Climate Change

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11
05
ISSN
1862-4359

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Umwelt
Bundes
Amt

Für Mensch und Umwelt

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The Future in Our Hands

21 Climate Policy Statements for the 21st century

by

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Federal Environmental Agency

This Publication is only available on the internet
http://www.umweltbundesamt.de/klimaschutz/
as a PDF document that can be downloaded.

Publisher: Federal Environmental Agency (Umweltbundesamt)
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Berlin, March 2006

Introduction

Climate change is one of the biggest challenges facing mankind today. Although we have seen a tremendous increase in scientific findings on the pending risks and knowledge of potential options for action over the past decades, global greenhouse gas emissions which are the reason for man-made climate change still continue to rise alarmingly.

What we now need to do is to pave the way towards the required turnaround in favour of climate protection in many areas of business and society. Many of the technologies needed to reduce greenhouse gas emissions are already available, and the cost of climate protection is affordable. The sooner we act, the more time we will have for the necessary technical and social adaptation, including fundamental changes in the ways we do business and in our lifestyles. The Framework Convention on Climate Change and the Kyoto Protocol mark a first step in the direction of effective climate protection.

The Federal Environmental Agency (UBA) now presents a climate policy strategy based on 21 statements. Taking climate change both already observed and projected in the future, as well as the scientific reasoning for emission reduction goals, the Agency outlines environmental quality and action goals in the first section (statements 1 to 10) and then illustrates the measures and instruments that can be used to reach these goals for the Federal Republic of Germany (statements 11 to 21).

The proposals put forward in this concept are also the result of a host of publications by the Agency in which these proposals are described in greater detail. For sources and downloads, please visit: http://www.umweltbundesamt.de/klimaschutz.

We have designed this climate protection concept as a contribution to the international and national debates on future climate policy.

1. Climate change and its impact so far

Climate change has begun and is more dynamic than expected. The temperature over the past decade rose world-wide by an average of 0.7°C - first and foremost as a consequence of greenhouse gas emissions. Some of the resultant phenomena include more frequent extreme weather events, for instance, heat waves, and a significant retreat of glaciers.

Today, climate change can already be observed world-wide. For instance, mean temperature in Europe has risen by 0.95°C since 1900; this is higher than the global average increase of 0.7°C (+/- 0.2°C). In different regions of northern Europe, precipitation has increased over the past 100 years by 10-40% whilst southern Europe recorded a decline of up to 20%. During the same period, there were fewer cold days and more hot days.[1] In addition to this, all of the ten hottest years observed since 1861[2] occurred after 1990 (refer to Fig. 1). These include all years from 1997 to 2003.[3] During the past century, sea level rose on a global average by 10 to 20 cm, and this increase has in fact accelerated in recent years.

Area covered by snow (annual average) in the northern hemisphere have declined by 10% since 1960, and the annual duration of the freeze-up of lakes and rivers has decreased by around 14 days. Over the subtropic latitudes, on the other hand, rainfall has decreased. The latest, reliable findings from recent years showed that most of the increases in temperature that occurred in the past 50 years are due to anthropogenic activities.[4]

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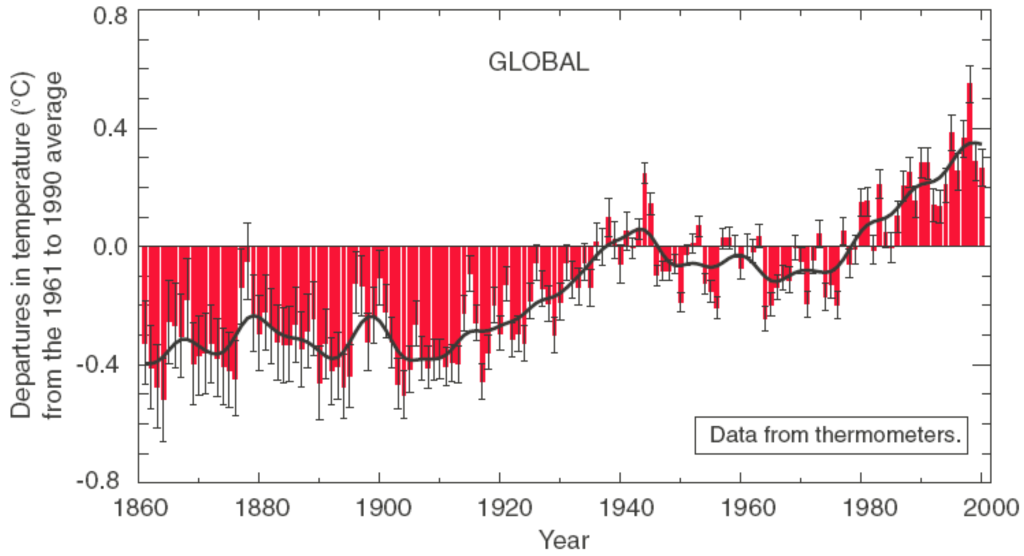
[1] EEA 2004: Impacts of Europe's changing climate, an indicator-based assessment, Luxembourg.

[2] Since 1861, the density of systematic weather observation has been sufficient for statistical evaluation.

[3] Data compiled by the British Met Office and University of East Anglia for the World Meteorological Organization (WMO), refer to the press release at: http://comm.uea.ac.uk/press/release.asp?id=325.

[4] The climate changes observed, including rising temperatures, cannot be plausibly explained by natural factors alone. Figure A1 (appendix) shows that both natural **and** anthropogenic factors (above all, the increase in greenhouse gas emissions resulting from human activities) must be considered if a satisfactory match is to be reached between model results and observations.

Fig. 1: Combined annual land-surface air and sea surface temperature anomalies (°C) 1861 to 2000,



Source: IPCC – Intergovernmental Panel on Climate Change (ed.), 2001: Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the IPCC. *Cambridge: Cambridge University Press. The error bars (I) indicate measuring uncertainties.*

Climate change in Germany

Between 1990 and 1999, Germany experienced its warmest decade of the 20th century. Nine of these years and all of the years up to now of the 21st century were above the long-term average (8.3 °C).

Mean temperature has risen in the past 100 years by 0.8°C (i.e. by an average of 0.08°C per decade), although a significant acceleration in temperature rise to 0.17°C per decade was seen in the recent decades. This warming trend shows seasonal differences, for instance, warming in winter was found to be strongest in recent decades.

Mean precipitation has also increased in the past 100 years in Germany with significant regional and seasonal differences. The trend showed considerably more precipitation in west Germany, whilst precipitation in east Germany declined. Precipitation – just like temperature – increased more in winter than in summer.

Climate change, however, is not only seen in the changes in mean values of climate parameters, but also in the growing number of extreme climate events. These extreme events are of particular interest to both business and national economies due to their enormous damage potential. Although single events cannot be clearly attributed to anthropogenic climate change, it is still likely that extreme events will increase and become more extreme as climate continues to change. British scientists noted that human-induced climate change has doubled the likelihood of events such as the heat wave in the summer of 2003.[5]

Impacts of climate change world-wide

In recent decades in particular, climate change has led to more frequent and more intensive drought in some parts of Africa and Asia. Since 1970, the Pacific Ocean has seen more frequent, more persistent and intensive temperature anomalies (so-called "El-Niño events“), often with adverse effects, for instance, on human health, settlements, on agriculture and forestry.[6]

Between 1850 and 1980, Alpine glaciers lost almost half of their mass. In the years that followed up to 2000, another 20-30% of the remaining glaciers melted with another 10% lost alone during the dry, hot year of 2003. This development can be observed in all glacier regions (with the exception of the Norway's coastal glaciers and the glaciers in New Zealand). The extent of Arctic sea ice has decreased over the past 25 years by around 7%, with around 5.3 days added every ten years to the summer melt season. Ice thickness decreased by around 40% over the past 40 years.

The insurance industry is also feeling the effects of climate change. Around 64% of major disasters in Europe and 79% of the resultant economic damage since 1980 have been directly linked to climate and weather (such as storms, floods). Another 25% of events, such as landslides, avalanches, drought periods and heat waves, are

[5] Stott, P. A., Stone, D. A. & Allen, M. R. 2004: Human contribution to the European heat wave of 2003, Nature 432, 610–614.

[6] IPCC 2001: Climate Change 2001, The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the IPCC. Cambridge: Princeton University Press.

indirectly linked.[7] On average, the number of major disasters in the 1990s almost doubled compared to the previous decade.

Single extreme events in Germany illustrate the damage potential that such events can bring.

Flooding in August 2002

In November 2002, the Federal Government reported the overall economic damage of the flood disaster for Germany to be €9.2bn. 18 deaths were recorded in Germany and almost 200 in Europe.[8]

Heat wave in Europe in August 2003

An area covering several million square kilometres was hit by this heat wave (France, Spain, Portugal, Italy, Germany, Switzerland, Austria, the UK, Benelux countries, Poland and Slovakia). According to reinsurance companies, extensive damage was caused particularly in agriculture (US$12.3bn). Forest fires also caused extensive damage (US$1.6bn in Portugal alone).[9]

The International Red Cross reported that in the first two weeks of August 2003, between 22,000 and 35,000 more people died in Europe than expected with normal summer temperatures. According to conservative estimates by Germany's National Meteorological Service (Deutscher Wetterdienst, DWD), 7,000 additional deaths were recorded in Germany. This was why DWD came to the conclusion that – in terms of the number of deaths – this heat wave was the biggest natural disaster in Europe in the past 500 years.

These climate changes and their effects are the climate system's response to greenhouse gas emissions up to the mid-1970s. Due to the inertia of the climate system, the effects of greenhouse gas emissions over the past decades have yet to come. The greenhouse gases which we will emit in the future will even worsen this "historical burden".

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[7] Wirtz, A. 2004: Naturkatastrophen in Europa, Münchner Rück, unpublished.

[8] Münchner Rück insurance company, Topics, Jahresrückblick Naturkatastrophen 2002.

[9] Schär, Ch. and Jendritzky, G. 2004: Hot news from summer 2003, Nature 432, 559–560.

2. Future climate change and its effects

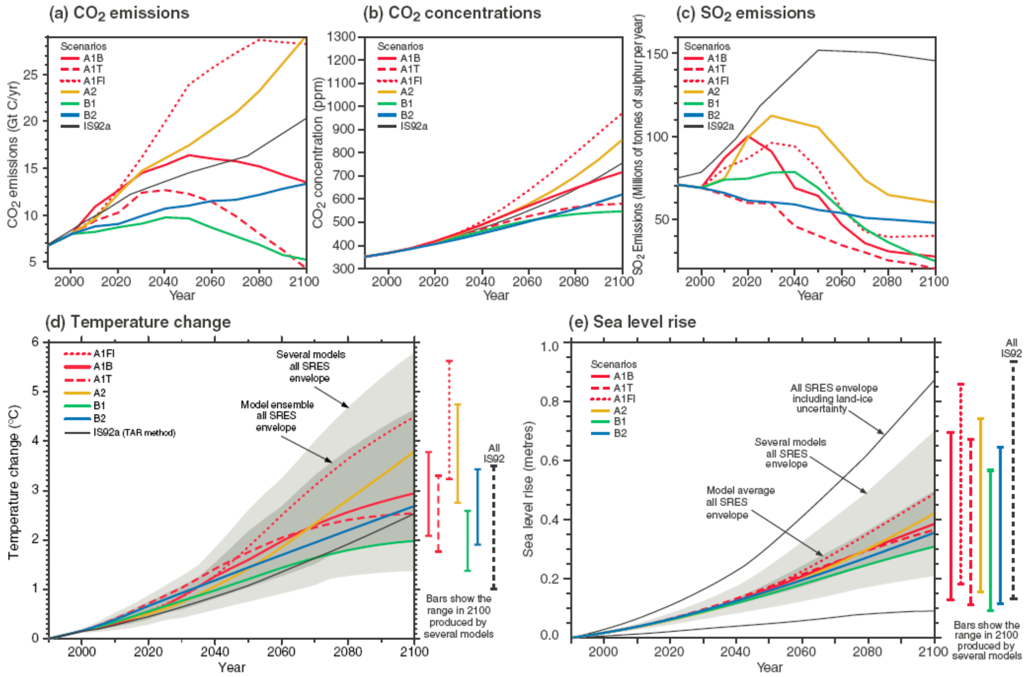
> If greenhouse gas emissions are to continue at the current rate, further warming by 1.4 to 5.8°C can be expected by the year 2100, along with serious consequences for mankind and the rest of nature, such as a rise in sea level by another 9 to 88cm. Even at the lower end of this temperature scale, there is a risk that most of Greenland's ice sheet will melt and that sea level rises by up to 7m in the long term.

