Umweltforschungsplan des
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Naturschutz, Bau und Reaktorsicherheit

# Quantitative Analyse von globalen und regionalen Emissionspfaden und Klimaszenarien im Rahmen der Fortentwicklung der internationalen Klimapolitik

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**Kurzbeschreibung**

Dieser Bericht untersucht drei Fragestellungen im Rahmen der Fortentwicklung des internationalen Klimaschutzregimes. Im ersten Teil wird das Regelwerk unterm Kyoto Protokoll zu überschüssigen Emissionszertifikaten untersucht. Dieses Regelwerk für die zweite Verpflichtungsperiode 2013-2020 wurde in Doha 2012 angenommen. Dieses Regelwerk umfasst den so-genannten Art. 3.7ter als auch die Previous Period Surplus Reserve. In einem zweiten Teil wird der Frage nachgegangen, was ein ‚faires' EU28 Ziel für 2030 sein könnte. Das Fazit ist, dass das EU28 Ziel, die inländischen Emissionen um 40% unter 1990 zu senken, nicht ausreichend ist. Es müsste durch zusätzliche inländische Reduktionen oder Unterstützung für Reduktionen im Ausland noch deutlich untermauert werden, um verschiedenen Kriterien der ‚Fairness' gerecht zu werden. Im letzten Teil wird untersucht, welche Formulierung eines Langfristzieles zur Dekarbonisierung im Pariser Abkommen sinnvoll sein könnte.

**Abstract**

This report examines three issues in the context of the international climate change regime evolution. In the first part of this report, the regulatory framework is examined under the Kyoto Protocol of how to deal with surplus emission allowances. This set of rules for the second commitment period 2013-2020 was adopted in Doha 2012 Design. This framework includes the so-called Art. 3.7ter and the Previous Period Surplus Reserve. In a second part of the question will be, what could be a, fair 'EU28 target for 2030th The upshot is that the EU28 target, the domestic emissions by 40% below 1990 is not sufficient. It would have to be underpinned significantly by additional domestic reductions or support for reductions abroad to meet various criteria, fairness' needs. The last part examines the formulation of a long-term goal for decarbonisation in the Paris Convention could be useful.

## Inhalt / Contents

# List of figures

# List of tables

## List of abbreviations

| Abbreviation | Explanation |
|---|---|
| **ADP** | Ad-hoc Working Group on the Durban Platform |
| **Annex A** | An Annex to the Kyoto Protocol defining the regulated emission gases and sources, i.e. all emissions except landuse related emissions. |
| **Annex B** | The Annex of countries with QELROs in the Kyoto Protocol |
| **Annex I** | The industrialised countries as defined within the UNFCCC |
| **Art. 3.7ter** | Article in the Doha agreements 2012, which caps future emission targets at historical emission levels |
| **CERs** | Certified Emission Reductions |
| **COP** | Conference of the Parties |
| **CP1** | First commitment period under the Kyoto Protocol |
| **CP2** | Second commitment period under the Kyoto Protocol |
| **ERUs** | Emission Reduction Units |
| **INDC** | Intended Nationally Determined Contribution |
| **LULUCF** | Land Use, Land-Use Change and Forestry |
| **Non-Annex I** | So-called developing countries as defined within the UNFCCC |
| **PPSR** | Previous Period Surplus Reserve |
| **QELROs** | Quantified Emission Limitation and Reduction Commitments |
| **SBSTA** | Subsidiary Body for Scientific and Technical Advice |
| **UNFCCC** | United Nations Framework Convention on Climate Change |

## Zusammenfassung

Dieses Forschungsprojekt hat drei Hauptforschungsschwerpunkte. Zum einen untersucht das Forschungsprojekt Möglichkeiten, wie man mit überschüssigen Emissionsgutschriften aus der ersten Verpflichtungsperiode unter dem Kyoto-Protokoll umgehen kann. Eine Reihe von möglichen Regeln wurde untersucht, wie mit bestehenden Überschuss dank einer Previous Period Surplus Reserve und mit der Vermeidung von neuen Überschüssen in nachfolgenden Verpflichtungszeiträumen umgegangen werden kann. Letzteres kulminierte im so-genannten Art. 3.7ter Artikel. Da die Paris Vereinbarung wahrscheinlich einem anderen Regelsatz folgen wird, müssen die in Doha getroffenen Regeln eher in ihrem substantiellen Charakter als mögliche Prezedenzfälle eingestuft werden. Eine direkte Anwendung in einem für die Zeit nach 2020 verhandelten Abkommen ist nicht abzusehen – wäre jedoch angesichts der Notwendigkeit globale Emissionen zu reduzieren evtl. wünschenswert in indirekter Form.

Ein zweiter Forschungsschwerpunkt befasste sich mit der Frage, was ein faires EU-Ziel für die Zeit nach 2020 sein könnte. Die EU schlug bisher eine 40% Minderung der EU-Emissionen als Beitrag zur Pariser Vereinbarung vor. Es ist jedoch bisher nicht klar, ob und wenn ja, dann in welchem Umfang dieses inländischen Ziel durch die Unterstützung von Klimaschutzmaßnahmen in anderen Ländern oder zusätzliche inländische Klimaschutzmaßnahmen aufgestockt werden könnte. Diese Forschung Projekt hat festgestellt, dass statt einem 40% Ziel unter 1990, eher ein Ziel von 40% unter dem aktuellen Niveau (2010) oder mehr als 60% gegenüber 1990 nötig wäre, um verschiedenen Kriterien der Fairness zu genügen. Auch eine lineare Zielflugbahn in Richtung 2050er Zielen würde ein stärkeres Ziel als die derzeitige 40% ige Reduktion unter 1990 nahelegen.

Drittens untersuchte dieses Forschungsprojekt Optionen für ein globales langfristiges Ziel im Rahmen der Pariser Vereinbarung. Auch zur Vorbereitung auf den G7-Gipfel in Elmau wurden verschiedene Dekarbonisierung und Phase-out-Ziele in Bezug auf ihre Eignung als langfristiges globales Ziel untersucht. Die wichtigste Schlussfolgerung dieser Forschung ist, dass ein Kohlenstoff-fokussiertes Ziel (im Gegensatz zu einem Ziel welches alle Treibhausgase mit einschliesst) aus der Sicht der Wissenschaft angemessener wäre. Darüber hinaus werden eine Reihe von Ziel-Optionen untersucht und miteinander verglichen, nämlich ein Phase-out-Ziel für die Netto-$CO_2$-Emissionen aus dem globalen Energieversorgungssektor, und ein Phase-out-Ziel für die globalen $CO_2$-Emissionen in der zweiten Hälfte dieses Jahrhunderts.

Abgesehen von den Forschungsergebnissen, welche in diesem Bericht enthalten sind, konnte das Forschungsprojekt auch eine Reihe von verbalen informellen Beiträgen liefern. Zum Beispiel wurde im Laufe des Prüfungsprozesses der IPCC-Arbeitsgruppenbericht das Ministerium fortlaufend unterstützt- auch in den Plenarsitzungen zur Annahme des ersten, dritten IPCC Arbeitsgruppenberichtes, und des Syntheseberichtes in den Jahren 2013 und 2014.

## Summary

This research project had three major research foci. Firstly, the research project investigated options of how to deal with surplus emission credits from the first commitment period under the Kyoto Protocol. A ruleset was investigated that could both deal with existing surplus (the Previous Period Surplus Reserve) and prevent the generation of new surplus in subsequent commitment periods (the so-called Art. 3.7ter article). Given that the Paris agreement is likely to contain a different ruleset altogether, the ruleset that was adopted in Doha could possibly have precedence character rather than direct application in a post-2020 world.

A second research focus dealt with the question what a fair EU target would be for the post-2020 period. The EU announced a domestic 40% mitigation as contribution to the Paris agreement, although little is clear whether and if so to what extent this domestic target would be topped up by support for mitigation action elsewhere or additional domestic mitigation action. This research project established that a 40% target below current 2010 levels, or more than 60% below 1990 levels, would likely meet multiple criteria of fairness. Even a linear target trajectory towards 2050 mitigation levels would suggest stronger targets than a 40% reduction.

Thirdly, this research project investigated options for a global long-term target as part of the Paris agreement. As well in preparation for the G7 Elmau summit, various decarbonisation and phase-out targets were examined in regard to their suitability as long-term target. The main conclusion of this research is that a carbon-focussed target (opposed to one that deals with all GHGs) is more appropriate from the viewpoint of the science. Beyond that, an array of target options are mutually enforcing and consistent with each other, namely a phase-out target for net $CO_2$ emissions from the power supply sector, then a phase-out target for global $CO_2$ emissions in the second half of this century.

Apart from the research results in this report, the research project contained a number of verbal informal contributions, e.g. in course of the review process of the IPCC Working Group reports that were adopted in the Plenary session during 2013 and 2014.

# 1 Introduction

This report contains the main research results from the research project "Quantitative analysis of global and regional emission pathways and climate scenarios in the context of the further development of inter-national climate policies", which was conducted in close cooperation with the Federal Ministry of the Environment, Nature Conservation, Building and Nuclear Safety of Germany. None of the research results necessarily represent the viewpoint of the Federal Ministry though.

