weit über die Grenzen eines bestimmten Landes hinaus vorantreiben können. Das Fraunhofer ISI befasste sich mit der Auswertung kostengünstigster Emissionspfade, die mit der Temperaturgrenze des Pariser Klimaabkommens vereinbar sind, und trug gemeinsam mit dem New Climate Institute zur Quantifizierung der Emissionsreduktionspotenziale bei, die eine projizierte Senkung der Kosten für erneuerbare Energien widerspiegeln. Das Ecologic Institute spielte eine führende Rolle bei der Bewertung der europäischen Politik, und hier insbesondere des Vorschlags des European Climate Law, und war maßgeblich an der Entwicklung einer Kommunikationsstrategie und der Verbreitung der Projektergebnisse beteiligt.

Die im Rahmen des Projektes durchgeführte Analyse wurde hauptsächlich auf acht Länder angewendet. Das besondere Interesse galt dabei der Europäische Union. Deutschland und weitere sechs Länder wurden u.a. aufgrund ihrer Bedeutung für die Entwicklung der Klimaverhandlungen, ihrer strategischen Bedeutung aus Sicht der EU, und ihrer Relevanz aufgrund des Umfangs der Treibhausgasemissionen ausgewählt. Auf der Grundlage dieser Kriterien wurden China, USA, Indien, Brasilien, Japan und Kanada als Schwerpunktländer identifiziert. Gleichzeitig wurde vereinbart, dass die Analyse auch weitere Länder berücksichtigen kann, falls dies zur Erreichung der Projektziele beiträgt.

Verteilung der Minderungsbemühungen nach Fairness- und Kosteneffektivitätsansätzen

Eine der Hauptziele des Projektes war die Frage zu beantworten wie die Lücke zwischen den im Rahmen des NDCs bereits eingereichten Zusagen und den mit dem Pariser Klimaabkommen kompatiblen Emissionspfad, geschlossen werden kann. Um diese Frage zu beantworten, haben wir in der Studie "Fairness- und Cost-Effectiveness-Based Approaches to Effort-Sharing under the Paris Agreement“ die Auswirkungen verschiedener Ansätze auf die Verteilung dieser zusätzlichen Anstrengungen untersucht.

Die Verteilung der Minderungsanstrengungen zwischen den Hauptemittenten nach den Gerechtigkeitsansätzen erfolgte nach der vom Climate Action Tracker (CAT) entwickelten Methodik. Sie besteht aus einer Zusammenstellung einer breiten Palette von Literatur darüber, was verschiedene Forscher aus vielen Perspektiven als "fairen" Beitrag zur Treibhausgasreduktion ansehen würden (Wachsmuth *et al.*, 2019).

Die Anwendung verschiedener Equity-Ansätze ergab eine große Bandbreite an Ergebnissen. Die mit den Equity-Ansätzen kompatible Emissionen für 2030 und 2050 wurden mit den historischen Werten aus den Jahren 2005 und 2015 verglichen um die notwendige Emissionssenkung zu berechnen. Der Vergleich zwischen den auf Gerechtigkeit basierenden Emissionen und den historischen Emissionswerten resultiert im Großen und Ganzen in zwei Kategorien von Ländern. Auf der einen Seite könnte Indien nach dem Equity-Ansatz ihre Emissionen im Jahr 2030 sogar erhöhen. Zum anderen müssten alle anderen in dieser Studie erfassten Länder ihre Emissionen im Jahr 2030 im Vergleich zu den historischen Emissionsniveaus erheblich reduzieren. Tatsächlich zeigen die auf dem Equity-Ansatz basierenden Analysen, dass die Vereinbarkeit mit dem Emissionsreduktionsziel von 1,5°C Deutschland und Japan zwingen würde, bis 2030 negative Emissionswerte zu erreichen.

Für das Jahr 2050 weisen Equity-Ansätze noch große Bandbreiten zwischen den Ländern auf. Erwartungsgemäß sind jedoch alle Emissionsniveaus für alle Länder 2050 geringer als 2030. Verglichen mit den Werten von 2015 reicht die Emissionsreduktion bei den 2°C-kompatiblen Emissionswerten von -164% für Japan bis +83% für Indien, während die Kompatibilität mit dem 1,5°C Ziel eine Emissionsreduktion von -227% für Japan bedeuten würde. Nur Indien dürfte seine Emissionen noch um bis zu 22% erhöhen. Ausschließlich auf der Grundlage von Gerechtigkeitserwägungen müssten bis Mitte des Jahrhunderts alle in dieser Studie erfassten Länder (mit Ausnahme Indiens, Brasiliens, und Chinas) negative Emissionsniveaus erreichen.

Um die Verteilung der Anstrengungen nach den Kriterien der Kostenwirksamkeit zu beurteilen, haben wir einen Ansatz auf der Grundlage von Grenzvermeidungskostenkurven (MACCs), die die gesamten zusätzlichen Kosten für die Emissionsreduzierung messen, verwendet. Eine Einschränkung dieser Methode besteht darin, dass die MACCs, die im globalen Kosten-Wirksamkeits-Ansatz für die Verteilung der Emissionsreduktionen auf die untersuchten Länder angewendet werden, nicht die THG-Emissionen aus der Landwirtschaft und dem Abfallsektor abdecken, die in den zuvor beschriebenen Fairness-basierten Ansätzen enthalten sind. Um einen Vergleich der Ergebnisse aus beiden Ansätzen zu ermöglichen, erweitern wir daher die kostenwirksame Verteilung auf diese Sektoren.

Aufgrund des Fehlens von MACCs für diese beiden Sektoren haben wir länderspezifische Daten über die aktuellen Emissionen in Landwirtschaft und Abfallsektor und die sektoralen Emissionstrends sowie die global notwendigen Emissionsreduktionen in den Sektoren verwendet. Für letztere gehen wir davon aus, dass die relative Reduktion in Bezug auf den Emissionstrend länderübergreifend gleich ist, und verwenden - aus Gründen der Einheitlichkeit - die gleichen globalen Daten, die wir zur Ableitung der energie- und prozessbezogenen Emissionen aus den globalen Emissionspfaden verwendet haben. Für die aktuellen Emissionen und die Emissionstrends verwenden wir die offiziellen Daten, die im Rahmen des UNFCCC-Protokolls für alle untersuchten Länder berichtet wurden, mit Ausnahme von China und Indien, wo wir zusätzliche Daten von Ding et al. (2017) und Dhingra & Mehta (2017) erheben mussten. Wir gehen davon aus, dass sich die derzeitigen Emissionstrends bis 2030 abflachen, um die aktuellen Trends nicht zu überbewerten.

Für alle Länder sind die relativen Emissionsreduktionen im Hinblick auf 2005 und 2015 nach Einbeziehung der Emissionen aus der Landwirtschaft und der Abfallwirtschaft geringer, weil das

Minderungspotenzial in diesen Sektoren wesentlich geringer ist. Dieser Effekt wird für die Länder mit einem steigenden Emissionstrend in diesen Sektoren (Brasilien, China und Indien) verstärkt. Die Veränderung der relativen Emissionsreduktionen ist für Brasilien besonders groß, da mehr als ein Drittel seiner Emissionen im Jahr 2015 aus diesen Sektoren stammen. Für alle anderen hier untersuchten Länder ist die Veränderung geringer als im globalen Durchschnitt, ebenso wie der Anteil der Landwirtschaft und aus Abfall an den gesamten Treibhausgas Emissionen.

Für die Mehrheit der untersuchten Länder ist die Least-Cost-basierte Emissionsminderung weniger streng, als sie es nach der Equity-Ansatz-basierten Verteilung in den Jahren 2030 und 2050 sowohl bei einem 2°C-konsistenten als auch bei einem 1,5°C-konsistenten Pfad sein müsste. Die wichtigsten Ausnahmen sind hier China und Indien, für die die auf Equity-Ansatz-basierenden Bandbreiten der Treibhausgasemissionen sowohl 2030 als auch 2050 wesentlich höher sind als die Emissionen auf der Grundlage eines Least-Cost-Ansatzes. Für die USA und Brasilien ist dies entweder 2030 oder 2050 ebenfalls der Fall, allerdings nur im Hinblick auf die Kompatibilität mit dem 2°C-Temperaturziel von Paris.

In einer neueren Studie haben wir untersucht, wie die Diskrepanz der Ergebnisse aus dem Equity- und dem Least-Cost -Ansatz geschlossen werden kann (Höhne and Wachsmuth, 2020). Wenn das nationale Potenzial nicht groß genug ist, um einen fairen Beitrag zu leisten (wahrscheinlich für die meisten Industrieländer), sollten diese Länder andere Länder bei der Emissionsreduktion zu unterstützen.

Eine solche Unterstützung sollte nicht die kostengünstigeren Reduktionen in Entwicklungsländern finanzieren, da solche Reduktionen von den Ländern selbst durchgeführt werden müssen, um ihre strengen inländischen Emissionsziele festzulegen und zu erfüllen. Die finanzielle Unterstützung sollte insbesondere dazu beitragen, sektorale *lock-ins* zu vermeiden. Eine Analyse der Unterschiede zwischen kosteneffektiven 2°C- und 1,5°C-Pfaden kann dazu beitragen, die Potentiale zur Emissionsreduzierung zu identifizieren, bei deren Umsetzung diese Länder unterstützt werden sollen.

Bewertung der Potentiale zur Emissionsminderung

Die mögliche Verteilung der Emissionsreduktionsbemühungen auf die verschiedenen Vertragsstaaten unter Berücksichtigung der spezifischen Umstände stand im Mittelpunkt eines im Rahmen des Arbeitspakets 4 veröffentlichten Berichts (Fekete *et al.*, 2019). Der Bericht zog für jedes Land Schlussfolgerungen, inwieweit die Minderungsziele auf der Grundlage des sozioökonomischen und politischen Kontextes, der Treibhausgasemissionen und Energieprofile sowie des Emissionsreduktionspotenzials, verstärkt werden könnten.

Die für die Bewertung ausgewählten Länder unterscheiden sich hinsichtlich ihres sozioökonomischen Kontextes erheblich. Während Brasilien, China und Indien als Entwicklungsländer eingestuft werden können, gehören Kanada, Deutschland, Japan und die Vereinigten Staaten von Amerika zu den hochindustrialisierten Ländern. Dies spiegelt sich auch im Human Development Index (HDI) wider, der die Lebenserwartung, den Zugang zu Bildung und die Pro-Kopf-Einkommensindikatoren misst. Demnach liegen Kanada, Deutschland, Japan und die Vereinigten Staaten von Amerika bei über 0,9, während Brasilien und China mit 0,76 bzw. 0,75 gleichauf liegen und Indien mit 0,64 am niedrigsten bewertet wird.

Der GINI-Index, der die Ungleichheit misst, zeigt ein wesentlich vielfältigeres Bild. Je höher der Wert des Index, desto größer ist die Ungleichheit. Während Brasilien das Land mit den größten Ungleichheiten von allen ausgewählten Ländern ist, sind die Vereinigten Staaten von Amerika das Land mit der größten Ungleichheit unter den *entwickelten* Ländern. In Deutschland und Japan ist das Einkommen vergleichsweise gleichmäßig verteilt.