If current emission trends were to continue, then carbon dioxide concentrations in the atmosphere would rise from today's 370ppmv[10] to between 540 and 970ppmv by the year 2100. The level before industrialisation was around 280ppmv. This means that global mean temperature would rise by an additional 1.4 to 5.8°C.

In order to analyse future climate change, various scenarios were developed, each with different assumptions concerning the development of anthropogenic greenhouse gas emissions (refer to the coloured lines in Fig. 2). All the scenarios show a clear rise in both temperature and sea level. The coloured bars on the right edge of Fig. 2 show the uncertainty range for the respective scenarios. The grey area in part (d) marks the entire range of temperature change to be expected during this century (1.4-5.8°C).

[10] The abbreviation ppmv stands for "parts per million“ and refers to the volume share of a gas per 1 million parts. 370ppmv thus means 370 for each 1,000,000 volume parts.

Fig. 2: The Global Climate of the 21st century



Source: IPCC – Intergovernmental Panel on Climate Change (ed.) (2001): Climate Change 2001: Synthesis Report. Contribution of Working Groups I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press. Summary for policymakers.

Even following the successful stabilisation of greenhouse gas concentrations, temperature will continue to rise for decades and sea level for centuries due to the inertia of the climate system. Up to the year 2100, sea levels can be expected to rise by another 9-88cm.[11]

This is why further serious impacts of climate change can be expected for the future with increasing expected risks as temperature rises. The scenarios show that certain climate impacts increase gradually whilst others could rise both quickly and abruptly if temperature rise were to exceed certain thresholds. If global mean temperature were to increase by 1-2°C above the pre-industrial level, this would mean, for instance, that Greenland's ice would be likely to melt over the next 1,000 years and sea levels could be expected to rise as a result of this by up to 7m. With an increase in

[11] This range is the result of a compilation of the results from various models. Compared to the IPCC's Second Assessment Reports, this range was narrowed slightly, however, it still remain fairly large.

temperature of more than 2°C, the Thermohaline Circulation in the North Atlantic can be expected to weaken or shut down. The risk of the West Antarctic ice sheet collapsing would increase and this would lead to a rise in sea level by another 4-6m over a period of 300 to 1,800 years.[12] Processes of this kind would not only have disastrous consequences for coastal regions world-wide, they would also be practically irreversible.

With all the uncertainties of the climate scenarios, it is vital that such large-scale and serious effects be avoided. Feedbacks in the climate system further add to these risks which - beyond a certain temperature rise – could lead to a self-acceleration of climate change, for instance, a strongly reduced uptake of carbon in oceans and the terrestrial biosphere or a change in sunlight absorption and reflection (albedo) due to the retreat of the Arctic Sea ice.

A warming of just a few degrees can seriously damage many ecosystems. A rise of 1-2°C in temperature results in a shifting of habitats to other regions in the case of 15-20% of all ecosystems. This threatens, for instance, the habitats of salmon in the US and of polar bears in the Arctic. A temperature rise of more than 2°C would put at risk half of the Baltic and Mediterranean habitats for migrating birds and would mean the complete loss of valuable ecosystems, e.g. Australia's Kakadu wetlands which have been listed as a World Heritage site.[13]

Economy is also affected by the consequences of climate change, initially with clear regional differences. Above all, food and water supply are at risk.[14] Experts believe that a temperature rise of less than 1°C would already mean considerable losses for Africa, somewhere in the region of 4% of economic performance (GDP). A warming of more than 2°C and upwards would mean that significant, global net losses for national economies will have to be expected – i.e. the losses suffered in all regions

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[12] Estimations of the risk and speed of a full-scale collapse of the West Antarctic ice sheet still diverge considerably. However, this risk is increasingly estimated as being higher with the disintegration of the Larsen A and B ice shelves. Examples of the risks of abrupt, large-scale events are listed in Table A1 in the appendix.

[13] Examples of the effects on ecosystems can be found in table A2 (appendix).

[14] Examples of the effects on food security and water can be found in table A3 (appendix). For examples of the effects on human health, refer to table A4 (appendix).

and sectors together would outweigh any benefits which may occur in other regions and sectors. The adverse impacts of climate change are expected to fall disproportionately on developing countries and, in particular, on poor groups of the population and will threaten their livelihood. More frequent flooding in developing countries will result in more widespread respiratory disease and diarrhoea together with malnutrition as a consequence of harvest losses caused by climate change.[15]

In industrial nations too, long hot periods will increasingly threaten health, above all, of the older and weak, especially those in urban areas.

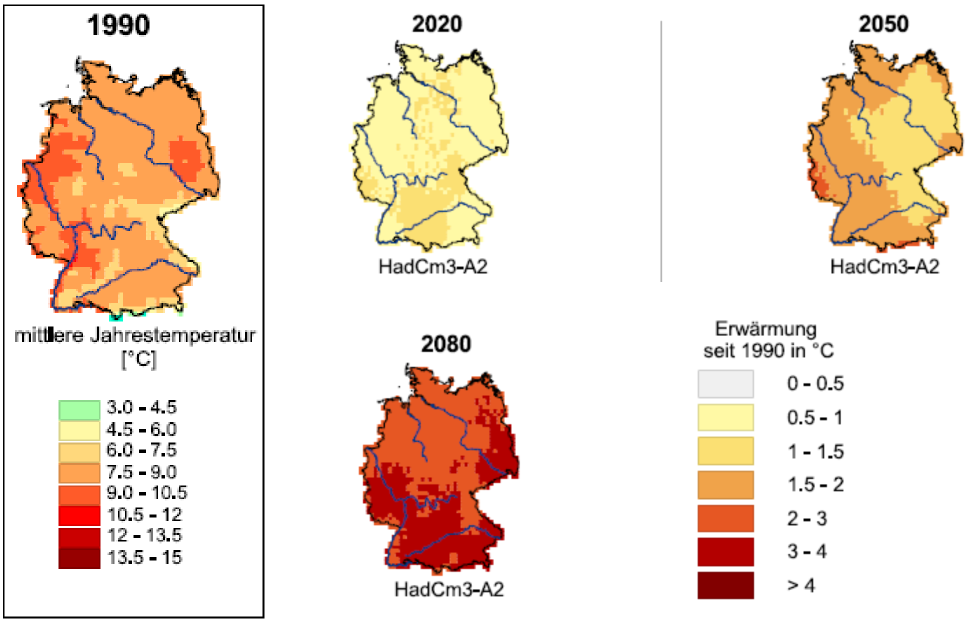
In light of the very different and serious consequences of even a slight change in temperature, the increase in temperature of 1.4-5.9°C forecast by the Intergovernmental Panel on Climate Change (IPCC) if no climate protection measures are introduced is unacceptable.

Future climate change and consequences for Germany

Without effective climate protection, climate in Germany will also continue to change. According to model calculations, a significant warming of around 0.8-1.8°C could take place by the year 2050 (refer to Fig. 3). This will be more pronounced in the south west than in the north east and also more pronounced in winter than in summer.

[15] Examples of the effects on economies can be found in table A5 (appendix).

Fig. 3: Change in annual mean temperature in Germany



Source: Cramer, W. u. a. 2005: Klimawandel und Klimaanpassung in Deutschland - Vulnerabilität klimasensitiver Systeme, UBA report FKZ 201 41 253, Berlin.

Precipitation is more likely to increase in winter and to decline in summer. This can ultimately lead to warmer, wetter winters and hotter, drier summers.

With a view to extreme climate events, it is very likely that heat waves will become more frequent and the number of frost days will decline. It is also considered likely that the frequency and intensity of heavy precipitation – above all in winter – will increase. The incidence of storms is also likely to increase.

These climate changes will have implications for human health, agriculture and forestry, water management, coastal and flooding protection, power stations and building systems, urban development, the tourism industry, the insurance and finance sector, nature conservation and power generation.

3. Limiting the rise in temperature and the required action goals

> Recent findings show that the climate system is more sensitive than originally believed to an increase in greenhouse gas concentration levels. In order to ward off dramatic damage, it is necessary to limit the increase in global temperature to a maximum of 2°C compared to pre-industrial levels. Above this range, experts expect wide-spread disturbance of biosphere and water balance, and abrupt climate changes will become more likely. In order to maintain this "2°C target", atmospheric greenhouse gas concentrations must eventually be stabilised at 400 parts per million (ppm) of CO_2 equivalents. This means: The increase in global emissions must be brought to a halt over the next 10 to 20 years. Following this, emissions will have to be reduced by 2050 to less that half of today's level - or one quarter of the "business as usual trend“ (i.e. an emission increase of close to 20% per decade). Fairness to the developing countries requires that emissions by industrialised nations would have to decline even more stringently by 80% by the year 2050 compared to the year 1990 as the reference level.

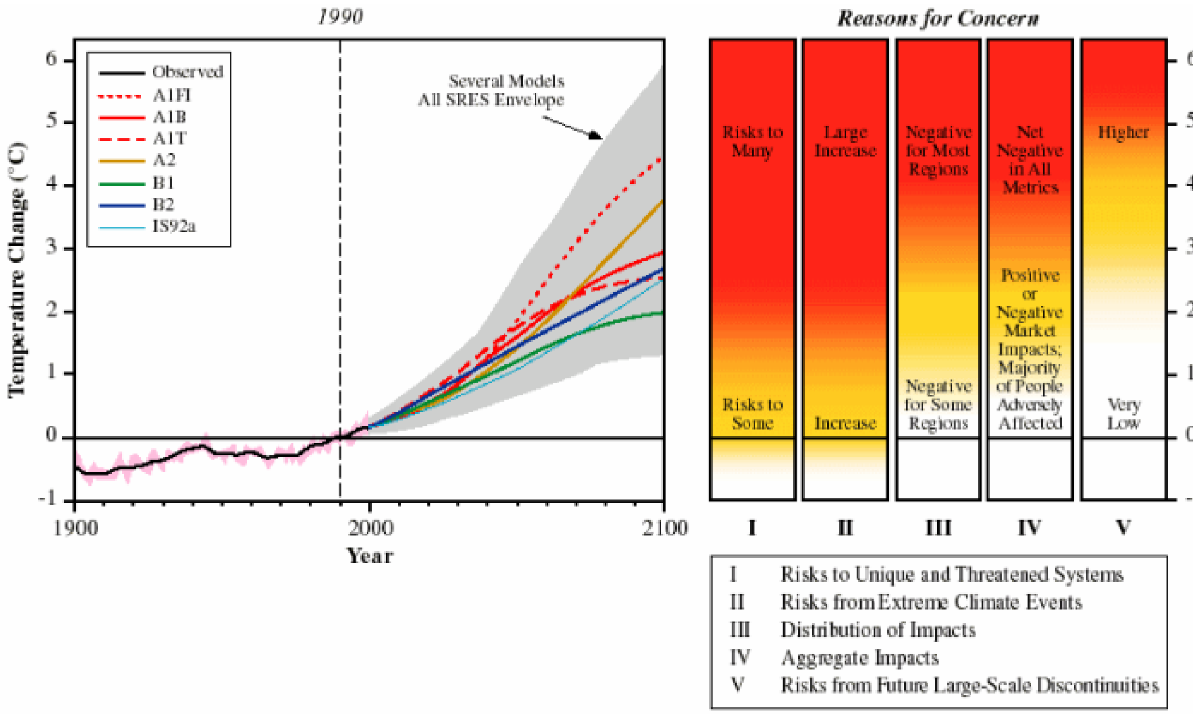
The aims contained in the statement above constitute an interpretation of Article 2 of the Framework Convention on Climate Change in which the community of nations laid down the environmental goal of *"stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.“*

Such an interpretation assumes an understanding of the risks involved in climate change, i.e. those that are deemed to be tolerable and those that are not. These are ultimately value decisions that are, however, based on facts and which are supported by the application of ethical principles.[16]

[16] Ethical principles and their application in the interpretation of Article 2 of the Framework Convention on Climate Change are presented in detail in Konrad Ott et al. 2004: Reasoning goals of climate

With its "Reasons for concern" concept, the Intergovernmental Panel on Climate Change (IPCC) has supplied policymakers with a tool to identify "dangerous" climate change. This concept describes the relationship between temperature rise and the risk of adverse impacts for unique and threatened ecosystems (e.g. the habitat of polar bears), the occurrence of extreme climate events (e.g. drought, storms and heavy rainfall), the distribution of impacts, aggregate impacts and the risk of future, large-scale events (e.g. shut-down or weakening of the Thermohaline circulation or the disintegration of the West Antarctic ice sheet). The IPCC does not, however, specify any defined levels above which risks are no longer tolerable (refer to Fig. 4).

