# *Principle-based, comparable, Annex 1 targets*

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*"What's the point of taking your NAMA to a dry watering hole? " Yvo de Boer* [1]

## *Introduction*

CAN, at this point, has developed the basic framework of its position on A1 targets. The critical remaining piece to be decided is a set of concrete numbers: explicit, principle-based, "dual quantified" targets for Annex 1 countries, consisting of domestic mitigation obligations (DMOs) plus international mitigation obligations (IMOs). The primary goal of this study is to help CAN define such a set of targets.

We have been chartered by CAN's Mitigation Working Group to develop a set of such dual quantified targets for CAN's consideration, building upon the relevant existing CAN International positions, in particular its April 2009 position paper on the Annex 1 aggregate target. This position paper specifies that "developed countries have a dual quantified obligation to reduce emissions at home and support developing countries in their efforts to substantially deviate from business as usual emissions growth." And that these dual quantified obligations are to be derived from, on the one hand, "an aggregate reduction target of more than 40% by 2020 below 1990 levels," and on the other, "finance and technology to developing countries covering the agreed costs of their measurable, reportable and verifiable (MRV) nationally appropriate mitigation actions (NAMAs)."[2]

Our goal is to define such dual targets in a way that allows both the domestic and international side of national dual targets to be precisely quantified (a step which, incidentally, would help to identify and prevent "double counting") and, by so doing, to enable a meaningful and robust "comparability of effort."

There are two points worth drawing out at the start:

- Though CAN's stated positions have not explicitly done so, this analysis recognizes the distinction between Annex 1 Parties and Annex 2 Parties. Annex 1, of course, is the set of all developed country Parties. It is this set of countries (modified slightly) to which the Kyoto Protocol assigns "Quantified emission limitation and reduction commitments." Annex 2 is a subset[3] of Annex 1 that excludes the "economies in transition" and Turkey[4], i.e., the relatively poor nations among Annex 1. It is Annex 2 Parties that are bound by the following provisions of UNFCCC Article 4:
    - to "provide new and additional financial resources to meet the agreed full costs incurred by developing country Parties in complying with their obligations" [Article 4.3]
    - to "assist the developing country Parties that are particularly vulnerable to the adverse effects of climate change in meeting costs of adaptation to those adverse effects" [Article 4.4], and

- to "to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties, to enable them to implement the provisions of the Convention" [Article 4.5])

Consequently, we have interpreted CAN's position to mean that all Annex 1 countries are assigned DMOs as their just share of the 40% Annex 1 reduction, whereas IMOs are assigned only to Annex 2 countries.

- The results of our analysis may seem implausibly ambitious, since they imply efforts far beyond the level that Annex 1 countries have offered to take[5]. However, this is largely a consequence of scientific necessity , which of course implies positions that are, at the moment, politically unrealistic. Thus, *any* framework that would actually achieve a global peak in emissions in the next few years followed by a rapid decline to near-zero levels of emissions, would be seen as politically unrealistic. For comparison purposes, the final version of this report (post Copenhagen) will compare the results here (designed with a cumulative budget of 1000 $GtCO_2$ between 2000 and 2050, which Meinshausen assessed to present a 25% risk of exceeding 2°C) to those resulting from an even more stringent 350 ppm concentration target. For the moment, all we will say about the 350 results is that they will make the numbers below seem entirely tractable.

In sum, we seek to be consistent with the science, the provisions and principles of the UNFCCC, and the realities of the international impasse. To that end, we have focused on Annex 1 targets within a transitional "Copenhagen period," which we have modeled as a period that extends from 2010 until 2020. In practice, the Copenhagen transition will have to be mapped into formal commitment periods, but this is a matter that we have deferred. Our point is rather that there must be such a transition, that it must begin with a great deal of immediate action, and that, all told, it must enable the trust and momentum building necessary to move us, in 2020 if not before, into a principle-based, global regime.

## *Based on applying Greenhouse Development Rights in a "CAN compliant" way*

This study is based on the Greenhouse Development Rights (GDRs) approach, and is also designed to be "CAN compliant", in the sense of providing a useful analytical rubric and set of results that can directly contribute to CAN members' strategizing and campaigning.

We will not review GDRs in any detail here, save for two points:

- GDRs is a simple (but not "too simple") method of translating the UN notion of "common but differentiated responsibilities and respective capabilities" into quantified national obligations, using on an empirically-based indicator of national responsibility and capacity. It defines a Responsibility-Capacity Indicator (or RCI) such that national obligations do not reflect the comparatively small emissions and incomes of impoverished people who live below a "development threshold," And, critically, it does so in a manner that accounts for intra-national disparities in income and emissions.

- GDRs was initially designed as a principle-based effort-sharing approach for the *global* allocation of effort. For this analysis, for the period up to 2020, it is applied to Annex 1 countries alone. As explained later in more detail (see The Copenhagen Period, below) the rationale for this is not only CAN compliance, but also consistency with the UNFCCC and the Bali Action plan. This may serve as a necessary transitional solution before evolving to a period of global principle-based differentiation. During this period, the total global effort is presumed to be divided into three partitions, two of which are allocated on the basis of RCI-based effort-sharing.
    - Domestic mitigation obligations (DMOs), which are allocated to Annex 1 countries on the basis of their national RCI.

- International mitigation obligations (IMOs), which are allocated to Annex 2 countries on the basis of their national RCI.

- Unsupported action, which is undertaken voluntarily by non-Annex 1 countries.

Much more information about GDRs can be found at www.greenhousedevelopmentrights.org. See the publications section of the site for a variety of introductions, including, most exhaustively, the most recent (Dec 2008) edition of the GDRs book.

Note that the final version of this report (post Copenhagen) will feature a comparably rigorous and reproducible analysis of a historical-responsibility based resource-sharing system, and compare the results to such an analysis to those of the RCI-based effort sharing analysis contained here.

As for CAN compliance, it is sought in a number of ways, which are reviewed just below:

## *2°C and 350 ppm global pathways*

The focus of this analysis is a pathway consistent with the CAN International goal – "to limit warming to well below 2˚C with a high probability." To that end, again following the CAN International position, "a global peak in emissions shall be achieved within the next commitment period (2013-2017)". As these criteria are still indeterminate in terms of specifying a precise emission pathway, we have provided two possible interpretations of it. The first we refer to here as the "2°C pathway", the second the "350 ppm pathway". Both of these are arguable too weak, given the trends in the science. In any case, in this draft, our analysis is based on the 2°C pathway, and we will extend this analysis later to include the 350 ppm pathway.

- Our 2°C pathway is based on the results of the analysis by Meinshausen et al. (2009), which concluded that we can preserve a reasonable probability (about 75%) of keeping warming below 2°C, as long as cumulative $CO_2$ emissions between 2000 and 2050 are kept below 1000 gigatonnes of $CO_2$ and comparable reductions are made in non-$CO_2$ greenhouse gases.

- Our 350 ppm pathway (350 ppm $CO_2$, not $CO_2$e) is based on the work of Hansen et al. (2009), which presents a central case for a 350 ppm pathway with a $CO_2$ budget of about 750 gigatonnes between 2000 and 2050. (Note that Meinshausen hasn't yet calculated the temperature implications of this pathway, though we hope it can be done in the near future[6]. Note too that this pathway could, if we are unlucky, lead to more than 2°C of warming.)

Note that we've modified both Meinshausen's 2°C pathway and Hansen's 350 ppm $CO_2$ pathway. These modifications were necessary to take account of the 2007-2009 emissions drop that corresponded to the global "great recession." Note too that neither of these pathways is absolutely definitive. In both cases, variations are possible. However, the carbon budgets here are so limited that the mathematically allowable variations are really quite minor. In this sense, our pathways can, quite legitimately, be taken as representative.[7] Here are their details:

| | *350 ppm pathway* | *2°C pathway* |
|---|---|---|
| **Cumulative CO2 budget (2000 to 2050)** | 750 GtCO2 | 1000 GtCO2 |
| **Remaining CO2 budget ( 2010 to 2050)** | 420 GtCO2 | 670 GtCO2 |
| **Year of peak emissions** | 2011 | 2013 |
| **Peak emissions (as % above 1990 levels)** | 25 % | 27 % |
| **Time from peak to max rate of decline** | 5 years | 7 years |
| **2020 emissions (as a % below 1990)** | - 42 % | - 7 % |
| **2050 emissions (as a % below 1990)** | - 100 % | - 86 % |
| **Max annual rate of emissions decline** | - 10 % / yr | - 6 % / yr |
| **Risk of exceeding 2°C** | ?? | 25% |

**Table 1. The 350 ppm and 2°C pathways compared**

The difference between these two budgets – 250 gigatonnes $CO_2$ – might easily appear less important than it actually is. Obviously, this difference makes up a significant portion of the 1000 gigatonne, 2000 to 2050 2°C emissions budget. But even more to the point, it is a *very* significant fraction of the *total remaining* emissions budget, since approximately 330 gigatonnes of this 1000 gigatonne budget was consumed between 2000 and 2009. More bluntly, over this past decade, we've already consumed nearly one-third of the 21st Century's 2°C budget (330 out of 1000 gigatonnes $CO_2$) that was available, and nearly *half* of its 350 ppm budget (330 out of 750 gigatonnes $CO_2$).