The research project was conducted in a time, when the international climate regime was in the process of substantial renewal. Not only was the second commitment period negotiated. As well, the upcoming Paris negotiations for a global regime after 2020 were ever more present in the ADP negotiations.

This double renewal process of the international climate regime was determining the various research foci during this quantitative analysis period. First, the surplus emission allowances of the 2008 to 2012 commitment period threatened to undermine the future of any future regime with a Kyoto-like accounting regime. Thus, fixes had to be found to make a future accounting based regime viable and guard against the pitfall of perverse incentives, where surplus emission allowances can be seen as a valuable commodity and hence provide a dis-incentive against ambitious mitigation targets by all countries. At least, the un-willingness to contribute with ambitious climate mitigation should not undermine efforts elsewhere. The first chapter of this report hence deals with the question of how surplus emission allowances can be dealt with in the Kyoto-like accounting of the international climate regime.

The second question deals with the vital question of target setting within the new climate regime. Even if one guards against 'hot air', the question is how ambitious is 'ambitious enough'. Hence, this research project developed numerical quantifications of a number of allocation approaches to investigate the European targets for a post-2020 period. The second chapter thereby looks into the question of how much the domestic 40% target of the EU would need to be topped up by either additional domestic mitigation or support for mitigation action elsewhere.

Lastly, the research project focussed on the question what potential long-term targets could be for the Paris agreement. Arguably, the lack of strong ambition within the proposed INDCs could mean that any long-term target would possibly be the test of whether the Paris agreement is a success or not in the eyes of many stakeholders. Based on the findings of the IPCC Fifth Assessment Report, this research project investigated a number of options for such a long-term target. The third chapter of this report provides the details.

In addition, the research project consisted of a number of verbal advisory on various question of climate science and the international climate regime. Specifically, the research project accompanied the deliberations and adoption process of the WG1, WG3 and Synthesis Report of the Fifth IPCC Assessment Report.

# 2 How to deal with surplus emission allowances in the international climate regime?

## 2.1 The ruleset of Doha and its precedence character for the future

This chapter investigates the climate targets in the second commitment period for the Ukraine after the set of decisions taken in Doha, December 2012.

Ukraine has been a key country in the new ruleset of Art. 3.7ter and PPSR, which together restrict new targets to historical emission levels and prevent the case, where surplus credits could swamp the international credit market. While the second commitment period is limited and scope and lacks substantial mitigation targets that would create demand for any surplus credits anyway, the significance of this ruleset could potentially unfold in the future for a global agreement.

Either in Paris at COP21, or in subsequent negotiations for a new international climate regime, a first-step quality criteria for climate targets could be, whether they lead to an absolute reduction of emissions (Art. 3.7ter). With the likely lack of internationally fungible emission allowance units in a post-2020 regime, the precedence character of a PPSR (Previous Period Surplus Reserve) might be further down the line.

However, the question might arise internationally as well, how to treat overachievement, and whether to then permit countries to account for earlier overachievement when a compliance assessment (or a weaker form of target review) is undertaken. That incentive for overachievement is important, but historical evidence has indicated that the disincentive to set ambitious targets in the first place might outweigh the benefit of any rule that treats non-used emission allowances / or overachievement, as if it were a national asset.

The remainder of this chapter focusses on the specific target situation for Ukraine, directly after the Doha decisions. It should be taken into account that, as of September 2015, the negotiations in regard to the precise application of Art. 3.7ter and PPSR are still ongoing. Due to continued strong interventions by Ukraine and others, parties are negotiating further so-called ‘clarifications’ of this rule-set.

## 2.2 Ukraine’s situation after Doha in focus

The remainder of this chapter assumes a rule set and state of the discussion as directly after the Doha decision.

Ukraine pledged a -20% reduction by 2020 relative to 1990 levels. Current 2008-2010 emissions by Ukraine are -58% below 1990 levels. Under the Doha Agreement, the effective target for Ukraine is -58% below 1990, although the inscribed QELRO is only 76, i.e. -24% below 1990 levels. This is due to the effective limitation of targets for the second commitment period at the country’s 2008-2010 emission level (Art. 3.7ter).

If Ukraine uses the ambition mechanism to update its QELRC to the 2008-2010 level of its emissions, then any future increasing emissions beyond that level could be offset using carried-over AAUs from the first commitment period, up until total emissions are close slightly above the originally proposed QELRC (76% of 1990 emissions) and well beyond reference scenario projections.

Analysis of Art. 3.7ter & Likely course of action by Ukraine, and possible ways of support: Ukraine generated a substantial surplus of AAUs in the first commitment period, since its CP1 target (100% of 1990 emissions) was well beyond the actual emissions. The total surplus (which Ukraine refers to as its “legitimately acquired sovereign property” ) amounts to 2’643 $MtCO_2eq$ (or 330 $MtCO_2eq/yr$ when evenly distributed over the 8-year CP2 commitment period).

Without Art. 3.7ter, Ukraine would have had a substantial carry-over from the first commitment period, it would also have generated substantial new surplus, given that its proposed QELRC target of 76% is well beyond middle-range reference emission projections and well beyond current emissions (see Figure 1 below).

If Ukraine chooses to be part of the second commitment period, there are two options: First, a stringent option: In this case, Ukraine would not change its QELRO of currently 76%. The effect would be that any emissions above today's emission levels and up 76% relative to 1990 levels would need to be offset by Ukraine, either by LULUCF (projected to cover only 1%) or buying international offsets. Ukraine could of course engage in mitigation action to keep its domestic emissions below the 2008-2010 levels (see Figure 1a).

Secondly, a less stringent option, using CP1 surplus and the ambition mechanism until 2014: If Ukraine updates its QELRC target to the level of 2008-2010 emission then it could access its carried-over AAU surplus to the extent that future emissions increase above the 2008-2010 level. Thus, Ukraine would – under any plausible future emission projection – meet its CP2 target without having to engage in either emission reductions or in any international offset acquisitions. Furthermore, Ukraine could continue to take part in the emission trading mechanisms and sell some of its carried over surplus to other countries . (see Figure 1b)

Although in the second case no domestic emission reductions would be required by Ukraine to be part of the second commitment period, it could be that Ukraine chooses not join the CP2. The reasons could be that (a) Ukraine acts "in solidarity" with Belarus and Kazakhstan, who both do not have CP1 surplus to cover any emission increases beyond 2008-2010 levels , or (b) Ukraine is not willing to agree to the principle of Art. 3.7ter of stable or decreasing emissions or not willing to update its QELRC to 42% from the current 76% for (geo-)political reasons.

In theory, a participation in the second commitment period by Ukraine could be incentivised by Germany, if a substantial programme were designed and supported to effectively stabilize emissions until 2020 in Ukraine. Even in the case of reference-case emission increases, Ukraine would then not be "dependent"/"forced" to use their "sovereign property" of carried over CP1 units to meet their CP2 targets, provided that the mitigation action is sufficient to stabilise emissions.

In the case of a participation, the mitigation wedge that would need to either be achieved by domestic reductions or international credits could be of the order of 53 $MtCO_2eq/yr$ for Ukraine (average difference between grey line and blue bars over 2013-2020 in Figure 1 below). Of this mitigation wedge, approximately…

- ... 9 $MtCO_2eq/yr$ could be met by LULUCF credits (estimate).
- ... all the remaining part, up to even 330 $MtCO_2eq/yr$ could be met by carried over CP1 AAUs (if the QELRC is adjusted downwards to 42%, so that the assigned amount reflects the 2008-2010 emission levels).
- ... alternatively, if CP1 surplus units either cannot or shall not be used for CP2 compliance, then about 44 $MtCO_2eq/yr$ mitigation action (under a medium-low reference case projection) would need to be either mitigated or offset by CER and ERU acquisitions.

General comment: Art. 3.7ter could be seen as a substantial innovation within the climate regime, as industrialised countries are now facing de facto limits in terms of their proposed targets for the second commitment period. In the light of the 2°C target, a further increase of emissions by industrialised countries in the decade when global emissions would have to peak, seems inconsistent and is now de facto prohibited by Art. 3.7ter for participating countries.

