After Durban:
Risk of delay in raising ambition lowers chances for 2°C, while heading for 3.5°C

Climate Action Tracker Update, 11 December 2011

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Summary

- ***The Durban Climate Summit concluded with the groundbreaking establishment of a new body to negotiate a global agreement covering all countries by 2015 (Ad Hoc Working Group on the Durban Platform for Enhanced Action). With a new agreement not scheduled to take effect until 2020 the new agreement appears unlikely to affect the level of action in 2020 already pledged.***

- ***As the agreements in Durban do not propose additional action before 2020 the risk of exceeding 2°C remains very high. Action to implement the Durban Agreements will need to be quick to increase emission mitigation and hence have a chance at reaching this goal. Catching up on postponed action is costly and the technological and economic options required to do so are largely untested - or unknown. The Climate Action Tracker estimates that global-mean warming would reach about 3.5°C by 2100 with the reduction proposals currently on the table.***

- ***Impacts of climate change are likely to be considerably more severe in all parts of the world for a 3.5°C warming above pre-industrial (compared to 1.5°C or 2°C):***
    - ***Regional temperature over land areas is projected to increase much more than the global average, and would be strongly amplified in some regions (e.g. 4°C global average means 6-8°C in southern Europe, 2°C global average means 3-4°C in that region)***
    - ***Crop yields are projected to decline in most regions, while water stress will become a major issue in many regions, especially parts of Africa, Central Asia and parts of Latin America.***
    - ***Several potential global-scale tipping points are associated with warming beyond 3°C that are not associated with 1.5°C or 2°C, such as:***
        - ***the possible dieback of the Amazon rainforest***
        - ***corals reefs dissolving and being irreversibly replaced by algae and sea grass***
        - ***irreversible long-term loss of the Greenland ice sheets***
        - ***risk of release of methane hydrates in ocean floor sediments***
        - ***permafrost thawing due to fast rising arctic temperatures***
    - ***Approximate estimates indicate that the most extreme costs will be felt in West Africa and South Asia, with 3.5% of regional GDP in residual damage for 2°C warming and 5-6% for 3°C warming.***
    - ***With a 2°C warming, adaptation costs would be half those associated with a 3°C temperature rise. As with the impacts, regional cost of adaptation and residual damage are highly diverse.***

- ***There are still options available to close the gap between current globally planned mitigation and what is needed to hold warming below 1.5 or 2°C, if action takes place fast (i.e. before 2015).***

Durban risks commitment to warming over 3°C

> ***Even the +0.8°C increase in global average temperature already observed has had a noticeable impact. With a temperature increase of 2°C there would be considerable impacts. But with temperatures heading towards 3.5°C, the impacts are likely to be more drastic and move to a distinctly higher level of risk.***

Along the pathway to 3-4°C global-mean warming above pre-industrial, the world is likely to face severe impacts. Here, we provide an overview of some of the major climate impacts reported in the scientific literature, with an emphasis on the differences between a 3-4°C and a 2°C warming scenario.

The severity of most climate impacts increases continuously with global mean temperature. In addition, the so-called climate tipping points will respond abruptly when certain temperature thresholds are crossed and thus pose a high risk of unprecedented climate impacts.

These thresholds are often not well quantified. The figure below maps these and other impacts in their approximate relation to projected warming levels, ranging from 1.5 and 2 to 3-4°C warming. Effects are explained in more detail in the next few pages.