Figure 1 shows the budget consumed between 2000-2009 (the grey area), the portion that remains to be emitted during the 2010-2050 period, relative to a 350 target (the red area), and the additional budget available during 2010-2050 if we accept the more risky goal of 2°C (the thin red line). And, for comparison, it also shows an emissions pathway based on the proposal put forward by the G8 governments to halve emissions by 2050. This "G8-style pathway" peaks shortly after 2020, sees emissions halving (relative to 1990 levels) by mid-century, and consumes, during the 2010-2050 period, a total of 1170 gigatonnes $CO_2$ – nearly three times the emissions that are permissible under the 350 pathway. It is clearly much less stringent than either the 350 ppm or 2°C pathways, and even though it is often presented as being consistent with a 2°C target, it in fact has a greater than 50% chance of blowing right past 2°C, based on the Meinshausen analysis. The more entrenched such definitions of the 2°C pathway become, the more they can be used to delay the mobilization that is actually needed by allowing emissions to rise for another decade or more. [8]

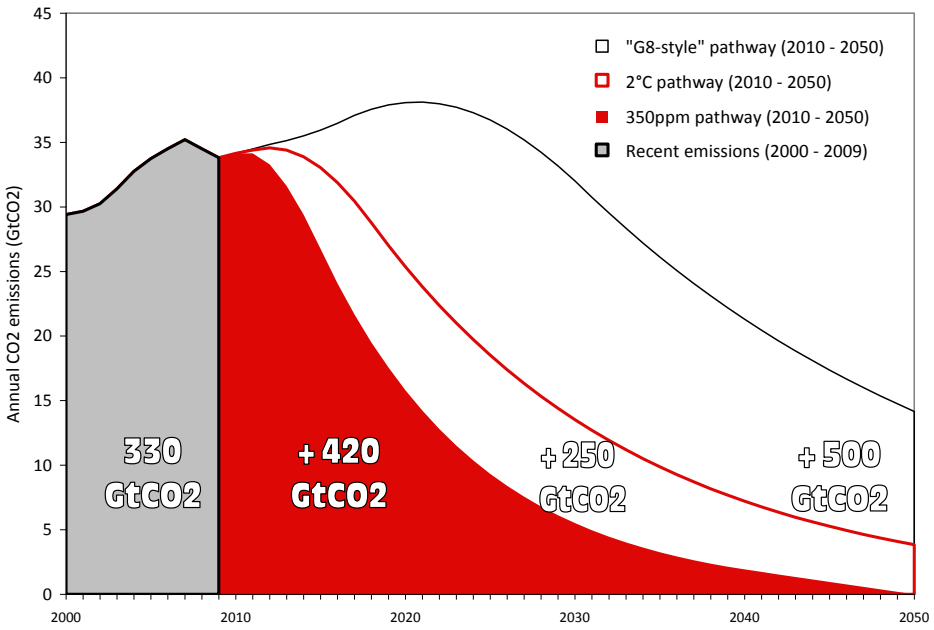


**Figure 1 shows the century's emissions to date (the grey area), the 350 pathway (the top of the red area), a 2°C pathway consistent a 75% chance of keeping warming below 2°C (the thin red line), and a "G8 style" pathway consistent with the proposal of the G8 nations to halve global emissions by 2050 (the thin black line). It also shows (the big numbers) the number of gigatonnes of $CO_2$ that each step in this sequence of ever less adequate targets would add to total cumulative emissions.**

## *Dual quantified targets*

CAN International, as noted above, has taken the position that

> "Developed countries have a dual quantified obligation to reduce emissions at home and support developing countries in their efforts to substantially deviate from business as usual emissions growth."

More specifically,

> "Developed countries must commit to delivering finance and technology to developing countries covering the agreed costs of their measurable, reportable and verifiable (MRV) nationally appropriate mitigation actions (NAMAs). These developed country commitments must be quantified, measurable, reportable and verifiable."

And...

> "The combination of MRV-supported NAMAs and autonomous mitigation actions in developing countries according to their capacities should lead to a substantial deviation from business as usual emissions growth. "

This position is based on a view of the obligations of Annex 1 countries, particularly as rooted in Article 4 of the UNFCCC. But it is also – and more decisively – based on the fundamental reality of the climate crisis. This reality, as we all know, is one in which we confront the climate crisis as a profoundly divided society that must simultaneously grapple with a development crisis – to the point where we cannot hope to stabilize the climate if, at the same time, we are closing the path to prosperity and sufficiency for the world's poor. More specifically, given that the majority of mitigation efforts needed to stabilize the climate must occur in the South, these must be made in a manner that, at a minimum, does not undermine development.

Figure 2 makes the implications of this situation clear.

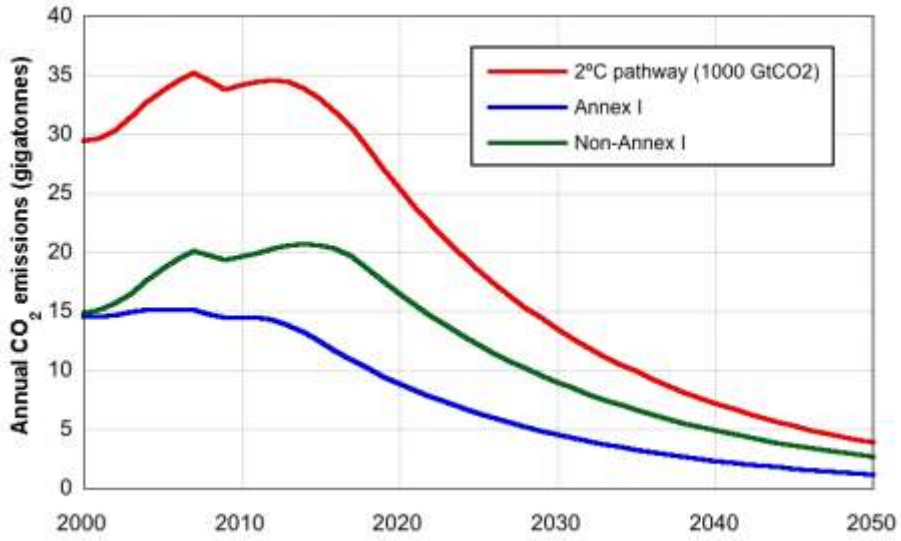


**Figure 2. The red line shows the global 2°C pathway, the blue line shows wealthy world (Annex 1) emissions declining by 40% below 1990 levels by 2020, and by 95% by 2050. The green line shows, by subtraction, the severely limited emissions space that would remain for the developing countries.**

Figure 2 shows the same 2°C pathway (the red solid line) as is shown in Figure 1. It also reveals the portion of that budget that developed countries would consume (along the blue emissions path) – assuming they undertake mitigation efforts sufficient to cut emissions 40% between now and 2020, continue to reduce their emissions by approximately 6% annually in the ensuing decades, reaching 95% below 1990 levels by 2050. Such efforts would of course be well beyond the Annex 1 reduction pledges currently on the negotiating table.

But would they be enough? Simple subtraction[9] gives us the emission pathway (the green line) that would, in this future, be available to the rest of the world (i.e., the developing world). This pathway implies extraordinarily ambitious reductions in the South. Its emissions would need to peak by 2015, fall 15% from today's levels by 2020, continue dropping by about 6% each year in the decades following, and reach 85% below today's levels by 2050. But, very much in contrast to the North, all this would have to happen while, at the same time, the majority of the South's citizens were either struggling out of poverty or (often desperately) seeking a meaningful improvement in their standards of living.

The tension between climate protection and expanding access to energy services arises from the fact that the only *proven* routes up from poverty still involve an expanded use of energy and, consequently, a seemingly inevitable increase in carbon emissions. Indeed, in the absence of environmental constraints, emissions in the South would certainly rise much more rapidly than the North's, as the South's citizens finally gained access to the energy services, built the infrastructure that they've so long needed, and, hopefully, moved toward some sort of parity in well-being with the citizens of the North. Which is exactly why it is so difficult for the people of the South to imagine an equitable future in a sharply carbon-constrained world. To be blunt – the South is deeply and *justifiably* concerned that an inequitable climate regime will force a choice between development and climate protection.