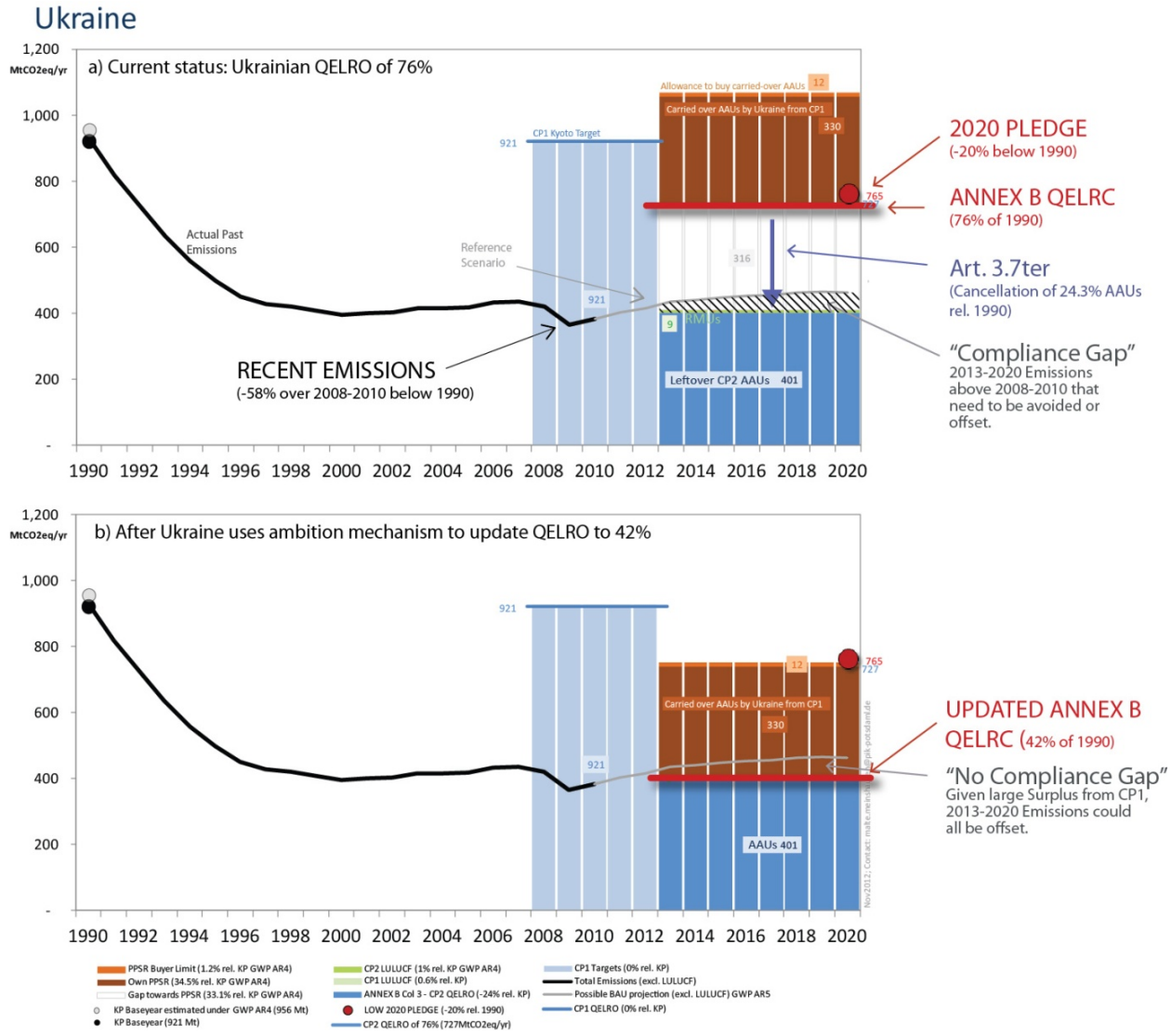


Figure 1 - Overview of Ukraine's actual emissions (black line), reference projections (grey line), Ukraine's proposed 2020 pledge under the Protocol (red large circle) of -20% below 1990 as well as its proposed target (QELRC) for the second commitment period (red solid horizontal line in upper panel). The upper panel denotes the current state with Ukraine's QELRC at 76% of 1990 emissions and a resulting "compliance gap" between the (uncertain) reference scenario and the average 2008-2010 emissions. The lower panel denotes a case where that "compliance gap" could be avoided, i.e. by adjusting Ukraine's QELRC towards its 2008-2010 emissions from 76% to 42% of 1990 emissions.

## 2.3 A way forward for the negotiations? Allowing access to the PPSR.

The discussions with Ukraine are still ongoing as of July 2015. One simple way forward would have been, if the Annex B QELRC of Ukraine would be adjusted to reflect the 2008-2012 emission levels. For political reasons, another solution that would allow Ukraine to increase its emissions and be still in compliance with second commitment period targets would be (apart from the obvious solution of lowering emissions) to adjust the level of emissions after which the PPSR can be accessed. If that reference level is not any more the Annex B QELRC target times base year emissions, but now adjusted towards the historical 2008-2010 emission level, then Ukraine could make use of CP1 surplus credits that are stored in its Previous Period Surplus Reserve (PPSR). The following diagrams explain that mechanism graphically.

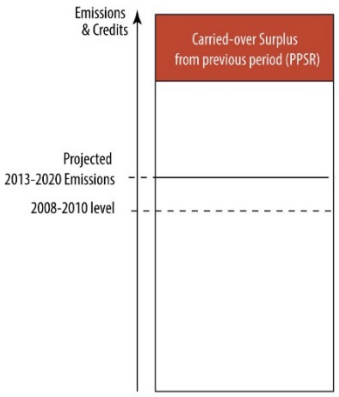


Figure 2 - A hypothetical situation of a country A that has projected 2013-2020 emission levels above its 2008-2010 emission levels, an Annex B target for CP2 above its 2008-2010 emission levels and surplus emission allowances from the first commitment period in its PPSR, the Previous Period Surplus Reserve.

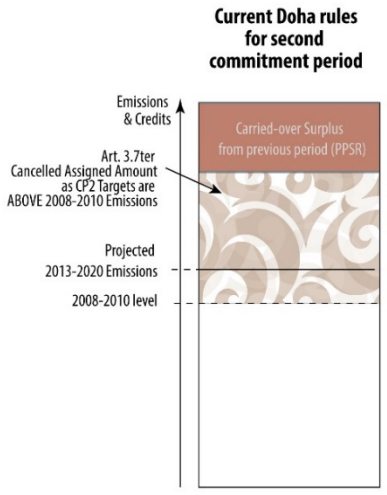


Figure 3 - The effect of Art. 3.7ter on such a country A would be that any part of its initial assigned amount that is above the 2008-2010 emission level gets cancelled (patterned area).

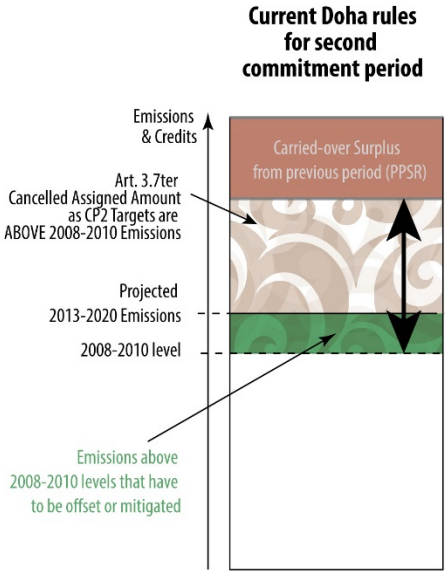


Figure 4 - The country with cancelled initial assigned amounts due to Art. 3.7ter but projected 2013-2020 emission levels above the 2008-2010 levels would need to either mitigate the emissions above its 2008-2010 levels (green area) or offset it.

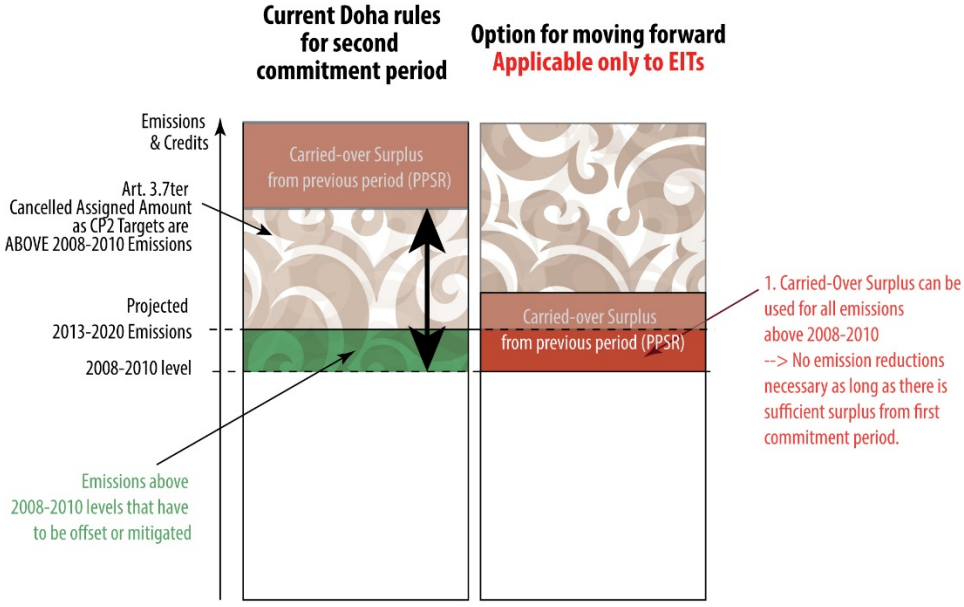


Figure 5 - A possible change of the Art. 3.7ter rules (or clarification, depending on the politically more appropriate wording) could be to allow access to the PPSR

# 3 What would a fair EU28 contribution be to a post-2020 target regime?

This chapter analyses what an appropriate EU 2030 climate target would be in order to enable the world to achieve the 'below 2°C target'.