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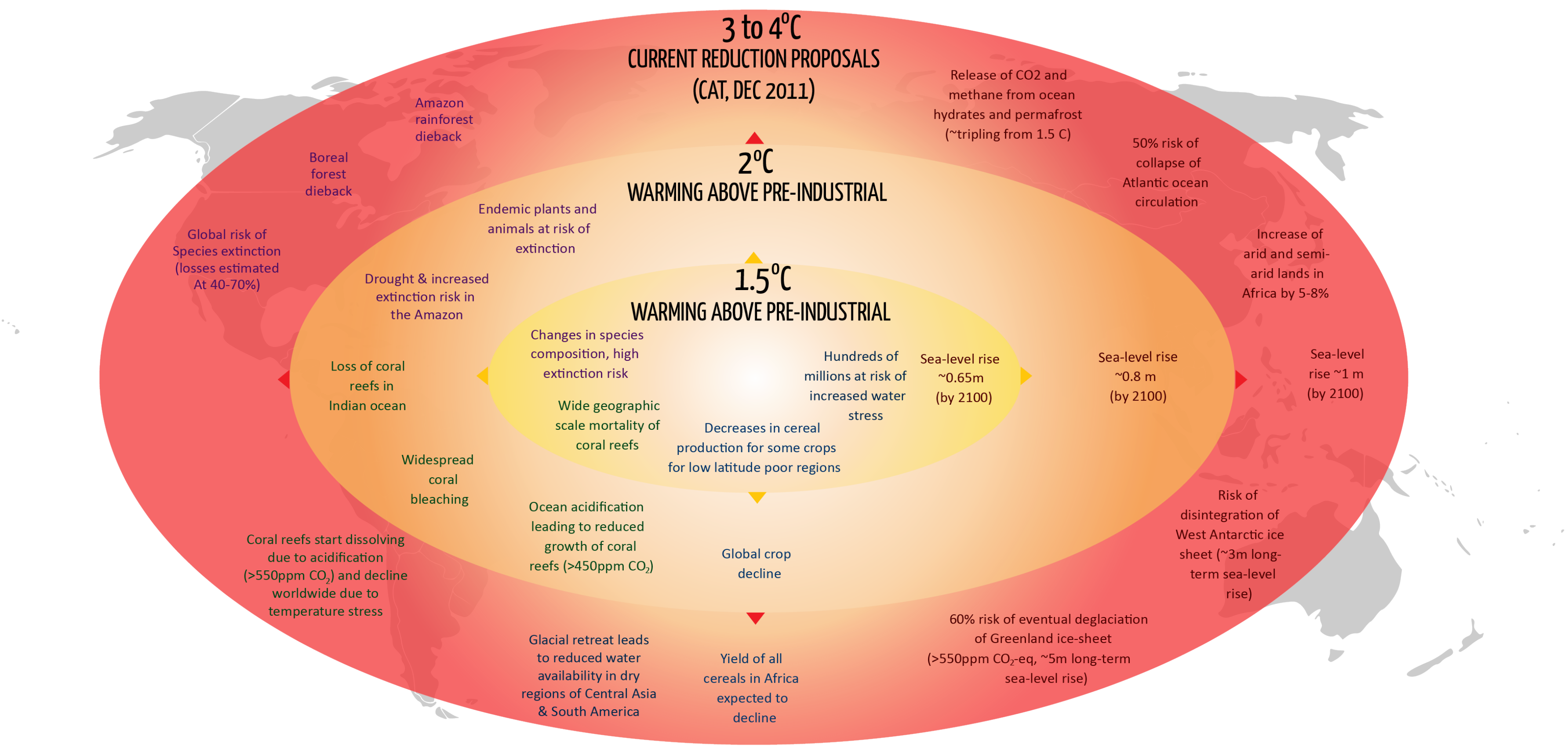
A SNAPSHOT OF A WARMING WORLD

As the agreements in Durban do not propose additional action before 2020 the risk of exceeding 2°C remains very high. Action to implement the Durban Agreements will need to be quick to increase emission mitigation, for having a chance of deviating projected warming from the current pathway leading to 3.5°C by 2100. A limit of 1.5°C will already lead to considerable impacts, and more with 2°C. But with temperature increases heading towards 3.5°C, the impacts reach a distinctly higher level of risk. The impact examples in this figure are illustrative and not comprehensive.



