Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

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Fourth Assessment Report (AR4) of the IPCC (2007) on Climate Change

Part III - Mitigation of climate change

Summary 04/05/2007

The report of Working Group III of the Intergovernmental Panel on Climate Change (IPCC) is the third and final working group contribution to the IPCC's Fourth Assessment Report (AR4). It focuses on measures to reduce climate change and considers possible options for the mitigation of emissions of greenhouse gases (GHG) with regard to scientific, technological, environmental, economic and social aspects. Overall, since the publication of the Third Assessment Report (TAR) in 2001, the scientific procedures for estimating GHG mitigation potential have improved considerably, especially from a regional and sectoral point of view. The IPCC WG III AR4 report

- emphasises the urgency of effective climate protection;
- refers to the narrow remaining time horizon of two decades for limiting mean temperature increases to 2°C compared to pre-industrial levels (EU 2°C target);
- shows how known technologies (e.g. renewable energies) can reduce GHG emissions, provided that appropriate incentives are created and investments in research and development are increased;
- in stabilisation scenarios, now considers not only carbon dioxide (CO_2) but also the other most important GHGs;
- studies scenarios with low GHG emissions with which the 2°C target could be achieved which were not considered in the TAR;
- provides cost estimates for implementing GHG mitigation that are lower overall than in the TAR.

1. Global GHG emission trends

Between 1970 and 2004 global GHG emissions increased by 70%, between 1990 and 2004 by 24%. Emissions of CO_2, quantitatively the most significant GHG, increased from 1970 to 2004 by 80% (1990 to 2004: 28%). A range of policies and a decline in global energy intensity in production and consumption have been effective in reducing GHG emissions in different sectors and many countries. The scale of such measures, however, has not yet been large enough to counteract the global growth in emissions.

In 2004, developed countries (UNFCCC Annex I), with a 20% share of world population, accounted for 46% of global GHG emissions, although their economies have a lower energy intensity in relation to GDP compared to non-Annex I (developing) countries.

Without additional mitigation measures, fossil fuels are projected to dominate the global energy mix to 2030 and beyond. On this premise, global GHG emissions are projected to increase by 25 to 90% by 2030 (relative to 2000), depending on the scenario, and by up to 270% by 2100. Two thirds to three quarters of the increase in CO_2 emissions from energy would come from developing countries,

although their per capita CO_2 emissions will remain substantially lower (2.8 to 5.1 t CO_2/cap) than those of developed countries (9.6 to 15.1 t CO_2/cap).

2. Emissions mitigation to 2030 – potential and costs

- Studies show that there is a significant economic potential for the mitigation of global GHG emissions in all sectors over the next two decades. The rule of thumb is: the higher the CO_2 price per tonne, the more CO_2 emissions can be avoided and the lower the level at which atmospheric CO_2 concentrations can be stabilised. A carbon price of up to 50 US$/t CO_2-eq. allows a stabilisation level of around 550 ppm CO_2-eq., a price of 100 US$/t CO_2-eq. leads to stabilisation at 450 to 550 ppm CO_2-eq. This would correspond to an average global warming of 2° to 3°C compared to pre-industrial times (before 1750).
- The IPCC scientists have identified large GHG saving potentials in all sectors, e.g. improving the energy efficiency of buildings, improved energy supply and increased efficiency, more combined heat and power, renewable energies, increased fuel switch from coal to gas,
- The macro-economic costs are estimated at below 3% (in several studies 1-2%) of global gross domestic product (GDP), if atmospheric GHG concentrations are stabilised at between 445 and 535 ppm CO_2-eq. The maximum value of 3% corresponds to a reduction of the average annual GDP growth rates of less than 0.12%. However, these costs are lower in overall economic terms if
    - an active climate protection policy stimulates technological change to a greater extent, for example by investing revenues from a carbon tax directly in the development of climate friendly or low carbon energies or technologies;
    - near-term benefits on health of measures to reduce air pollution are taken into account, alongside other co-benefits such as increased energy security.
- Studies suggest that mitigation opportunities with net negative costs have the potential to reduce emissions by around 6 GtCO_2-eq/yr in 2030. Realizing these requires dealing with implementation barriers.
- Changes in lifestyle and behaviour patterns can contribute to climate change mitigation across all sectors. Management practices can also have a positive role.
- The following short to medium-term measures can set the course for a long-term reduction of global GHG emissions: investments in energy infrastructure in developing countries, modernisation of energy infrastructure in developed countries and policies to promote general energy security. Further co-benefits are lower air pollution, improved balance of trade as well as wealth creation and employment in general. The additional investment requirement arising from the need to mitigate GHG emissions is projected to be negligible to 5-10% compared to the investments which are needed in any case.
- Renewable energies and increased efficiency also has a positive effect on energy security, employment and on air quality. Renewable energies can have a share of 30 to 35% of total electricity supply in 2030, given costs relative to other supply options and at carbon prices of up to 50 US$/t CO_2-eq.
- There are multiple mitigation options in the transport sector but their effect may be counteracted by growth in the sector. Market forces alone, including rising fuel costs, are not expected to lead to significant emissions reductions. Efficiency improvements with the potential to mitigate CO_2 emissions from the aviation sector in the medium term are expected to only partially offset the growth of aviation emissions.
- Generally, the higher the price of fossil fuels, the more competitive will be low-carbon alternatives.