Fig. 4: Reasons for concern about projected climate change impacts



The left panel displays the observed temperature increase (relative to 1990) and the scatter range of the projected temperature increase (after 1990). The right panel displays a concept with five reasons for concern regarding climate change risks evolving through 2100. White indicates neutral or small negative or positive impacts or risks, yellow indicates negative impacts for some systems or low risks, and read means negative impacts or risks that are more widespread and/or greater in magnitude.

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protection. Specification of Art. 2 UNFCCC. Umweltbundesamt Berlin, FKZ 202 41 252. Priority rules with relevance for climate change can be derived from ethical principles. These priority rules are listed in overview A1 in the appendix.

Based on the expected impacts of climate change as shown in chapter 2, an overall assessment is needed on the level at which the risks of a certain rise in temperature are to be seen as "dangerous". The preservation of ecosystems, sustainable, positive economic development and the protection of food production, which are added as ancillary conditions to the goal formulated in the Framework Convention on Climate Change, could serve as central criteria.

If the universal and inter-subjective validity of certain ethical principles is recognised, then a temperature rise of 1 °C above pre-industrial levels would have to be classified as dangerous and would require effective countermeasures.
It should be possible to *regionally* secure food production world-wide at a certain minimum share yet to be defined. Global warming of just 1°C additionally threatens up to 800 million people with water scarcity or hunger, this figure will even rise to 3 billion people in the case of a warming of more than 2°C. Another factor that aggravates this situation further is that in some regions world-wide food supplies are faced with inadequate trade structures and insufficient buying power to secure subsistence.[17] Current findings on future climate change unfortunately indicate that certain ecosystems, habitats and species in many regions will already be unable to adapt to climate change and its impacts with a temperature rise of even less than 1°C. The impacts on ecosystems and national economies as well as the risk of large-scale, irreversible climate events increase significantly with a warming of between 1°C and 2°C.

All in all, it becomes clear that serious damage must be expected even with a temperature increase of less than 2°C. Beyond this threshold, damage and risks increase dramatically. The current state of knowledge thus supports, that a warming of 2°C compared to the pre-industrial age has to be defined as a strict upper limit for a global increase in temperature.[18]

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[17] Refer to Ott, K. et. al 2004: Reasoning goals of climate protection. Specification of Art. 2 UNFCCC. Umweltbundesamt Berlin, FKZ 202 41 252.

[18] Although limiting the rise in global temperatures to much less than 2°C is worth striving for, present knowledge suggests that in practical terms this is an unrealistic guiding goal for action. From a political point of view, it is probably impossible to implement the very drastic reductions in emissions that are needed in the short term. A temperature increase of 0.7°C has already been recorded up to now. Even if all anthropogenic emissions of greenhouse gases were to immediately cease, temperatures would

Based on the IPCC's Second Assessment Report and the serious climate risks described therein, the Council of EU Environment Ministers passed a resolution already in 1996 that the rise in mean global temperature should not increase by more than 2°C above the pre-industrial level. The European Council affirmed this goal in March 2005. Such long-term limitation of mean global temperature rise requires that the concentration of greenhouse gases in the atmosphere be stabilised as formulated as a goal in the Framework Convention on Climate Change. Due to the remaining uncertainties, a target value for greenhouse gas concentration can only be derived as a probability statement.[19]

Figure 5 shows that if greenhouse gases are stabilised at 400ppm for all Kyoto gases, the risk of temperature rising by more than 2°C on average would be around 25%. If, in this case, warming is to be avoided with a likelihood of at least 75%, then the aim would have to be to stabilise the concentration of greenhouse gases below 400ppmv for all Kyoto gases (around 360ppmv of CO_2).[20] Stabilising at 550ppm of

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still rise higher than 1°C above the pre-industrial level (refer to Hare, B. and Meinshausen, M. 2004: How Much Warming are we Committed to and How Much Can be Avoided?, PIK report No. 93).

[19] It is not possible to state precisely which greenhouse gas concentration leads to which increase in temperature because scientific uncertainties still exist with regard to this climate sensitivity. Climate sensitivity of 2°C would therefore mean that with a greenhouse gas concentration of 550ppmv of CO_2 equivalents (all Kyoto gases), a temperature increase of 2°C relative to the pre-industrial age would occur. Scientists at the IPCC also assume that this climate sensitivity is somewhere between 2 and 4°C. Refer to the IPCC Working Group I Workshop on Climate Sensitivity - Workshop held in Paris, France, 26–29 July 2004,

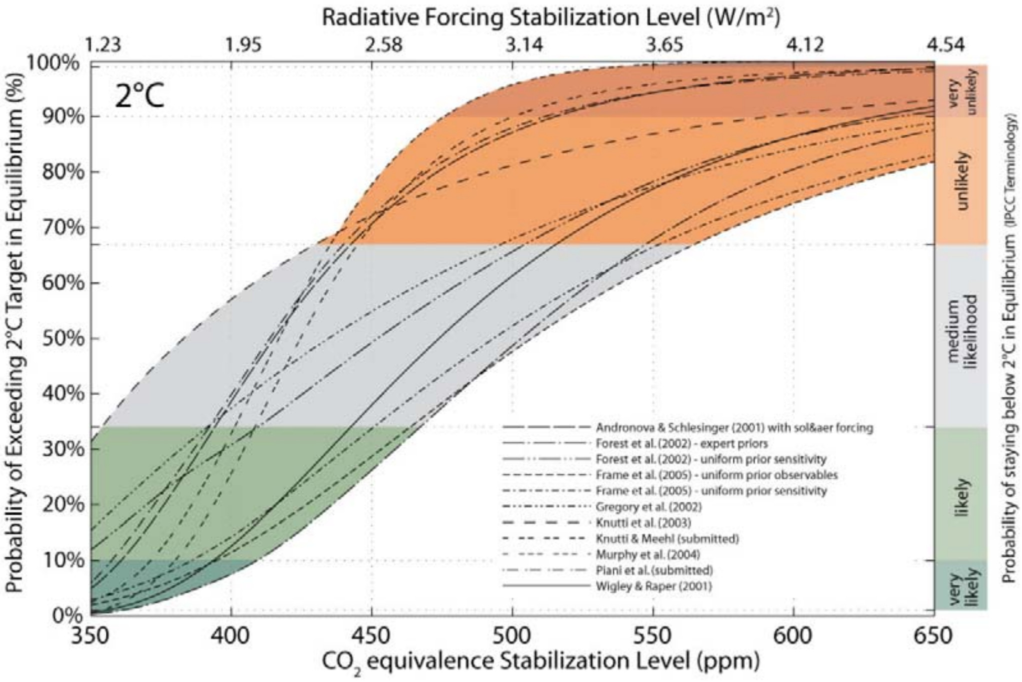
Details under http://ipcc-wg1.ucar.edu/meeting/CSW/product/CSW_Report.pdf

The conclusion derived from this workshop: Kerr, R. A. 2004: Three Degrees of Consensus in *Science* 13 August 2004; 305: 932-934

[20] Meinshausen and Hare (2004) use this IPCC terminology for statements on likelihood. According to these statements, an overshooting of the 2°C target is only considered to be "unlikely" (i.e. the risk is less than 33%) if the greenhouse gas concentration is stabilised below 360ppmv of CO_2 or 400ppmv of CO_2 equivalents. The chance of adhering to the 2°C temperature limit is on average more than 74%. Source: Hare, B. and Meinshausen, M. 2004: How Much Warming are we Committed to and How Much Can be Avoided?, PIK Report No. 93. Other examples of such likelihood density functions can be found in Jones, R.N. 2003: Managing the risk of climate change. Paper prepared for the OECD Project on the Benefits of Climate Policy, 12-13 December 2002, Paris, ENV/EPOC/GSP(2003)22/FINAL.

CO_2 equivalents (all Kyoto gases), on the other hand, would merely mean a chance of around 1 to 6 (16%) of remaining below the 2°C temperature increase.

Fig 5**:* ***Risk of a global warming of more than 2°C



Risk of a more than 2°C increase in relation to pre-industrial temperatures for various stabilisation levels of greenhouse gas concentrations, source: B. Hare, M. Meinshausen, October 2004: How Much Warming are we Committed to and How Much Can be Avoided?, PIK Report No. 93.

Since today's concentration of CO_2 in the atmosphere, i.e. 370ppmv, is already above the target concentration of around 360ppmv, it must be lowered in the long term to below today's level. A temporary "overshooting" of this long-term limit for greenhouse gas concentrations does not automatically lead to an overshooting of the 2°C temperature target due to the inertia of the climate system. However, suitable measures must be taken in order to lower greenhouse gas concentrations as quickly as possible.[21]

Necessary long-term reductions in global emissions

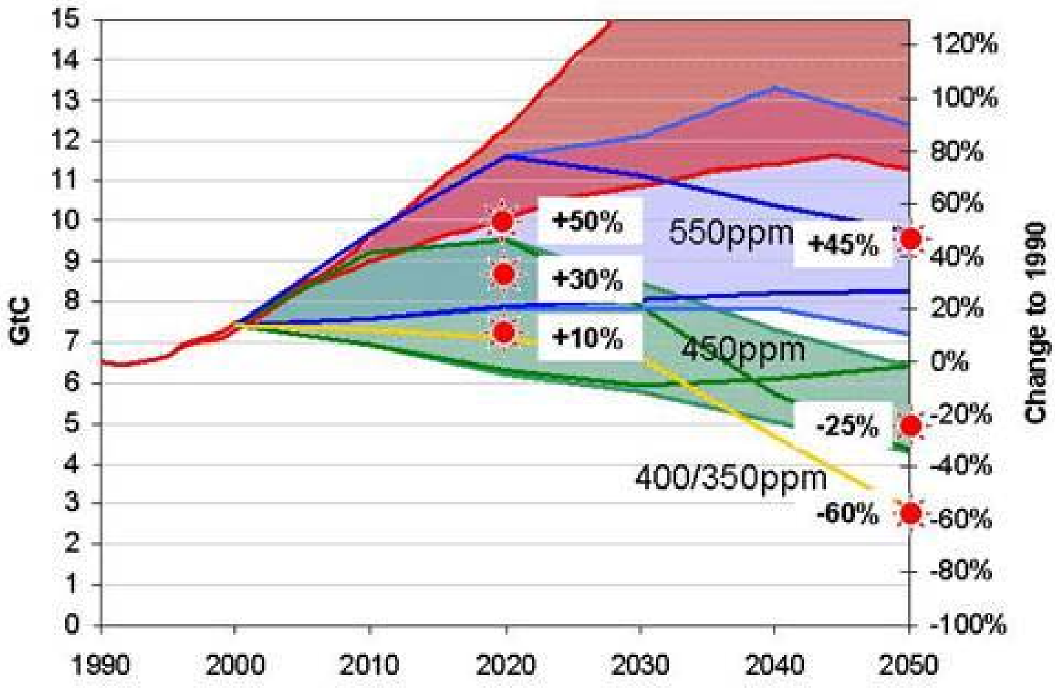
Current studies on the stabilisation of greenhouse gas concentrations below 450ppmv show that the necessary global reduction in greenhouse gas emissions up to the year 2050 is around 45-60% in relation to the 1990 level (refer to Fig. 6).[22]

In order to reduce the risk of overshooting the 2°C limit to less than 25%, global reductions in greenhouse gas emissions by 2050 are necessary in the order of more than 50% (relative to 1990). Compared to the business-as-usual scenario described in chapter 5, this means a reduction of more than 80%.

[21] For this purpose, emissions must be lowered in the long term to below the carbon levels taken up by oceans and the biosphere. In addition to this, for instance, the CO_2 discharged in biomass power stations could be stored in geological formations. This would "withdraw" from the atmosphere in total as much CO_2 as the biomass took up whilst growing.