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Regional precipitation and temperature

Most land areas experience – or are projected to experience – higher temperature increase than the global average, while the oceans warm relatively slower. Such temperature and precipitation changes differ widely for different locations and seasons.

Warming is expected to be especially amplified in Polar Regions. With 4°C global warming, Northern Africa is projected to experience high (greater than 6°C) temperature increases and large precipitation decreases. During summer, Southern Europe and the adjacent part of Central Asia are projected to warm by 6-8°C, and precipitation to decrease by 10 per cent or more[1].

Such local amplifications should be kept in mind for a better understanding of the differences between the worlds of 2°C and 3-4°C warming above pre-industrial.

Ecosystems and biodiversity

A 2°C temperature rise may already induce major losses of endemic plants and animals in Southern Africa and north-eastern Australia[2]. As warming exceeds 2-3°C relative to pre-industrial levels, 20-30% of species assessed worldwide would be at high risk of extinction[2]. Above 4°C this number may rise to 40-70% [2].

Marine ecosystems are also threatened, with the emblematic case of coral reefs (see the section on tipping points), partly because oceans present weaker seasonal changes of temperature and marine ecosystem are less resilient to long-term changes in temperature[4].

Food security and water resources

In a 2°C world, there is a global risk of crop yield decline[5], for instance a 20% reduction of millet yield in Sahel Africa is projected[7]. With an increase of 3-4°C above pre-industrial levels, all types of cereals are projected to decline in Africa[8], with decline of Sahelian millet yield reaching 40%[7].

Other severe, adverse effects on human societies are expected worldwide for a 3-4°C warming, some of which are listed below.

In Africa, the proportion of arid and semi-arid lands is likely to increase by 5% to 8% (60-90 million ha)[9]. Economic assessments indicate that South-African crop net revenues could fall by as much as 90% by 2100, with small farmers being the most affected[3]. Agriculture losses could lead to GDP losses by 2100 of 2-7% in part of the Sahara, 2-4% in Western and Central Africa and 0.4-1.3% in Northern and Southern Africa[8].

In China, sharp increases of area with critical agricultural water stress in North China Plain and North-East China Plain are projected[10] . In central Asia, Chile, Argentina and Peru, water availability will be affected by glacial retreat[11, 12].

Sea-level rise

The melting of mountain glaciers and ice sheets, and the expansion of oceans as they warm are all projected to cause sea-level to rise.

Sea level projections based on observed changes of sea-level and temperature during the past 1000 years[13, 14] indicate a rise of ~80 cm in a 2°C warming scenario and a ~100 cm in a 3.5°C warming scenario over the course of the century.

There is a higher risk that the Greenland ice sheet will destabilise under 3.5°C of global warming[15] and, in the longer term (centuries to millennia) will contribute to several metres of sea level rise. The risk of a collapse of the West Antarctic Ice sheet also increases with rising global temperatures.

Tipping elements in the climate system – severe risks for warming above 3.5 degrees

The climate system inherently includes tipping points. As a tipping point is approached, it means that even a tiny extra perturbation of a climate variable can cause a strongly-enhanced response of the system. This crossing leads to a different state of the underlying system and is often irreversible on a human time scale. Several potential, large-scale tipping points are associated with warming beyond 3°C.

The Amazon Rainforest

The possible dieback of the Amazon rainforest[16] constitutes a very important tipping point. The scientific literature indicates that Amazon is directly threatened by droughts. The risk of an abrupt dieback cannot be excluded even in a 2°C world, although CO_2 fertilisation may offset such effect[17].

If global mean temperature increases towards 3-3.5°C there is a risk of major loss (20-80%) of the Amazon and its biodiversity. [2]. Recent projections indicate a significant risk of complete dieback for a global warming around 4°C even with sustained CO_2 fertilization[17].

Coral reefs

Even a 1.5°C warming[2] puts marine ecosystems at risk, with coral reefs worldwide projected to experience bleaching[a] due to more frequent high ocean-surface temperature events, especially in the Indian Ocean between 0-15°S latitude[18]. More frequent bleaching events block recovery and leads to the demise of coral reefs.