The paths in Figure 2 show emission cuts occurring at comparable rates in the North and the South. By doing so, they depict a 2030 world in which the typical northerner would still consume carbon at nearly three times the pace

of the typical southerner. All told, Figure 2 depicts a future in which the developed countries – with a fifth of the world's population – consume more than a third of the remaining, quickly vanishing global emissions budget. And do so despite being already responsible for the vast majority of past emissions, and – not coincidentally – controlling most of the world's advanced infrastructure and three-quarters of its income, and thus enjoying a far greater ability to manage a rapid greenhouse transition. In fact, to be very clear about the still largely unappreciated implications of this situation, it's pretty obvious that an alternative apportioning of the remaining budget – in which northern emissions declined even more quickly than is shown here – would probably be more plausible, in raw technical and developmental terms, for they would allow a larger share of the very limited remaining emissions budget to be consumed in the South, which needs that budget much, much more than the North.

In all this, the underlying problem is of course that little of the global carbon budget remains. Regardless of how the residual budget is apportioned, there is no future scenario in which the South has sufficient space to avoid a rapid decarbonization transition that, in anything like a business-as-usual world, threatens its prospects for development. Thus, the only way to secure its enthusiastic engagement (the only kind that will work) is to ensure that it has the assistance necessary to support a transition that, while being rapid and comprehensive, nevertheless allows human development to continue unimpeded. Nor is this a novel conclusion, unique to this analysis; it underlies the UNFCCC commitment by developed countries to provide finance and technological support to developing countries, and the NGO call for the developed countries to take on "international mitigation obligations" that are just as prominent, official, and legally binding as their domestic mitigation obligations.

In this context, the point is clear. As a civilization, we have the money and technology needed to negotiate a successful climate transition (properly considered, it wouldn't even be expensive, at least not compared to the alternative), but most of that money and technology is still in the North. The implication, and we admit it's a challenging one, is that even in this world of nations, the mitigation burden really is a shared global one. In taking a fair share of that burden, an Annex 1 country – or more precisely an Annex 2 country – takes a share of a global burden, a total, dual target that is generally, and properly, too large to be satisfied within its own borders. To be absolutely clear: northern targets of the appropriate magnitude can only be met by a combination of ambitious domestic mitigation and consensual, collaborative support for international mitigation. This rather implacable fact, moreover, is fundamental, and reflects the structural reality of the situation – if the climate crisis is to be successfully managed, the wealthy countries must both reduce their own emissions and provide the international support necessary to drive a rapid global climate transition.

## *The Copenhagen period (modeled here as a 2010 to 2020 transition)*

Accordingly, in the coming "Copenhagen period", options are quite constrained. Consistency with the UNFCCC and the Bali Action Plan – as well as the political and ethical structure of the situation – demands that legally binding targets (for both domestic mitigation and support for international mitigation) be assigned to Annex 1 countries alone. This doesn't mean that the non-Annex 1 countries won't be meaningfully engaged; as the implacable mathematics of the carbon budget demands, the South will be ground-zero for the massive redefinition of development that is now so absolutely necessary. That the South must at the same time rely on the financial and technological resources of the North does not by any means imply that its commitments – in human capital and political resources – are any smaller, or that it will not be bearing the considerable risks of embarking on an as-yet unproven path that marries radical decarbonization to human development. Moreover, the South has clearly shown that it is willing to commit its own resources to this low-carbon transition. (See Table 2, below).

None of this is to say that legally binding non-Annex 1 countries commitments might not soon be legitimate, and even necessary. It is certainly the case that sustaining a global mobilization to combat climate change will require that we evolve beyond the static Annex 1/non-Annex 1 divide, to a system of equitable burden-sharing based on global principle-based differentiation, and the sooner the better. But before this is possible, we must, for all the

reasons discussed above, negotiate a transition based on legally binding Annex 1 commitments, along with aggressive non-Annex 1 collaboration and voluntary actions. Once the viability of a path that simultaneously advances human development and climate protection can be proven, the climate regime can enter a phase of global differentiation and legally binding commitments for all countries.

Thus, in this analysis, we focus on the Copenhagen phase, explicitly recognize non-Annex 1 voluntary unsupported actions, and define Annex 1 commitments as follows:

- The Annex 1 Domestic Mitigation Obligation is calculated as follows:
    - First, the total mitigation requirement corresponding to the aggregate Annex 1 target (40% below 1990 emissions) is calculated. The 40% target is assumed to be a "bright line" minimum – it is not offsetable through reductions in non-Annex I countries, and must be wholly discharged through domestic mitigation.
    - Then, this aggregate mitigation requirement is allocated to each Annex 1 country in proportion to its RCI (Responsibility and Capacity index).
- The Non-Annex 1 International mitigation Obligation is calculated as follows:
    - First, ***Voluntary unsupported mitigation*** of Non-Annex 1 countries is estimated on the basis of publically tabled voluntary mitigation plans, as tabulated by Climate Analytics and EcoFys at www.climateactiontracker.org. If no such estimate is available for a given non-Annex 1 country, we assume here it voluntarily exploits half of its (coarsely-estimated) no-regrets mitigation potential. [10]
    - Then, ***Supported mitigation*** is calculated as the total mitigation required in non-Annex 1 countries, minus the estimated Voluntary mitigation. This, in the language of Bali, would be achieved through NAMAs with MRV financial and technological support from Annex 2 countries. The IMO for each Annex 2 country is calculated by allocating the total supported mitigation in proportion to its RCI).

It's useful to look at this graphically:

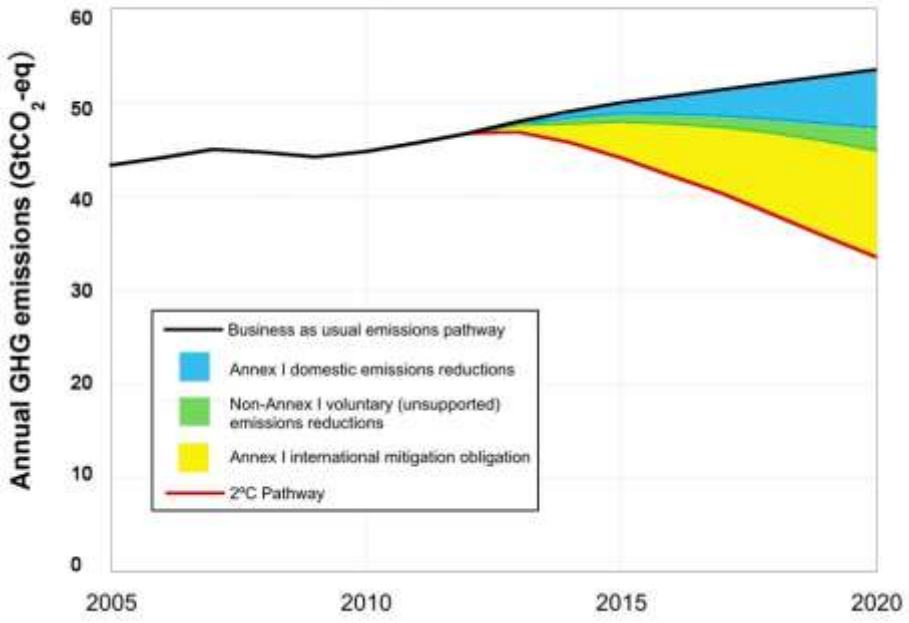


**Figure 3. BAU emissions in GtCO2 (black line), along with three types of reductions (1) domestic reduction in Annex 1 countries (in blue), (2) unsupported non-Annex 1 voluntary reductions (as estimated by Climate Action Tracker), and (3) non-Annex 1 reductions supported by international mitigation obligations for Annex 2 countries.**

It's also useful to look at this "big picture" in table form. These calculations are done for 2020, against an updated (2009, and thus post-recession) IEA BAU trajectory. Again, the Annex 1 target is 40% (below 1990), which amounts to about 6 GtCO2 of reductions, out of a total of 20 GtCO2 required to reach the 2°C pathway. That leaves nearly 14 GtCO2 of reductions in developing countries, given the overall global emissions budget defined by the 2°C pathway. This distribution of mitigation actions is the direct result of assuming an aggregate 40% Annex 1 domestic mitigation obligation; whether this is an optimal distribution of mitigation, is unclear, given the rate at which developing countries must expand energy services in order to combat poverty.