Die Unterschiede im Pro-Kopf-BIP korrelieren bis zu einem gewissen Grad mit den Pro-Kopf-Treibhausgasemissionen. Die höchsten Emissionen mit etwa 19-20 tCO_2/Kopf wurden in den Vereinigten Staaten von Amerika und Kanada verzeichnet. Die Pro-Kopf-Emissionen in Indien und Brasilien waren mit 2,1 bzw. 4,8 tCO_2 die niedrigsten der ausgewählten Länder. China, Deutschland und Japan lagen dazwischen mit Pro-Kopf-Emissionen von 9 bis 11 tCO_2. Ein anderes Bild ergibt sich bei der Betrachtung der Emissionsintensität der Wirtschaft. In diesem Fall verzeichnen China und Japan die höchsten Emissionen pro BIP-Einheit, während die Emissionsintensität der Wirtschaft in Japan und Deutschland am niedrigsten ist, was vor allem auf den hohen Anteil von Dienstleistungen an der BIP-Erzeugung zurückzuführen ist.

Zur Bewertung des Emissionsreduktionspotenzials in verschiedenen Sektoren haben wir Modelle verwendet, die von einer möglichst kosteneffizienten Verteilung der Anstrengungen ausgehen. Das bedeutet, dass die billigsten Minderungsoptionen zuerst eingesetzt werden, unabhängig davon, welches Land sie umsetzt. Die kosteneffektiven Minderungspotenziale basieren auf den jüngsten Grenzvermeidungskostenkurven (MACC) aus der POLES-Datenbank (ENERDATA, 2018), die zur Ableitung global kosteneffizienter nationaler Pfade verwendet wurden.

Die Berechnungen zeigen, dass für alle Länder das größte Potenzial für Emissionsreduktionen im Energiesektor liegt. Die Kompatibilität mit dem 1,5°C-Ziel nach den Kriterien der Kosteneffizienz würde dazu führen, dass die Emissionen aus diesem Sektor zwischen 2015 und 2030 in China, Kanada und Japan um über 60% zurückgehen. Die bisherigen Emissionsreduktionen in diesem Sektor führen in Deutschland zu einem etwas geringeren Emissionsminderungspotenzial von 42%. Gleichzeitig könnte Deutschland, neben Kanada und den Vereinigten Staaten von Amerika, mehr als die Hälfte seiner Emissionen im Gebäudesektor reduzieren. Im Verkehrssektor ergibt sich ein wesentlich differenzierteres Bild, wobei Brasilien, China und Indien ihre Emissionen möglicherweise sogar noch steigern könnten. Dies ist auf die vergleichsweisen niedrigen Emissionen aus diesem Sektor in diesen Ländern zurückzuführen. Da auch für diese Länder Emissionen aus allen Sektoren zurückgehen müssen und diese Sektoren in den meisten Fällen bis 2050 vollständig dekarbonisiert werden müssen, ein vorübergehender Anstieg der Emissionen aus dem Verkehrssektor würde zu einer Zunahme der „Stranded Assets“ führen.

Der politische Kontext für die Emissionsreduktion unterscheidet sich zwischen den untersuchten Ländern erheblich: Ausgehend von sehr negativen Entwicklungen in Bezug auf den Klimaschutz in Brasilien und den Vereinigten Staaten von Amerika bis hin zu sehr viel positiveren Entwicklungen in der Europäischen Union. In den übrigen Ländern standen einigen positiven Entwicklungen oft negative gegenüber. Dies zeigt sich unter anderem durch auf der einen Seite ehrgeizige Maßnahmen und Anstrengungen zur Emissionsreduktion vor Ort und Beiträgen zum Emissionsanstieg im Ausland, z.B. durch die Finanzierung von Kohlekraftwerken, auf der anderen Seite. Eine klare Schlussfolgerung war auch, dass sich im Gegensatz zum sozioökonomischen Kontext, der sich nur langsam und stetig ändert, sich der politische Rahmen, innerhalb dessen Entscheidungen mit Auswirkungen auf den Klimawandel getroffen werden, schnell ändern kann.

Auswirkungen sinkender Kosten für den Klimaschutz auf die Steigerung der Ambitionen zur Emissionsminderung

Seit der Vorlage der ersten (I)NDCs ist ein deutlicher Rückgang der Kosten von Klimaschutztechnologien zu verzeichnen. Daher wurde die Studie zur Bewertung der sozioökonomischen und politischen Rahmenbedingungen für die Emissionsreduzierung durch drei Diskussionspapiere ergänzt, die sich mit dem Potenzial für eine Erhöhung der Ambitionen befassen, die sich allein aus der prognostizierten Senkung der Kosten der wichtigsten Klimaschutztechnologien ergibt.

Das Diskussionspapier von (Wachsmuth and Anatolitis, 2018) vergleicht die globalen Kostenprojektionen für die wichtigsten Minderungstechnologien in den jüngsten Berichten mit denen, die im Vorfeld der COP21 verfügbar waren. Die Ergebnisse der Evaluierung zeigen, dass die vorausgesagten Energiekosten in den neueren Berichten in den Jahren 2025 und 2030 erheblich niedriger ausfallen, nämlich um bis zu 51-52% für Photovoltaik und Onshore-Wind (in der Spanne zwischen 17-52% für Photovoltaik, 11-51% für Onshore-Wind) sowie um mehr als 36% für Offshore-Wind (in der Spanne zwischen 36-44%). Bei Lithium-Ionen-Batterien, die in Elektrofahrzeugen verwendet werden, bestand eine größere Unsicherheit hinsichtlich der Kostensenkung (mit einem Anstieg der oberen Bandbreite im Jahr 2025), aber die Reduzierungen der prognostiziert Batteriekosten reichen von 38% im Jahr 2025 bis zu 52% im Jahr 2030 (Bandbreiten zwischen +14% und -32% im Jahr 2025 und zwischen -19% und - 52% im Jahr 2030). Dies kann ein Ausgangspunkt für die Revision der NDCs sein, die jedoch eine detaillierte Analyse des techno-ökonomischen Potenzials und der sozio-ökonomischen Bedürfnisse eines bestimmten Landes erfordern würde.

In zwei Studien, die sich auf Kanada bzw. Chile konzentrierten, haben wir gezeigt, dass eine bloße Reinvestition der Einsparungen, die sich aus dem Rückgang der Kosten der Technologien im Vergleich zu den Vor-COP21-Projektionen ergeben, es beiden Ländern ermöglichen würde, ihre jeweiligen NDCs zu stärken. Dies würde zu einer Stärkung des kanadischen Emissionsreduktionsziels für 2030 um 1 bis 2%-Punkte führen. Für Chile könnte eine Verbesserung der Emissionsintensität der Wirtschaft um zwischen 1 und 2%-Punkten für das bedingungslose Emissionsreduktionsziel und zwischen 3-5% für das bedingte Ziel höher ausfallen. Allerdings sollte die Emissionsreduktion in den neuen NDCs deutlich über diese Werte hinausgehen, um das "höchstmögliche Ziel", wie es im Pariser Klimaabkommen beschrieben ist, widerzuspiegeln. Diese Bewertung hat allerdings gezeigt, wie viel mehr bei gleichem Aufwand getan werden könnte, da die Kosten für erneuerbare Energien und Speicherung viel schneller gesenkt werden könnten (Wachsmuth and Anatolitis, 2018; Fekete and Leonardo Nascimento, 2019; Fekete and Nascimento, 2019).

Spillover-Effekt von Klimaschutzmaßnahmen

Kosten des Klimaschutzes können durch innerstaatliche Klimaschutzmaßnahmen zusätzlich gesenkt werden, insbesondere wenn diese durch *Active Leadership* auf der internationalen Bühne und durch *Transfer Agents*, die die Politikdiffusion erleichtern, begleitet werden (Steinbacher, 2016). Basierend auf dieser Annahme haben wir untersucht, auf welche Weise innerstaatliche Maßnahmen Emissionsreduktionen in anderen Ländern auslösen können, die deutlich über die Reduktion in einem bestimmten Land hinausgehen.

In einer Studie, die sich auf den Spillover-Effekt inländischer Klimaschutzmaßnahmen konzentrierte, haben wir drei Mechanismen untersucht, die zur Erleichterung der Emissionsreduzierung in **anderen Ländern** eingesetzt werden könnten, selbst wenn ihr Hauptziel die Verringerung der **inländischen** Emissionen wäre. Der wichtigste dieser Mechanismen, die *Policy Diffusion*, hat bereits dazu beigetragen, einige erfolgreiche politische Maßnahmen zu verbreiten und aus den Fehlern anderer Länder zu lernen. Der zweite Mechanismus, die *Benefits of the Economies of Scale*, könnte durch die Schaffung von Märkten für Produkte, die für die Dekarbonisierung benötigt werden, und durch die Festlegung von Standards gestärkt werden, an die sich die Hersteller auch bei der Produktion für andere Märkte halten werden. Schließlich ermöglicht es die *technological complementarity* einem Land, die globalen Anstrengungen zu erleichtern, indem es spezifische Nischenlösungen beisteuert, ohne die das Erreichen von GHG-Emissionsneutralität nicht möglich wäre (Climate Analytics, 2020).

In der Studie wird argumentiert, dass der Spillover-Effekt nationaler Maßnahmen durch die COVID-19 verursachte Gesundheits- und Wirtschaftskrise verstärkt werden könnte. Während ungewöhnliche Zeiten ungewöhnliche Maßnahmen erfordern, könnten politische Führer dazu neigen, Maßnahmen zu ergreifen, die in anderen Ländern bereits beschlossen wurden. Eine Fokussierung der Konjunkturpakete in einem Land auf wirtschaftliche Erholung durch eine radikale Erhöhung der Investitionen in Klimaschutz kann die Wahrscheinlichkeit deutlich erhöhen, dass sich andere Länder in ihren Konjunkturpaketen ebenfalls auf den Klimaschutz konzentrieren und damit transformative Veränderungen auslösen. Die Länder können den Spillover-Effekt ihrer grünen Konjunkturpakete durch eine entsprechende Erhöhung der Klimaschutzambitionen und die rechtzeitige Vorlage neuer und aktualisierter NDCs im Jahr 2020 nutzen.

Der Weg der Europäischen Union zum Klimaschutz-Leader

Im Rahmen des Projektes haben wir auch die Diskussion um die langfristige Strategie der Europäischen Union und ihr Emissionsreduktionsziel für 2050 begleitet und analysiert. Im Dezember 2018 haben wir umgehend auf die Veröffentlichung der langfristigen strategischen Vision der Europäischen Kommission "Clean Planet for All" und die begleitende vertiefte Analyse reagiert. In unserem Arbeitspapier haben wir darauf hingewiesen, dass die in der Bewertung verwendeten Emissionspfade nicht zwingend mit dem Pariser Klimaziel kompatibel sind (Wachsmuth, Schaeffer and Hare, 2018).