A parallel effect involves acidification of the upper ocean layers due to absorption of CO_2 as the atmospheric CO_2 concentration rises. Due to acidification, marine organisms like coral reefs are increasingly inhibited in their ability to sequester calcium for growth. Above 450 ppm CO_2 in the atmosphere (a bit above 2°C in the long term) ocean acidification may prevent coral reefs from growing [19, 20]. At 550 ppm CO_2 (about 3°C in the long term), corals will start dissolving and be irreversibly replaced by algae and sea grass, although sea-surface temperature increase will likely have an even greater impact on coral reefs[20, 21].

Greenland Ice Sheet

Summer melting at the surface is a main part of the Greenland Ice Sheets mass loss. Regions of summer melting expanded significantly during recent years.

The surface of a thinner ice sheet is at lower altitudes, where temperatures are warmer and thus drives even further melting. The ice sheet cannot sustain itself once its thickness has dropped below a critical level.

The threshold for irreversible loss due to melting has been estimated to occur around 3.1 ± 0.8°C of global warming[15]. However, the speed of retreat is slow and in the order of thousands of years.

Atlantic thermohaline circulation

The Atlantic thermohaline circulation is a crucial part of the global ocean circulation system and has a large influence on the regional climate in several world regions. Part of this circulation is the Gulf Stream that causes Western Europe to be comparatively warm relative to other regions at the same latitude (such as northern Canada). The thermohaline circulation may be inherently unstable and geological history shows several time periods of a collapse.

The risk of collapse under global warming is estimated to rise from a 10% change in a 2°C world to a flip-of-the-coin change (50%) in a 3-4°C world[22]. The collapse would lead to an abrupt cooling in Northern Europe, significant impacts on Northern Atlantic fisheries and an abrupt regional sea-level rise of up to 0.5m along North American coastlines[23-26].

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[a] For their survival, corals depend on a symbiotic relationship with the algae living in their tissues. If ocean-surface water rises a few °C above average, it triggers the corals to expel the algae, turning them white. The frequency of warm water events increases with rising temperatures. . Rare warm water events allow corals to recover between events, but higher frequencies lead to coral death.

Methane Hydrates

Large amounts of methane are stored as methane hydrates in ocean floor sediments. A warming of the deep ocean may lead to their release to the atmosphere.

Because methane is a strong greenhouse gas, a massive release would lead to further warming that may release even more methane from the ocean. This feedback may push the climate system to a different state. However, inventories, observations and modelling are in a very early stage of scientific development. The risk of methane release increases for warming above 2°C[27].

Permafrost

Recent observations show large areas of permafrost thawing due to rapidly rising arctic temperatures. The permafrost soils store large amounts of organic carbon – about four times the cumulated global anthropogenic carbon emissions until today – and their thawing releases CO_2 and methane to the atmosphere.

Similar to the methane hydrates, their release can cause further warming, feeding back to even more release of GHGs from the thawing soils. This may ultimately push the global climate to a different state. A recent expert review estimates GHG releases from permafrost to triple under warming to 3.75°C in 2100 in comparison to a less than 2°C warming limit[b].

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[b] Polar warming of 2°C (low estimate) compared to 7.5 °C (high estimate) over 1985-2004 average. Assuming a polar amplification factor of 2 (IPCC 2007), this refers to global warming levels of 1 °C (near today) and 3.75 °C.

Costs of adaptation and residual damage are estimated to rise rapidly with warming

The cost of adaptation and the damage that cannot be avoided through adaptation measures is projected to be substantially higher in a 3.5°C world.

The stronger impacts at higher warming levels are associated with higher costs of adaptation and "residual damage" of climate change. Residual damage is an estimate of the level of monetary damages that would need to be accepted based on economic considerations, because the available adaptation options would be even more expensive.