| | **Annex 1** | **Non-Annex** | **Global** |
|---|---|---|---|
| Emissions in 1990 | 17441 | 18509 | 35950 |
| Business as usual emissions in 2020 (IEA WEO-2009) | 16377 | 37069 | 53446 |
| | | | |
| Annex 1 Domestic reductions (to reach 40% below 1990) | - 5912 | | - 6057 |
| Non-Annex 1 Voluntary reductions (unsupported) | | - 2454 | - 2454 |
| Annex 2 International mitigation obligation (reductions occur in non-Annex 1) | | - 11367 | - 11367 |
| ***Total reductions required to reach 2°C pathway*** | ***- 6057*** | ***-13821*** | ***-19878*** |
| | | | |
| Emissions in 2020 | 10465 | 23049 | 33513 |
| Emissions in 2020 (percent below BAU) | - 36% | - 38% | - 37% |

**Table 2. BAU emissions and emissions consistent with the 2°C pathway in 2020 (MtCO2-e), along with associated Annex 1 dual quantified obligations and Non-Annex 1 voluntary reductions (as per Climate Action Tracker). Annex 1 obligations are separated into domestic mitigation obligations (for all Annex 1 countries) and international mitigation obligations (for Annex 2 countries) to support reductions in non-Annex 1 countries).**

Note, in all this, that different countries will at different times and under different circumstance apportion different fractions of their efforts within – and outside – their own territories. They will in some cases allocate more resources to domestic decarbonization and in the other cases concentrate on supporting decarbonization in the developing world. But in any event, and despite all variance of circumstance, it is the sum of a country's efforts that, finally, will determine if it's pulling its own weight. It is certainly, and irreducibly, only with respect to that sum that "comparability of effort" can have any coherent meaning.

Also, and finally, none of this is to imply that scepticism about offsetting should or will disappear. But today's concerns about double counting and supplementarity are impelled, more than anything else, by the altogether inadequate level of Annex 1 ambition. They would be far less pressing under the scenario being considered here, one in which mitigation targets are actually set at an appropriate level of stringency. Indeed, all real 2°C pathways involve a great deal of mitigation in both the North and the South. In this context, offsets (properly managed and limited) would no longer be loopholes to be closed off, but rather a means – one among others, and subsidiary to public finance – by which the wealthy world can meet its dual obligation.

## *Preliminary Results: Annex 1 Domestic Mitigation Obligations and Annex 2 International Mitigation Obligations*

The main results of this analysis, of course, are national targets. Here we show the high-level results, on both the domestic mitigation and international mitigation sides. A complete listing can be found in the appendix.

The CAN International "Position on an Annex I aggregate target" states that "Developed countries must adopt an aggregate reduction target of more than 40% by 2020 below 1990 levels. National targets (domestic mitigation obligations, or DMOs) are to be derived from this aggregate target." This aggregate domestic target, which we as a hard 40%, amounts to a slightly more than 6 $GtCO_2$ of overall Annex 1 domestic mitigation obligations (see Table 2). National DMOs are then simply defined as shares of this 6 $GtCO_2$, and assigned to all Annex 1 countries in proportion to their RCI. The assumption here is that trading *within* Annex 1 will be unrestricted, and will serve to equalize the marginal cost of abatement across the "Annex 1 bubble." (For comparison, Appendix B introduces an alternative approach, in which the ClimStrat tool, using marginal cost curves from a particular techno-economic model – POLES – is used to estimate the costs in each country of achieving the 6 $GtCO_2$ of Annex 1 reductions. When this method is fully implemented, DMOs will be assigned to Annex 1 countries such that mitigation *costs* – rather than mitigation tons -- are proportional to their RCIs.)

Similarly, national IMOs are defined as a share of the total supported reduction needed in non-Annex 1 countries, which comes to somewhat more than 11 $GtCO_2$ (see Table 2) and assigned to Annex 2 countries on the basis of their RCI. The dual target is shown as the sum of these two obligations, in tons, though in practice (see below) the IMO is better expressed in cash terms.

| Country or region | Emissions in 1990 | BAU in 2020 | Share of RCI in 2020 | DMO | Domestic target as reduction relative to 1990 | IMO | Dual obligation | Dual target as reduction relative to 1990 |
|---|---|---|---|---|---|---|---|---|
| | MtCO2e | MtCO2e | % | MtCO2e | % | MtCO2e | MtCO2e | % |
| **EU 27** | **5214** | **4417** | **30.8%** | **-1863** | **-51%** | **-3469** | **-5333** | **-118%** |
| New Member | 1220 | 980 | 3.1% | -187 | -35% | 0 | -187 | -35% |
| EU 15 | 3993 | 3437 | 27.7% | -1676 | -56% | -3469 | -5145 | -143% |
| **Other Annex II** | **8024** | **9127** | **63.1%** | **-3815** | **-34%** | **-7898** | **-11713** | **-132%** |
| Australia | 438 | 557 | 2.3% | -142 | -5% | -295 | -437 | -73% |
| Canada | 625 | 827 | 3.9% | -238 | -6% | -493 | -730 | -85% |
| Iceland | 3 | 3 | 0.0% | -2 | -54% | -4 | -5 | -171% |
| Japan | 1218 | 1164 | 11.9% | -736 | -65% | -1527 | -2262 | -190% |
| New Zealand | 63 | 82 | 0.3% | -18 | 2% | -38 | -56 | -59% |
| Norway | 43 | 54 | 0.5% | -33 | -50% | -69 | -101 | -209% |
| Switzerland | 51 | 43 | 0.6% | -39 | -92% | -82 | -121 | -253% |
| United States | 5584 | 6396 | 42.2% | -2600 | -32% | -5391 | -7991 | -129% |
| **Other Non Annex II** | **4203** | **2833** | **6.1%** | **-377** | **-42%** | **0** | **-377** | **-42%** |
| Belarus | 134 | 93 | 0.1% | -9 | -38% | 0 | -9 | -38% |
| Croatia | 33 | 32 | 0.1% | -7 | -25% | 0 | -7 | -25% |
| Russia | 3142 | 2259 | 3.8% | -334 | -39% | 0 | -334 | -39% |
| Ukraine | 894 | 450 | 0.4% | -33 | -53% | 0 | -33 | -53% |
| **All Annex I** | **17441** | **16377** | **100%** | **-6057** | **-40%** | **-11367** | **-17425** | **-106%** |

**Table 3. Dual quantified obligations for Annex I countries, showing EU aggregates only (see appendix for table including all EU countries).**

It is worth pointing out that the reduction requirement (of 6 GtCO2 in Annex 1 and 14 GtCO2 in non-Annex 1 in 2020) is a measure of total mitigation effort relative to a reference emission trajectory that reflects a no-climate-policy situation. For the purposes of this analysis, we take the IEA's WEO-2009 business-as-usual scenario as our reference trajectory, as a reasonable proxy, but by no means a definitive one. Correspondingly, when a domestic target is calculated for a country, it is calculated by subtracting the country's DMO from its reference emissions level.

In keeping with tradition, we express the domestic target as a percent reduction below 1990 emissions in the above table. This approach explains some of the quirkiness in the domestic targets, which range from *minus* 92% for Switzerland to *plus* 2% for New Zealand. This reflects the fact that emissions below 1990 are a less useful measure of effort than reductions relative to a reference trajectory. Thus, even countries such as New Zealand that appear to be getting "off the hook" still need to engage in significant domestic mitigation efforts because of their high reference emissions in 2020. Moreover, it also has an IMO of 38 MtCO2-e **in addition to** its DMO of 18 MtCO2-e, and it is the sum of the two that constitutes its real mitigation obligation. (It would be free, of course, to reduce its IMO by mitigating even more domestically.)

## *International mitigation obligations — in financial terms*

In this spirit, we've calculated Annex 1 IMOs that are consistent with assuming a 40% aggregate Annex 1 target, implying the remainder of the reductions needed for the 2°C emissions pathway would need to be made within the non-Annex 1 countries. Initially, we've expressed these IMOs in terms of tons to be mitigated. This, however, is only one way of looking at IMOs. The real point of this exercise is to estimate the financial resources that Annex 1 countries should commit to providing for non-Annex 1 mitigation, by converting the IMOs into a financial quantity. To that end, in Table 4 we show results for three figures for average mitigation costs -- $20 per ton, $50 per ton, and $100 per ton. (Note, these are just meant as indicative figures, not our own estimates of expected average costs.)

| **Country or Region** | **Domestic Reductions below 2020 BAU** | **International Mitigation Obligation in 2020** | **International Mitigation Obligation in 2020 @ $20/ton CO2e** | **International Mitigation Obligation in 2020 @ $50/ton CO2e** | **International Mitigation Obligation in 2020 @ $100/ton CO2e** |
|---|---|---|---|---|---|
| | $MtCO_2e$ | $MtCO_2e$ | $US Billions | $US Billions | $US Billions |
| EU 15 | -1676 | -3469 | 69 | 173 | 347 |
| Australia | -142 | -295 | 6 | 15 | 29 |
| Canada | -238 | -493 | 10 | 25 | 49 |
| Iceland | -2 | -4 | 0 | 0 | 0 |
| Japan | -736 | -1527 | 31 | 76 | 153 |
| New Zealand | -18 | -38 | 1 | 2 | 4 |
| Norway | -33 | -69 | 1 | 3 | 7 |
| Switzerland | -39 | -82 | 2 | 4 | 8 |
| United States | -2600 | -5391 | 108 | 270 | 539 |
| **Total Annex II** | **-5680** | **-11367** | **227** | **568** | **1137** |

**Table 4: Domestic Reductions and international mitigation obligation in tons for Annex 2 countries, plus cost estimates for international mitigation obligations at three plausible average costs per ton of mitigation in 2020.**

Finally, note that the CAN Finance position posits a reference mitigation need of $100 billion in public money in 2020. But if the mitigation gap is as large as we estimate it to be – given our BAU and global emissions budget assumptions – this would imply an average cost of mitigation of about 11.5 dollars per ton in 2020. We consider this to be an implausibly low figure.