3. Climate protection after 2030

In order to stabilise the concentration of GHGs in the atmosphere, emissions would need to peak and decline thereafter. The lower the stabilisation level, the more quickly this peak and decline would need to occur. Note: the stabilisation level determines the ultimate increase in temperature. Mitigation efforts over the next two to three decades will determine to a large extent the long-term global mean temperature increase and the corresponding climate change risks and impacts that can be avoided.

If very low GHG stabilisation levels are aimed for, the CO_2 already accumulated in the atmosphere means that concentrations will first exceed the targeted level (overshooting) before they can decline again.

In the context of these time- and climate-related dependencies, the IPCC scientists come to the following conclusions:

- If GHG concentrations are limited to 445 to 490 ppm CO_2-eq. and global mean temperature increases are to be restricted to 2.0 to 2.4°C compared to pre-industrial levels, emissions must peak within the next 15 years and drop by around 50-80% compared to today's levels (ca. 50% against 1990) by 2050. In scenarios which assume a stabilisation level of 535 to 590 ppm CO_2-eq., the global mean temperature will rise by 2.8 to 3.2°C, and by 3.2 to 4.0°C for stabilisation at 590 to 710 ppm CO_2-eq. As the temperature in higher northern latitudes rises more than the global average, in the last two scenarios the critical temperature threshold for the Greenland ice sheet would be exceeded – with considerable long term impacts on the sea level rise. They are also much higher than the EU's 2° C target.
- Studies on the effects of global warming on feedback mechanisms in the carbon cycle and the climate system indicate that these temperature ranges could be underestimated.
- The macro-economic costs of implementing low GHG concentrations (445 to 535 ppm CO_2-eq.) are estimated at less than 5.5% (in several studies 2-3%) of global GDP in 2050 (corresponding to a reduction of annual GDP growth rates of less than 0.12%).
- The GHG stabilisation levels studied can be achieved by deployment of a range of technologies that are already commercially available and those that are expected to be commercialised in the coming decades – but only if appropriate and effective incentives are in place for investments, cost reductions and for the further development and deployment of a wide portfolio of low carbon technologies or those with zero or even negative CO_2 emissions.
- The lower the CO_2 stabilisation target, the greater the number of technologies used and the higher the investments in research, development and deployment of such technologies in the next decades. Delayed emission reductions lead to investments that lock in more emission-intensive infrastructure and development pathways. This significantly constrains the opportunities to achieve lower stabilisation levels.

4. Climate protection: measures and instruments

Pricing of CO_2 emissions is vital and creates incentives for producers and consumers to make significant investments in low-GHG products, technologies and processes with low or zero emissions. Government policies including economic instruments, government funding and regulations are also needed in order to provide a real or implicit price of carbon. A broad range of instruments – standards, taxes, charges, tradable emissions permits, voluntary agreements – are available to establish markets for low CO_2 or zero emission technologies.

In a multi-gas strategy which reduces all climate relevant GHGs, incentives must be put in place in all sectors that produce emissions: energy supply, transport, buildings, industry, agriculture, forestry, waste management.

In addition to the instruments already identified, AR4 stresses that effective technology transfer in developing countries has a high priority in the reduction of global CO_2 emissions. Favourable enabling conditions must be created for large investments in non-Annex I countries.

The IPCC report notes the achievements of the UN Framework Convention on Climate Change and its Kyoto Protocol. They have led to a large number of national measures. New institutional mechanisms have been set up which can serve as a platform for enhanced future CO_2 mitigation measures. The creation of a global CO_2 trading scheme is viewed as another major success. The continued implementation of the guiding principle of sustainable development is also seen as an important factor to accompany specific measures for the reduction of global CO_2 emissions.

In addition to the priority goal of global GHG mitigation, an effective climate protection policy is also economically useful, strengthens respective national energy security and reduces the health costs arising from regional and local air pollution.

The costs of the Kyoto Protocol in the first commitment period (2008-2012) will probably be lower than described in the TAR, which estimated costs at global GDP losses of 0.2-2% or 0.1-1.1% in 2012, depending on assumptions about the extent of global emissions trading.