Im März 2020 haben wir während virtueller Stakeholder-Workshops zur Diskussion um das Europäische Klimaschutzgesetz beigetragen und haben im April 2020 in einer Analyse die wichtigsten Schlussfolgerungen zu den Möglichkeiten wie der von der Kommission vorgelegte Entwurf verbessert werden könnte, präsentiert (Meyer-Ohlendorf, 2020). In der Analyse wird argumentiert, dass der Vorschlag der Kommission für ein europäisches Klimagesetz, sollte er angenommen werden, einen wichtigen Fortschritt darstellen würde. Er würde ein rechtsverbindliches EU-Ziel für die Erreichung der Klimaneutralität bis 2050 festlegen - ein Meilenstein in der Klimapolitik der EU. Der Vorschlag enthält auch neue Prozesse, um sicherzustellen, dass alle EU-Politiken mit dem neuen Klimaneutralitätsziel der EU in Einklang stehen. Trotz verschiedener Umsetzungsprobleme verfügt die EU über einen relativ starken Rechtsrahmen für die Einbeziehung ihrer Bürger in die Klimapolitik. Das europäische Klimagesetz würde diesen Rahmen weiter verbessern. Wir haben auch festgestellt, dass eine zusätzliche Stärkung der Bürgerbeteiligung notwendig ist.

Zu den Herausforderungen, die in der Analyse aufgezeigt wurden, gehört die Tatsache, dass die EU-Klimaneutralität zum Zeitpunkt der Abfassung dieses Berichts lediglich als kollektives Ziel für die EU definiert wurde. Dies würde es schwierig machen, einzelne Mitgliedstaaten zur Verantwortung zu ziehen. Eine weitere Schwäche des Kommissionsvorschlags war die fehlende Spezifizierung des Klimaneutralitätszieles. Der Entwurf des Klimaschutzgesetzes legt lediglich fest, dass die EU die Emissionen auf netto null reduzieren wird, spezifiziert aber keine weiteren Details. Schließlich sah das europäische Klimaschutzgesetz nicht vor, ein unabhängiges wissenschaftliches Beratungsgremium einzurichten. Erfahrungen aus den Mitgliedstaaten zeigen, dass ein solches Gremium die Kohärenz zwischen langfristigen Zielen und kurzfristigen Maßnahmen unterstützen und die Rolle der Wissenschaft bei der Entscheidungsfindung stärken würde. Dadurch könnte es dazu beitragen, den notwendigen politischen Willen zur

Dekarbonisierung der Volkswirtschaften aufzubauen und aufrechtzuerhalten und das Vertrauen der Öffentlichkeit in die Klimapolitik zu stärken.

Öffentlichkeitsarbeit

Die Ergebnisse des Projekts wurden veröffentlicht und unter den politischen Entscheidungsträgern unter Verwendung einer zu Beginn des Projekts entwickelten Outreach-Strategie verteilt. Um die Aufnahme der Projektergebnisse zu maximieren, identifizierte die Strategie die wichtigsten Ereignisse und Prozesse auf internationaler und europäischer Ebene, die während der Durchführung des Projekts stattfanden. Dies betraf die Elemente des UNFCCC-Prozesses (insbesondere den Talanoa-Dialog) und verschiedene Prozesse, die gleichzeitig auf EU-Ebene stattfanden, z.B. den Strategieprozess EU 2050, die Europawahlen und die Debatte über die Zukunft Europas. Aufgrund des begrenzten Umfangs des Projekts wurden die relevantesten Elemente und Akteure, die an diesen Prozessen beteiligt waren, als Zielgruppen für die Ergebnisse des Projekts ausgewählt.

Schlussfolgerungen

Die Verabschiedung des Pariser Abkommens mit dem langfristigen Temperaturlimit hat wichtige Auswirkungen auf die Verteilung der Anstrengungen zwischen den Vertragsparteien des Abkommens. Der Vergleich zwischen den Emissionsminderungen, die nach den Equity- und Kosten-Wirksamkeits-Ansatz ermittelt wurden, zeigt erhebliche Unterschiede zwischen diesen beiden Ansätzen. Diese Diskrepanz kann geschlossen werden, indem die Länder unterstützt werden, in denen die nach den Kosten-Wirksamkeit-Kriterien berechneten Emissionsreduktionen höher sind als diejenigen, die sich aus der Anwendung von Equity-Ansatz ergeben. Gleichzeitig muss sichergestellt werden, dass eine solche Unterstützung nicht die billigsten Reduktionen in Entwicklungsländern finanzieren und nicht zu einem *carbon lock-in* führt.

Die Transformation weg von fossilen Brennstoffen hin zu erneuerbaren Energien kann auch zur Erreichung einer Reihe von Zielen der nachhaltigen Entwicklung beitragen. Aufgrund ihres vielfältigen Charakters, der rasch sinkenden Kosten und ihres Beschäftigungspotenzials wird die Entwicklung erneuerbarer Energien, ergänzt durch Energieeffizienzmaßnahmen, dazu beitragen, den Zugang zu erschwinglicher und sauberer Energie zu verbessern (SDG7), Armut und Ungleichheiten zu verringern (SDG1 und SDG10) und die Entwicklung nachhaltiger Städte und Gemeinden zu erleichtern (SDG11). Deswegen sollte bei der Unterstützung solcher Länder, in denen die nach den Kosten-Wirksamkeit-Kriterien berechneten Emissionsreduktionen höher sind als diejenigen, die sich aus der Anwendung von Equity-Ansatz ergeben, die spezifischen sozioökomischen Aspekte in Betracht gezogen werden um das Erreichen der jeweiligen SDGs zu maximieren.

Der spezifische politische Kontext in den jeweiligen Ländern ist von großer Bedeutung, wenn es darum geht, das Potenzial für eine Steigerung der Klimaschutzziele zu bewerten. Im Gegensatz zu den sozioökonomischen Rahmenbedingungen, die sich mit wenigen Ausnahmen nur langsam ändern, kann sich das politische Umfeld, in dem der Klimaschutz stattfindet, jedoch rasch verändern. Dies gilt insbesondere für zwei der untersuchten Länder - Brasilien und die Vereinigten Staaten von Amerika. Diese Veränderungen - positive und negative - haben einen Spillover-Effekt auf andere Länder. Dieser Effekt tritt auch dann ein, wenn die externen Auswirkungen einer Politik nicht das ausdrückliche Ziel bestimmter Politiken (oder deren Fehlen) sind. Er kann jedoch erheblich verstärkt werden, wenn die nationalen Klimaschutzbemühungen mit einem *Active Leadership* und der Unterstützung durch *Transfer Agents* einhergehen.

Der Spillover-Effekt bietet der EU die Möglichkeit, auf Emissionsminderungen Einfluss zu nehmen, die weit über die mit ihren eigenen Maßnahmen angestrebten Ziele hinausgehen. Die Verabschiedung des Ziels der Klimaneutralität bis spätestens 2050, ergänzt durch ein ehrgeizigeres Emissionsreduktionsziel für 2030 und die Unterstützung von Klimaschutzbemühungen in anderen Ländern, bietet das Potenzial für eine Beschleunigung der globalen Klimaschutzbemühungen.

Zum Zeitpunkt der Abfassung dieses Berichtes war das europäische Klimagesetz jedoch noch in der Diskussion und in der vom Ministerrat vorgeschlagenen Fassung fehlten wichtige Elemente, wie die Schaffung einer Agentur, die die Erreichung der Emissionsreduktionsziele überwachen und notwendige Änderungen vorschlagen würde, sowie die Verpflichtung, nach 2050 zu negativen Emissionen überzugehen. Auch das für 2030 gesteckte Ziel wurde immer noch nicht angenommen. Die Auseinandersetzung mit diesen Elementen ist allerdings nicht nur unerlässlich um das EU Ziel der Klimaneutralität bis 2050 zu erreichen, sondern könnte der EU auch dabei helfen, die globale Transformation hin zu kohlenstoffarmen Volkswirtschaften erheblich zu beschleunigen, indem sie die Zusammenarbeit zwischen Ländern mit einer starken Klimaagenda stärkt und dabei möglicherweise sogar die Führung übernimmt.

1 Introduction

1.1 Background

In December 2015, the parties to the UNFCCC agreed in the Paris Agreement to the temperature limit of holding the increase in the global average temperature to “well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels”. The achievement this goal depends on the mitigation effort reflected in the Nationally Determined Contributions (NDCs), the first wave of which was submitted before the adoption of the Paris Agreement, and the second is to take place in 2020. Each successive NDC should represent a progression beyond the previous one and reflect the highest possible levels of ambition (UNFCCC, 2015a).

The emissions reduction pledges reflected in the first wave of the NDCs were far from achieving the Paris Agreement temperature goal. According to calculations of the Climate Action Tracker (CAT), if fully implemented, the pledges would lead to warming of 2.8°C. Many of these pledges have not been backed by respective policies, thus resulting in warming of 3.6°C (Climate Action Tracker, 2016). The situation was projected to even worsen with the departure of the United States from the Paris Agreement. This move that was to be expected since Donald Trump’s victory in the US presidential elections in November 2016, was formally announced on 1 June 2017 and became effective on November 4th 2020.

This large and potentially even increasing gap between the pledges expressed in the NDCs and the Paris Agreement temperature limit posed two main and interrelated questions: what potentials exists to close this gap and how this additional effort could be distributed between different countries. Regarding the first question, all countries have far-reaching emissions reduction potentials, which continuously increase as the costs of transition to low-carbon economy decrease. In addition, addressing and the realization of these emissions’ reduction potentials has noticeable co-benefits for the respective national economies, such as decreasing air pollution, increasing energy independence, and jobs creation.

Regarding the question about the distribution of effort, already before the adoption of the Paris Agreement there were numerous approaches with focus on different criteria, such as historic responsibility, equality, capability, or cost effectiveness. However, no consensus could be reached in the international community on which approach should drive the distribution of effort. The adoption of the Paris Agreement with a more stringent Paris Agreement temperature limit, combined with the insufficient contributions of its signatories, made this question even more relevant.

The project “Implications of the Paris Agreement on national climate efforts” (FKZ 3717 41 102 0) aimed at contributing to answering these questions. The project was implemented by a consortium of four organizations: Fraunhofer ISI, NewClimate Institute, Ecologic Institute and Climate Analytics. In addition to leading the consortium, Climate Analytics contributed its expertise in the assessment of emissions pathways of Paris scenario development and jointly with New Climate Institute focused on the assessment of the equity approaches. It also looked into the question how domestic action can drive emissions reduction well beyond the borders of a particular country. Fraunhofer ISI focused on the assessment of the least cost emissions pathways compatible with the Paris Agreement temperature limit and contributed, jointly with New Climate Institute, to the quantification of the emissions reduction potentials reflecting a projected decrease in the costs of renewables. Ecologic Institute played a leading role in the assessment of the European policies, especially the proposal of the European Climate Law and was instrumental in developing a communication strategy and dissemination of the project's results.

1.2 Country selection

While from the beginning of the project the focus of the analysis on the European Union was clear, Germany and additional six countries were selected. This final selection took into consideration the following elements:

- The country's role at the climate negotiations, especially the those who were expected to lead the way in the PA's negotiations
- Strategic importance from the EU's point of view
- Relevance due to the size of the emissions

Based on these criteria, in addition to the EU and Germany, also China, USA, India, Brazil, Japan, and Canada were selected as the main focus countries. At the same time, it was agreed that the assessment may also concern other countries if such a focus will be justified with contribution to the project's purpose.

1.3 Structure

The results of the project are summarized in chapters 2 to 5 of this report. Chapter 2 summarizes the results concerning the distribution of the mitigation effort between the countries selected based on the least cost and equity approaches. Chapter 3 looks into the specific circumstances in each of the selected countries. It also takes a horizontal approach by assessing the impact of a much faster decrease in the costs of the climate mitigation technologies than expected on the level of ambition for the new wave of the NDCs. Chapter 4 presents how domestic climate change mitigation effort influences emissions reduction beyond the respective country. Finally, Chapter 5 takes a closer look at the developments in the EU, especially at the backdrop of the discussion about the EU's long-term emissions reduction goal. Chapter 6 concludes.