## *Conclusions*

The Copenhagen accord will be an utter failure if it does not support a real prompt start and an early, sustainable, global emissions peak. But that's just the beginning of what must be accomplished during the Copenhagen period. The further problem is trust building, between North and South and within civil society, and beyond trust building, a proof of concept in which it is actually shown that rapid mitigation can be achieved while at the same time preserving, and even bettering, the human development prospects of the poor.

2020 is only a decade away. But it is not impossible to imagine that, given a provisional success in Copenhagen, the necessary further steps will become possible in time. The analysis here is intended to illuminate these steps, and by so doing to reduce the chances of calamity. The finance problem is not going to go away.

## *The post-Copenhagen challenge*

Cost estimates for true adequacy are converging on large but manageable numbers. It is time to begin looking ahead to the necessity of defensible comparability system, if we intend to achieve true adequacy. In any case,

principle-based A1 comparability appears to be a pre-requisite for a successful sequencing transition, and we'll be a lot better off if it is defined to include a development threshold.

# *Appendix A*

## *2020 DMOs for Annex 1 countries.*

| Country | emissions in 1990 | Share of RCI in 2020 | BAU in 2020 | DMO in 2020 | As reduction relative to 1990 | As reduction relative to 2005 | As reduction relative to 2020 BAU |
|---|---|---|---|---|---|---|---|
| | MtCO2-e | % | MtCO2-e | MtCO2-e | % | % | % |
| Austria | 74.1 | 0.6% | 77 | 39 | -49% | -57% | -51% |
| Belgium | 124.8 | 0.8% | 108 | 51 | -54% | -53% | -47% |
| Denmark | 66.1 | 0.5% | 54 | 32 | -67% | -64% | -60% |
| Finland | 64.3 | 0.5% | 58 | 27 | -53% | -53% | -47% |
| France | 529.9 | 4.2% | 475 | 257 | -59% | -58% | -54% |
| Germany | 1176.8 | 6.6% | 806 | 399 | -65% | -55% | -49% |
| Greece | 92.3 | 0.6% | 105 | 39 | -28% | -43% | -37% |
| Ireland | 52.4 | 0.4% | 56 | 25 | -41% | -52% | -45% |
| Italy | 476.0 | 3.6% | 480 | 218 | -45% | -51% | -45% |
| Luxembourg | 10.9 | 0.1% | 11 | 5 | -46% | -53% | -48% |
| Netherlands | 192.0 | 1.3% | 142 | 80 | -68% | -62% | -57% |
| Portugal | 53.9 | 0.4% | 70 | 23 | -12% | -39% | -33% |
| Spain | 265.0 | 2.2% | 372 | 135 | -11% | -42% | -36% |
| Sweden | 65.2 | 0.7% | 56 | 43 | -79% | -78% | -76% |
| United Kingdom | 749.7 | 5.0% | 566 | 305 | -65% | -60% | -54% |
| **Total EU 15** | **3993** | **27.7%** | **3437** | **1679** | **-56%** | **-55%** | **-49%** |
| | | | | | | | |
| Bulgaria | 104.4 | 0.2% | 91 | 10 | -22% | 37% | -11% |
| Czech Republic | 191.9 | 0.6% | 141 | 34 | -44% | -23% | -24% |
| Estonia | 33.7 | 0.1% | 23 | 4 | -45% | -18% | -19% |
| Hungary | 84.5 | 0.3% | 77 | 19 | -32% | -23% | -25% |
| Latvia | 21.9 | 0.1% | 14 | 3 | -52% | -16% | -23% |
| Lithuania | 37.7 | 0.1% | 26 | 6 | -45% | -16% | -21% |
| Poland | 431.5 | 1.2% | 385 | 73 | -28% | -16% | -19% |
| Romania | 229.8 | 0.3% | 153 | 19 | -42% | 0% | -12% |
| Slovakia | 63.6 | 0.2% | 50 | 10 | -38% | -17% | -21% |
| Slovenia | 21.9 | 0.1% | 20 | 7 | -39% | -31% | -34% |
| **Total EU 12** | **1221** | 3.1% | **980** | **185** | **-35%** | **-21%** | **-19%** |
| **Total EU 27** | **5214** | **30.8%** | **4417** | **1864** | **-51%** | **-48%** | **-42%** |
| | | | | | | | |
| Australia | 437.6 | 2.3% | 557 | 142 | -5% | -20% | -26% |
| Canada | 625.4 | 3.9% | 827 | 238 | -6% | -21% | -29% |
| Iceland | 3.3 | 0.0% | 3 | 2 | -55% | -51% | -55% |
| Japan | 1218.0 | 12.2% | 1164 | 740 | -65% | -67% | -64% |
| New Zealand | 62.6 | 0.3% | 82 | 18 | 2% | -13% | -22% |
| Norway | 43.0 | 0.5% | 54 | 33 | -51% | -66% | -61% |
| Switzerland | 50.7 | 0.7% | 43 | 40 | -93% | -92% | -91% |
| United States | 5583.8 | 43.0% | 6396 | 2610 | -32% | -42% | -41% |
| **Other Annex 2** | **13238** | **63.0%** | **9127** | **5687** | **-34%** | **-43%** | **-42%** |

| Country | emissions in 1990 | Share of RCI in 2020 | BAU in 2020 | DMO in 2020 | As reduction relative to 1990 | As reduction relative to 2005 | As reduction relative to 2020 BAU |
|---|---|---|---|---|---|---|---|
| | MtCO2-e | % | MtCO2-e | MtCO2-e | % | % | % |
| Belarus | 133.7 | 0.2% | 93 | 9 | -37% | -5% | -10% |
| Croatia | 32.9 | 0.1% | 32 | 7 | -24% | -16% | -21% |
| Russia | 3142.1 | 5.4% | 2259 | 323 | -38% | -10% | -14% |
| Ukraine | 894.4 | 0.5% | 450 | 32 | -53% | -2% | -7% |
| **Other Non Annex 2** | **4203** | 6.2% | **2833** | **371** | **-41%** | **-9%** | **-13%** |
| **ALL A1** | **17441** | 100% | **16377** | **6057** | **-40%** | **-39%** | **-37%** |