[22] WBGU recommends that in order to adhere to the 2°C limit and hence stabilisation goals of below 450ppmv of CO_2, a global emission reduction of 45-60% by 2050 compared to 1990 must be targeted, in WBGU 2003: Climate Protection Strategies for the 21st Century: Kyoto and Beyond, Berlin, p. 2. Meinshausen et al. assume that emissions (including those resulting from land use) will have to be reduced by 50% compared to 1990 if greenhouse gas concentrations (Kyoto gases) are to be stabilised at 400ppmv of CO_2 equivalents. In the case of 450ppmv, this is around 30% (Meinshausen, M., W. Hare, T. Wigley, D. van Vuuren, M. den Elzen, R. Swart "Multi-gas emission pathways to meet climate targets" submitted at "Climatic Change").

Fig. 6: ***Possible CO_2 emission pathways up to 2050***



The red markings are examples of possible emission values in 2020 and 2050 for the three stabilisation levels considered. With regard to 400ppmv of CO_2, emissions in 2020 could then still be 10% above the 1990 level and in 2050 would have to be around 60% below this level. With regard to 450ppmv of CO_2, emissions in 2020 could still be 30% above the 1990 level and in 2050 would have to be around 25% lower than the 1990 level.
Source: Höhne et al. 2005: UBA Berlin, Climate Change series 2/05, FKZ 203 41 148/01.

In any case, the current increase in emissions must be stopped over the next 10-20 years and a significant reduction is necessary thereafter. Fairness to developing countries requires that emissions by industrialised nations would have to decline disproportionately, by at least 80%, by the year 2050 in relation to the 1990 reference year. This corresponds to a 10-tonne reduction in annual per-capita emissions of CO_2 from today's average of 12 tonnes to about two tonnes. The faster this takes place the more leeway will become available to newly industrialised and developing countries for a temporary increase in emissions. By the end of the 21st century, greenhouse gas emissions world-wide should be reduced to below two tonnes per capita.

4. Adapting to the impacts of climate change

All nations must nowhave to protect themselves against the consequences of climate change by reducing damage already caused today by climate change to agriculture, forests, infrastructure and human settlements. Developing countries need the support of the industrialised nations who largely caused climate change. The budgets provided by various funds so far are insufficient for this task - adaptation must be integrated as a central aspect into general planning and co-operation on development. However, adapting to the consequences of the enhanced greenhouse effect will only alleviate rather than solve the problem of climate change.

International climate negotiations initially focused on emission control and reduction.[23] Where, how and to what extent measures are necessary in order to adapt to climate change and its impacts and how the related costs can be covered: these are questions that are being increasingly raised especially by developing countries. The Parties to the Framework Convention on Climate Change have repeatedly emphasized that short-term, effective adaptation measures were necessary. For instance, the industrialised nations have declared their willingness to support developing countries in their adaptation measures.[24] However, the budgets provided through international climate protection agreements alone will not suffice for the adaptation measures that are needed in the long term.

Due to the close links and difficulty in distinguishing between adaptation to climate change and general measures of development co-operation, it is advisable to handle adaptation to a large extent in the context of existing development co-operation. One

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[23] Cf. Najam, A., Huq, S. and Sokona, Y. 2003, "Climate negotiations beyond Kyoto: developing countries concerns and interests", Climate Policy, 3 (2003) 221-231, and H. Ott, B. Brouns, H. Winkler, S. Kartha, M.J. Mace, S. Huq, Y. Kameyama, A.P. Sari, J. Pan, Y. Sokona, P.M. Bhandari, A. Kassenberg, E. La Rovere, A. Rahman, 2004, "South-North Dialogue - Equity in the Greenhouse", GTZ, PN 2001.2184.8, available at: http://www.wupperinst.org/download/1085_proposal.pdf.

[24] Refer also to "Delhi Declaration" of the 8th Conference of the Parties to the Convention in New Delhi 2002 http://unfccc.int/resource/docs/cop8/07a01.pdf.

necessary precondition for the long-term ability of poorer countries to adapt to climate change is their sustainable, positive economic development.

The longer climate continues to change unchecked, the more hefty the impacts will be in the future, and this will in turn lead to greater damage and higher costs for adaptation measures. In addition to this, adaptation is practically no longer possible in the case of certain climate changes or once impacts have reached a certain extent. In light of this, a significant reduction in greenhouse gas emissions must be seen as a priority and more efficient long-term form of "adaptation".

Contrary to widespread opinion, adaptation is not just a necessity for developing countries. Climate change and its impacts have already begun to affect industrialised nations too. Extreme climate events in recent years, such as storms, flooding and periods of drought, have caused considerable damage to business and economies. Without suitable climate protection, the climate change currently observed will increase in the future, leading to further, clearly negative impacts on humans and their natural environment. This is why – in addition to climate protection measures that are effective in the long term (reduction of greenhouse gas emissions) – industrialised nations must also introduce adaptation measures.

Establishing a competence centre on "Climate Impacts and Adaptation" at the Federal Environmental Agency

Germany is also called upon to develop an adaptation strategy that can be integrated into the German climate protection strategy. Since adaptation requirements need to be analysed and measures introduced in Germany, the Federal Environmental Agency is preparing to set up a "Climate Impacts and Adaptation“ (KomPass) competence centre.

The work of the KomPass centre at the Federal Environmental Agency will be orientated towards the following goals:

- to compile knowledge concerning future risks of climate change in a generally understandable form and to communicate this to decision makers and the public at large;
- to establish a network – comprising players from business, administration and politics – in order to guarantee the capture and flow of information;
- to identify suitable regional adaptation measures and to support the implementation of these measures on various levels (municipal, regional, national);
- to identify, evaluate and communicate strategic elements for recommendations for action;
- to operate PR activities geared towards different target groups in order to boost awareness for the climate protection measures needed.

The work of the competence centre will help us to recognise the risks of climate change in Germany and to communicate these risks to decision-makers. By doing so, KomPass will make it possible to adequately combat these risks.

5. Global emission trends

> The community of nations has so far failed to stabilise global emissions and to reverse the rising trend. The Kyoto Protocol contains emission reduction obligations only for industrialised nations by an average of around 5% of their 1990 emissions. This important first step was hard fought for politically and is a major success for international environmental policy, however, it is not enough. The agreed emission reductions by industrialised nations of around 1 billion tonnes of CO_2 equivalents (by 2012) are already more than offset by a global increase in emissions by some 3 billion tonnes.

The necessary reduction of greenhouse gas emissions must be seen with a view to the strong increase in global emissions that is expected for this century. The Intergovernmental Panel on Climate Change (IPCC) has developed scenarios to describe future emissions without climate protection measures (business as usual).[25] These are based on the different assumptions concerning basic social and economic developments in the world. A medium scenario (A1 AIM) is used here as an example. This scenario is based on the assumption that by 2050 CO_2 emissions world-wide will increase to 230% (60 gigatonnes of CO_2) of the 1990 level (26 gigatonnes of CO_2), and by contrast, to around 120% "only" in the OECD countries.[26]

Against this backdrop, the long-term reduction in greenhouse gas emissions needed requires that the growing trend be brought to a halt and emissions subsequently reduced drastically. The Kyoto Protocol for the years 2008-2012 foresees an average

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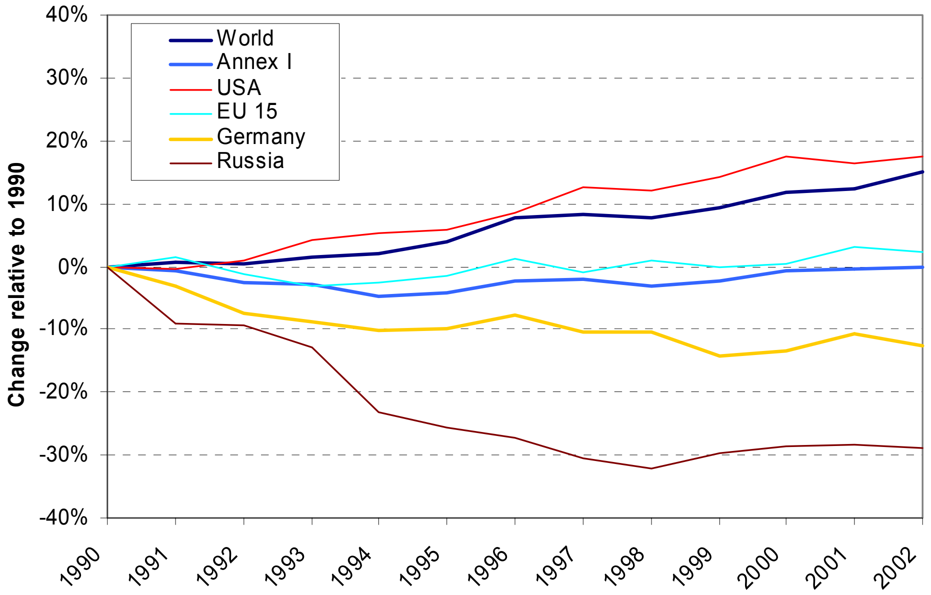
[25] In a special report, scenario families A1, A2, B1 and B2 (SRES scenarios) were developed which were each based on different assumptions concerning the degree of international interaction in economics and lifestyle. Scenarios A1T, A1FI and A1B distinguish between different technical developments. Fig. A2 (appendix) provides an overview of the reference development (BAU) of emissions in relation to the different scenarios.

[26] The strong increase in emissions in developing countries is in part due to the fact that the IPCC scenarios (SRES) are based on recovering development in these countries. The International Energy Agency (IEA), for instance, sees less optimistic economic prospects for these countries together with lower emissions (cf. IEA 2004: World Energy Outlook, Paris.).

emissions reduction by industrialised nations of 5.2% or around 1 billion tonnes of CO_2 equivalents compared to the 1990 level. Emissions by the EU (15 member states) in 2003 were 1.7% below the 1990 level whilst emissions in Germany during the same period declined by 18.5%.[27] On the whole, CO_2 emissions by industrialised nations in 2002 were around the same level as 1990. The significant reduction in emissions in the former Soviet Union states and eastern Europe – which were in part due to a decline in economic activities – are confronted by a significant increase in emissions in the majority of western industrialised nations.

Fig. 7: Energy-related CO_2 emissions, 1990 to 2002



Source: International Energy Agency (IEA) 2004/2001: CO_2 Emissions from fossil fuel combustion, OECD, Paris.

The reduction targeted with the Kyoto Protocol will be more than compensated for by the increase in emissions in nations without quantitative emission reduction obligations. An increase of more than 3 billion tonnes in global greenhouse gas

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[27] Cf. European Environment Agency 2005: Annual European Community greenhouse gas inventory 1990-2003 and inventory report 2005, http://reports.eea.eu.int/technical_report_2005_4/en/EC_GHG_Inventory_report_2005.pdf.

emissions was already recorded in 2002.[28] Without additional climate protection measures, emissions can be expected to rise by another 1.5 billion tonnes by the year 2010.[29]

However, the Kyoto Protocol is an important first step in climate policy on the way towards solving the climate problems. It creates important framework conditions for the community of nations to co-operate on climate protection. The plausible implementation of the obligations undertaken by industrialised nations is a vital precondition for the involvement of other nations in climate protection efforts. The participating nations can thus gain experience and win the necessary trust and commitment of the business sector. Only if a true reduction in emissions is achieved in industrialised nations will it be possible to convince developing countries to go down the road of climate-friendly development.

[28] According to the World Resources Institute (2005), emissions of all Kyoto gases rose between 1990 and 2000 by 3.37 billion tonnes of CO_2 equivalents. The IEA (2004) recorded an increase in CO_2 emissions alone of 3.2 billion tonnes from 1990 to 2002.

[29] Cf. World Resources Institute 2005: Climate Analysis Indicators Tool (CAIT), http://cait.wri.org.