## 3.1 Summary and context.

Only a reduction of at least 15% in addition to the proposed 40% EU domestic reduction (i.e. -55% allocation target) would set the EU on a path in line with its full range of 80% to 95% reductions by 2050. On the other hand, if the EU were to retain only a domestic 40% target and other countries were to present equivalently unambitious targets, global emissions could rise by up to +49% above 1990 levels – far off-track from a trajectory that keeps climate change impacts limited to those below 2°C warming.

With a -55% allocation target, there is still the risk that global 2030 emissions might be 31% higher than in 1990, but at least the EU were to make a contribution slightly above one of the weakest allocation approaches, the per-capita convergence.

Global Emissions have to return to around 1990 levels by 2030 in order to stay below the internationally recognized target of limiting warming to below 2°C – before emissions have to be halved by 2050.

## 3.2 EU Targets following a linear trajectory.

Irrespective of effort sharing approaches, the EU could follow a simple linear trajectory towards its 2050 targets, resulting in an 8% to 15% additional reduction by 2030. Starting from 2012 emissions, achieving the EU 2050 targets of 80% to 95% by 2050 would suggest a target range of 48% to 55% below 1990 in 2030. In order to avoid stranded investments in the next decades, an early start towards decarbonisation and towards our 2050 targets seems pertinent.

Achieving 2050 milestones can happen by strong reductions early or later. If emission reductions are kept high and only reduced shortly before 2050 more substantially, the cumulative amount of emissions is going to be higher. For global emission scenarios that investigate cost-effective pathways to stay below 2°C warming, a general feature is that reductions tend to happen earlier, as otherwise large negative emissions later on will have to offset too high cumulative emissions early on. Thus, while many countries with lower per-capita emissions can be expected to only start decreasing their absolute emissions later on, it would be the task of the EU to start reducing earlier in order for the world to follow cost-effective pathways. Here, we conservatively assume a smooth linear transition from today's emission's levels in 2012 towards 2050 targets of -80% to -95% below 1990. With such a linear transition, 2030 targets would lie in the range of -48% to 55% below 1990 by 2030, i.e. 8% to 15% in addition to the proposed 40% domestic reductions (see Figure 7).

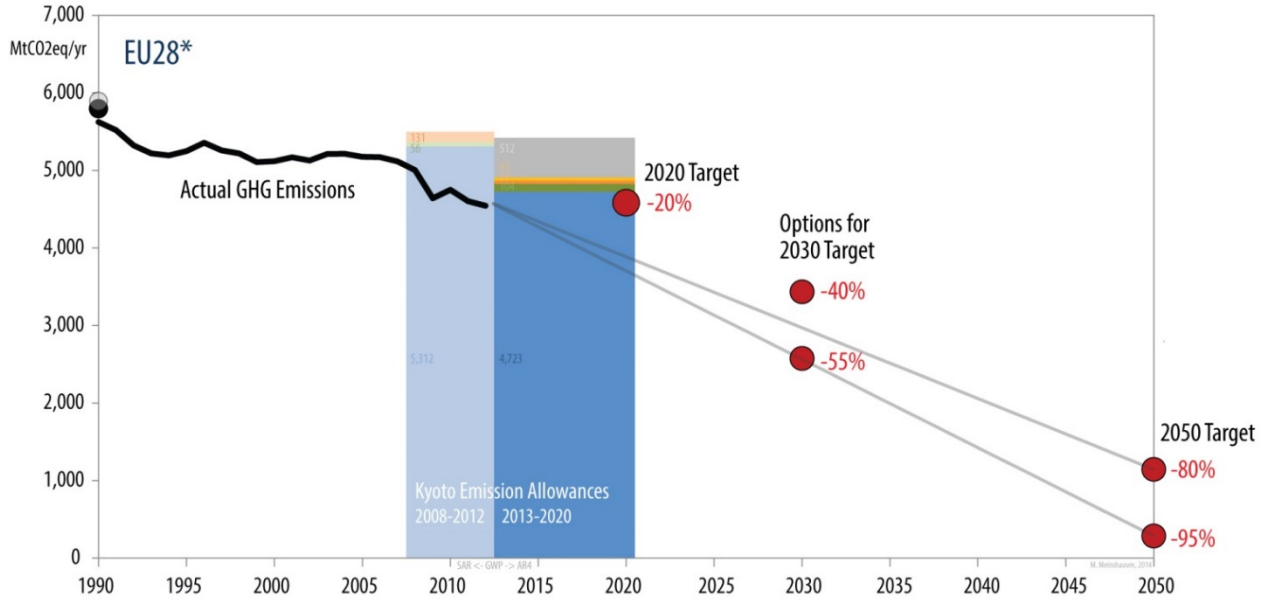


Figure 6 - The actual EU greenhouse gas emissions from 1990 to 2012 (black thick line), the Kyoto Protocol Emission Allowances for the EU (vertical bars), targets for 2020 and 2050 as well 2030 target options (red circles). The figure shows that the -20% target for 2020 and the 40% option for 2030 are substantially less ambitious than a linear achievement of the 2050 targets would imply. A 55% target by 2030 would be in line with a linear achievement of the 95% 2050 target. The Kyoto Protocol emission allowances consist of initial allocations (blue bars), landuse credits (green), acquisitions of ERU and CER credits in the 2008-2012 period from JI and CDM projects, respectively (orange and yellow), as well as surplus ERU and CER credits for the 2013-2020 period (orange and yellow) and banked AAU credits in the Previous Period Surplus Reserve (grey).

## 3.3 What is a 'fair share'?

An 'at least 40% domestic' EU reduction is in line with EU's 2050 Low Carbon Roadmap that suggests 40% to 44% domestic reductions to be cost-effective by 2030. The 2050 Low Carbon Roadmap notes also that the 80% target of the 80% to 95% target range for 2050, can be considered as "domestic":

*"The transition towards a competitive low carbon economy means that the EU should prepare for reductions in its domestic emissions by 80% by 2050 compared to 1990" (EU 2050 Roadmap[1], page 4).*

A cost-efficient domestic reduction by 40% does not have to be in line with shouldering a part of the global mitigation effort that is in line with an interpretation of the "Common but differentiated responsibilities and respective capabilities" (CBDR&RC) principle. In fact, in case of the EU, none of the dominant effort sharing approaches in the literature would suggest that a 40% reduction would be sufficient.

Together with an additional commitment of X% to support mitigation elsewhere, this is EU's fair share to the global mitigation challenge. How much additional reduction X% is appropriate should

[1] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52011DC0112

be guided by the analysis whether global emissions would be sufficiently reduced, if other countries offered an equivalently ambitious effort to the EU. If X% is too low, the EU would not act in line with its commitment to avoid dangerous climate impacts in excess of 2°C.

While the judgement of what actually would constitute a "fair share" for the EU28 differs wildly, basically all approaches imply that X% would need to be a substantial number.

If the world were to follow one of the effort sharing approaches that is most favourable for the EU, an 11% additional reduction (i.e. 40% + 11% = 51%) by 2030 from the EU would be sufficient to bring global emissions back to 1990 levels in 2030.

Almost all other approaches however would ask the EU for substantially more reductions, e.g. 18%, or 33% or even higher additional reductions (with effective allocations of 58% and 73%, respectively). In fact, the approach presented by the Environmental NGOs in form of the Climate Equity Reference Calculator even suggests a target of -175% (i.e. 135% additional reductions) below 1990 to be a fair allocation share for the EU28 by 20302.

Without additional commitments by the EU, i.e. only a 40% domestic target, and assuming "comparable action" elsewhere, global emissions could be up to +49% above 1990 by 2030. This is far higher than 2°C consistent trajectories. Even a mere 51% EU reduction could see global emissions to rise by 36%, if every country or region were to pick an interpretation of "fair" by picking the approach that requires the least reductions for that country.

Thus, only an additional reduction of above 11%, e.g. 15% or even much more, on top of an 'at least 40% domestic reduction target' would provide a chance…

- to provide a mitigation contribution that can be considered "fair", even if only under the most favourable (to the EU) of possible interpretations of what "fair" is.
- to return global emissions to 1990 levels by 2030.
- to avoid warming in excess of 2°C.
- to re-establish the EU as an international player that can set an example for other countries' actions.
- to avoid setting the negative example of only being in line with the least ambitious end of effort sharing approaches.

## 3.4 Global Emissions have to return to around 1990 levels by 2030.

Greenhouse gas emissions increased substantially since 1990 from around 40 $GtCO_2eq/yr$ to 50 $GtCO_2eq/yr$. In order to keep warming to below 2°C, greenhouse gas emissions would have to be reduced close to zero by the end of the century, with unabated fossil fuel emissions to be phased-out even earlier. For 2050 emissions, the IPCC AR5 provided a range for scenarios with a likely chance of staying below 2°C, with global reductions of 41% to 72% below 2010 emissions3. This range comprises the goal of halved global emissions by 2050 compared to 1990, a milestone that is consistent with the lowest of the four IPCC benchmark scenarios (so-called RCPs) – the only RCP scenario that is in line with the 2°C target. For 2030, this RCP2.6 pathway indicates emissions of approximately 1990 levels, i.e. 40$GtCO_2eq$. If 2030 emissions were above 50 $GtCO_2eq/yr$, the need for steep annual reductions in the 2030 to 2050 period could be substantially increased – with global

[2] See http://gdrights.org/calculator/

[3] IPCC AR5 WG3 Summary for Policymakers, Table SPM.1, Page 12.

reductions of around 4.5% per year and more4. Thus, the milestones for avoiding warming in excess of 2°C warming with a likely chance would be to bring global emissions back to 1990 levels by 2030 and half them by 2050.