Hof et al.[28] looked at the difference in costs between a 2°C and 3°C world, and found that by 2100, the costs of adaptation and residual damage globally would be 1% of global GDP for the 2°C case, and 2% at 3°C (see figure below).

Due to the highly diverse regional impacts and GDP developments, there is a large diversity in regional costs. Most extreme are the costs for the west Africa and south Asian regions, estimated by Hof et al. at about 3.5% of GDP at 2°C, and between 5% and 6% at 3°C. In both cases the residual damages are much larger than the costs of adaptation, and decrease considerably with lower warming levels. Note that such cost estimates are even more uncertain than the impact assessments they are based on.

An estimate for the global cost of damages of 2% of GDP by 2100 is consistent with the 2006 Stern Review. More recent literature has used the same model but with updated parameters. The results indicate that Stern underestimated the costs, which could rise above 6% of GDP globally in 2100[29].

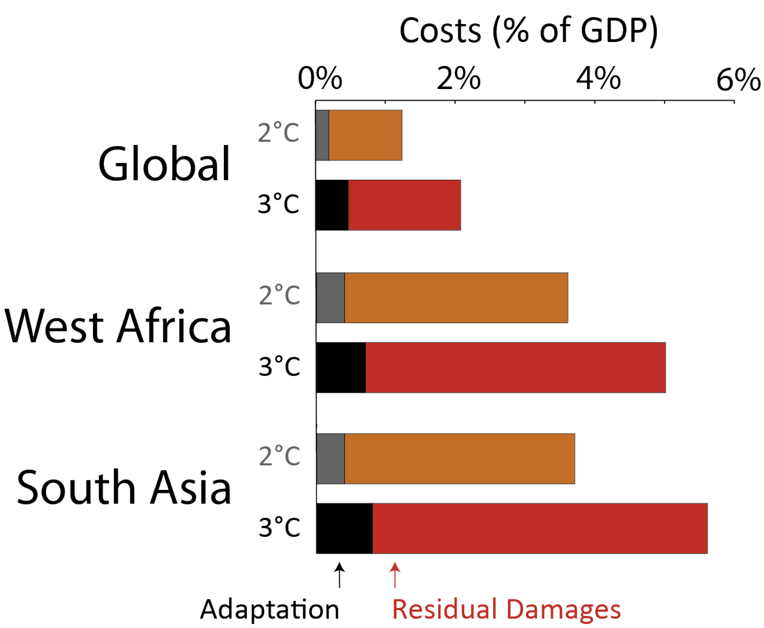
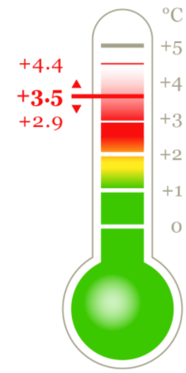


Figure: Illustrative estimates for costs of adaptation and residual damage from climate change for regions under a 2°C and a 3°C scenario.[28]

Agreement in Durban risks delay in raising ambition, which lowers chances of meeting 2°C



As the agreements in Durban do not propose additional action before 2020 the risk of exceeding 2°C remains very high. Action to implement the Durban Agreements will need to be quick to increase emission mitigation and hence have a chance at reaching this goal. Catching up on postponed action is costly and the technological and economic options required to do so are largely untested - or unknown

The Climate Action Tracker estimates that global-mean warming would reach about 3.5°C by 2100 with the current reduction proposals on the table.

The agreements in Durban provide for a roadmap for a legally binding agreement to be implemented from 2020. This agreement on the process and the legal form is an important step in the right direction.

A separate crucial issue is the ambition level of this binding agreement.

The agreements have kept the ambition level of emission reduction proposals of countries for 2020 unchanged. We showed earlier this week that current proposals in aggregate are insufficient to limit temperature increase to 2°C as agreed one year ago.