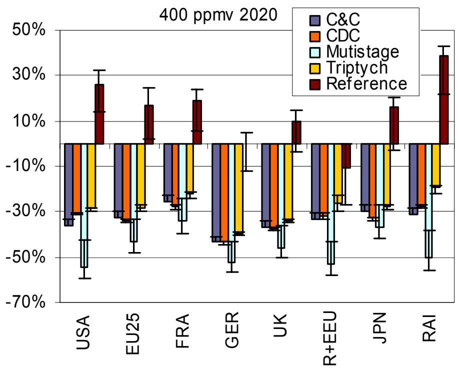
6. Reducing global emissions

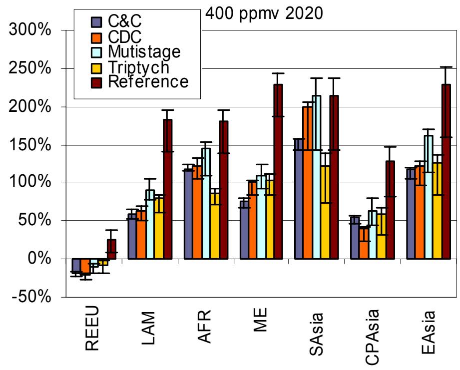
In order to achieve the long-term goal of the United Nations Framework Convention on Climate Change, global emissions will have to decline from 2020 on at the latest. This requires the participation of all nations in the long term. Emissions by industrialised nations will have to decline by one third till the year 2020 compared to the 1990 levels. In their Conclusions in March 2005, the EU Heads of State or Government endorsed this by calling upon industrialised nations to consider emission reduction targets in the order of 15 to 30 percent by the year 2020. The involvement of the US as the currently largest emitter of greenhouse gases and the participation of large developing countries – such as China, India and Brazil where strong increases in emissions will continue in the years to come – will be particularly important in light of the global nature of this challenge.

The Federal Environmental Agency's (UBA) assessment is, that the emission reduction targets agreed to up till now in the Kyoto Protocol are far too low to achieve successful international climate protection because global emissions will continue to rise too quickly. This trend must be stopped in the long term and a turnaround will have to take place. The longer emissions continue to increase the more difficult and expensive the unavoidable medium and long-term emission reduction measures will be. This is why more far-reaching emission reduction targets beyond the scope of the Kyoto Protocol must be agreed to on an international scale in the years to come.

All nations will be required to take part in this process – however, in different ways and to different extents. The Federal Environmental Agency has commissioned the examination of the results of various approaches towards the distribution of emission reduction contributions. Fig. 8 shows examples of reduction contributions that result from four selected approaches. The fifth bar on the far right shows the reference development that was used for each region. In the case of the EU(25), this results, for instance, in a reduction by 2020 of at least 30% compared to 1990, whereas emissions could be expected to increase by more than 15% if no new climate protection agreements are reached (BAU scenario).[30] The values for Germany for all the burden distribution scenarios presented show an emission reduction of at least 40% by 2020 relative to 1990. In the case of China (part of the CP-Asia region in Fig. 8), no climate protection measures would mean that greenhouse gas emission could be expected to rise by around 130%, whilst the various climate policy approaches examined hint to a 40-60% rise in emissions only compared to 1990.

Fig 8: ***Emission budgets according to different burden distribution approaches for selected regions/nations and pursuing a CO_2 stabilisation target of 400ppmv***





The values in the Figure above[31] refer to all Kyoto greenhouse gases, the stabilisation level, however, refers to CO_2 only. 400ppm of CO_2 correspond to around 470ppm for all greenhouse gases, whilst 450ppm correspond to around 550ppm for all greenhouse gases. Source: Höhne et al. 2005: UBA Berlin, Climate Change Series 2/05, FKZ 203 41 148/01. RF+ = Russia plus the Annex I countries from the former Soviet Union (without the Baltic states); RAI = other Annex I countries; RFSU = Rest of Former Soviet Union (without Annex I); LAM = Latin America; ME = Middle Ease; CP-Asia = China, North Korea, Mongolia.

These examinations show that it would only be possible to uphold the 2°C temperature limit if industrialised nations reduced their greenhouse gas emissions by 2020 by an average of one third compared to the 1990 reference year.

[30] Refer to statement 8 for an explanation on distribution approaches.

[31] The burden distribution approaches compared here are "Contraction and Convergence“ (C&C), "Common but differentiated Convergence“ (CDC), a four-stage approach (multi-stage) and Triptych, version 6.0. BAU refers to the reference development. For more details of the multi-stage approach, refer to statement 8.

This is why the Federal Environmental Agency (UBA) also supports the intermediate goal proposed by the German Federal Government to reduce EU greenhouse gas emissions by 2020 by 30% compared to 1990. Against this background, Germany has announced its commitment to a 40% reduction.[32] In the subsequent periods, emissions in Germany will need to be reduced more than 50% by 2030 and more than 40% in the EU compared to 1990. By the mid-21st century, emissions will have to be reduced to a fifth, i.e. by 80% compared to 1990. The Enquete Commission of the 14th German Bundestag "Sustainable Energy Supplies in View of Globalization and Liberalization" has shown the feasibility of this reduction for Germany.[33]

In March 2005, the European Council proposed considering emission reduction targets of 15-30% by 2020 compared to 1990 for industrialised nations.[34] These targets are continuously subjected to cost-to-benefit analyses. Furthermore, the Council of Europe referred to the resolution by the Council of EU Environment Ministers on 10 March 2005 which envisages a 60-80% reduction by 2050. From the Federal Environmental Agency's point of view, this would only be sufficient if today's industrialised nations were to commit themselves to the upper end of the values stated (-30% by 2020 and –80% by 2050).

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[32] The results depicted in Fig. 8 show that these reduction contributions hover at the edge of the spectrum that results from the different burden distribution approaches. In the multi-stage approach examined, the reduction contributions for Germany totalled more than 50% and more than 40% for the EU by the year 2020.

[33] Final report by the Enquete Commission of the 14th German Bundestag, "Sustainable Energy Supplies in View of Globalization and Liberalization", Bundestagsdrucksache 14/9400.

[34] Spring meeting of the European Council in Brussels on 22-23 March 2005, Presidency Conclusions, http://ue.eu.int/ueDocs/cms_Data/docs/pressData/de/ec/84347.pdf.
The Kyoto baseline year was stated as the reference year. This is usually 1990. In some countries, this can also be 1995 for the following greenhouse gases: sulphur hexafluoride, partially halogenated fluorohydrocarbons and perfluorinated hydrocarbons.

Involving the US as well as newly industrialised and developing countries

Participation by the US – as the world's largest emitter of greenhouse gases – in global emissions reduction is one of the key preconditions for the success of climate protection.[35] And not just with regard to reaching global climate protection goals, but also with regard to the success of multilateral co-operation. Whilst the current US government shows no signs of returning to multilateral negotiations, recent years have seen some change in the climate protection positions in the US federal states.[36] For instance, nine federal states in the north east are jointly planning with five east Canadian provinces to establish an emissions trading system and to bring greenhouse gas emissions down to the 1990 level by 2010. Such a system could in the future even be linked to the EU's emissions trading system and would thus provide an opportunity to achieve cost reductions, more widespread participation in climate protection and greater acceptance for climate protection (particularly within the US).

The US government's strategy has changed in as far as it no longer disputes that climate change is real. However, US concepts for suitable solution strategies diverge strongly from those of the majority of EU member states. The US is focusing primarily on the long-term reduction of non-CO_2 greenhouse gases, on so-called "clean coal"[37] and on hydrogen technology. Although no sufficient reductions in greenhouse gases can be expected in the short term in these areas, there could still be a potential starting point for greater co-operation, for instance, by co-ordinating tasks in the field of technology research and development and exchanging results.[38] The German-

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[35] The US is responsible for around 20% of global greenhouse gas emissions, followed by China (14.7%) and the EU25 with 14%.

[36] The majority of federal states now have plans in place for effective climate protection measures, beginning with partial goals for renewable energies right through to reduction targets for greenhouse gas emissions. Refer to Pew Center 2004: Climate Change Activities in the United States 2004 update. http://www.pewclimate.org.

[37] The aim of the "Clean Coal" initiative is to reduce emissions of sulphur and nitrogen compound and mercury. The efficiency of coal-fired power stations is also to be improved, so that carbon dioxide emissions per kilowatt of electricity generated will decline.

[38] Approaches already exist, for instance, within the scope of an IEA Implementing Agreement (IEA 1977) and the Climate Technology Initiative (CTI). In this context, efforts must be made in order to ensure that (i) these activities are not pursued at the expense of other technologies in the field of

American action programme for environmentally friendly and efficient energy, development and climate protection from February 2005 and its follow-up process emphasise the action fields of technology development and the greater use of more efficient and environmentally friendly technologies as well as improved energy efficiency.[39] In the same manner, the "Asian-Pacific partnership for clean development and climate" formed by US, Japan, Australia, China, India and South Korea on 28 July 2005 focuses on technological co-operation.[40]

In addition to US involvement, the proposed environmental quality goal (warming < 2°C) also requires co-operation with newly industrialised and developing countries. Five of these countries[41] are together responsible for around one quarter of today's global greenhouse gas emissions – this is comparable with the values for the US. By 2025, the share of these countries could increase to one third (refer to Fig. 9).[42]

At the G8 summit in July 2005, the heads of state or government of the leading industrialised nations adopted both the Gleneagles Plan of Action[43] on "Climate Change, Clean Energy and Sustainable Development" as well as dialogue in the G8 and with newly industrialised and developing countries, thus triggering a process that aims to achieve progress in the shaping of climate-friendly, sustainable energy policies. The International Energy Agency expects investment in the energy sector to total 16 billion US$ by 2030. The Gleneagles Plan of Action underlines the need to direct these investment flows into sustainable paths and to develop and improve framework conditions for markets. The G8 initiatives should be welcomed as a

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energy efficiency and renewable energies which promise short-term effects, (ii) hydrogen production is linked to renewable energy capacities and (iii) "clean coal" with carbon sequestration remains merely a bridging technology due to its uncertainties and limited storage potential.

39 Cf. http://www.bundesregierung.de/artikel-,413.792404/Deutsch-amerikanisches-Aktions.htm.

40 This is a non-binding declaration of co-operation in various fields of climate protection. The initiative is explicitly designed not to compete with the Kyoto Protocol, but is intended to merely supplement it. Refer to: http://www.state.gov/g/oes/rls/fs/50335.htm.

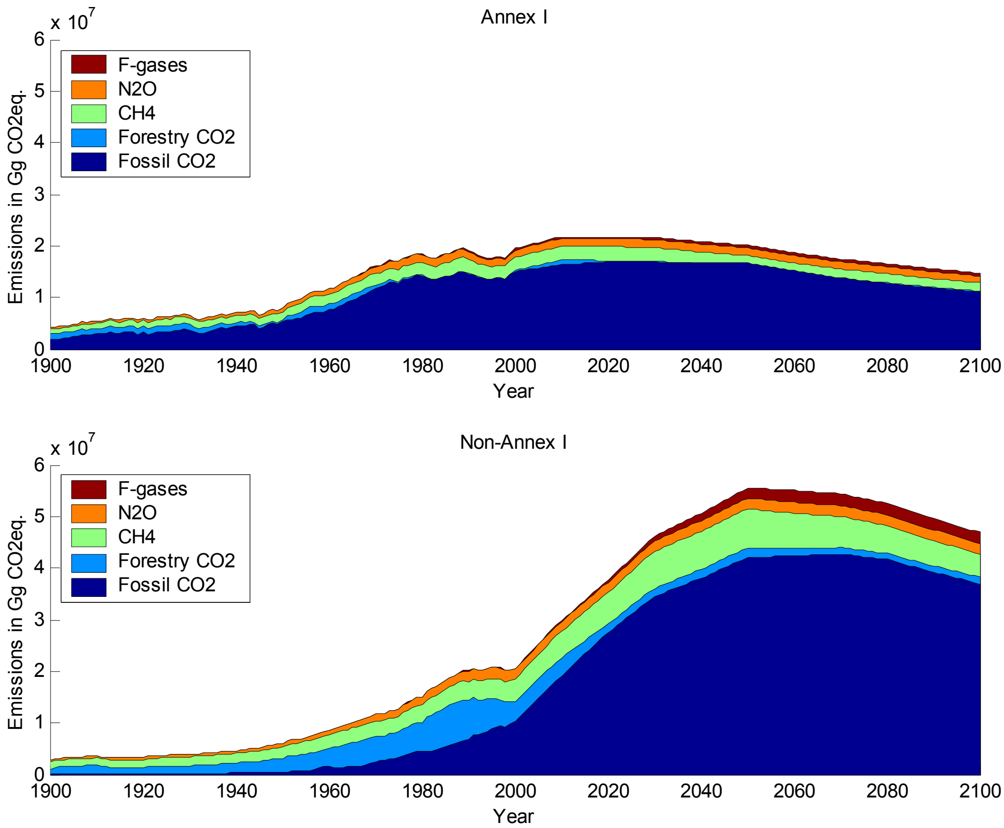
41 These are China, India, Brazil, Mexico and South Korea.