**Table A1: Domestic mitigation obligations in 2020 for all Annex I countries (excluding Turkey).**

## *2020 Dual obligations for Annex 2 countries.*

| Country or region | Emissions in 1990 | BAU in 2020 | Share of RCI in 2020 | DMO | Domestic target as reduction relative to 1990 | IMO | Dual obligation | Dual target as reduction relative to 1990 |
|---|---|---|---|---|---|---|---|---|
| | MtCO2e | MtCO2e | % | MtCO2e | % | MtCO2e | MtCO2e | % |
| Austria | 74.1 | 77 | 0.7% | 39 | -49% | 81 | 120 | -158% |
| Belgium | 124.8 | 108 | 0.9% | 51 | -54% | 105 | 156 | -138% |
| Denmark | 66.1 | 54 | 0.6% | 32 | -67% | 66 | 98 | -167% |
| Finland | 64.3 | 58 | 0.5% | 27 | -53% | 57 | 84 | -141% |
| France | 529.9 | 475 | 4.7% | 256 | -59% | 531 | 787 | -159% |
| Germany | 1176.8 | 806 | 7.2% | 398 | -65% | 824 | 1222 | -135% |
| Greece | 92.3 | 105 | 0.7% | 39 | -28% | 81 | 120 | -116% |
| Ireland | 52.4 | 56 | 0.5% | 25 | -41% | 52 | 77 | -140% |
| Italy | 476.0 | 480 | 4.0% | 218 | -45% | 451 | 669 | -140% |
| Luxembourg | 10.9 | 11 | 0.1% | 5 | -46% | 11 | 16 | -147% |
| Netherlands | 192.0 | 142 | 1.5% | 80 | -68% | 166 | 246 | -154% |
| Portugal | 53.9 | 70 | 0.4% | 23 | -12% | 47 | 70 | -100% |
| Spain | 265.0 | 372 | 2.5% | 135 | -11% | 280 | 415 | -116% |
| Sweden | 65.2 | 56 | 0.8% | 43 | -79% | 88 | 131 | -214% |
| United Kingdom | 749.7 | 566 | 5.5% | 305 | -65% | 631 | 935 | -149% |
| EU 15 | **3993** | **3437** | **30.5%** | **1676** | -56% | 3469 | 5146 | -143% |
| Australia | 437.6 | 557 | 2.6% | 142 | -5% | 295 | 437 | -73% |
| Canada | 625.4 | 827 | 4.3% | 238 | -6% | 493 | 731 | -85% |
| Iceland | 3.3 | 3 | 0.0% | 2 | -54% | 4 | 6 | -171% |
| Japan | 1218.0 | 1164 | 13.4% | 738 | -65% | 1527 | 2265 | -190% |
| New Zealand | 62.6 | 82 | 0.3% | 18 | 2% | 38 | 57 | -59% |
| Norway | 43.0 | 54 | 0.6% | 33 | -50% | 69 | 102 | -210% |
| Switzerland | 50.7 | 43 | 0.7% | 39 | -92% | 82 | 121 | -254% |
| United States | 5583.8 | 6396 | 47.4% | 2605 | -32% | 5391 | 7996 | -129% |
| **Other Annex II** | **8024.3** | **9127** | **69.5%** | **3815** | -34% | 7898 | 11714 | -132% |
| **All Annex II** | **12018** | **12564** | **100%** | **5492** | **-41%** | **11367** | **16859** | **-136%** |

**Table A2: Dual obligation for all Annex II countries.**

## *The bottom line (IMO in monetary terms) for all Annex 2 countries*

| Country | Share of Annex II Int'l mitigation obligation | International mitigation obligation in 2020 | International mitigation obligation in 2020 @ $20/ton CO2e | International mitigation obligation in 2020 @ $50/ton CO2e | International Mitigation obligation in 2020 @ $100/ton CO2e |
|---|---|---|---|---|---|
| | $MtCO_2e$ | $MtCO_2e$ | $US Billions | $US Billions | $US Billions |
| Austria | 0.7% | 62 | 1.2 | 3.1 | 6.2 |
| Belgium | 0.9% | 80 | 1.6 | 4.0 | 8.0 |
| Denmark | 0.6% | 50 | 1.0 | 2.5 | 5.0 |
| Finland | 0.5% | 43 | 0.9 | 2.2 | 4.3 |
| France | 4.7% | 405 | 8.1 | 20.2 | 40.5 |
| Germany | 7.2% | 628 | 12.6 | 31.4 | 62.8 |
| Greece | 0.7% | 62 | 1.2 | 3.1 | 6.2 |
| Ireland | 0.5% | 40 | 0.8 | 2.0 | 4.0 |
| Italy | 4.0% | 344 | 6.9 | 17.2 | 34.4 |
| Luxembourg | 0.1% | 8 | 0.2 | 0.4 | 0.8 |
| Netherlands | 1.5% | 127 | 2.5 | 6.3 | 12.7 |
| Portugal | 0.4% | 36 | 0.7 | 1.8 | 3.6 |
| Spain | 2.5% | 213 | 4.3 | 10.7 | 21.3 |
| Sweden | 0.8% | 67 | 1.3 | 3.4 | 6.7 |
| United Kingdom | 5.5% | 481 | 9.6 | 24.0 | 48.1 |
| EU15 | 30.5% | 2645 | 53 | 132 | 265 |
| Australia | 2.6% | 224 | 4.5 | 11.2 | 22.4 |
| Canada | 4.3% | 375 | 7.5 | 18.7 | 37.5 |
| Iceland | 0.0% | 3 | 0.1 | 0.1 | 0.3 |
| Japan | 13.4% | 1166 | 23.3 | 58.3 | 116.6 |
| New Zealand | 0.3% | 29 | 0.6 | 1.4 | 2.9 |
| Norway | 0.6% | 52 | 1.0 | 2.6 | 5.2 |
| Switzerland | 0.7% | 62 | 1.2 | 3.1 | 6.2 |
| United States | 47.4% | 4111 | 82.2 | 205.5 | 411.1 |
| **TOTAL Annex II** | **100.0%** | **8667** | **173** | **433** | **867** |

**Table A3: International mitigation obligation in tons for all Annex II countries, plus cost estimates for international mitigation obligations at three plausible average costs per ton of mitigation in 2020.**

# *Appendix B1*

## *Utilizing Marginal Abatement Cost curves to assign mitigation obligations using ClimStrat*

***NOTE THAT THE MODELING WORK IN THIS SECTION WAS PROVIDED BY SEAN HEALY AND KATJA SCHUMACHER OF THE ÖKO INSTITUTE OF BERLIN. THIS SECTION SHOULD BE CONSIDERED PRELIMINARY AND SHOULD NOT BE CITED OR CIRCULATED WITHOUT PERMISSION OF THE ÖKO INSTITUTE.***

*The Climate Strategies Tool (ClimStrat), designed by the Fraunhofer Institute for Systems and Innovation Research, (Fhg ISI) and Öko-Institute, has been used in this study to provide an alternative approach to quantifying the division of domestic mitigation obligations (DMOs) and the associated costs of each Annex II Party fulfilling its International Mitigation Obligation (IMO). ClimStrat is implemented in Microsoft Access, and is designed to help policy makers perform quick and flexible "on-the-spot" analyses of international climate policy proposals. To meet this goal ClimStrat draws on an extensive database rather than performing its own simulation runs. In particular, ClimStrat includes Marginal Abatement Cost (MAC) curves (derived from the POLES model) that allow one to either or both (a) set a target such that marginal costs are equalized (minimizing total costs), or (b) calculate the costs of meeting targets that are set in absolute terms. Additional information about ClimStrat is included in Appendix B2.*

*The primary objective of the ClimStrat-based study is to allow us to develop an allocation method that takes into account the varying domestic mitigation costs within Annex I (so called "mitigation potential"), and also to ensure comparability of effort by using the GDRs-derived responsibility and capacity indictor (RCI). Thus instead of dividing a total mitigation obligation expressed in tons in proportion to the RCI, we first used ClimStrat to estimate the cost-minimizing allocation of reduction effort across Annex I countries, then calculated the total cost of meeting the Annex I 40% "Bright Line" target (40% below 1990 levels). This amount, expressed in dollars (actually Euros, but here converted to dollars) was then divided in proportion to Annex I RCIs; from this, we could then calculate the appropriate domestic reduction (in tons) for each country to match its fair share of monetary costs.*

*This is experimental work, and several caveats need to be borne in mind. First, the baseline used does not precisely match the baseline used in the analysis in the main text. A certain amount of judgment was exercised to get the maximum compatibility between the options available in ClimStrat and the reductions below baseline specified in the primary case. Secondly, MAC curves involve a great deal of subjectivity and uncertainty under the best of circumstances. POLES is only one of many energy-economy models that have been used to generate MAC curves, and in fact, as noted below, it generates (and ClimStrat includes) multiple MAC curves depending on various scenario assumptions. A discussion of the issues here is far beyond our scope, but clearly a great deal of sensitivity analysis will be required before the calculations here can be considered more than preliminary.*

*The primary scenario considered using ClimStrat is described in tables B1 through B4 below. In table B1, we show 2020 BAU emissions, domestic Annex I reductions equal to 40% below 1990 levels, and NAI reductions comparable to the primary analysis. Because the POLES baseline that is used does not include emissions from land use, the global target in 2020 is smaller than the global target in the main analysis. The Annex I baseline is also noticeably higher. Non-Annex I voluntary reductions are the same.*

| | Annex 1 | Non-Annex 1 | Global |
|---|---|---|---|
| *Business as usual 2020 ($MtCO_2e$)* | *18,893* | *26,616* | *45,509* |
| *Annex 1 Domestic reductions: 40% below 1990 ($MtCO_2e$)* | *7,426* | *0* | *0* |
| *Non-Annex 1 Voluntary reductions: unsupported ($MtCO_2e$)* | *0* | *2,454* | *0* |
| *Annex 2 International mitigation obligation: supported reductions in non-* | *0* | *5,265* | *0* |
| *Physical emissions in 2020 ($MtCO_2e$)* | *11,138* | *18,897* | *30,035* |
| *Physical emissions in 2020 : (percent below BAU)* | *-41%* | *-29%* | *-34%* |

***Table B1. BAU emissions and allocation of physical reductions between Annex I and non-Annex I in ClimStrat-based scenario. (Compare to Table 2). See text.***