2 Fairness- and Cost-Effectiveness- Based Approaches

To contribute to answering the question on how to close the gap between the already submitted pledges and the emissions pathway resulting in meeting the Paris Agreement temperature limit in the study "Fairness- and Cost-Effectiveness-Based Approaches to Effort-Sharing under the Paris Agreement" we looked into the repercussions of using different approaches in which this additional effort can be distributed. We started with a closer look at the implications of the temperature limit for the carbon budget based on available literature to-date, i. e. SR1.5C of IPCC (2018). Subsequently we looked at the results of distributing this budget using equity approaches and least cost approaches (Wachsmuth et al., 2019). In a more recently published study, we looked at the ways in which the discrepancy between the results from these two approaches can be used to facilitate cooperation between different countries on the pathways to full decarbonisation (Höhne and Wachsmuth, 2020).

2.1 Methodological framework resulting from the Paris Agreement temperature goal

In 2009, the goal of limiting warming to below 2°C was ingrained in the Copenhagen Accord (UNFCCC, 2009). This limit was subsequently adopted at the international level in the Cancun Agreements in 2010 where it was expressed as an aim "to hold the increase in global average temperature below 2°C above preindustrial levels" (UNFCCC, 2011). In 2015 the final report of the UNFCCC's Structured Expert Dialogue concluded that a warming of 2°C cannot be considered safe (UNFCCC, 2015b). This ultimately led to the adoption of the Paris Agreement's long-term temperature goal of "holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risk and impacts of climate change" (UNFCCC, 2015a).

The temperature goal is further specified by the long-term emissions goals outlined in Article 4.1. It points out that in order to achieve the long-term temperature goal of the agreement the following three requirements need to be fulfilled:

- global greenhouse gas (GHG) emissions need to peak as soon as possible, recognising that peaking will take longer for developing country Parties,
- the global peaking of emissions needs to be followed by rapid emissions reductions, and
- a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases needs to be reached in the second half of this century.

The last point means that the global aggregate sum of direct human induced emissions and removals by sinks of greenhouse gases needs to be zero in the second half of the century, with the timing based on the "best available science". It is important to note that this does not mean that the global aggregate sum of sources and sinks needs to be zero at the same time in every region of the world, as some regions may be sinks and other regions sources of emissions.

The former Cancun Agreements' 2°C temperature limit, and the currently binding Paris Agreement's temperature limit, have quite different implications for long-term emissions levels and for the implementation of the long-term emissions goals in Article 4.1. The Cancun Agreement's 2°C temperature limit has generally been assessed in the scientific community as holding global mean temperature rise to below 2°C during the 21st century with a likely (more than 66%) chance (see e.g. scenarios in IPCC's AR5 and UNEP's Emissions Gap report series and see Schleussner et al 2016). This implied that global greenhouse gas emissions need to be reduced by 40-70% in 2050 below 2010 (35-55% below 1990) levels and reach globally aggregated zero emissions by 2080-2100 (IPCC, 2014b). Globally, energy- and industry-related CO2 emissions would need to be reduced by 2050 by 35-80% below 2010 (10-70% below 1990) levels, reaching zero around 2060-2075 (IPCC, 2014a).

Based on the up-to-date scientific literature and available energy-economic scenarios, the Paris Agreement's long-term temperature limit can be represented by pathways that hold warming to below 2°C with at least 80% probability and below 1.5°C by 2100 with a more than 50% chance (Schleussner et al 2016). Achieving this goal requires that global emissions are reduced by 70-95% below 2010 (65-90% below 1990) levels by 2050, and reach globally aggregated zero emissions by 2060-2080. Emissions from global energy and industry will need to be reduced by 2050 by at least 95% in comparison to 2010 (Rogelj, Schaeffer & Hare, 2015). These pathways mainly correspond to the pathways characterized as '1.5°C with no or limited over-shoot' in the IPCC SR1.5 (Wachsmuth et al. 2018).

Table 1: Characterization of emissions reductions scenarios in the scientific literature that informed establishment of temperature limits in Cancun (2010) and Paris Agreement (2015).

	Cancun Agreements	Paris Agreement
Probability of staying below 2°C	>66%	>80%*
Probability of staying below 1.5°C	(>25%) **	>50%*
Global GHG emissions reduction in 2050 in comparison to 1990	By 35-55%	By 65-90%
Global GHG emissions reduction in 2050 in comparison to 2010	By 40-70%	By 70-95%
Global energy and industry emissions reduction in 2050 in comparison to 1990	By 10-70%	By 95-125%
Global energy and industry emissions reduction in 2050 in comparison to 2010	By 35-80%	By 95-120%
Global energy and industry emissions reach zero	Around 2060-2075	Around 2045-2055

* Emissions scenarios that fully achieve the long-term temperature goal of the Paris Agreement need to provide a perspective on both its warming limits ("well below" 2°C and 1.5°C). Scenarios that achieve a 50% probability to drop warming below 1.5°C by 2100 in general simultaneously achieve a probability of 80% to hold warming below 2°C during the 21st century – see Schleussner et al (2016).

** The brackets symbolize the fact that the 1.5°C warming limit was not part of the global temperature goal formulated in the Cancun Agreements. The emissions scenarios informing the "below 2°C" temperature limit adopted in Cancun hold warming below 2°C with more than 66% probability, which is typically associated with a simultaneous probability of limiting warming to 1.5°C by 2100 with a probability of 25% or more – see Schleussner et al (2016).

The respective temperature limits have often been associated with a specific carbon budget. Just before the 2°C limit was engrained in the Copenhagen Accord, a paper by Meinshausen, et al. estimated that in order not to exceed that temperature goal, the combined emissions in the period 2000-2050 should not exceed 1 437 $GtCO_2$ (Meinshausen et al., 2009).

As there is a close to linear relationship between the carbon emissions and the magnitude of warming, associating the respective temperature limits with a carbon budget is possible up to approximately 2000 $GtCO_2$ (MacDougall and Friedlingstein, 2014). However, the distribution of the emissions over time does also play an important role. A significant temperature overshoot, even if followed by a massive application of negative emissions, could trigger some positive feedbacks of the planetary system that may accelerate the warming (MacDougall *et al.*, 2015). Hence, a distribution of efforts should take into account not only the emissions budget but also its realisation over time in the form of an emissions pathway.

2.2 Effort sharing based on equity approaches

The distribution of the still remaining emissions budget between the major emitters according to the equity approaches was conducted using the methodology developed by the Climate Action Tracker (CAT). It consists of a compilation of a wide range of literature on what different researchers from many perspectives would consider a "fair" contribution to greenhouse gas reductions (for more in-depth explanation see Section 3.2 of (Wachsmuth *et al.*, 2019)).

Given the large variability of equity proposals, criteria and metrics, each country has a wide equity range. For the global emissions, emissions allowances are not derived from equity approaches, they are consistent with the benchmark pathways from the CAT pathways for 1.5°C and 2°C. The emissions allowances compatible with the 1.5°C and 2°C temperature limits for year 2030 and year 2050 are compared to the historical values from 2005 and 2015.

Table 2: Absolute and relative GHG emissions excluding LULUCF in 2030 derived from equity-based allowances for selected countries and the EU28.

	CAT AGGREGATION OF FAIRNESS-BASED APPROACHES					
Country	**Historical 2005 [GtCO2e]**	**Historical 2015 [GtCO2e]**	**Maximum emissions in 2030 to remain compatible with the respective temperature limit [GtCO2e]**		**Minimum emissions reduction compared to 2015 required to not exceed the respective limit**	
			1.5°C	**2°C**	**1.5°C**	**2°C**
Brazil	0.83	1.03	0.43	0.74	-58%	-28%
Canada	0.73	0.72	0.33	0.44	-55%	-39%
China	7.63	12.70	8.40	10.69	-34%	-16%
Japan	1.38	1.32	-0.17	0.30	-113%	-77%
India	1.91	2.71	4.52	6.38	67%	135%
Germany	0.99	0.91	-0.03	0.26	-104%	-72%
United States	7.34	6.62	1.76	3.49	-73%	-47%
EU28	5.23	4.33	0.76	1.92	-82%	-56%
World	39.98	46.86	28.04	37.58	-40%	-20%

Source: Historical emissions levels for Brazil, Canada, Japan, Germany, the United States, and the EU28 based on the UNFCCC. Emissions for India and China based on CAT. Global Emissions based on PIK's PRIMAP-hist dataset. Emissions for 2030 based on CAT effort-sharing methodology (Climate Action Tracker, 2019c; PIK, 2019; UNFCCC, 2019). For simplicity, we only use as benchmark in the main tables in this report the lower and upper end of the part of the range that is consistent globally with either 1.5°C or 2°C. The emissions allowances compatible with the 1.5°C and 2°C temperature limits for year 2030 (Table 7) and year 2050 (Table 8) are compared to the historical values from 2005 and 2015.

The comparison between equity-based emissions allowances and historical emissions levels shows broadly two categories of countries. On the one hand, countries like China and India could, based solely on fairness considerations, increase their emissions levels by 2030. This is mostly due to the inclusion of equity approaches reflecting current levels of emissions and historic responsibility. On the other hand, all the other countries covered in this study would need to reduce substantially their emissions in 2030, compared with historical emissions levels. Indeed, fairness-based ranges show compatibility with the 1.5°C emissions reduction goal would require Germany and Japan to reach negative emissions levels in 2030 whereas the USA emissions would have to decrease by at least 73% to remain in the 1.5°C- compatible range. However, when assessing these ranges, it needs to be taken into consideration that they are also influenced by the number of data points (studies and scenarios) for each country.

For 2050 fairness-based emissions allowances compatible with the 1.5°C and 2°C temperature limits have still wide ranges across the countries, even wider than in 2030 in absolute terms. However, as expected, all the emissions levels for all countries are smaller in 2050 than in 2030. When compared to 2015 levels, for the 2°C-compatible emissions levels, the emissions reduction ranges from -164% for Japan to +83% for India, while for 1.5°C compatible emissions reduction, the deviation ranges from -227% for Japan to +22% for India. Based solely on equity considerations, by mid-century all the countries covered in this study need to reduce their emissions and except for India and China would need to reach negative emissions levels under fairness-based considerations of the Paris Agreement.

Table 3: Absolute and relative GHG emissions excluding LULUCF in 2050 derived from equity-based allowances for selected countries, EU28 and world

	CAT AGGREGATION OF FAIRNESS-BASED APPROACHES					
Country	**Historical 2005 [GtCO2e]**	**Historical 2015 [GtCO2e]**	**Maximum emissions in 2050 to remain compatible with the respective temperature limit [GtCO2e]**		**Minimum emissions reduction compared to 2015 required to not exceed the respective limit**	
			1.5°C	**2°C**	**1.5°C**	**2°C**
Brazil	0.83	1.03	0.02	0.43	-98%	-58%
Canada	0.73	0.72	-0.16	0.05	-123%	-93%
China	7.63	12.70	5.40	8.23	-58%	-35%
Japan	1.38	1.32	-1.68	-0.84	-227%	-164%
India	1.91	2.71	3.32	4.96	22%	83%
Germany	0.99	0.91	-1.03	-0.42	-215%	-146%
United States	7.34	6.62	-2.32	-0.14	-135%	-102%
EU28	5.23	4.33	-4.09	-1.76	-194%	-141%
World	39,98	46,68	11.22	19.31	-81%	-62%

Source: Historical emissions levels for Brazil, Canada, Japan, Germany, the United States, and the EU28 based on the UNFCCC. Emissions for India and China based on CAT. Global Emissions based on PIK's PRIMAP-hist dataset. Emissions for 2030 based on CAT effort-sharing methodology (Climate Action Tracker, 2019c; PIK, 2019; UNFCCC, 2019).