42 Among the newly industrialised and developing countries, China, India, Brazil, Mexico, South Korea, Indonesia, Iran and South Africa are of particular importance for the success of international climate protection, because these countries rank among the world's 20 largest emitters of greenhouse gases.

43 Cf. http://www.fco.gov.uk/Files/kfile/Klima_Aktionsplan.pdf.

bridging step. They contribute towards the necessary deepening and expansion of multi-lateral co-operation within the scope of the Framework Convention on Climate Change and the Kyoto Protocol.

Fig. 9: ***Historical and future emissions by Annex I and non-Annex I states***



Presented according to the IPCC SRES A1B scenario. Source: Höhne et al. 2003: UBA Berlin, Climate Change Series 1/03, FKZ 201 41 255. Annex I of the Framework Convention on Climate Change includes the EU25 states (except for Malta and Cyprus) in addition to the US, Canada, Japan, Australia, Russia, Ukraine, Belarus, Bulgaria, Iceland, New Zealand, Norway, Romania, Switzerland and Turkey. Non-Annex I covers all other countries.

7. Involving countries in different ways

Future international agreements and conventions on climate protection will have to adequately consider the different situations of the countries involved. Due to their higher greenhouse gas emissions – both past and present – and economic strength, industrialised nations are obliged to make a special contribution towards reducing greenhouse gas emissions. The principle of fairness – such as the polluter-pays principle, the ability-to-pay principle and development priorities – should guide the involvement of newly industrialised and developing countries in future international climate protection agreements.

When considering future contributions by individual nations towards reducing greenhouse gases, fairness criteria have a decisive role to play.[44] If the polluter-pays and ability-to-pay principles are recognised, then industrialised nations will be have to reduce their greenhouse gases more stringently due to their higher emissions and greater economic strength. Per-capita emissions of these countries are on average around 5 times higher than emissions by other countries.[45] Per-capita income in 1999 in industrialised nations and countries undergoing a transition to a market economy (Annex I)[46] was on average more than 15 times that in newly industrialised and

[44] Many authors have explored approaches towards the further shaping of the climate protection regime. During the course of this work, fairness criteria were identified that can be reflected in a differentiation of the timing and/or stringency of the respective commitments. The major criteria are the polluter-pays principle (historical emissions), the ability-to-pay principle (economic strength), the principle of need (development level), the sovereignty principle (allocation of emission rights on the basis of current emissions) and the principle of equity (equal emission rights per capita).

[45] Average per-capita emissions total 15.3t of CO_2 equivalents in the Annex-I countries compared to 3.2t in non-Annex I countries of the Framework Convention on Climate Change (FCCC), cf. Höhne et al. 2003 on behalf of the Federal Environmental Agency (UBA).

[46] Annex I of the Framework Convention on Climate Change includes the countries of the EU 25 (except Malta and Cyprus), the US, Canada, Japan, Australia, Russia, Ukraine, Belarus, Bulgaria, Iceland, New Zealand, Norway, Romania, Switzerland and Turkey.

developing countries (non-Annex I).[47] In addition to this, it is primarily the industrialised nations that have the technology needed to reduce greenhouse gas emissions, along with the research and innovation potential to develop new technologies.

Articles 3.1 and 3.2 of the Framework Convention on Climate Change explicitly acknowledge that states have to bear differentiated responsibilities for climate change which also depends on their capabilities to contribute towards combating climate change. This is also laid down in the Kyoto Protocol which initially contained commitments for greenhouse gas reductions by industrialised nations and countries undergoing transition to a market economy only (appendix I, cf. Fig. 10).

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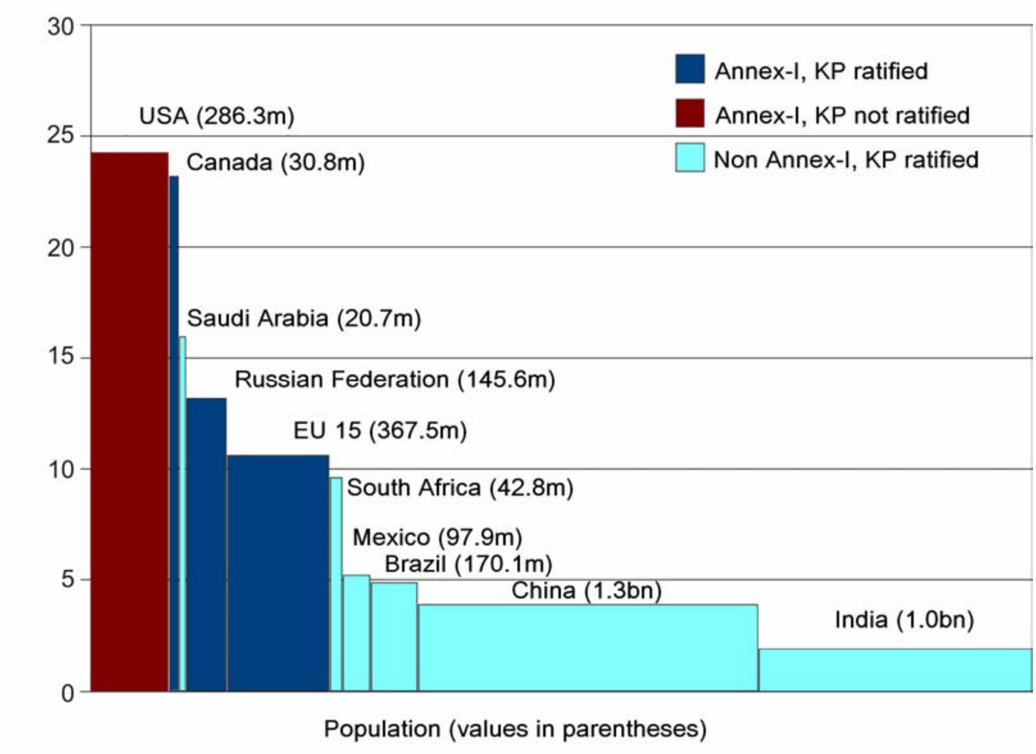
[47] This should not hide the fact that significant differences exist even within the group of Annex-I countries. Details based on exchange rates, source: IEA 2001 CO_2 Emissions from fossil fuel combustion 1971-1999, IEA Paris.

Fig. 10: Greenhouse gas emissions per capita in tonnes of CO_2-equivalents and population (2000)



Source: Data according to CAIT, World Resources Institute, http://cait.wri.org, the width of the bars represents the relative size of the population.

In the majority of newly industrialised and developing countries, economic and social development have – often for reasons of poverty – priority over environmental goals. This is why considerable effort must be made to link these priorities with climate protection requirements. On the whole, a climate-protecting path of development must be taken with reasonable financial and technical support by industrialised nations.[48]

[48] "In the face of global warming, new models of development and nature conservation will be needed which are climate proof and climate friendly.“ Cf. New Economics Foundation and IIED 2004: Up in smoke? Threats from, and responses to, the impact of global warming on human development.

A host of proposals have been made for the further shaping of international climate protection agreements.[49] In order for newly industrialised and developing countries to be able to take part sensibly in binding climate protection measures, the concrete development planning of these countries must be considered in addition to aspects of fairness, such as the polluter-pays principle and the ability-to-pay principle. The contribution by developing countries could be orientated towards indicators, such as, per-capita greenhouse gas emissions and per-capita income. Combined indicators are also conceivable, such as, the capability-responsibility index that was developed on the basis of the two aforementioned indicators.[50] The type of contribution must be shaped individually in each case. Whilst the Kyoto Protocol defines a binding absolute emissions reduction goal for industrialised nations, other options are available to newly industrialised and developing countries that take into account their specific situation and are thus more likely to gain political acceptance. Emission reduction goals could initially be agreed to for certain sectors only and on a voluntary basis for some countries.[51]

[49] For a comparison of such approaches, refer to Höhne et al. 2003: Evolution of commitments under the UNFCCC: Involving newly industrialized economies and developing countries, Umweltbundesamt Berlin, Climate Change series 1/03, FKZ 201 41 255.

[50] The Capability-Responsibility Indicator (CRI) is proposed by Criqui et al. “Greenhouse gas reduction pathways in the UNFCCC process up to 2025” by CNRS (France), RIVM (Netherlands), ICCS (Greece), CES (Belgium) for the EU Commission DG Environment, 2003; (http://europa.eu.int/comm/environment/climat/pdf/pm_techreport2025.pdf2003). Fig. A3 (annex) compares per-capita income and per-capita emissions (all greenhouse gases without emissions from land use) in selected states.

[51] Overview A2 (annex) lists possible types of climate protection goals.
The layout of this list already shows that the different types of goals address different groups of countries. On the other hand, these aims can also be seen as steps towards the gradual participation of countries in the climate protection regime.

8. Proposal by the Federal Environmental Agency: "Four-stage convergence"

> The Federal Environmental Agency (UBA) proposes involving developing countries in climate protection within the next two decades with a set of gradual obligations. Such an international policy architecture could involve a series of stages for participation with differing types of incentives and obligations, differentiated according to each country's per-capita greenhouse gas emission levels and per-capita income. The long-term goal should be to reduce emissions by the end of the century to a level below 2 tonnes of CO_2 equivalents per capita of the population.

The UBA proposes basing the character and stringency of countries' contributions from 2013 onwards on four stages with the transition from one stage to the next based on precise criteria. While some countries will continue to have binding quantitative commitments, others will graduate over time into more stringent forms of participation.[52] Defining threshold criteria and the types of commitment creates the leeway needed to balance interests in international negotiations. A multi-stage concept is also well suited to take into account the different economic conditions in developing countries.[53] The flexibility of the multi-stage approach with regards to

[52] Different variants of this kind of stage concept can be found in literature, for instance, with Criqui et al. 2003: Greenhouse gas reduction pathways in the UNFCCC process up to 2025, CNRS (France), RIVM (Netherlands), ICCS (Greece), CES (Belgium) for EU Commission DG Environment http://europa.eu.int/comm/environment/climat/pdf/pm_techreport2025.pdf; Höhne, den Elzen, Weiss 2005 (submitted): Common but differentiated convergence; Ecofys: "Options for future international action on climate change" by Ecofys for German Environmental Protection Agency, 2003/2005 http://www.umweltbundesamt.org/fpdf-l/2246.pdf and Umweltbundesamt series on Climate Change 2/05; CAN: "A Viable Global Framework for Preventing Dangerous Climate Change" by Climate Action Network (CAN). http://www.climatenetwork.org/docs/CAN-DP_Framework.pdf ; Wuppertal Institut, Germany and EDRC, South Africa 2004: South-North-Dialogue: Equity in the greenhouse, http://www.wupperinst.org/download/1085_proposal.pdf; NIES 2003: Dual track approach, by Yasuko Kameyama, Japan, http://www.nies.go.jp/social/post2012/pub/dp2003-3ver2.pdf

[53] On the other hand, this high degree of flexibility also means that such a complex concept places high demands on the negotiation process. Furthermore, flexibility dwindles the more demanding the stabilisation goal.

timing, character and scope of involvement by developing countries is one of the outstanding advantages of this concept. In this way, it can be clearly communicated to developing countries, that after 2012 they are not expected to immediately assume binding and absolute emission reduction goals in the manner proposed in the Kyoto Protocol. At the same time, a long-term, more reliable political framework would be created, providing decision-makers and companies with the necessary foresight for planning and investment.

The political discussions on the shape of future international action against climate change shows that key elements of the Kyoto framework should also continue to play a central role in agreements for the phase after 2012. This includes commitments concerning the limitation or reduction of emissions by countries (quantitative goals), international emission trading and a system of monitoring commitments and sanctions in case of non-compliance. The quantitative goals for emission control can be organised as a system comprising four groups (stages):

Stage 1: The poorest countries with per-capita greenhouse gas emissions of below 3.0 tonnes of CO_2 equivalents annually are initially excluded from any quantitative commitments (including large parts of Africa and Asia, as well as India and Indonesia). Emissions by these countries follow the respective reference scenario (business as usual).