*Next, Climstrat was used to calculate the allocation of physical reductions among Annex I countries that equalized marginal costs, and thus minimized total costs. This resulted in an estimated marginal cost of $116/ton (76 Euros, converted at 1.5:1), and a total cost of 319 billion dollars, implying an average cost of about $43/ton. At the same time, the Climstrat tool calculated the minimal cost of meeting the rest of the global target through non-Annex I reductions. The resulting marginal cost for the total of 7719 MtCO2 of reductions was $42/ton, for a total cost of $138 billion. These numbers are shown in table B2; at this point the division between NAI voluntary action and supported action (Annex I IMOs) is not translated into monetary terms.*

| 2C_Pathways | Annex I | Non Annex I |
|---|---|---|
| *AI40 Limit Pathway (MtCO2e)* | *11,138* | *18,915* |
| *Marginal Abatement Price ($/tCO2e)* | *116* | *42* |
| *Net Reduction (MtCO2e)* | *7,426* | *7,719* |
| *Cost (billions of dollars)* | *319* | *138* |

***Table B2. Cost estimates for meeting Annex I 40% below 1990 target and global target, equalizing marginal costs within Annex I and within Non-Annex I.***

*The most important part of this analysis is shown in Table B3, which demonstrates the consequences of calculating an allocation based on cost-minimization (note that this is Annex I cost-minimizing), and an allocation based on RCIs. The table shows 1990 emissions, 2020 BAU and cost-minimizing emissions, the reduction in tons and percent compared to 1990 and to 2020, and the total and average cost of domestic reductions. Finally, in the three right-hand columns, it shows the countries share of the Annex I RCI in 2020, the share of the total Annex I cost that is proportional to its RCI, and the ratio of its cost-minimizing allocation to its RCI based share, in percentage terms.*

| | Emissions 1990 | Bau2020 | Marginal Abatement Cost | Emis2020 | GHG Reduction (Domestic) Below 1990 Levels | | GHG Reduction (Domestic) Below 2020 Levels | | Cost of GHG Reduction (Domestic) in 2020 | Average cost | Share of RCI 2020 | RCI-based share of total cost | Cost of domestic reductiions vs RCI-based share |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Country | (MtCO2e) | (MtCO2e) | (Ū/tCO2e) | (MtCO2e) | (%) | (MtCO2e) | (%) | (MtCO2e) | ($ Millions ) | ($/ton | (percent) | ($ Millions ) | (percent) |
| Ukraine | 922 | 584 | 116 | 264 | 71% | 658 | 55% | 320 | 10,750 | 34 | 0.54% | 1,734 | 16% |
| Belarus | 127 | 104 | 116 | 47 | 63% | 80 | 55% | 57 | 1,909 | 34 | 0.15% | 481 | 25% |
| Romania | 248 | 183 | 116 | 87 | 65% | 161 | 53% | 96 | 3,519 | 37 | 0.31% | 997 | 28% |
| Bulgaria | 117 | 85 | 116 | 33 | 72% | 84 | 62% | 53 | 1,731 | 33 | 0.16% | 523 | 30% |
| Estonia | 42 | 26 | 116 | 12 | 71% | 29 | 53% | 14 | 555 | 40 | 0.07% | 229 | 41% |
| Russian Fed. | 3,326 | 1,984 | 116 | 789 | 76% | 2,538 | 60% | 1,195 | 39,966 | 33 | 5.43% | 17,302 | 43% |
| Slovakia | 74 | 65 | 116 | 34 | 54% | 40 | 49% | 32 | 1,230 | 39 | 0.17% | 546 | 44% |
| Lithuania | 49 | 30 | 116 | 14 | 71% | 35 | 53% | 16 | 652 | 40 | 0.09% | 300 | 46% |
| Croatia | 33 | 36 | 116 | 16 | 51% | 17 | 56% | 20 | 712 | 35 | 0.11% | 352 | 49% |
| New Zealand | 62 | 105 | 116 | 59 | 4% | 3 | 44% | 46 | 1,893 | 41 | 0.30% | 969 | 51% |
| Poland | 454 | 385 | 116 | 206 | 55% | 248 | 46% | 179 | 7,639 | 43 | 1.23% | 3,923 | 51% |
| Latvia | 26 | 15 | 116 | 7 | 73% | 19 | 53% | 8 | 320 | 40 | 0.05% | 167 | 52% |
| Czech Republic | 194 | 165 | 116 | 73 | 62% | 121 | 56% | 92 | 3,355 | 37 | 0.56% | 1,793 | 53% |
| Australia | 416 | 721 | 116 | 406 | 3% | 11 | 44% | 315 | 12,960 | 41 | 2.35% | 7,492 | 58% |
| Hungary | 98 | 90 | 116 | 55 | 44% | 43 | 39% | 35 | 1,378 | 39 | 0.32% | 1,026 | 74% |
| Canada | 592 | 897 | 116 | 510 | 14% | 83 | 43% | 387 | 15,179 | 39 | 3.93% | 12,526 | 83% |
| Greece | 105 | 156 | 116 | 94 | 10% | 10 | 39% | 61 | 2,482 | 41 | 0.64% | 2,054 | 83% |
| Portugal | 59 | 97 | 116 | 66 | -12% | -7 | 31% | 30 | 1,371 | 45 | 0.38% | 1,202 | 88% |
| Spain | 288 | 491 | 116 | 318 | -11% | -31 | 35% | 173 | 7,817 | 45 | 2.23% | 7,124 | 91% |
| Slovenia | 19 | 21 | 116 | 11 | 39% | 7 | 45% | 9 | 361 | 38 | 0.12% | 371 | 103% |
| United States | 6,135 | 7,167 | 116 | 4,115 | 33% | 2,020 | 43% | 3,052 | 129,825 | 43 | 43.00% | 137,104 | 106% |
| Ireland | 56 | 79 | 116 | 54 | 3% | 2 | 32% | 26 | 1,123 | 44 | 0.42% | 1,324 | 118% |
| Finland | 71 | 66 | 116 | 38 | 46% | 33 | 42% | 28 | 1,182 | 42 | 0.45% | 1,439 | 122% |
| Belgium | 145 | 157 | 116 | 112 | 23% | 33 | 29% | 45 | 2,019 | 45 | 0.84% | 2,670 | 132% |
| Germany | 1,228 | 1,164 | 116 | 814 | 34% | 414 | 30% | 351 | 15,551 | 44 | 6.57% | 20,948 | 135% |
| Netherlands | 212 | 219 | 116 | 158 | 25% | 54 | 28% | 60 | 2,941 | 49 | 1.32% | 4,219 | 143% |
| Luxembourg | 13 | 15 | 116 | 10 | 21% | 3 | 29% | 4 | 188 | 45 | 0.09% | 280 | 148% |
| France | 566 | 676 | 116 | 500 | 12% | 67 | 26% | 176 | 8,574 | 49 | 4.23% | 13,493 | 157% |
| Japan | 1,272 | 1,572 | 116 | 1,054 | 17% | 218 | 33% | 519 | 24,637 | 48 | 12.18% | 38,835 | 158% |
| Iceland | 3 | 4 | 116 | 3 | 11% | 0 | 27% | 1 | 52 | 45 | 0.03% | 97 | 187% |
| Denmark | 70 | 70 | 116 | 51 | 28% | 20 | 28% | 19 | 876 | 45 | 0.52% | 1,673 | 191% |
| Austria | 79 | 94 | 116 | 72 | 9% | 7 | 24% | 22 | 1,062 | 47 | 0.65% | 2,062 | 194% |
| United Kingdom | 772 | 625 | 116 | 465 | 40% | 307 | 26% | 160 | 7,864 | 49 | 5.03% | 16,038 | 204% |
| Norway | 50 | 61 | 116 | 44 | 11% | 6 | 27% | 17 | 750 | 45 | 0.55% | 1,743 | 232% |
| Italy | 517 | 551 | 116 | 453 | 12% | 64 | 18% | 98 | 4,724 | 48 | 3.60% | 11,463 | 243% |
| Sweden | 72 | 72 | 116 | 51 | 30% | 22 | 29% | 21 | 922 | 44 | 0.70% | 2,239 | 243% |
| Switzerland | 53 | 61 | 116 | 44 | 16% | 9 | 27% | 17 | 750 | 45 | 0.65% | 2,079 | 277% |
| **Total** | **18,564** | **18,893** | | **11,138** | **40%** | **7,426** | **41%** | **7,755** | **318,816** | **41** | **100%** | **318,816** | **100%** |