A more detailed analysis of the fairness-based allowances for the countries selected shows that while the ranges are wide and differ substantially across countries, there are some general patterns that can be observed:

- Overall, the lower end of emissions allowances (more stringent end of the fair share range) under the 1.5°C-compatible scenarios tends to be lower, sometimes significantly lower, than the lower end of 2°C compatible scenarios for most countries, as would be expected.
- Some of the difference in the width of the fairness-based ranges can be explained by the number of data points (studies & scenarios) available for each country (see Annex 2). In general, much more data points (65 on average) are available for 2°C-compatible scenarios than for 1.5°C-compatible ones. In particular, the capability-cost category is the only one for which there are not studies in the literature for the 1.5°C. Coverage is also limited for the equal cumulative per capita emissions category. This means that the results for 2°C-compatible scenarios are more robust and more literature on the equitable allowances under the Paris Agreement would allow a better understanding of the implications of the different criteria for specific countries.

2.3 Cost-effectiveness approach to distribute the global carbon budget

In the literature, there are different cost-based approaches to construct mitigation pathways that are cost-optimal in a certain sense. Optimal welfare approaches distribute mitigation efforts among countries based on the optimization of the global gross domestic product. This requires a macroeconomic analysis of the global economy, which is a rather complex endeavor and therefore bound to high uncertainties. There are similar approaches based on the optimization of additional energy system costs or total energy expenditures that cover only the energy system instead of the full economy. A more direct cost-based approach to distribute the global mitigation requirement to the countries or regions is the cost-effectiveness approach. In this approach, the mitigation effort is divided among countries based on marginal abatement cost curves (MACCs) that measure the total additional cost of reducing emissions.

In our project, we pursued the cost-effectiveness approach based on MACCs, as it can be realized without setting up of additional complex models and also enables to distribute the mitigation costs not only to countries but also to sectors in a simple way. On the other hand, MACCs do not reflect interrelations and feedbacks between sectors. Another limitation of this approach is that the MACCs applied in the global cost-effectiveness approach to the distribution of emissions reductions to the countries under study do not cover GHG emissions from the agriculture and the waste sector, which are included in the fairness-based approaches described earlier. To enable a comparison of the results from both approaches, we hence expand the cost-effective distribution to those sectors in this subsection.

Due to the lack of MACCs for those two sectors, we use country-specific data on the current emissions of the sectors and the sectoral emissions trends as well as the globally necessary emissions reductions in the sectors. For the latter, we assume that the relative reduction with regard to the emissions trend is the same across countries and – in order to ensure consistency – apply the same global data we used to derive the energy- and process-related emissions from the global CAT pathways. For the current emissions and the emissions trends, we use the official data reported under the UNFCCC protocol for all countries under study, except for China and India, where we had to collect additional data from Ding et al. (2017) and Dhingra & Mehta (2017). We assume that current emissions trends flatten until 2030 in order not to overrate the current trends.

In the next step the resulting pathways for the agricultural and waste emissions are added to the results for the energy- and process-related emissions, in total leading to the figures given in Table 4 and Table 5. For all countries, the relative emissions reductions with regard to 2005 and 2015 are lower after including agricultural and waste emissions because the mitigation potential is substantially lower in these sectors. This effect is increased for those countries with a rising emissions trend in these sectors (Brazil, China and India). The change in relative emissions reductions is particularly large for Brazil because more than one third of its emissions in 2015 are from these sectors. For all other countries under study here, the change is smaller than in the global average, as is the share of agriculture and waste emissions in the total GHG emissions.

Table 4: Total GHG emissions reductions in 2030 when GHG emissions from agriculture and waste are added to cost-effective pathways for energy-and process-related emissions

Country	GHG emissions 2005 [$GtCO_2eq$]	GHG emissions 2015 [$GtCO_2eq$]	Minimum emissions reduction in 2030 vs. 2015 [in %]		Minimum emissions reduction in 2030 vs. 2005 [in %]	
			2°C-consistent	1.5°C-consistent	2°C-consistent	1.5°C-consistent
Brazil	0.90	1.13	-19%	-30%	2%	-12%
Canada	0.73	0.71	-42%	-52%	-44%	-54%
China	7.63	12.70	-28%	-46%	20%	-9%
Japan	1.38	1.32	-39%	-51%	-41%	-53%
India	1.91	2.71	-2%	-29%	39%	1%
Germany	0.98	0.90	-35%	-44%	-41%	-49%
United States	7.32	6.64	-38%	-51%	-44%	-55%
EU28	5.23	4.33	-37%	-46%	-47%	-55%
World	45.00	51.00	-26%	-45%	-16%	-38%

Source: Own calculation based on data from the POLES-Enerdata model, UNFCCC inventories, Ding et al. (2017) and Dhingra & Mehta (2017)

Table 5: Total GHG emissions reductions in 2050 when GHG emissions from agriculture and waste are added to cost-effective pathways for energy-and process-related emissions

Country	GHG emissions 2005 [$GtCO_2eq$]	GHG emissions 2015 [$GtCO_2eq$]	Cost-effective effort-sharing in 2050 vs. 2015 [in %]		Cost-effective effort-sharing in 2050 vs. 2005 [in %]	
			2°C-consistent	1.5°C-consistent	2°C-consistent	1.5°C-consistent
Brazil	0.90	1.13	-53%	-64%	-42%	-55%
Canada	0.73	0.71	-78%	-87%	-78%	-87%
China	7.63	12.70	-69%	-83%	-48%	-72%
Japan	1.38	1.32	-74%	-87%	-75%	-87%
India	1.91	2.71	-51%	-72%	-31%	-60%
Germany	0.98	0.90	-77%	-87%	-79%	-88%
United States	7.32	6.64	-74%	-85%	-76%	-86%
EU28	5.23	4.33	-73%	-84%	-78%	-87%
World	45.00	51.00	-62%	-78%	-57%	-75%

Source: Own calculation based on data from the POLES-Enerdata model, UNFCCC inventories, Ding et al. (2017) and Dhingra & Mehta (2017)

2.4 Complementing fairness-based effort-sharing distributions with cost-effectiveness-based distributions

For the majority of countries under study, the cost-effectiveness-based reduction of emissions is less stringent than it would have to be according to the fairness-based distribution in 2030 and 2050 both for a 2°C-consistent and a 1.5°C-consistent pathways. The main exceptions here are China and India, for which the fairness-based ranges of GHG emission allocation is substantially higher than the respective allocation based on a cost-effectiveness approach both in 2030 and 2050. For the United States and Brazil, this is also the case either in 2030 or in 2050, but only with regard to compatibility with the pre-Paris 2°C temperature goal.

In a more recent study, we investigated further how the disparity of the results from the equity and cost-effectiveness approaches can be closed (Höhne and Wachsmuth, 2020). If the national potential is not substantial enough to represent a fair contribution (likely for most developed countries), these countries should support other countries to make the transition. If the highest possible ambition leads to faster reductions than the fair contribution (likely for many developing countries), these countries would receive financial support.

Such support should not finance the cheapest reductions in developing countries as such reductions are to be implemented by the countries themselves in order to set and meet their stringent domestic emission targets. The financial support should, in particular, help to avoid sectoral lock-ins such as investments in less carbon intensive, but nonetheless GHGs emitting power plants, or replacing older combustion vehicles by newer ones. Investments in carbon neutral solutions especially in the more challenging sectors, such as steel or cement, usually require much higher efforts compared to current NDC pathways, most of which were designed to be in line with the now outdated below-2°C limit. The difference between cost-effective 2°C and 1.5°C pathways can help identify the difficult steps that could be supported, although some caution is required in the interpretation due to uncertainties about future cost developments.

3 Assessment of the potentials to increase emissions reduction targets

The potential distribution of the emissions reduction efforts between different Parties taking into account specific circumstances, was the focus of a report published in the framework of Work Package 4 (Fekete et al., 2019). The analysis focused on Brazil, Canada, China, Germany, India, Japan, United States, and the EU. However, the EU is the subject of the subsequent section and will thus be excluded from this section to avoid repetition. For each country, the report drew conclusions to what extent mitigation targets could be strengthened, based on the following elements:

- **The socioeconomic context**: The socioeconomic data, including urbanisation and electrification percentages, Human Development Index reflecting life expectancy, education, and per capita income, and wealth inequality expressed by Gini Coefficient.
- **Greenhouse gas emissions and energy profiles**: GHG and energy profiles show which areas are most critical to consider for mitigation efforts.
- **Emissions projections in comparison to mitigation targets**: Some countries were set to (over-) achieve their mitigation targets, while others were lagging behind in implementation.
- **Emissions pathways resulting from global least-cost pathways and an equitable distribution of mitigation efforts**: In this regard the study built upon the results of the effort sharing study described in the preceding section
- **Insights regarding the political context of mitigation ambition**: This section looked into the political feasibility of, for example, the phasing out of counterproductive measures such as fossil fuel subsidies, and increasing mitigation ambition overall is investigated in the last section of each country profile.

In addition to the study assessing the socio-economic and political framework for emissions reduction, three other discussion papers published in the framework of the project looked into the potential to increase ambition in the next wave of the NDCs on the basis of new projections concerning the costs of renewable energies and batteries. The methodology to assess the potential to increase the level of ambition resulting from decreasing mitigation costs was developed by Fraunhofer ISI (Wachsmuth and Anatolitis, 2018). This methodology has been used in two case studies for Canada and Chile prepared by New Climate Institute (Fekete and Nascimento, 2019; Fekete, Nascimento and Lütkehermöller, 2019).

3.1 Socio-economic context

The countries selected for the assessment differ significantly in terms of their socio-economic context. Whereas Brazil, China, and India can be classified as developing countries, Canada, Germany, Japan, and the United States belong to the highly industrialized countries. This is reflected in the Human Development Index (HDI) measuring life expectancy, access to education, and per capita income indicators, with the latter four scoring above 0.9, Brazil and China on par at 0.76 and 0.75, respectively, and India scoring the least at 0.64. The GINI index measuring inequality, presents a much more diverse picture. The higher the value of the index, the biggest the inequality. While Brazil is the country with the largest inequalities of all selected countries, the United States is the country with the largest inequality among developed countries. In Germany and Japan, the income is comparatively the more equally distributed (see Table 6).

Table 6: Selected socio-economic indicators

	Brazil	Canada	China	Germany	India	Japan	United States	European Union
Urbanisation rate	87%	81%	60%	77%	34%	92%	82%	75%
Electrification rate	100%	100%	100%	100%	95%	100%	100%	100%
GDP/cap (USD/cap)	8.921	46.195	10.262	47.639	2.104	40.247	65.118	34.843
HDI [0 – 1]	0.76	0.92	0.76	0.94	0.65	0.92	0.92	n.a.
GINI index [0 – 100]	53.3	34.0	38.6	31.7	35.7	32.1	41.5	n.a.