**Table 1**- Global GHG Milestones for 2°C. Here, conservative central values are stated. For example, the UNEP GAP report derives a 2030 emission level that is consistent with 2°C of only 35 $GtCO_2$/yr (range 32-42$GtCO_2$)[5].

| **Milestones for 2°C** | **2030** | **2050** |
|---|---|---|
| **Emissions ($GtCO_2$/yr)** | 40 | 20 |
| **Reductions rel. 1990** | 0% | -50% |

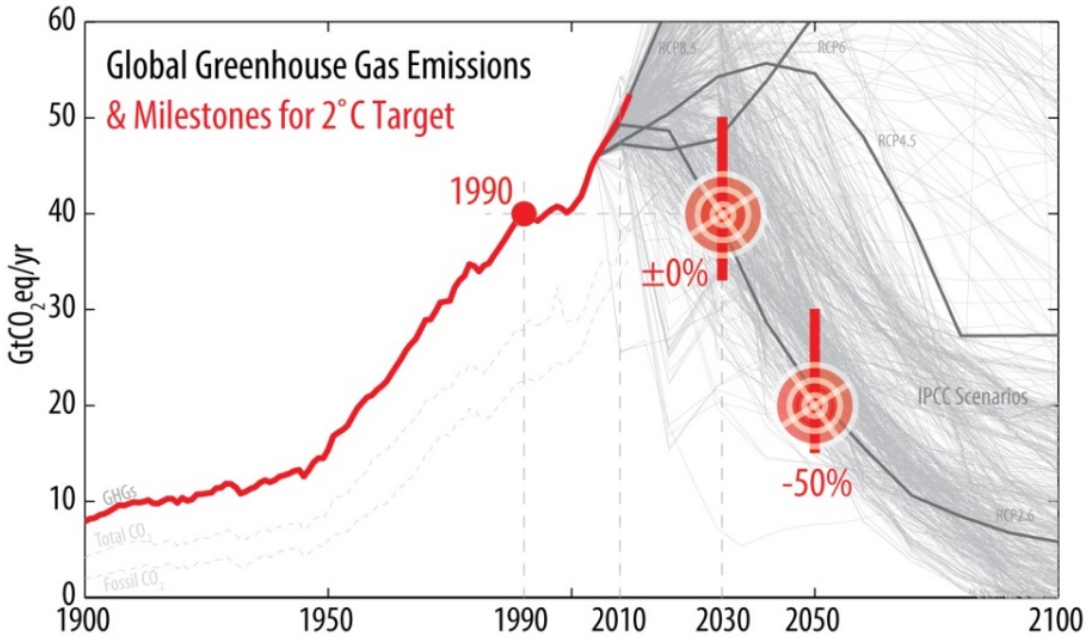


Figure 7 - Past emissions and scenarios of future global greenhouse gas emissions. Shown are as well milestones in line with the 2°C target for 2030 and 2050 (red circles) – with the milestones closely reflecting emissions of the lowest of the four IPCC RCP scenarios. The full range of scenarios that are deemed technically feasible and economically viable are shown in grey, with only the lower ones being in line with 2°C, though.

[4] IPCC AR5 WG3 Summary for Policymakers, Figure SPM.5, Page 14.

[5] See UNEP Emission Gap Report 2013, Page xiii, UNEP GAP Report 2013

## 3.5 Background on different allocation approaches.

A large number of effort sharing approaches are discussed in the literature, summarized in five equity categories in IPCC AR5 WG3[6]. Given that IPCC AR5 results are only given for large regions, including the two regions OECD and EIT that the EU28 is a member of, the derivation of EU28 targets from the IPCC is not straightforward. In fact, given the diverse groupings (e.g. USA, Canada and Australia are in the same OECD group with some EU28 members) an appropriate derivation of EU28 targets requires to re-run effort sharing calculations with country-specific data for historical emissions, population, GDP etc. For most effort-sharing approaches, the EU 2030 targets relative to 1990 turn out to be nominally more ambitious compared to other OECD countries or EITs, given a certain part of grandfathering in most allocation approaches and the strong reductions in the EU28 between 1990 and 2010, as well as lower population trend in EU28 compared to other OECD members.

Given these complications, we re-ran three effort sharing approaches on a country-specific level to reflect the range of the literature (see Table 2). Namely:

(1) a **"per-capita convergence"** approach, in which all per-capita emissions linearly converge, except for those under the world average per—capita emission levels. Those countries are allowed to grow their emissions until they pass a prescribed level of world average per-capita allocations. Per-capita convergence approaches illustrate for the EU28 and other industrialised countries the lenient end of the spectrum, i.e. suggest relatively less ambitious reduction targets for high per-capita emitters compared to other effort sharing approaches.

(2) In addition, we examine one specific **"cumulative per-capita convergence"** approach, in which landuse $CO_2$ and other GHG emissions since 1950 are taken into account. The reason of choosing this allocation approach is that it illustrates a strong position by some newly industrialized countries such as China and Brazil, who speak in favour of taking into account historical emissions, either via its induced global mean temperature or simply via its cumulative sum. Note that if either landuse $CO_2$ emissions were excluded or an earlier starting year than 1950 were chosen, this approach would result in more stringent targets for the EU28 compared to those presented here.

(3) Lastly, we look at one implementation of the "**Greenhouse Development Rights**" approach. This approach is currently advocated by Environmental NGOs in the form of the Climate Equity Reference Calculator (see GDR Calculator). Note that our chosen implementation with annually updated indices and different baselines compared to the online calculator results in substantially less stringent targets for the EU28 region. When including landuse $CO_2$ and starting cumulative emissions from 1950 and otherwise using default settings in the online calculator the EU28 target for 2030 would be -175% (i.e. 100% stronger than the "-73%" shown in Table 1 above) for a so-called "weak 2°C "pathway (corresponding to the pathway shown in Figure 1 above).

(4) Lastly, we included a meshed approach to reflect the potential real-world setting that every country picks the approach that would result in the least reduction targets for that country, here called the "**Pick & Choose**" approach. In this scenario, the EU's 2030 target is chosen as the benchmark for other countries to act equivalently strong, where "equivalence" is defined for each country as the effort sharing approach out of the analysed three, which would allow that country the least stringent emission reduction.

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[6] See e.g. Figure 6.28 in IPCC AR5 WG3, where reductions are shown for 5 world regions, not for the EU28 though.

Table 2 – 2030 Global Reductions relative to 1990 for various combinations of Effort Sharing approaches and EU reductions. The Pick&Choose category shows global aggregate emissions, if all countries and regions pick their respective least ambitious approach of the examined three effort sharing approaches. The cells highlighted in blue would return global emissions by 2030 to 1990 levels[7]. Note that both the greenhouse development rights approach and the equal cumulative per capita approach were chosen with settings to show comparatively less stringent reductions for the EU28, but result still in substantially more ambitious targets for EU28 than per-capita convergence.

| **EU Reductions below 1990 by 2030** | **Pick & Choose** | **Greenhouse Development Rights** | **Equal Cumulative Per Capita (since 1950)** | **Per-Capita Convergence** |
|---|---|---|---|---|
| **-40%** | +49% | +42% | +23% | +15% |
| **-51%** | +36% | +29% | +10% | +0% |
| **-58%** | +28% | +19% | +0% | -12% |
| **-73%** | +11% | +0% | -15% | -35% |
| **-82%** | +0% | -12% | -25% | -48% |

[7] Source: Calculations with the PRIMAPDB model, developed at Potsdam Institute for Climate Impact Research and The University of Melbourne, using 10 samples per effort sharing approach with different parameter settings. The Equal Cumulative Per Capita Implementation considers GHG gases since 1950, including landuse $CO_2$ emissions.

## 3.6 What if EU does not go beyond 40% with additional support?

Without additional commitments by the EU, i.e. only a 40% domestic target, and assuming "comparable action" elsewhere, global emissions could be up to +49% above 1990 by 2030.

The EU was one of the first actors to set a 2030 target in preparation for the Paris 2015 agreement. Other nations could hence take the EU target as an example to formulate "equivalently" stringent emission reduction targets. "Equivalent" does not mean that all countries, like China, India, or the USA would do a nominal reduction of -40% below 1990. In the case of countries with much lower per-capita emissions, that would not be fair, as the EU with a relatively high GDP/capita and per-capita emissions well above the world average would have the responsibility and capability to act first and foremost – a principle often referred to in the international UNFCCC negotiations as "Common, but differentiated responsibilities and respective capabilities", i.e. CBDR&RC.