***Table B3. See text.***

*What this shows is that there is a very large differential between the level of reductions that are cost minimizing, and the share of the costs that different countries should appropriately bear under an RCI-based allocation. For example, to reach its "optimal" level of reductions, Australia would need to spend almost $13 Billion, but its share of the $320 Billion total is only about $7.5 Billion; thus a fair allocation would result in other Annex I countries paying for emissions reductions in Australia. Note that this is a consequence of its emissions reductions being relatively cheap, such that the total dollar value of reductions becomes very large even while the marginal cost remains relatively low. Thus the countries which are generally presumed to have inexpensive reductions would be net "sellers" (e.g., the EITs), while the relatively efficient economies (the EU) would be net purchasers.*

*In theory, with knowledge of the cost curves of each country, a ton-based allocation can be calculated (in typical "% of 1990 fashion" as in the Kyoto Protocol) that would allow a country to meet its fair share of the intra-Annex I cost burden either by buying or selling additional permits up to the line of equal marginal cost. Indeed, this is the next step of our assessment and it should be ready for the next revision of this document; at that point, we will have completed the first version of a GDRs allocation that is based on defining comparable effort in monetary rather than ton-based terms. Nonetheless, even without these additional calculations, we can see that a policy based on a "bright line" for Annex I countries that is also cost-minimizing will require intra-Annex I trading in order to make the monetary costs a nation experiences line up with its fair share of Annex I mitigation obligations.*

*Finally, we show in table 4, an estimate of the costs of meeting the calculated target under a system of perfect global trading. This shows that, given the MAC curve assumptions used, the same amount of reductions could be met globally at a marginal cost of $66 Dollars, and a total cost of about $390 billion, which would represent savings of about 15% relative to the base case with a mandated 40% reduction among the Annex I countries.*

| ***2C_Pathways*** | ***Annex I*** | ***Non Annex I*** |
|---|---|---|
| *No AI Limit Pathway (MtCO2e)* | *30,053* | |
| *Marginal Abatement Price ($/tCO2e)* | *66* | |
| *Net Reduction (MtCO2e)* | *5,859* | *9,614* |
| *Cost ($ Million)* | *147,704* | *242,140* |

***Table B4. Global costs and distribution of emissions reductions associated with unrestricted global trading,***

*Much work remains to be done with this analysis. As noted below in the further description of the model, there are alternative baselines already available which can be compared with these runs. Equally importantly, a further sensitivity analysis of the consequences of differential marginal cost curves within Annex I countries will allow a more comprehensive analysis of the possibilities for integrating mitigation potential into equity-based burden sharing schemes.*

# Appendix B2

## Description of ClimStrat and Methodology

*By Sean Healy, Öko Institute, Berlin, Germany.*

*The Climate Strategies Tool (Climstrat) is an Access-based tool to help policy makers perform quick and flexible "on-the-spot" analyses of international climate agreement proposals. It has three different sections:*

- *an information module to provide data on emissions, production or socio-economic indicators for single countries or regions;*
- *a target module to create and analyze climate agreement scenarios with respect to their global environmental effectiveness. The available target types include national as well as sectoral targets, absolute, no-lose and dual targets and per capita and per t/MWh targets.*
- *A trade module to analyze the costs of realizing these targets. Different emissions trading and offsetting scenarios can be defined for calculating the costs.*

*To meet the main aim of providing an "on-the-spot" analysis tool, ClimStrat draws on an extensive database rather than performing its own simulation runs. In addition to an extensive selection of historical data, different policy runs were performed using the energy model POLES and the results added to the database. By using the POLES data to create carbon abatement cost curves, ClimStrat maintains the flexibility to create its own emission and international climate agreement scenarios.*

*Currently, four different sets of carbon abatement cost curves are included in Climstrat differing in their global emission pathways as well as energy price developments, among others. For the purpose of this study the cost data derived from Climstrat is based upon the POLES scenario_No CCS and therefore it does not take into account the impact of the global recession. However, it is important to acknowledge that Climstrat also includes the POLES scenario_Low GDP Growth - and this scenario does specifically consider the impact of the recent financial downturn on the BAU emissions of the Annex Parties. The following methodology was implemented in order to derive the equalized marginal cost data from Climstrat related to both the Annex I (AI) and the Non Annex I (NAI) Group:*

*All AI Parties were allocated a 40% GHG reduction from 1990 emission levels in the reduction module of Climstrat. By setting the GHG reduction target at 40% below 1990 emission levels it was possible to compare the differences in the MAC curves of each AI Party. This reduction scenario (AI 40_Equal Marginal Costs) was then selected in the trade module of Climstrat along with the cost projection scenario from POLES (scenario 1_noCCS). The option to set a cap for offsetting credits was set at 0% for each AI Party. The exclusion of trading international offsets was selected to ensure that the costs associated with an AI Group GHG reduction of 40% below 1990 emission levels was only delivered through domestic action. However, emission trading within the AI group was included in the model run, which enables a greater level of cost efficiency in the abatement of GHG emissions.*

*In order to ensure that the 2°C pathway was not exceeded, the NAI Parties were allocated the remaining emissions budget, which was derived from the difference between the global emissions target (30 053 $MtCO_2e$) and the AI40*

*emissions budget (11 138 $MtCO_2e$). A reduction target of 29% below 2020 BAU emissions was set for each NAI Party. This reduction scenario (NAI 29_Equal Marginal Costs) was then selected in the trade module of the Climstrat tool along with the cost projection scenario from POLES (Scenario 1_No CCS). As with the previous model run, emission trading within the NAI group was included to determine the equalized marginal cost of the NAI Group reducing emissions to the required level of 18 915 $MtCO_2e$ by 2020.*

# NOTES

[1] http://www.thaindian.com/newsportal/enviornment/time-for-copenhagen-deal-running-out-un-climate-chief_100257576.html

[2] http://www.climatenetwork.org/climate-change-basics/by-meeting-and-date/bonn-i-mar-apr-2009/CAN-A1aggregate_target_position7Apr09-FINAL.pdf

[3] Annex 2 is a subset of Annex 1 consisting of the United States, Canada, Japan, Australia, New Zealand, and the EU 15 countries.

[4] Turkey, though it was originally listed as member of Annex 2, and is still in Annex 1, is treated in this analysis as a non-Annex 1 country. Turkey was deleted from Annex 2 by a decision that entered into force 28 June 2002, pursuant to 26/CP.7 adopted at COP 7, and was also excluded from Annex B of the Kyoto Protocol. This analysis therefore treats Turkey as a non-Annex 1 country, although this is an interpretation worthy of further deliberation.

[5] See, for example, the UNFCCC Secretariat (2009) estimate that reduction pledges by Annex 1 countries sum to a patently inadequate 17-24% reduction below 1990 levels by 2020. A second technical analysis (AOSIS, 2009) estimates the combined Annex 1 pledge to be 10-16%. These estimates date from August to October 2009, months before the Copenhagen Conference of Parties to the UNFCCC, and will soon be superseded by more definitive numbers.

[6] A simple power law extrapolation based on Meinshausen's Table 1 suggests that the risk of exceeding 2°C would be about 15%, assuming on "illustrative default" parameters, with a range of 5-30%.

[7] For our analysis of both of these pathways, see "A 350 emergency pathway" at http://gdrights.org/2009/10/25/ a-350-ppm-emergency-pathway-2/

[8] In July, the G8 leaders meet in the Italian town of L'Aquila and announced the goal of reducing global emissions by 50% by 2050, with the wealthy countries making 2050 cuts of 80%. This pathway, which we estimate produces CO2 emissions of about 1500 gigatonnes for the 2000-2050 period, would (based on Meinshausen et al.) give less than 50% chance of staying below 2ºC. Nevertheless, many will argue that a Copenhagen agreement that enables such a pathway would be a momentous success. (See for example, Nicholas Stern, *Deciding our future in Copenhagen: will the world rise to the challenge of climate change?* December 2009, http://www2.lse.ac.uk/granthamInstitute/pdf/ sternPolicyBrief.pdf). The problem is that such a spin, useful though it may be in the short run, is likely to backfire, for it will inevitably be taken to justify the further deferral of decisive steps. What is needed is a rapid transition to a global emergency regime, and we doubt that a softer target will make this more likely. Soft conceptions of the target actually increase the odds that the fundamental North / South impasse will remain in place.

[9] By consuming about 240 gigatonnes $CO_2$ between now and 2050 out of a total global budget of 670 gigatonnes, the Annex 1 countries would leave only 450 gigatonnes $CO_2$ for the South.

[10] Our estimates of Non-Annex 1 no-regrets potential are derived from McKinsey's well known mitigation cost studies, which estimated zero-cost options to grow to about 10% of 2030 baseline emissions. We take this number, scaled to 2020, and then divided in half. The logic of this division is that no-regrets action is not really free. There are, after all, those pesky "barriers" to no-regrets action.