Data Sources: (Statista, 2019; The World Bank, 2019c, 2019a, 2019d; Transparency International, 2018b; United Nations Department of Economic and Social Affairs: Population Division, 2018a; United Nations Development Programme (UNDP), 2018a).

3.2 Greenhouse gas emissions profiles

The differences in the GDP per capita correlate to some degree with the GHG emissions per capita. The highest emissions at around 19-20 tCO_2/capita have been recorded in the United States and Canada, per capita emissions in India and Brazil were the lowest of the selected countries, with 2.2 and 5.4 tCO_2, respectively. China, Germany, and Japan were in between with emissions per capita between 9-11 tCO_2. Different picture shows when looking at emissions intensity of the economy. In this case China and Japan record the highest emissions per unit of GDP, whereas emissions intensity of the economy in Japan and Germany is the lowest, mostly due to the high share of services in the GDP generation.

Table 7: GHG emissions indicators

Indicator	Brazil	Canada	China	Germany	India	Japan	USA	EU	World
GHG/cap [tCO_2e/cap]	5.4	19.8	9.4	11.1	2.2	10.2	20.0	8.7	6.3
GHG/GDP [tCO_2e/mln USD]	543	438	1.056	249	1.123	265	334	265	586
Energy/GDP [ktoe/mln USD]	0.2	0.2	0.2	0.1	0.4	0.1	0.1	0.1	0.2
Global share of emissions [%]	2.4%	1.5%	27.3%	1.9%	6.3%	2.7%	13.7%	8.2%	100%

Data sources: (Gütschow *et al.*, no date; IEA, 2020; The World Bank, 2020). GHG indicators for 2017 were calculated using PRIMAP data and exclude contributions from the LULUCF sector.

Brazil's rapid economic growth until the financial crisis in 2008/2009 has also led to an increase in energy consumption, especially from fossil-fuels. Between 1990 and 2015 Brazil's total primary energy demand has more than doubled. While the absolute consumption of oil and traditional biomass and waste has increased steadily, their shares in the primary energy mix have declined moderately. The major upward trend has been in the rising share of natural gas, which has increased sharply from 2% in 1990 to 11% in 2016. The growth in demand can be particularly attributed to the rise in consumption of power and transportation fuels. Electricity is primarily produced from hydropower, with smaller shares from natural gas and coal. However, Brazilian hydropower has been vulnerable to draughts, which has led the government to invest in procuring power from other sources, including fossil fuels (Climate Action Tracker, 2019a).

Canadian emissions are mainly driven by energy use, emitting 82% of the total emissions (excluding LULUCF). With a relatively clean grid, the Canadian power sector emissions have a smaller share than in the case of the other countries (except for Brazil). Emissions from the oil and gas sector and transport sector make up a major share of energy combustion emissions, followed by the building sector. Canada's per capita emissions are more than three times the world average due to its small, affluent population. In total, Canada emitted close to 2% of global emissions in 2012.

Energy combustion emissions contribute a majority (77%) to China's overall emissions and come mostly from the use of coal in power generation. Coal also makes up 65% of Chinese primary energy supply. Oil (18%), gas (6%), traditional biomass (4%), and hydro (3%) contribute smaller shares. Industrial emissions account for another 14% and have increased four times since 2000. Per capita emissions in China are comparable with the average for the EU and higher than other countries with similar levels of GDP per capita. China alone emits 23% of global emissions.

India's emissions have been on a steady rise. In 2016, GHG emissions excluding LULUCF stood at 2.8 $GtCO_2e$. Energy combustion contributes to three-quarters of the total emissions. Agriculture (14%) is the second largest contributor. The majority of energy combustion emissions are from power generation, manufacturing industries and transport, which reflects the increase in economic activity and prosperity in the last decades. Yet signs of a partial decoupling of emissions and economic activity are visible. Emissions per unit of economic output has been on a declining trend and stood at 1227 tCO_2e/mln USD in 2016. India's GDP per capita has been increasing at a higher rate than its per capita emissions. An average Indian emits three times less than the world average. Yet the socio-economic inequity in India makes a lower per capita emission also an indicator of the future need for energy, which will likely be accompanied by an increase in emissions.

Germany's emissions declined by 28% between 1990 and 2017. However, emissions reductions have stalled during the last decade. Energy combustion constituted the largest share of emissions (85%) in 2015, followed by agriculture (7%) and industry (7%). The emission intensity of the economy stood at 262 tCO_2e/mln USD in 2016—this was 13% higher than in 2014 mainly due to the slump in economic growth that year. Overall, Germany emits 1.76% of global emissions.

Japan's emissions dipped in 2008 following the financial crisis, grew steadily for the next three years thereafter and receded in 2014, 2015 and 2016. Almost 91% of Japanese emissions originate from energy combustion. After allocating energy-related emissions from power and steam generation to the final demand sectors, the industrial sector had the largest share (38%), followed by commercial and other buildings (20%), transport (19%), residential buildings (16%) and power plants (7%) (MoEJ, 2018).

Oil and gas dominate the US primary energy mix, with the former contributing 37% and the latter 30% in 2017. Coal contributes another 15%. While fossil fuel use has historically been high, 2005 marked a turning point in the US's energy use profile. With the massive uptake of fracking techniques for oil and gas drilling, the role of natural gas in the energy mix has grown post-2005, while that of coal has declined. Indeed, natural gas has replaced coal as the biggest fossil fuel-based power generation source. Nuclear, biomass and waste continue to have a small but consistent contribution. The share of non-hydro renewables has increased in past years with the support of federal tax credits and state level policies but currently stands at only 1% of primary energy.

3.3 Emissions reduction potential

To assess the emissions reduction potential in different sectors we used models that distribute global emission pathways in line with the temperature limits to countries, assuming a most cost-efficient distribution of efforts. This means that the cheapest mitigation options are used first, regardless of which country implements them. The cost-effective reduction potentials were based on recent marginal abatement cost curves (MACC) from the POLES database (ENERDATA, 2018), which were used to derive globally cost-effective national pathways.

The calculations indicate the largest potential for emissions reduction for all countries in the energy sector. Compatibility with the 1.5°C according to the cost-effective criteria would result in emissions from this sector decreasing by over 55% between 2015 and 2030 in China, Canada, and Japan. The emissions reductions in this sector so far result in slightly lower emissions reduction potential in Germany at 42%. At the same time, Germany, next to Canada and the United States, could more than half its emissions in the buildings sector. The picture for transport is much more varied, with Brazil, China, and India, possibly even increasing their emissions, but simultaneously significant potential in industrialized countries can be expected. This results from comparatively low emissions from this sector in the developing countries under study. However, a temporary increase in emissions from transport would result in increasing stranded assets, as emissions from all sectors will have to decrease and in most cases these sectors have to be fully decarbonized by 2050.

Table 8: Cost effective emissions reduction potential for 1.5°C-compatible pathway in different sectors in 2030 vs. 2015

	Energy	Industry	Buildings	Transport
Brazil	-50%	-38%	-39%	+7%
Canada	-61%	-59%	-50%	-39%
China	-55%	-41%	-58%	+16%
European Union	-51%	-47%	-48%	-37%
Germany	-42%	-52%	-56%	-35%
India	-51%	-4%	-50%	+79%
Japan	-60%	-46%	-35%	-42%
United States	-61%	-56%	-39%	-42%

3.4 Political context

The political context for emissions reduction differs significantly between the countries assessed. While climate policy started to play a role in Brazil's policy-making process during the presidencies of Lula da Silva (2002-2010) and Dilma Rousseff (2010-2016), this has changed with the victory of Jair Bolsonaro who took over as the country's president on 1st January 2019. Bolsonaro's government has represented regression on climate action in Brazil, with important legislative changes including the weakening of the institutional and legal framework that helps to fight deforestation and other environmental offenses, as well as reforms that substantially weaken the participation of civil society, including pro-environment groups, in policymaking and in oversight of policy implementation (Climate Action Tracker, 2019b). While Bolsonaro backed down on his initial plans to leave the Paris Agreement, one cannot expect a significant increase in the level of ambition of Brazil's NDC. Such expectations are further weakened by the increasing discrepancy between the existing NDC and the emissions trends, resulting especially from the accelerating deforestation.

Canada's disposition toward climate action over the past two decades has been strongly linked to the respective government in power. Those affiliated with the centre-left Liberal party generally highlight the need for climate action and have committed Canada to ambitious targets, while the decade in which the country was led by the Conservative Party under Stephen Harper (2006-2015) saw less political support at the federal level for climate change action. However, political disposition and actual emissions trajectories do not correlate: annual Canadian emissions rose by roughly 115 MtCO2eq in the "Liberal-led" years of 1993-2005 to about 720 MtCO2eq, whereas they were at similar levels (having dipped significantly around the 2008 recession) when Harper left office. No Canadian governments' ambition for climate action has lined up with its actual emissions reduction policies. The importance and political weight of fossil fuel extraction has caused conflicts between energy and climate policies under all Canadian governments throughout the past decades and continues under the current Trudeau government in the form of what activists have called "climate hypocrisy" (Bill McKibben, 2017).

In the last 15 years, China has emerged as a key player in the UNFCCC negotiations. During this period, China surpassed the US to become the largest GHG emitter between 2000 and 2005 (EDGAR 4.3.2). With its influence on global GHG emissions and the role it played in the Paris process, China has been regarded as one half of the 'G-2', together with the USA (Bodansky, 2016). As the leader of the G77 bloc in the UNFCCC, China has always been vocal about keeping a distinction between rich and poor countries in the negotiation process in light of the 'common but differentiated responsibilities and respective capabilities' principle (CBDR-RC), which still creates tension between negotiation blocs like the EU and the Umbrella group (Darby, 2018). At the same time, China has been working constructively with the EU and the US. In the lead up to the 2015 Paris climate conference (COP21), the joint announcement made by China and the US in 2014 boosted confidence among many observers that COP21 would be a success, and the joint presidential statement in September 2015, which laid out a joint vision for the COP21, strengthened this confidence (Bodansky, 2016). Furthermore, in recent years, the EU and China have held bilateral talks to accelerate climate action (European Commission, 2018). In September 2020 Chinese President XI Jinping announced the goal of achieving carbon neutrality by 2060 (Climate Action Tracker, 2020).

On its part the EU presented itself as global champion on curbing climate change. To live up to this role, the EU has not only enacted the most encompassing set of policies aimed at economy-wide emissions reduction in the world (Delreux & Happaerts, 2017) but has also routinely challenged the international community to keep up, in many cases setting the bar in terms of ambition and framing the negotiations at the international level (Oberthür & Groen, 2016).

Nevertheless, there is and has been a division between different EU Member States regarding how high to set the bar in terms of EU climate ambition. With other large global players failing to match the degree of action needed worldwide, some EU countries have questioned whether the EU should continue forging ahead unconditionally. Furthermore, domestic interests (e.g. concerning domestic energy resources) and diverse set of powerful incumbent (economic) players at the national level, have opposed further and more ambitious actions. Despite these divisions, in 2019 the EU member states managed to agree on the goal of reaching climate neutrality by 2050[1], The EU is still to ratchet up its emissions reduction goal for 2030 (see section 5).