Thus, under the possible situation that the ambition level of the EU's target is taken as the yardstick to nationally determine contributions from countries all around the world, it can be expected that in every country a principle of fairness prevails at the end of the day that would allow that country the highest possible emissions. Other industrialised countries might – like the EU – find the per-capita convergence approach to be the most attractive, while those with historically low emissions (e.g. China) often proclaim the convergence of cumulative per-capita emissions to be fair – and hence could be expected to set their own targets accordingly. Specifically, China would set its target such that – under a cumulative per-capita approach – China's target would be fair compared to that of the EU (40% target by 2030).

This kind of setting is not unrealistic given the state of the international discussions, where the different countries' view on equity is very far apart and different actors claim very different approaches to be fair and equitable. The result is sobering. With a 40% reductions by the EU, world emissions would then likely to be +49% above 1990 levels by 2030.

Table 3 - Global Emissions in 2030 dependent on EU reductions by 2030, if other nations pick their respectively least stringent approach from either "per-capita convergence", "cumulative per capita" or "greenhouse development rights".

| **EU Reductions below 1990 by 2030** | **-40%** | **-45%** | **-50%** | **-55%** | **-60%** | **-82%** |
|---|---|---|---|---|---|---|
| **Global Emissions by 2030 rel. to 1990** | +49% | +43% | +37% | +31% | +25% | 0% |
| **Global Emissions by 2030 rel. to 2010** | +17% | +12% | +7% | +3% | -2% | -21% |

# 4 A 2060 $CO_2$ decarbonisation target

This chapter highlights options for a long-term decarbonisation target within the post-2020 climate change agreement, in particular a 2060 $CO_2$ phase-out target. Previous attempts to agree on a 2050 target of globally halved greenhouse gas emission were met with resistance from China, for example, who repeatedly stated that any global target would need to come with clarity on the regional/country-level responsibilities. Since then, new scientific insights emerged about the carbon budget and hence the inevitability of a complete phase-out of carbon emissions to halt global warming. This is reflected by numerous statements on carbon budgets and phase-out in the IPCC AR5 assessment report. All in all, decarbonisation targets seem to be a promising way forward to discuss long-term targets in the international UNFCCC climate negotiations.

**Box 1: Legal text options for a decarbonisation target within the Paris post-2020 agreement**

**Legal text.** A Paris post-2020 agreement could state something like:

- With a view to achieving the objective of Article 2 of the Convention, Parties agree that global greenhouse gas emissions need to **peak** by 2020 at the latest.
- Parties jointly commit to start the decarbonisation immediately, reducing **net** $CO_2$ **emissions** to zero until 2060 and phasing-out unabated **fossil fuels** $CO_2$ **emissions** by 2055.

*Alternative for 2nd Paragraph:*

- Parties jointly commit to reducing **net** $CO_2$ **emissions** to zero until 2060, while halting **deforestation** before 2020 and phasing-out unabated fossil fuels from the **energy supply sector** before 2040 or 2070 at the latest.

*In regard to greenhouse gases, the agreement could add:*

- Parties jointly commit to reducing **net greenhouse gas emissions towards zero by 2090** at the latest.
- Parties jointly commit to reducing **net greenhouse gas emissions by at least 50 % below 1990 levels by 2050** and towards zero by 2090 at the latest.

## 4.1 Multiple targets are consistent with each other.

As shown below, the following targets are not only consistent with each other, i.e. achievement of one target is supporting the achievement of another. They are as well consistent with the lower bound of the larger scenario literature, i.e. deemed to be technically feasible.

1) Phase-out energy & industry related global 'fossil fuel' $CO_2$ emissions by **2055**.
2) Phase-out net $CO_2$ emissions, i.e. including landuse, by **2060**.
3) **Halving of global GHG emissions** by 2050 below 1990 levels (or reducing by -40% to -70% below 2010) and lowering towards net-zero GHG emissions by end of the century, e.g. 2090.

In order to provide momentum for mitigation activities and direction for investment decisions worldwide, the new climate agreement should comprise both shorter and longer-term emission milestones, namely:

- a "before 2020" peaking year for global GHG emissions,
- 2025/2030 national contributions (potentially as well global "return to X by 2030" target),
- a 2050 target, e.g. global halved GHG emissions, and
- *a decarbonisation target*

Picking among those multiple consistent targets, will depend on the overall criteria that should be met**.** Long-term decarbonisation targets should be: (a) consistent with the 2°C target, (b) related to the IPCC AR5 findings, (c) easy to communicate, (d) creating momentum to direct long-term investment decisions.

There are three key advantages of phase-out/decarbonisation target:

1) **Clarity.** Decision makers and public have hard time to grasp many different percentages in many different years. A phase-out / ZERO target is very clear, and easy to communicate.
2) **Creating momentum.** More than any other long-term target type, a phase-out / zero target makes strategic investor decisions easier: There is no ambiguous signal of how much fossil fuel $CO_2$ emitting are still needed in the long-term: Zero.
3) **Circumventing equity cliff (somewhat)**. A decarbonisation milestone could potentially help to diffuse/circumvent equity questions that stalled a Copenhagen agreement on a global 2050 GHG reduction target, given that "sharing out zero emissions is zero for everyone" (to a first approximation). If regional specification is required, one could discuss regional differentiation in regard to the phase-out date

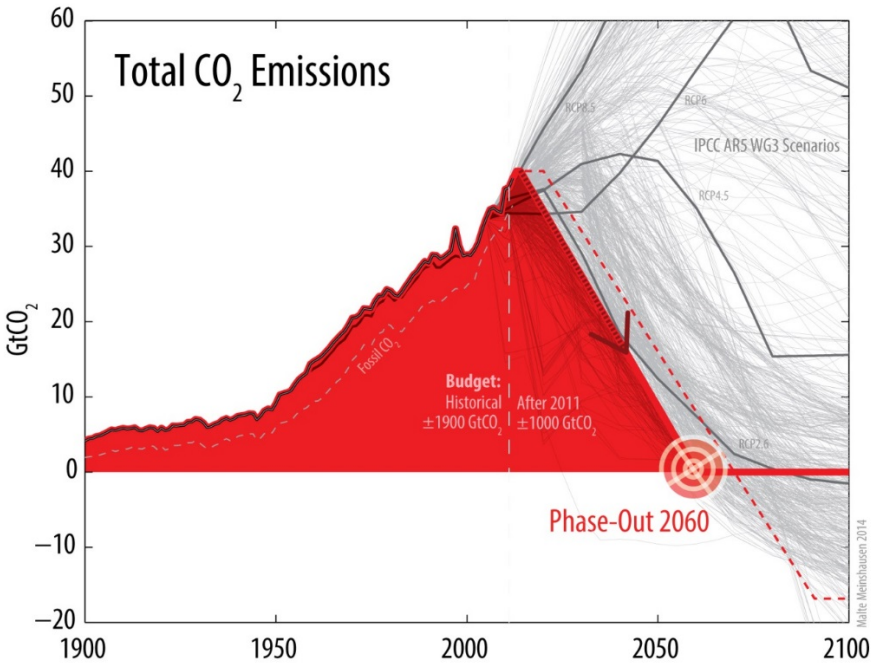


Figure 8 – The 2°C carbon budget (red area) and mitigation pathways. Historical $CO_2$ emissions (fossil, cement and landuse) up to 2011, future scenarios of the IPCC AR5 WG3 scenario database (thin grey lines) and RCP scenarios (dark grey lines). The 2900 $GtCO_2$ budget is split in an historical part (left from vertical white dashed line) and future budget (right red area). A linear phase-out target achievement from 2015 to 2060 for net $CO_2$ emissions would align a linear pathway with the RCP2.6 mitigation pathway until at least 2040 (large arrow)8. A delayed start of the phase-out pathway (until 2020) with a later phase-out date of 2070 would only obey the ~1000 $GtCO_2$ future budget, if substantially lower $CO_2$ emissions would follow after reaching net zero emissions (thing red dashed line).

[8] A 2060 phase-out date would imply slightly lower emissions than RCP2.6 from after 2040, but not imply negative emissions later in the 21st century. Aiming for a 2060 phase-out date would allow to revisit a new target after, e.g. 2040 in order to phase-out slightly later. Aiming for a later phase-out date right from the start would however most likely lead to too large cumulative emissions given the convex shape of the mitigation pathways.

## 4.2 The science is clear

There is however strong scientific underpinning for a "*carbon budget*" and a requirement for a "de-carbonisation / *full* $CO_2$ *phase out*". Staying within a carbon budget and achieving near-zero $CO_2$ emissions is a prerequisite to halt further warming. Without a phase-out of unabated fossil-fuel emissions and net zero $CO_2$ emissions, the climate system is going to continue to warm. To stay below 2°C warming, some $CO_2$ emissions, the so-called carbon budget, are still 'allowable' – with lower 'allowable' emissions (and less climate change impacts) for more ambitious climate targets (e.g. 1.5°C) and/or higher probabilities to achieve a 2°C target.