Stage 2: With per-capita emissions of between 3.0 and 3.5 tonnes and an annual per-capita gross domestic product of around 3000 $ upwards, developing countries also start to reduce the rise in their emissions by way of climate protection measures (for example, the majority of north African countries). This includes, for instance, that the best available techniques be applied in the case of new investments.

Stage 3: Countries with per-capita emissions of between 3.5 and 4.0 tonnes step up their efforts and take on quantified goals for limiting the increase in their emissions which would entitle them to sell certificates if they manage to outperform these goals (for example, China, South Korea, Mexico, Brazil and the majority of OPEC countries). The possibility to take part in emission trading provides an economic incentive to reduce emissions. The goals can be defined as voluntary goals and any failure to reach these goals would not be sanctioned. Since this means that the risk in conjunction with failure to fulfil commitments would be limited, it would then be possible to negotiate more demanding goals.

Stage 4: Countries with per-capita emissions of more than 4.0 tonnes subscribe to the emission reduction commitments in the manner set forth in the Kyoto Protocol. Countries in this stage must reduce their emissions by up to 4% per year. Countries with high per-capita emissions have to reduce their emissions more than countries with lower emissions. By 2020, this group will cover today's Annex-I countries only. The threshold for entering this group will be gradually reduced starting in 2020 from more than 4.0 tonnes per capita to below 2.0 tonnes in 2100. When a country reaches a very low level of per-capita emissions (1.5 tonnes per capita), no further emission reductions are required.

Stage-4 commitments would be legally binding and their fulfilment would be closely monitored in the manner foreseen in the Kyoto Protocol. In case of anticipated non--compliance, the countries in question would initially receive support in their search for ways to further reduce emissions. If a country ultimately fails to fulfil its commitments, suitable sanctions would be imposed, such as higher future reduction commitments.

Reclassification on the basis of the aforementioned criteria is carried out every 10 years in our example. Shorter intervals, for instance, five years, are also conceivable. Non-Annex-I countries would only be able to reach the 4th stage if they were previously in the 3rd stage for at least once decade. This means that outlandish demands on newly industrialised countries can be avoided. The values stated for greenhouse gas emissions and per-capita income which are used to distinguish the four stages can vary. If, for instance, the threshold for developing countries to enter the second stage were to be somewhat higher, the following thresholds would have to be lower in order to be able to achieve the overall environmental quality goal targeted, i.e. a long-term stabilisation of greenhouse gas levels at below 400ppmv.[54]

This proposal is generally speaking an open concept that can be flexibly adapted to the special interests of the contracting parties. In order to distinguish contributions by

[54] Fig. A4 (appendix) shows an example of the allocation of emission endowments under the four-stage convergence approach for stabilising CO_2 at 400ppmv.

industrialised nations in the fourth stage, for instance, more sophisticated approaches, such as "Triptych“ (see below for explanation), could be chosen which differentiate emission reduction commitments on the basis of the respective conditions in certain economic sectors. The involvement of newly industrialised countries could initially take place in the form of commitments for individual sectors or by demanding non-binding incentive goals which, when outperformed, could enable participation in emissions trading.

This flexibility with regard to the timing, character and scope of participation in emission reduction measures is the key advantage of the multi-stage approach. One disadvantage is that negotiations become more complex because many different individual parameters need to be negotiated, such as the type and stringency of goals as well as threshold criteria for the stage assignment.[55] All in all, a multi-lateral framework for contributions is maintained so that – despite different forms of participation - the climate protection regime is not just the sum of more or less demanding voluntary contributions by countries.

From 2020 onwards, the majority of today's developing countries will presumably be in the second and third stage as described above. The majority of countries in Latin America, the Middle East, East Asia and China will then have to start introducing measures to avoid emissions. On the other hand, some countries in South Asia and Africa will continue to remain in the first stage for a long time (refer to Fig. 11).

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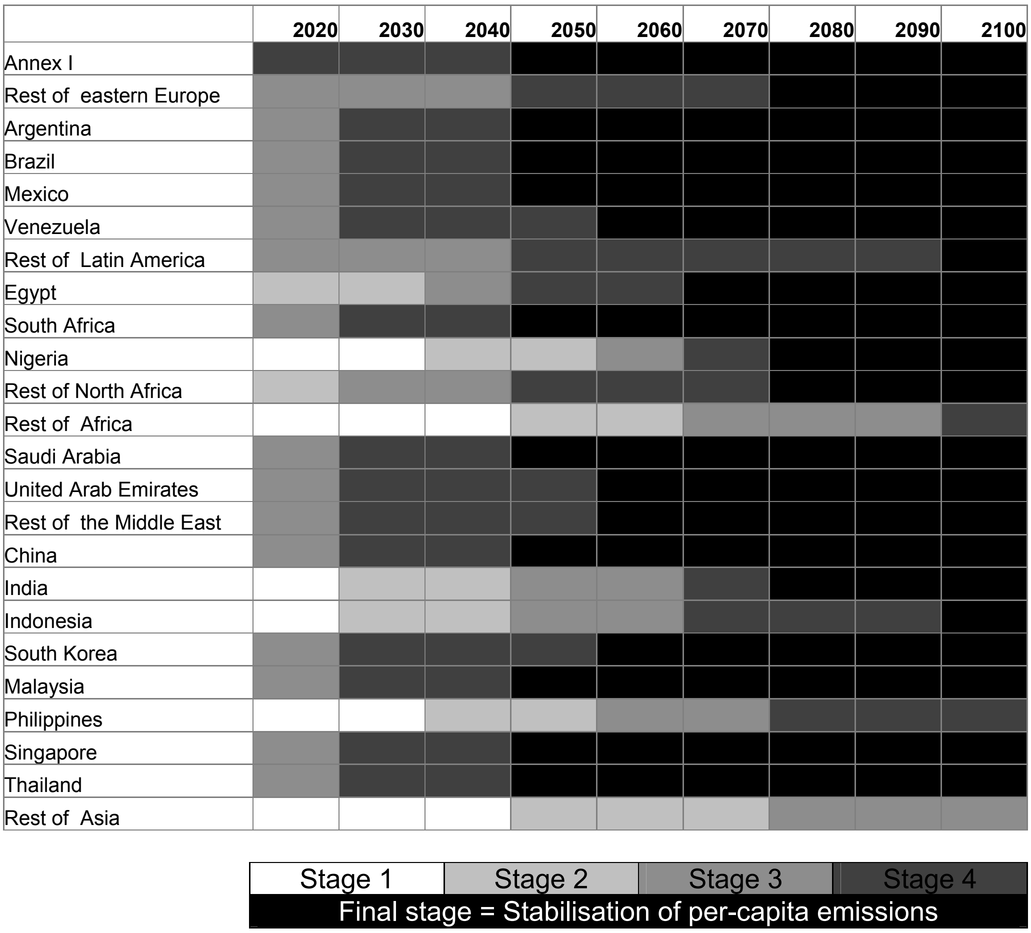
[55] In this case, experts must examine in depth whether and how measures that influence emissions and the removals of CO_2 caused by Land Use, Land Use Change and Forestry, can be integrated into the convention and how considering these (net) emissions affects the threshold values used.

Fig. 11: Stages of participation for selected countries in the four-stage convergence approach (400ppmv of CO_2)



Source: Höhne et al. 2005: Options for the second commitment period of the Kyoto Protocol, UBA Berlin, Climate Change series 2/05, FKZ 203 41 148/01.

In the long term, this kind of multi-stage concept will lead to a convergence of per-capita emissions as frequently demanded by developing countries with reference to reasons of fairness. This will occur around 2050 as shown in the concept described above. From around 2030 onwards, overall emissions by newly industrialised and developing countries will exceed those of industrialised nations.

Figure 12 is an example of the emission rights that result from this type of stage concept for industrialised nations (left) as well as newly industrialised and developing countries (right) for the years 2020 (top) and 2050 (bottom). The figure is merely used to illustrate and show the magnitude of the required emission reductions.

Deviations can result if one or more parameters are varied. International trading with emission rights is assumed. The information hence merely shows the emission rights assigned and not necessarily the actual emissions expected.

In order to achieve a stabilisation of CO_2 levels at 400ppmv within the scope of the four-stage convergence concept presented, emission reductions of 25-50% by 2020 and by 80-90% by 2050 are required in today's industrialised nations.[56] The results of the analysis for greenhouse gas concentrations at 400ppmv and at 450ppmv confirm that a reduction in emissions of 40% by 2020 is necessary for Germany and by 30% for the EU as a whole. The goal to reduce emissions in Germany by 80% by the year 2050, as recommended by the Enquete Commission of the 14th German Bundestag "Sustainable Energy Supplies in View of Globalization and Liberalization“, is also of the right magnitude (all figures relative to 1990).

In their Conclusions in March 2005, the EU Council of Ministers proposed considering emission reduction goals for industrialised nations of 15-30% by 2020 and of 60-80% by 2050.[57] From the Federal Environmental Agency's point of view, today's industrialised nations should commit themselves to the ambitous end of the ranges stated (-30% by 2020 and -80% by 2050).

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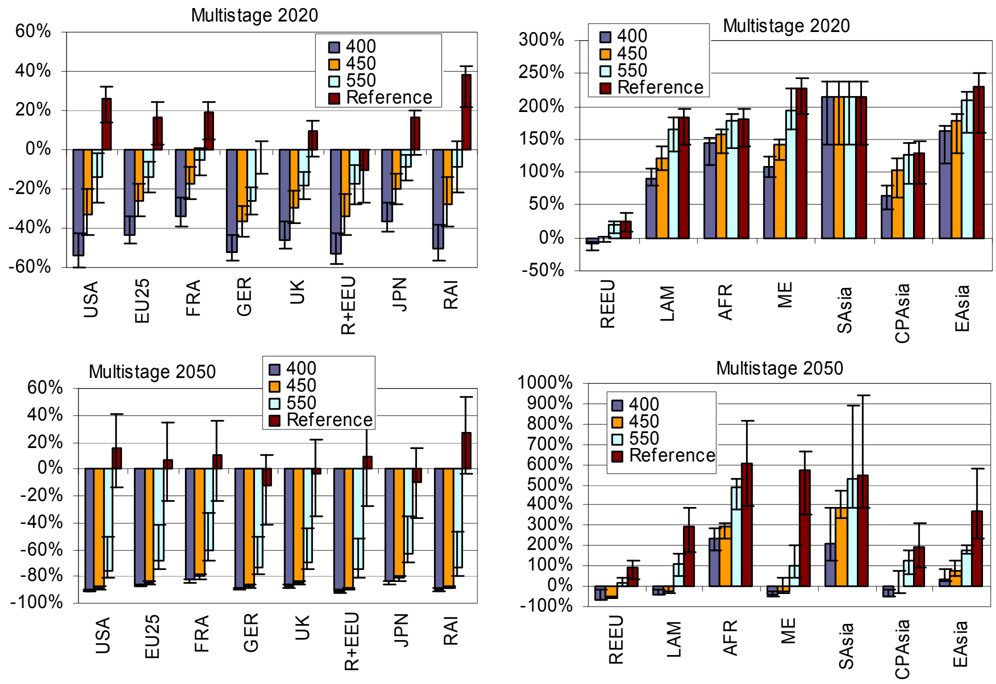
56 Table A6 (appendix) shows the emission reduction up to 2020 and 2050 compared to 1990 that is needed in order to achieve different CO_2 concentration levels.

57 Council Meeting in Brussels on 10 March 2005, Conclusions of the Council, http://ue.eu.int/ueDocs/cms_Data/docs/pressData/de/envir/84334.pdf.

The Kyoto baseyear was stated as the reference year. This is usually 1990. In some countries, this can also be 1995 for the following greenhouse gases: sulphur hexafluoride, partially halogenated fluorohydrocarbons and perfluorinated hydrocarbons.

Fig. 12 : Required emission reductions for greenhouse gases in the years 2020 and 2050 (compared to 1990) in the four-stage convergence approach



Data for different stabilisation levels (400, 450 and 550ppm of CO_2, corresponds to around 470, 550 and 650ppm for all greenhouse gases, including aerosols) and in the business-as-usual (BAU scenario.[58] Source: Höhne et al. Options for the second commitment period of the Kyoto Protocol, UBA Berlin, Climate Change series 2/05, FKZ 203 41 148/01. Abbreviations for countries: RF+ = Russia plus the Annex I countries from the former Soviet Union (without the Baltic states); RAI = other Annex I countries; RFSU = Rest of Former Soviet Union (without Annex I); LAM = Latin America; ME = Middle Ease; CP-Asia = China, North Korea, Mongolia.