The agreements in Durban also include a launch of a "workplan on enhancing mitigation ambition to identify and to explore options for a range of actions that can close the ambition gap with a view to ensuring the highest possible mitigation efforts by all Parties". However, the outcome is uncertain. It is unclear whether the ambition level for 2020 will actually be increased above the current pledges. Although the Cancun Agreements of last year called for developed countries to increase their ambition, there has been no such movement in the past year.

By now, countries should be well underway in implementing their unilateral 2020 reduction proposals that they mostly pledged in 2009, or before. Planning and implementing enhanced ambition for 2020 is urgent. It usually takes a few years from a decision to implement a policy to an actual effect on emissions. For example, an energy efficiency building code first has to be designed for e.g. one year and then will only enter into force, for example, a year later. It can then only affect emissions in three out of the five years for a period such as 2015 to 2020.

Meanwhile, we have lost another year to act. Bridging the emissions gap will be more difficult as another year passes with energy intensive infrastructure being built that will last and emit for decades. Many emission reduction opportunities are already lost that were still available a year ago.

International reduction targets and pledges of individual countries would lead to global emissions in 2020 totalling 55 $GtCO_2e$/year. This assumes confirmed unconditional pledges and lenient accounting rules. To be in line with limiting global average temperature increase to 2°C, global emissions need to be at about 44 $GtCO_2e$/year by 2020, and must steeply decline after that.

*Reductions required to keep to 1.5°C of warming overlap with the 2°C pathway until 2020, but need to decline more rapidly after that. Given the current 'pledge level' of 55 $GtCO_2e$/year in 2020, a **gap of 11 $GtCO_2e$/year** remains to reach the reduction level required. This is in line with the latest finding of the UNEP Bridging the Emissions Gap Report, which identifies a gap between 7 and 16 $GtCO_2e$ for the case closest to our analysis.*

*If governments implemented the most stringent reductions they have proposed, with the most stringent accounting for developed countries, the Climate Action Tracker has calculated the remaining gap would shrink to **9 $GtCO_2e$/year**. The range estimated in the UNEP report for the equivalent case is 3 - 11 $GtCO_2e$/year.*

The current pledges are far from a cost-optimal emission pathway to hold warming below 2°C. In theory there are pathways that follow the pledges until 2020 and still meet 2°C. In practice, however, there are very strong limits on their *technical and economic feasibility. If 2020 emissions are at a level consistent with a below 2°C pathway (44 $GtCO_2e$/year) then a reduction rate to 2050 of* ***2%/year*** *is needed globally.*

However, if 2020 emissions are in line with current pledges (55 $GtCO_2e$/year) then a reduction rate to 2050 of ***3.8%/year*** *is needed globally. This rate is almost two times faster and has major implications on technical feasibility and cost.*

Current pledges lead to a warming of 3.5°C (with a range of 2.9-4.4°C) above pre-industrial levels by 2100 and a CO_2 concentration of about 690 ppmv by that time. This level is far above the temperature limits of 2°C and 1.5°C mentioned in the Cancun Agreements.

Overall, the current agreement and the resulting aggregated emission-reduction pledges of all Parties fall far short of what is needed to get the world on track for limiting global warming to 2 and 1.5°C above pre-industrial levels.

Mitigation options exist to close the gap - if implemented over the next years

Strengthening pledges

Countries can strengthen their pledges in several ways:

Improve accounting *- Implementing stringent emission accounting rules for Annex-I can reduce the gap by 1-2 $GtCO_2e$/year, especially by minimising emission credits from LULUCF accounting and the carry-over of surplus allowances.*

Raise ambition *- All Governments moving to their more ambitious ("conditional") stated pledges would reduce the gap by another 1 $GtCO_2e$/year.*

Ensure integrity *- Avoiding double-counting of CDM credits is required to prevent the gap from increasing by up to 2 $GtCO_2e$/year. In other words: to stop the Gap from increasing, avoiding double-counting.*

Technical mitigation options: what is required?