A GHG phase-out target would imply two complications that a $CO_2$ phase-out milestone would not have:

1) $CO_2$ **emissions can go to zero and negative, other greenhouse gases can't:** A phase-out of emissions is technically possible for $CO_2$ emissions (decarbonisation) and for example fluorinated gases. For agricultural sources of methane ($CH_4$) and nitrous oxide ($N_2O$), substantial emission levels remain by the end of the century even under the most stringent mitigation scenarios. Thus, total greenhouse gas emissions can only be reduced to net zero, by offsetting $CH_4$ and $N_2O$ emissions via negative $CO_2$ emissions.
2) **To halt further warming, science is clear about need for de*carbon*isation and** $CO_2$ **budget; not so, for other gases.** For non-$CO_2$ gases, a substantial reduction of emissions would technically be sufficient to halt global warming. That is because methane, for example, has a relatively short lifetime. Thus, the warming that is induced by methane emissions is related to the current emissions rate, rather than the cumulative emissions. Thus, strictly speaking, there is no "*greenhouse gas budget*" and no "*zero GHG emission*" requirement in order to halt further warming.

For simplicity, to offset higher near-term emissions and/or to guard against unforeseen feedbacks, a "*zero GHG emission target*" could be an option, though. Net $CO_2$ emissions uptake (via afforestation or biomass burning and subsequent carbon sequestration and storage, BECCS) could offset remainder non-$CO_2$ GHG emissions in their climate effect. Thus, all greenhouse gases can be summarized into a phase-out or zero emission target. Politically, this might have an advantage of simplicity. Many of the 2°C emission scenarios and almost all of those that would imply a 50%:50% chance of staying below 1.5°C by the end of the century imply zero or negative GHG emissions before the end of the century.

Various NGO and Think Tanks prepare their Paris 2015 messages around "deep decarbonisation pathways", "phase-out" and "decarbonisation", such as the Climate Action Network[9].

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[9] "Climate Action Network calls for phasing out all fossil fuel emissions and phasing in a 100% renewable energy future with sustainable energy access for all, as early as possible, but not later than 2050."

"While phasing out fossil fuel emissions is essential, deep cuts in all greenhouse gases are necessary. Any solution to the challenge of climate change must address the land sector, which produces a quarter of the world's annual greenhouse gas emissions – more than all the world's buildings and vehicles. To stabilize the climate while satisfying growing demand for food and other agricultural products, including ensuring livelihood of millions of small holder farmers, the world must protect and manage forests and promote sustainable agricultural practices so that they act as sinks rather than sources of emissions – sequestering more carbon than they release, as soon as possible, while sustaining the human communities and ecosystems that rely on them while ensuring food security across the world is not hampered with these efforts. As part of these efforts, zero deforestation must be achieved no later than 2020."

"The message is clear: the only direction for all GHG emissions to go is down, rapidly, starting with a complete phase out of fossil fuel emissions."

Climate Action Network Position Paper on long-term goal

The IPCC quantified the cumulative carbon budgets that are still 'allowable', if global warming is allowed to proceed beyond today's levels, but should halt below 2°C warming with a likely chance: Approximately 1010 $GtCO_2eq$ after 2011[10]. This can be easily translated into global phase-out targets for $CO_2$, both by using emission scenarios in the literature as well as straight line phase-out assumptions.

Table 4 - The carbon budget for a likely chance to stay below 2°C and cumulative emissions of stylized phase-out pathways that keep within this budget of total $CO_2$ emissions.

| | **Total Budget** | **Already used over 1870 to 2011** | **Remainder of Budget for 2011 to 2100** |
|---|---|---|---|
| 2°C Carbon Budget / IPCC AR5 Working Group I:[11] | 2900 $GtCO_2$ | 1890 (1630 to 2150) $GtCO_2$ | 1010 (750 to 1270) $GtCO_2$ |
| 2°C Carbon Budget / IPCC AR5 Working Group III: [12] | n/a | n/a | 630 to 1180 $GtCO_2$ |
| 2060 Phase-Out: Historical Emissions, last decadal growth rate 2002-2012 continued until 2013, then linear phase-out from 2015 to 2060, then net zero emissions. | 2910 $GtCO_2$ | 1890 $GtCO_2$ | 1020 $GtCO_2$ |
| 2070 Phase-Out, then negative: Historical Emissions, last decadal growth rate 2002-2012 continued until 2013, then constant until 2019, then linear phase-out from 2020 to 2070, with net negative emissions afterwards. | 2910 $GtCO_2$ | 1890 $GtCO_2$ | 1020 $GtCO_2$ |

[10] IPCC WG1 quantifies the carbon budget for staying below 2°C with a likely chance as 2900$GtCO_2$, of which 1890 (1630 to 2150) $GtCO_2$ were already emitted by 2011. This leaves a remaining carbon budget of 1010 (range 750 to 1270) $GtCO_2$ for years 2012 and later (see IPCC WG1 SPM AR5 page 25).

[11] See Page 25 of IPCC AR5 Summary for Policymakers WG1, re-printed in Appendix.

[12] See Table SPM.1 of IPCC AR5 Working Group III.

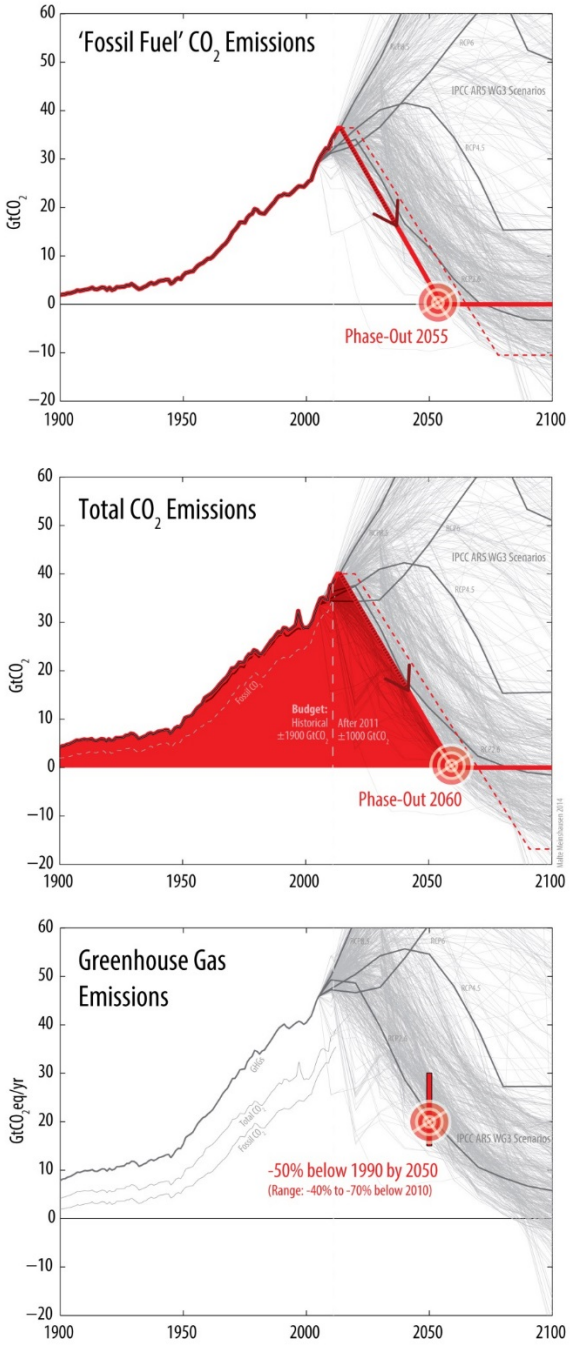


Figure 9 – Global milestones for energy & Industry related $CO_2$ emissions, i.e. fossil fuel, cement and potential negative energy related emissions (top panel), total $CO_2$ emissions, including landuse related emissions (middle panel), and total greenhouse gas emissions (bottom panel). Shown is the total $CO_2$ emission budget to stay below 2°C (red area in the middle panel), as well as emission phase-out dates for fossil fuel $CO_2$ emissions (2055), total $CO_2$ emissions (2060) and the milestone for greenhouse gas emissions of halved emissions by 2050 relative to 1990. In all three panels, more than 800 reference and mitigation scenarios from the IPCC AR5 WG3 scenario database are shown (thin grey lines) as well as the four RCP scenarios (darker grey lines). The only RCP scenario that has a likely chance to stay below 2°C is the lowest RCP2.6 scenario.