Due to Germany's membership in the EU, this country's climate policy is highly interlinked with EU climate policy. As a member state of the EU, Germany takes part in the EU-wide emission trading system (EU-ETS) established in 2008, which covers GHG emissions from the energy sector and the energy-intensive industry sectors. Furthermore, under the EU's Effort-Sharing Decision, Germany is required to reduce GHG emissions in the sectors not covered by the EU-ETS. In 2016, Germany submitted its Climate Action Plan 2050 to the UNFCCC — this constitutes the country's long-term GHG reduction strategy. In particular, the Climate Action Plan 2050 includes sectoral mitigation targets for 2030 in line with Germany's 2030 GHG reduction target as well as a more ambitious qualification of the long-term target range of near greenhouse gas neutrality, and a commitment to revise the pathway and in particular the 2030 target in the timeframe of the Paris Agreement (BMU, 2016). In 2020 the country adopted a plan to phase out coal combustion by 2038 (German Ministry for Economic Affairs and Energy, 2020).

India's political disposition towards climate change mitigation has evolved from defensive to increasing proactive. India is keen on defining its role in global climate governance while remaining cognisant of its domestic developmental concerns. Narratives of equity have been central to India's diplomatic position on its role in climate action (Dubash, 2013). More recently, the Indian position has seemed become an even more 'proactive' approach, targeting developmental objectives via climate action. For instance, in 2015, the Indian government decided to raise its renewable energy capacity to 175 GW by 2022. India also played a facilitative role in the run-up to Paris, including collaborating with France to launch the international solar alliance and supporting the 1.5°C framing (Narlikar, 2017). Political analysts see this flexibility and openness as a systematic shift in India's overall diplomatic approach since Copenhagen and a clear departure from its past engagement with the international community on the issue of climate change (Mohan, 2017; Narlikar, 2017; Mohan and Wehnert, 2018).

In Japan action on climate change has been generally stable with some variations over the last decade due to changes of the government in power. Since the country's mineral resources are negligible, Japan is strongly dependent on fossil fuel imports. This import dependence not only exposes Japan to market dynamics that may threaten its energy security, but its economic growth could also be negatively affected by price volatility. In its NDC, submitted in July 2015, the Japanese government presented a 2030 emissions reduction target of 26% below 2013 levels. This target foresees the use of credits from the LULUCF sector, and this, according to the Climate Action Tracker, translates into a 15% reduction compared to 1990 levels when the use of LULUCF-related flexibilities are avoided (Climate Action Tracker, 2019d). Japan remains an outlier in the G7 as the only member still actively seeking to develop new coal power generation. Japan has 45.5 GW of operating coal capacity, and an additional 8.7 GW are under construction with 4.4 GW in pre-construction stage (End Coal, 2019). Furthermore it is proactively exporting coal-fired power generation technology overseas (Climate Analytics & Renewable Energy Institute, 2018). Over the past three years, E3G's G7 Coal Scorecard reports have consistently

[1] even if Poland was at that point in time not in the position for a commitment to achieving this goal.

found Japan to be one of the worst performer across all six categories of analysis (Littlecott *et al.*, 2018).

Since 2017, the United States has undertaken no new policy action against climate change under President Trump and the Republican-led Congress. Instead, the few measures enacted under the previous administration (including vehicle emissions standards aimed at cutting carbon output of the country's transport sector) are being actively repealed. The Trump administration has also reduced taxes on fossil fuels. Beginning in January 2019, the federal excise tax on coal extraction was lowered (U.S. Department of the Interior, 2019). Similarly, the federal "oil spill" excise tax, which was imposed on crude oil and imported petroleum products, expired at the end of 2018 and was not renewed by the Trump administration (KPMG, 2019). Additionally, in August 2019, the EPA, under the insistence of the Trump administration, announced it will roll back Obama-era methane regulations in an attempt to boost oil and gas production (Puko, 2019). In April 2019, Congress Democrats Alexandra Ocasio-Cortez and Ed Markey proposed the so-called "Green New Deal", a large economic stimulus package to create clean-energy jobs and infrastructure. The plan was quickly defeated in the Senate, but the idea has remained alive in public discourse. Its major goals included achieving carbon neutrality by 2030 (Ocasio-Cortez and Markey, 2019). As a response to the radical measures of the Green New Deal, a different group of House Democrats unveiled a plan with a "more realistic" goal to cut carbon emissions to net zero by 2050 (Friedman, 2019).

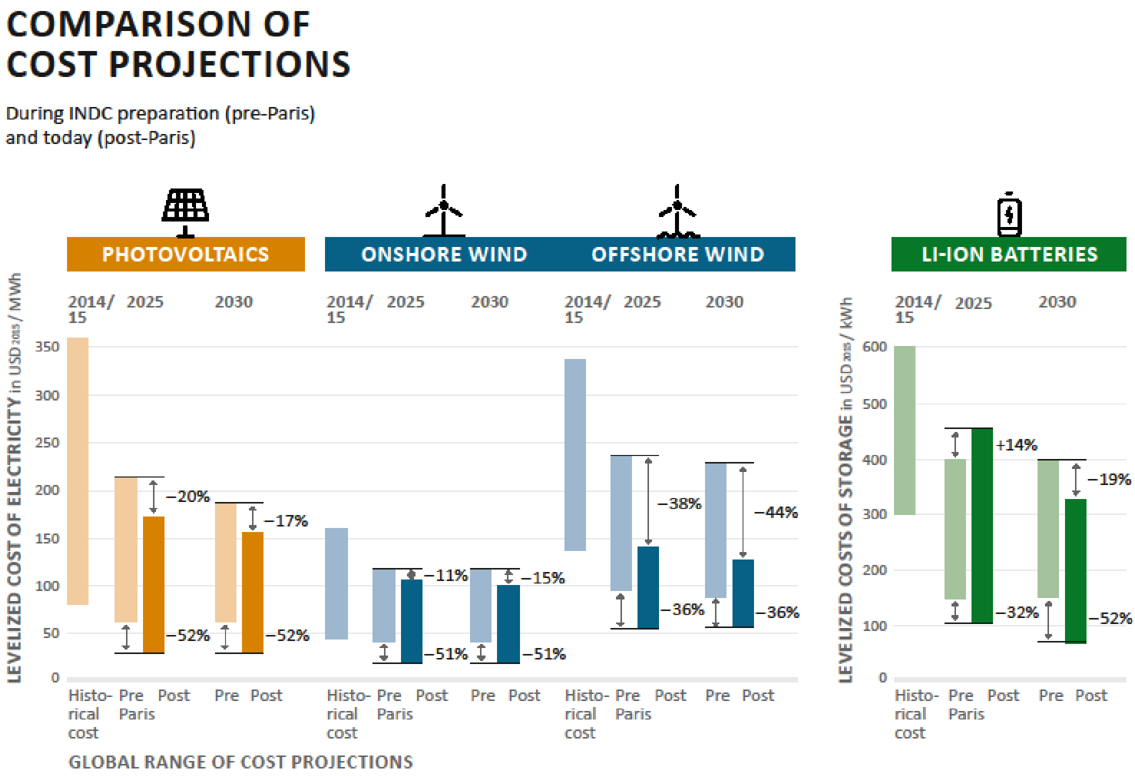
The victory of the presidential candidate, Joe Biden, during the elections on 3 November 2020 creates the potential for a significant change in the U.S. climate policy. The Biden Plan presented before the elections includes the goal of reaching net-zero emissions by 2050. Already by 2025 it plans to set new and more stringent fuel economy standards for cars and light-duty trucks. By 2035 electricity is to come exclusively from renewable sources and emissions from the building sector are to decrease by 50% (Biden&Harris, 2020; Washington Post, 2020).

3.5 Impact of decreasing costs of climate change mitigation on the level of ambition

The study assessing the socio-economic and political framework for emissions reduction has been complemented with three discussion papers looking at the potential for an increase in ambition resulting merely from projected decrease in the costs of the major climate mitigation technologies. The discussion paper by (Wachsmuth and Anatolitis, 2018) pointed out that since the submission of the NDCs in the run-up to the Paris Climate Summit in 2015 better and more up-to-date information concerning the cost projections for certain key mitigation technologies have become available. These updated projections should be taken into consideration as parties review and strengthen their NDCs by 2020.

In this discussion paper, they compared global cost projections for key mitigation technologies in recent reports with those that were available in the run-up to COP21. The results of the evaluation showed that the latest projections for levelized costs of energy in 2025 and 2030 were substantially lower, namely up to 51 – 52% for photovoltaics and onshore wind (ranges 17 – 52% for photovoltaics, 11 –51% for onshore wind) as well as more than 36 % for offshore wind (range 36 – 44%). For Lithium-Ion batteries used in electric vehicles, there was higher uncertainty about the reduction of costs (with an increase of the upper range in 2025), but the reductions of battery cost projections range up to 38% in 2025 and 52% in 2030 (ranges +14% – -32% in 2025 and -19% – -52%). This can be a starting point for the revision of the NDCs, which nevertheless would require a detailed analysis of a specific country's techno-economic potentials and socio-economic needs.

Figure 1: Projections for the levelized costs of energy/storage in 2025 and 2030 for renewable electricity and Lithium-Ion batteries before and after COP21 in Paris



Data source: (Wachsmuth and Anatolitis, 2018).

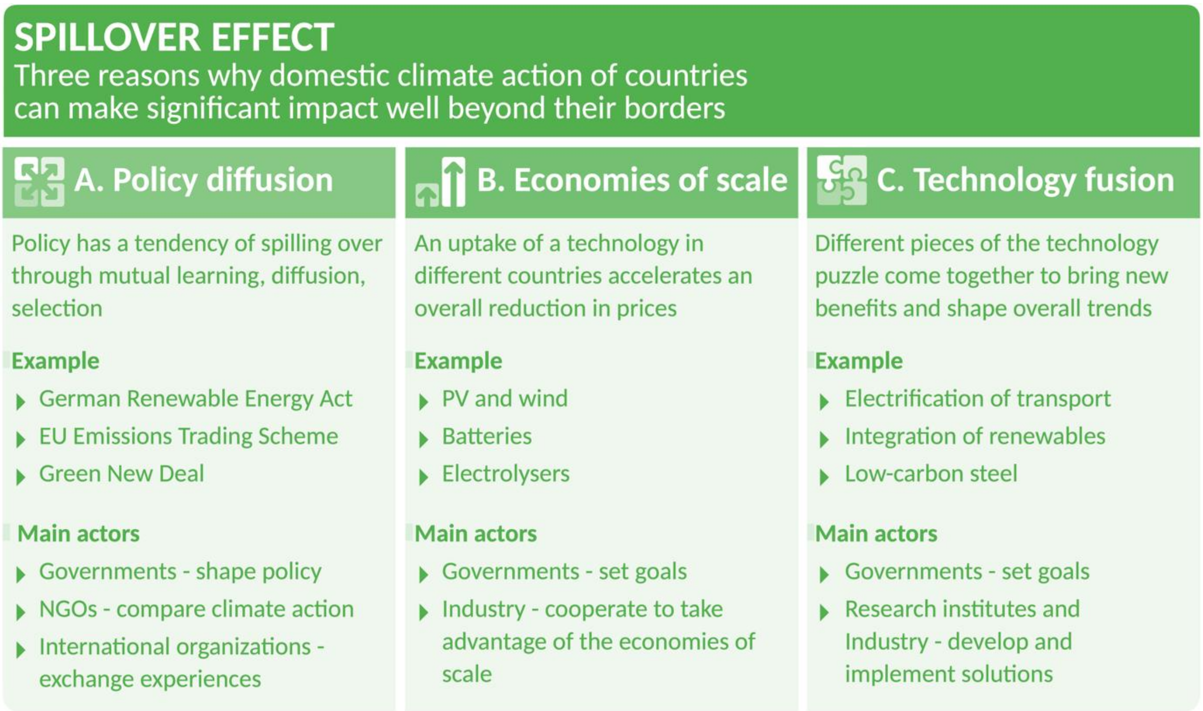
This more detailed analysis has been conducted by New Climate Institute for Canada and Chile (Fekete and Nascimento, 2019; Fekete, Nascimento and Lütkehermöller, 2019). The assessment indicated that by considering technology cost developments of wind, solar PV and batteries since 2017, Canada could increase the ambition of its NDC target. Assuming that cost savings in those technologies would be reinvested in the same area, the NDC target of 30% below 2005 levels could be reduced by 1 – 2%-points, or by 4 to 9 MtCO2e in 2030 in absolute terms. For Chile, the unconditional NDC target of 30% improvement of GHG intensity compared to 2007 moves downward by 1 – 2%-points, and the conditional targets of 35% to 45% by 3 to 5 pp. This reflects a reduction of 2 to 4 MtCO2e in 2030 of the unconditional targets, and 7 to 10 MtCO2e in 2030 of the conditional target range.