Reduce subsidies for fossil fuels *- This can decrease global CO_2 emissions by 2 $GtCO_2$/year[3] by 2020:*

- *Fossil-fuel consumption subsidies worldwide amount to $409 billion in 2010 and an estimated $660 billion in 2020[4]. Eliminating subsidies reduces fossil-fuel demand and emissions.*
- *Global renewable energy subsidies were only $66 billion in 2010.*

Implement renewables *- Increasing the global share of renewable energy production - from the current estimated 12% to 15% by 2020 - would reduce the gap by 4 $GtCO_2$/year.*

- *A further increase to 20% share will close the gap completely.*
- *In absence of climate policy the share is projected to be close to 10% by 2020[5], with growth in renewables capacity being over-compensated by growth in energy demand.*

Improve efficiency *- Intensify economy wide energy efficiency improvements. These are cost efficient and play a key role in the necessary transformation of the energy system.*

Eliminate deforestation *– Reducing net emissions from land-use change to zero can reduce the gap by 2 $GtCO_2e$/year.*

Reduce non-CO_2 emissions *- Strong mitigation action on non-CO_2 gases – methane and HFCs, which is highly feasible[6]*

Address bunker fuels *- Implementing full mitigation potential in international aviation and shipping would reduce the gap by up to 0.5 $GtCO_2e$/year.*

[3] IEA, OECD and World Bank (2010) "The Scope of Fossil-fuel subsidies in 2009 and a roadmap for phasing out fossil-fuel subsidies. An IEA, OECD and World Bank joint report prepared for the G-20 summit, Seoul (Republic of Korea) 11-12 November 2010".

[4] IEA (2011) "World Energy Outlook 2011", Paris, France

[5] Rogelj et al, forthcoming

[6] UNEP (2011) "Integrated assessment of black carbon and tropospheric ozone. Summary for decision makers", UNEP/GC/26/INF/20, Nairobi, Kenya.

Background on the Climate Action Tracker

The "Climate Action Tracker", www.climateactiontracker.org, is a science-based assessment by Ecofys, Climate Analytics and the Potsdam Institute for Climate Impact Research (PIK) that provides regularly updated information on countries' reduction proposals.

The Climate Action Tracker[g] reflects the latest status of the progress being made at international climate negotiations. The team that performed the analyses followed peer-reviewed scientific methods (see publications in Nature and other journals)[h] and significantly contributed to the UNEP Bridging the Gap Report[i].

The Climate Action Tracker enables the public to track the emission commitments and actions of countries. The website provides an up-to-date assessment of individual country pledges about greenhouse gas emission reductions. It also plots the consequences for the global climate of commitments and actions made ahead of and during the Copenhagen Climate Summit.

The Climate Action Tracker shows that much greater transparency is needed when it comes to targets and actions proposed by countries. In the case of developed countries, accounting for forests and land-use change significantly degrades the overall stringency of the targets. For developing countries, climate plans often lack calculations of the resulting impact on emissions.

Contacts

Dr. Niklas Höhne (n.hoehne@ecofys.com) - Director of Energy and Climate Policy at Ecofys and lead author at the IPCC developed, together with Dr. Michel den Elzen from MNP, the table in the IPCC report that is the basis for the reduction range of -25% to -40% below 1990 levels by 2020 that is currently being discussed for Annex I countries.

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g www.climateactiontracker.org

[h] e.g. http://www.nature.com/nature/journal/v464/n7292/full/4641126a.html and http://iopscience.iop.org/1748-9326/5/3/034013/fulltext

[i] http://www.unep.org/pdf/UNEP_bridging_gap.pdf

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Potsdam Institute for Climate Impact Research (PIK)

The PIK conducts research into global climate change and issues of sustainable development. Set up in 1992, the Institute is regarded as a pioneer in interdisciplinary research and as one of the world's leading establishments in this field. Scientists, economists and social scientists work together, investigating how the earth is changing as a system, studying the ecological, economic and social consequences of climate change, and assessing which strategies are appropriate for sustainable development.

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