## 4.3 Advantages and disadvantages of elements of decarbonisation targets.

| Characteristic of Target | Potential advantage | Potential disadvantage |
|---|---|---|
| **Scope of Gases** | | |
| **$CO_2$-only** | • Strong scientific underpinning.<br>• Available IPCC quotes on decarbonisation and quantified carbon budgets.<br>• Focusses attention on most important and strongest growing greenhouse gas, i.e. $CO_2$. | • Not in line with Kyoto "GHG-basket" approach. |
| **All Greenhouse Gases** | • In line with Kyoto "GHG-basket" approach.<br>• A net "GHG phase-out / zero emission milestone" is scientifically robust, to stay below a climate target and then "restore" the climate again. | • "A GHG budget" is scientifically not robust given the limited lifetime of $CH_4$ etc.<br>• A "zero GHG emission" target could be misunderstood as all $CH_4$ and $N_2O$ emissions are meant to be fully phased out, which is impossible due to food production. |
| **Timeframe** | | |
| **2040** | • Aligned with the nearer-bound range (2040 to 2070) provided by IPCC WG3 AR5 in regard to the 90% phase-out of unabated fossil fuel emissions in the electricity sector. | • New date that has not been floated in UNFCCC so far. |
| **2050** | • Useful timeframe for long-term investor decisions.<br>• Aligned with long-term targets of nations. | • Combined with global total GHG, $CO_2$ emissions, a 2050 timeframe might be more stringent than required for 2°C and is outside the current scenario literature range |

| Characteristic of Target | Potential advantage | Potential disadvantage |
|---|---|---|
| **2055** | • Close to the lower bound of the scenario literature.<br>• If taken as target for fossil fuel $CO_2$, then this is consistent with a 2°C carbon budget, if 2011-2100 landuse $CO_2$ emissions are assumed to be ~220 $GtCO_2$ as in the RCP2.6 scenario | • Odd number. |
| **2060** | • If taken as $CO_2$ phase-out year, can have advantage of being "new" number in negotiations. After unsuccessful launch of 2050 number, the 2060 timeframe might be able to open new room for compromise. | • Not as nicely aligned with national long-term targets that are related to 2050, not 2060. |
| **2070** | • Aligned with the farther-bound range (2040 to 2070) provided by IPCC WG3 AR5 in regard to the 90% phase-out of unabated fossil fuel emissions in the electricity sector.<br>• Aligned with almost complete net $CO_2$ emission phase-out in the IPCC RCP2.6 scenario.<br>• Aligned with "linear-phase" out of $CO_2$ emissions and consistency with IPCC carbon budget for likely chance of staying below 2°C. | • For some medium-term investment decisions and the political attention span, maybe too far out.<br>• New date that has not been floated in UNFCCC so far. |

| Characteristic of Target | Potential advantage | Potential disadvantage |
|---|---|---|
| **2100** | • In line with Kyoto "GHG-basket" approach.<br>• A net "GHG phase-out / zero emission milestone" is scientifically robust, to stay below a climate target and then "restore" the climate again. | • "A GHG budget" is scientifically not robust given the limited lifetime of $CH_4$ etc.<br>• A "zero GHG emission" target could be misunderstood as all $CH_4$ and $N_2O$ emissions are meant to be fully phased out, which is impossible due to food production. |
| **Sectors** | | |
| **Total emissions** | • Same scope as with all current targets in UNFCCC | • Earlier phase-out dates could be named for specific sectors, if the target wasn't related to total national emissions. Therefore "total emission" phase out targets could diminish the weight of the phase-out's signal to investors. |
| **Electricity sector** | • In line with IPCC WG3 AR5: statement on 90% phase-out between 2040 and 2070 specifically refers to electricity sector. | • Potentially facing critique for being selective, i.e. undermining sovereignty of nations to decide of how to reduce their emissions. |
| **Fossil fuel burning** | • Slightly more general than just electricity generating sector. Advantage to include transport etc.<br>• Leaves more complicate land-use sector out, which could have a zero deforestation target much earlier than the fossil fuels… | • Potentially facing critique for being selective, i.e. undermining sovereignty of nations to decide of how to reduce their emissions. |

# 5 Conclusion

This research project investigated a number of critical 'numerical' issues within the development of the international climate regime.

The first part of the research project was dominated by strong focus on the surplus emission credits of the first commitment period, and how to minimize potentially detrimental impacts on the ambition level of the second commitment period of the Kyoto Protocol. Similarly, the research investigated how 'hot air' could be prevented in in future commitment periods. This contributed to research that underpinned the Art. 3.7ter, adopted in Doha, 2012. Art. 3.7ter specifies that future emission targets for industrialised countries cannot be above historical emission levels. If that Art. 3.7ter logic would be applied to the INDCs that are put on the table for the Paris COP21 climate conference, some countries would be affected, notably Russia (who voiced strong reservations against Art. 3.7ter, despite the fact that formally that Article had not applied to Russia yet and will not directly apply to Russia in the future given that the ruleset of the new regime is going to be different to the one of the Kyoto Protocol).

The second major investigation within this research project was focussed on a fair European post-2020 target level. The announced 40% target by the EU is a domestic target, which can be topped up by providing support for mitigation elsewhere. This research project looked at a number of different allocation frameworks that could provide an indication of the range of possible 'fair share' contributions from the EU. The bottom-line result is that even under the most favourable allocation regimes, the 'topping-up' of the domestic EU 40% target would have to be substantial. The total of domestic mitigation and international support would be closer to a 40% below 2010 target, or well more than 60% below 1990 levels.

The third focus of this research project related to a global phase-out target. The Paris agreement could entail such a long-term target, and the current UNFCCC negotiation text contains a number of text references in that regard. In preparation for the G7 Elmau summit as well as the Paris negotiations, this research project summarized and detailed a number of options. This included a clarification of GHG versus $CO_2$-only targets, the various timeframes, and whether a carbon phase-out target would apply to the power sector only or to all sectors.

# 6 Annex: World Emission Share Tool

As an example of the numerical work in the background of this research project, a World Emission Share calculator is provided, available at: Dropbox repository of World Emission Share Tool

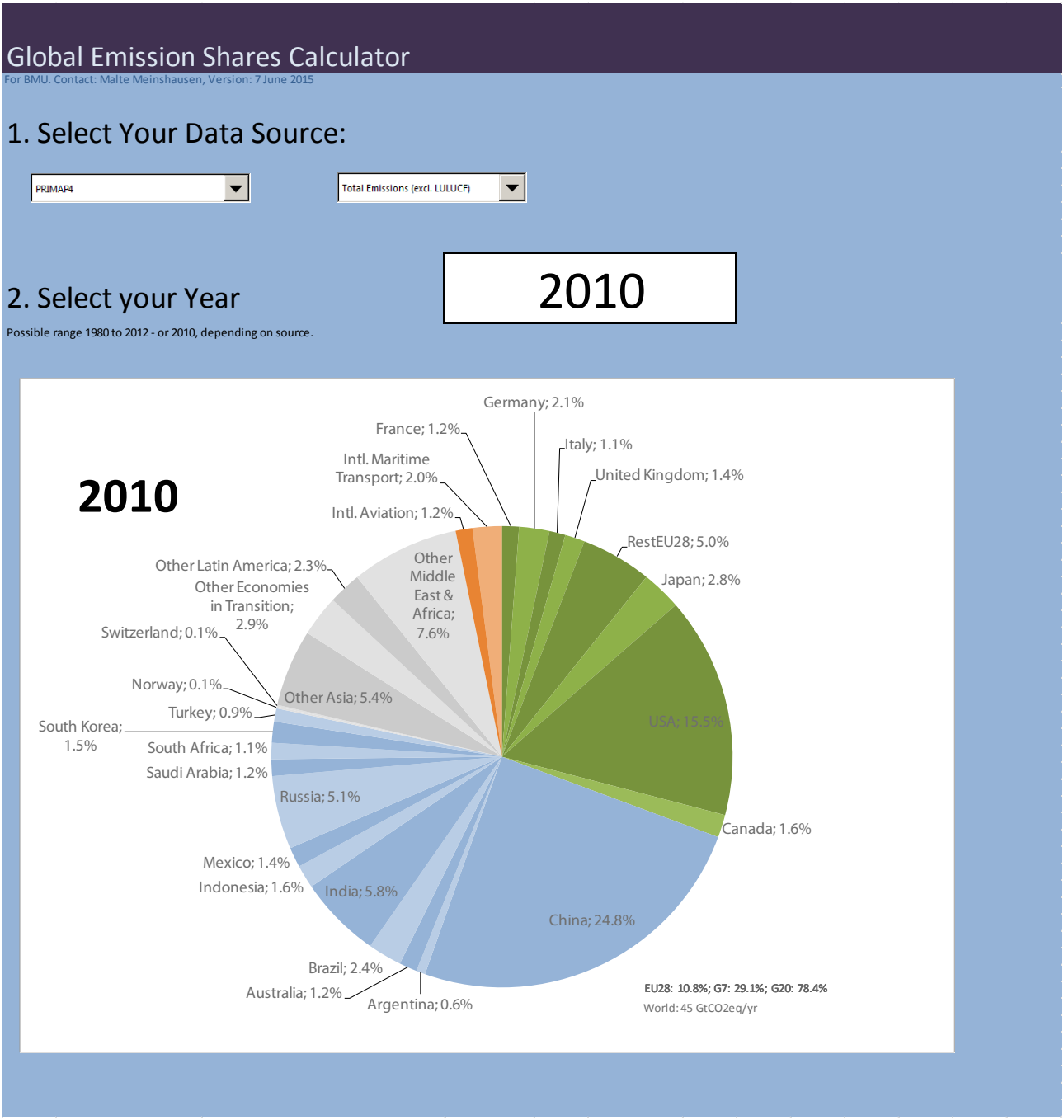


Figure 10 - Screenshot of the Global Emission Share Calculator.