4 Spillover effect of domestic action

The decreasing costs of climate mitigation technologies have different impact of different countries, depending on the socio-economic and political framework. But this impact can be strengthened by domestic climate action, especially if it is accompanied by active leadership at the international arena and by transfer agents facilitating policy diffusion (Steinbacher, 2016) respectively. A short study written in the framework of Work Package 5 looked into the mechanisms and drivers that result in internationalisation of the impact of domestic emissions reductions (Ancygier, 2020).

In the short study we identified three main mechanisms that result in internationalisation of the impact of domestic emissions reductions: policy diffusion, economies of scale, and complementarity of action resulting in the fusion of different technologies. Each of these mechanisms can be divided into specific drivers that can increase the impact of a particular mechanism, such as learning or emulation that accelerates policy diffusion, scaling up and export of domestic standards, increasing the benefits of economies of scale, and contributing niche solutions to a challenge that cannot be solved solely by one country.

Figure 2: Three main mechanisms resulting in the internationalisation of the domestic emissions reductions impact.



The study argued that the spillover impact of domestic action could be strengthened at the backdrop of the current COVID-19 induced health and economic crises. While unusual times call for unusual measures, political leaders may be prone to adopt measures that have already been adopted in other countries. Greening the recovery packages in one country may significantly increase the probability that other countries will also focus on climate mitigation in their recovery packages, triggering transformative change. Countries may leverage the spillover effect of their green recovery packages by a corresponding increase in the level of ambition and timely submission in 2020 of new and updated NDCs.

5 European Union’s path to climate leadership

The implementation of the project took place at the backdrop of the European Union scaling up its climate mitigation effort. The project consortium accompanied this process starting from participation in the EU 2050 Stakeholder Conference in July 2018 in Brussels, through a critical assessment of an early draft of the in-depth Analysis of the EU’s long-term emissions pathway, to a workshop and a report focusing on the European Climate Law. Since the report from the participation in the Stakeholder Conference was for internal use only, the subsections below describe the main conclusions from the assessment of the EU’s analysis of the EU’s long-term emissions pathway, and from the workshop and report focusing on the European Climate Law.

5.1 Assessment of the EU long term strategy to reduce GHG emissions

In the draft of the In-depth Analysis of its long-term strategy the European Commission presented 80% reduction of the EU’s GHG emissions by 2050 as being in line with the Paris Agreement’s long-term temperature goal (LTTG). In their report (Wachsmuth, Schaeffer and Hare, 2018) have shown this as questionable due to the Commission’s re-labelling of the former “hold-below-2°C” pathways associated with the 2010 Cancun Agreements as “well-below 2°C” pathways. Those “hold-below-2°C” path-ways had a 66% chance of limiting warming to 2°C and were further characterised by a peak warming of around 1.7-1.8°C.

By contrast, the actual Paris long-term temperature goal is, by design, a strengthening of the former “hold-below-2°C” goal. In their paper, strong arguments were provided that this implies achieving a lower peak warming and a higher probability of limiting warming to 2°C. Further, the "hold-below-2°C" pathways do not provide guidance in terms of lowering peak warming and increasing the probability of limiting warming to 1.5°C, an integral part of the Paris LTTG (unless with negative emissions at a scale the IPCC Special Report on 1.5°C does not deem feasible). At the same time, the IPCC SR1.5 is very clear about the increases in climate risks between 1.5°C and 2°C, which relates to the clause of the LTTG that holding warming well below 2°C significantly reduces the risks and impacts of climate change. This provides a clear argument for lower limit to peak warming.

Despite the shortcoming with regard to interpreting “well-below-2°C”, the report argued that the EU Strategic Vision was a clear shift away from the lower end of the former “80-95%” reduction target by 2050 towards achieving net-zero greenhouse gas emissions in 2050. This is based on the In-Depth Analysis, which shows that a greenhouse gas emission reduction of 90% by 2050 compared to 1990 is necessary to keep 1.5°C in range, while limiting negative emissions even calls for net-zero green-house gas emissions in 2050. Hence, the “net-zero greenhouse gas emissions in 2050” target chosen in the Strategic Vision is a reasonable choice in light of the Paris Agreement and the IPCC Special Report on 1.5°C, but 80% reduction by 2050 is not. Thus, the lower end of the current “80-95%” EU target is insufficient.

A year after the publication of our study, the heads of the EU member states unanimously endorsed the objective of achieving “a climate-neutral EU by 2050”. While the Polish government endorsed this goal as well, it stated that it could not commit to implementing it (European Council, 2019). Achieving climate neutrality by 2050 was one of the main goals of the European Green Deal (EGD) presented in December 2019 (European Commission, 2019). In the framework of the EGD the Commission was to propose European Climate Law aimed at bringing the goal of climate neutrality into law.

5.2 Assessment of the European Climate Law

In early March 2020 the European Commission published the proposal of the European Climate Law (European Commission, 2020). The assessment of the proposal and preparation of suggestions for its improvement was the subject of the online webinar which took place three weeks after the publication. The workshop gathered 18 experts from 11 organization and governmental institutions. The main conclusions from the workshop fed into an Analysis of the European Commission proposal published by Ecologic in April 2020 (Meyer-Ohlendorf, 2020).

The Analysis argued that if adopted, the Commission's proposal for a European Climate Law would mark important progress. It would set a legally binding EU target of reaching climate neutrality by 2050 – a milestone in EU climate policy making. It would determine that reductions can only be achieved domestically, excluding international offsets. The proposal also contains new processes on ensuring that all EU policies are consistent with the EU's new climate neutrality target. Despite various implementation problems, the EU has a relatively strong legal framework for involving its citizens in climate policies. The European Climate Law would improve this framework further but additional strengthening of public participation is necessary.

Among the shortcomings flagged by the analysis was the fact that EU climate neutrality was at the moment of writing defined as a collective target on the EU. As it did not oblige Member States to achieve climate neutrality by 2050 themselves it also could not be used as a ground for infringement against individual Member States. This system alone would make it difficult to hold individual Member States to account. It needs to be complemented by a continuation of the EU Climate Action Regulation after 2030.

Another weakness of the Commission's proposal was lacking specification of climate neutrality. The term "climate neutrality" is ambiguous. The term could mean 100 % domestic reductions and no removals but it could also mean large amounts of removals and corresponding lower domestic reductions. The ECL only stipulates that the EU will reduce emissions to net zero but does not specify further details in regard to a relationship between emissions and removals.

Finally, the European Climate Law did not plan to establish an independent scientific advisory body. This was contrary to the experience of some member states which adopted climate laws in the meantime, each of which also established independent scientific advisory bodies, often called Climate Change Committee or Council. These bodies differ in design. Despite these differences, experience from Member States shows that these bodies can support consistency between long-term goals and short-term action, enhance the role of science in decision-making, help build and maintain the necessary political will to decarbonize economies and strengthen public confidence in climate policies.

The amendments to the European Climate Law proposed by the European Parliament in October 2020 addressed some of the weaknesses, e.g. included the requirement to create European Climate Change Council that would among others asses the consistency of the EU's climate targets against the EU's international commitments and expanded the climate neutrality by 2050 goal with the obligation to achieve negative emissions afterwards (European Parliament, 2020). However, the amendments to the Commission's Proposal suggested by the Council of Ministers for Environment failed to address these shortcomings (Council of the European Union, 2020). At the moment of writing of this report the compromise version of the European Climate Law is still open.

6 Conclusions

The adoption of the Paris Agreement with the long-term goal of reducing temperature increase to "well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels" has important repercussions for the distribution of efforts between the Parties to the Agreement. The comparison between the emissions reduction levels determined according to the cost-effectiveness and equity-based criteria indicates significant differences between these two approaches. This discrepancy can be closed by countries with high emissions reductions goal according to the fairness criteria supporting countries where emissions reduction calculated according to the least-cost criteria are higher than those resulting from applying equity considerations. At the same time, it must be ensured that such support should not finance the cheapest reductions in developing countries and do not result in carbon lock-in.

The specific socio-economic circumstances need to be taken into consideration when the cooperation between countries with the high emissions reduction required by the equity criteria and high emissions reduction resulting from cost-effectiveness criteria is considered. Transformation away from fossil fuels towards renewables can also contribute to meeting a number of Sustainable Development Goals (SDGs). Due to their distributed character, rapidly decreasing cost, and employment potential, development of renewables complemented with energy efficiency measures will help to increase access to affordable and clean energy (SDG7), help to reduce of poverty and inequalities (SDG1 and SDG 10), and facilitate development of sustainable cities and communities (SDG11).

The specific political context in the respective countries is of great importance when assessing the potential for increasing climate ambition. However, contrary to the socio-economic framework which with few exception changes only slowly, the political environmental within which climate mitigation is taking place may change rapidly. This was especially the case for two of the countries assessed - Brazil and the United States. These changes – positive and negative – have a spillover effect on other countries. This effect takes place even if the external impacts of a policy are not the explicit objective of certain policies (or lack thereof). But it can be considerably strengthened if domestic climate mitigation effort is accompanied with active leadership and support of transfer agents.

The spillover effect creates an opportunity for the EU to influence emissions reductions well above those targeted by its own measures. The adoption of the goal of climate neutrality by 2050 at the latest, complemented with a more ambitious emissions reduction goal for 2030 and support for climate mitigation effort in other countries, offers the potential for accelerating global climate effort. However, at the time of writing, the European Climate Law was still under discussion and in the version proposed by the Council of Ministers was lacking important elements, such as creation of an Agency that would oversee the achievement of the emissions reduction targets goal and suggest necessary changes, and commitment to move to negative emissions after 2050. Also, the ratcheted up 2030 goal was still not adopted. Addressing these issues could help the EU to considerably shift global climate agenda, especially if it were joined with the United States and China, jointly representing almost half of global GHGs emissions.

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