In the scientific and political debate on possible burden distribution concepts, in addition to focusing on multi-stage approaches of this kind, attention is primarily

[58] The reduction goals for the US, particularly for 400ppmv, are very demanding. In order to avoid dangerous interference with the climate system, a stabilisation level is, however, needed that demands immediate and ambitious emission reductions of all nations. The national goal pursued by the US is to reduce greenhouse gas emissions by 18% in relation to gross domestic product by the year 2012. This means an increase in absolute emissions up to the end of the Kyoto period (2008/2012) of around 23% compared to 1990 levels. The targeted global stabilisation goal would hence be almost impossible to reach. In order to compensate for this increase, other nations would have to reduce their greenhouse gas emissions even more drastically. The distribution of reduction burdens shown in Figure 12 illustrates the responsibility of nations for climate change and their economic performance. Within the scope of international emission trading, countries would be able to buy emission rights in order to meet with their reduction goals.

given to the Contraction & Convergence (C&C) approach, the Triptych approach and a host of variants of these approaches. In the next section, these approaches will be explained and discussed with regard to their respective advantages and disadvantages compared to the multi-stage concept.

In addition to a continuous reduction of global emissions, the "Contraction & Convergence“ (C&C)[59] proposal also foresees the convergence of the per-capita allocation of emission rights for all states over a certain period of time. At the beginning, each country is allocated allowances equal to their actual emissions – at the end, equal per-capita allocation, irrespective of actual demand.[60] The emission rights allocated can be traded world-wide. All countries take part from the very beginning. One point in favour of this concept is its lack of complexity with a view to international negotiations. Agreement is merely required concerning the timeline for the convergence of per-capita endowments and the profile of total allowable emissions (and hence the stabilisation level for greenhouse gases concentration). The main disadvantage of this approach is its lack of flexibility. The respective economic performance and development of a specific country is not considered for the allocation of emission rights. Another objection is that with "Contraction & Convergence“ countries with per-capita greenhouse gas emissions close to today's global average (like China, for instance) would have to buy emission rights at an early point in time. This currently seems to be politically and economically unacceptable for these countries. The immediate participation of the least developed countries in emission trading also appears to be unlikely, especially since these countries seldom have the institutional capacity required.[61]

The GCCS approach[62] proposed by Wicke can be seen as a variant of the C&C proposal. This approach also envisages a global emission trading system, however,

[59] Cf. http://www.gci.org.uk.

[60] Emission rights are understood in this concept as the same right for all the earth's population which will gradually become valid over the course of the planned convergence. It is no coincidence that the allocation of emission rights in excess of demand (e.g. in parts of Africa) means a global redistribution of resources for reasons of fairness (rather than for reasons of climate protection policy) .

[61] In this context, WBGU proposes an "opt-out" which would offer developing countries the possibility to opt out of emission restrictions. WBGU 2003: Über Kyoto hinaus denken, Berlin, Springer.

[62] Wicke, L. 2004: Beyond Kyoto – A New Global Climate Certificate System. Heidelberg, Springer.

the allocation of emission rights takes place from the very beginning on the basis of equal per-capita emission rights world-wide. The chance of this approach prevailing politically must be viewed as very slim. First of all, the immediate equal distribution of emission rights would mean considerable international finance transfers which are likely to meet with significant resistance among companies and ministries of finance in almost all industrialised nations. Industrialised nations are to be given a certain period of transition – not least due to the significant capital stock bound in the energy infrastructure – in order to reduce their per-capita emissions. Secondly, the proposed stabilisation level of 550ppmv of CO_2 is insufficient from the point of view of climate protection. There would be a less than 10% chance of achieving the EU's 2°C target. Thirdly, the global equal distribution of emission rights – to be introduced from the beginning – would lead to unsurpassable difficulties in getting promising negotiations on more demanding global climate protection underway at all since industrialised nations would be likely to vehemently object to an immediate, global per-capita emission whilst newly industrialised countries are likely to object to an immediate, absolute restriction for their per-capita emissions of greenhouse gases.

The "Common but Differentiated Convergence" (CDC) approach is a modification of the "Contraction & Convergence" approach in as far as developing countries would not have to commit themselves to binding emission limits until their per-capita emissions start to rise to a certain level. Below a certain share of average per-capita emissions, participation in global emission trading takes place on a voluntary basis as long as reductions compared to the agreed baseline of emissions can be proven. This approach is more flexible than "Contraction & Convergence" with regard to the timing of developing countries’ participation in emission restrictions and is a very simple form of the multi-stage approach. The greatest difficulty with a view to negotiations is agreeing on the baseline of emissions because of the obvious incentive for developing countries in question to overestimate these "business-as-usual" emissions in order to claim comprehensive emission reduction successes, if possible, and to be able to sell in international emission trading.

The "Triptych" approach[63] initially defines specific goals for certain sectors that are subsequently compiled in a second step to form a national goal. This comprises, for instance, technical standards for high-energy industries competing internationally, power generation, agriculture and forestry, in addition to other sources. This means that it is easier to consider industry-specific circumstances when defining goals and to differentiate emission restrictions. This approach was originally developed in order to assist negotiations of countries' emission budgets for the first commitment period of the Kyoto Protocol among the EU member states. The triptych approach as such, however, does not define which countries are to take part in a climate regime and which are not. But it can be integrated into a multi-stage approach where, for example, the triptych method is used for a certain stage of commitments. This approach is very technical and complex. The allocation of emission rights is dependent on quite a number of individual parameters. The negotiation effort required must hence be estimated to be relatively high. One disadvantage that is often associated with this approach is the high volume of data required when calculating emission budgets. Valid data on emissions is needed from each of the different sectors. This kind of data, however, is also necessary with other approaches when at the end of a commitment period actual emissions are calculated against the emission rights assigned.

Summing up, it can be said that the decisive advantage of the multi-stage approach is its high degree of flexibility: It integrates different forms of participation in one concept and enables transition periods for participation. The most important disadvantages are (i) the relatively high effort needed for negotiations because many parameters, i.e. type of commitments, stringency and threshold criteria and values must be negotiated (high degree of complexity), (ii) the significant uncertainty concerning the emission reductions achieved because some countries will take part at a later point in time, uncertainty exists with regard to the point in time that a threshold is crossed and some types of commitments cannot be precisely quantified ex ante.

[63] Cf. Triptych 6.0 in Höhne et al. 2005: Options for the second commitment period of the Kyoto Protocol. Umweltbundesamt Berlin, Climate Change series 2/05, FKZ 203 41 148/01.

The following applies to all the approaches discussed: The political likelihood of implementation could be improved significantly through political cross references to other fields of politics. For instance, it was possible, not least due to the support of the EU, to achieve Russia's ratification of the Kyoto Protocol that had been in doubt for many years in exchange for supporting Russia's accession to the WTO. Another option for linking up with global trade activities is discussed in literature under the heading "border tax adjustments“. What is meant here is penalty duties or export subsidies for high-energy products which would otherwise find it difficult to compete when energy prices are considerably lower in countries without significant climate protection commitments.

There are, of course, also ties with development policy. The issue of allocating emission rights for greenhouse gases is frequently interpreted as the "allocation of development opportunities", i.e. restricting emissions is seen as intervention in the sovereignty of national development planning. In the same manner, some burden distribution concepts for international climate protection policy are explicitly orientated towards development policy-motivated transfer payments (e.g. the GCCS). The challenge for climate protection policy is to avoid excessively restricting economic development through all-too demanding emission restrictions and to make use of the opportunity to sell unused emission rights as an incentive for the participation of developing countries in climate protection whilst at the same time also avoiding that climate protection negotiations are primarily used to increase transfer payments to developing countries.

There are without doubt other cross references that can be made between climate protection policy and other fields of politics, however, to go into further detail at this point would exceed the scope of this publication.

9. The costs of climate protection and the costs of inaction

> Climate protection costs money. However, investment in climate protection pays off because it helps to avoid high economic, ecologic and socio-cultural losses that would result from the expected climate change consequences of inaction. If we fail to act, world-wide economic damage alone could reach a magnitude of several trillion euro per year by 2050, with about 100 billion in Germany alone. The expected cost of reducing emissions is much lower. Furthermore, active climate protection triggers investment and technical innovation.

The previous chapter shows that necessary precaution calls for substantial emission reductions to alleviate or avoid serious economic and other losses or damage (affecting health, ecosystems, cultural values, etc.) caused by climate change.

Estimates for the economic costs of inaction illustrate the economic challenge of climate protection which our society now faces. The German Institute for Economic Research (Deutsches Institut für Wirtschaftsforschung, DIW), for example, refers to integrated model calculations and expects that – if greenhouse gas emissions continue unchecked – the economic damage by the year 2100 will amount to as much as 20 trillion US dollar[64] per year. This would correspond to around 4 to 8% of the global economic output expected at that time. In 2050, the global damage could already cost more than 5 trillion US dollar. If, however, active and effective climate protection measures were initiated now, this damage could be cut by more than half (12 trillion US dollar). At around 3 trillion US dollar, the costs of climate protection would be far below this level. According to these calculations, damage of around 160 billion US dollar due to climate change could be avoided in Germany by the year

[64] The prices quoted by this source are expressed in US dollar on a 2002 price basis. At the end of 2002, the exchange rate totalled around 1.05 US dollar for the euro, so that the figures in the study can be approximately read in euro.

2100. The related costs would be in the order of 40 billion US dollar.[65] This calculation does not include potential damage due to abrupt climate change – such as the weakening of the Gulf stream or a dramatic rise in sea level – so that this figure represents a rather conservative estimate of potential damage.
A study by the European Commission estimates the total global damage caused by unchecked climate change at 74 trillion euro for the period up to 2200.[66] Given a stabilisation of greenhouse gas concentrations at a level of 550ppm of CO_2 equivalents, these costs could be reduced by more than 50% to around 32 trillion euro.[67]

Monetary assessments of climate change induced damage cover a very large bandwidth for several reasons. It is not possible to make reliable statements concerning the potential impacts of climate change, including economic consequences, because the extent of damage is largely influenced by assumptions related to potential adjustment measures, damage occurs world-wide and extends far into the future. Furthermore, some impacts do not easily lend themselves to monetary assessment, such as the extinction of species. Available results and estimates related to assessable damage are, however, sufficient to justify precautionary and preventive climate protection measures even in economic categories.

The Federal Environmental Agency (UBA) hence considers the so-called cost-effectiveness approach to be most appropriate, whereby the most efficient strategy is developed and pursued in order to achieve a particular environmental quality goal.

[65] Kemfert, C. 2005: Weltweiter Klimaschutz – Sofortiges Handeln spart hohe Kosten. Weekly report of DIW Berlin 12-13/05. The calculations quoted here suggest that the damage caused by climate change in the year 2050 will amount to some 5 trillion US dollar. At the same time, active climate protection measures capable of preventing a large part of the threatening damage will cost less than one tenth of this sum.

[66] A comparison with the DIW figures is possible to a limited extent only because the figures quoted here represent the aggregate costs for the entire 2005 to 2200 period, whilst the DIW figures constitute annual costs until 2100 only.

[67] Watkiss, P, Downing, T., Handley, C. and Butterfield, R. 2005: The Impacts and Costs of Climate Change, ‘Modelling support for Future Actions – Benefits and Cost of Climate Change Policies and Measures’ on behalf of the European Commission, DG Environment.

With regard to international climate protection, this corresponds to the search for the most cost-effective strategy possible in order to limit the global increase in temperature to less than 2°C compared to pre-industrial levels (refer to chapter 3).[68]

The German Advisory Council on Global Environmental Change (WBGU 2003), for example, examined such strategies designed to achieve the 2°C goal. This Advisory Council estimated the costs of stabilising the CO_2 concentration at a value of between 400 and 450ppmv at 0.2% to 1.7% of the gross world product in the year 2100.[69] Other studies show that targeted subsidies for and support of technical progress can yield significant cost reductions.[70] The Potsdam Institute for Climate Impact Research (PIK), for example, estimates the costs of stabilising greenhouse gas concentrations at between 400 and 450ppmv CO_2 at around 0.5% of gross world product (refer to Fig. 13) and hence at a level which is much lower than the costs of

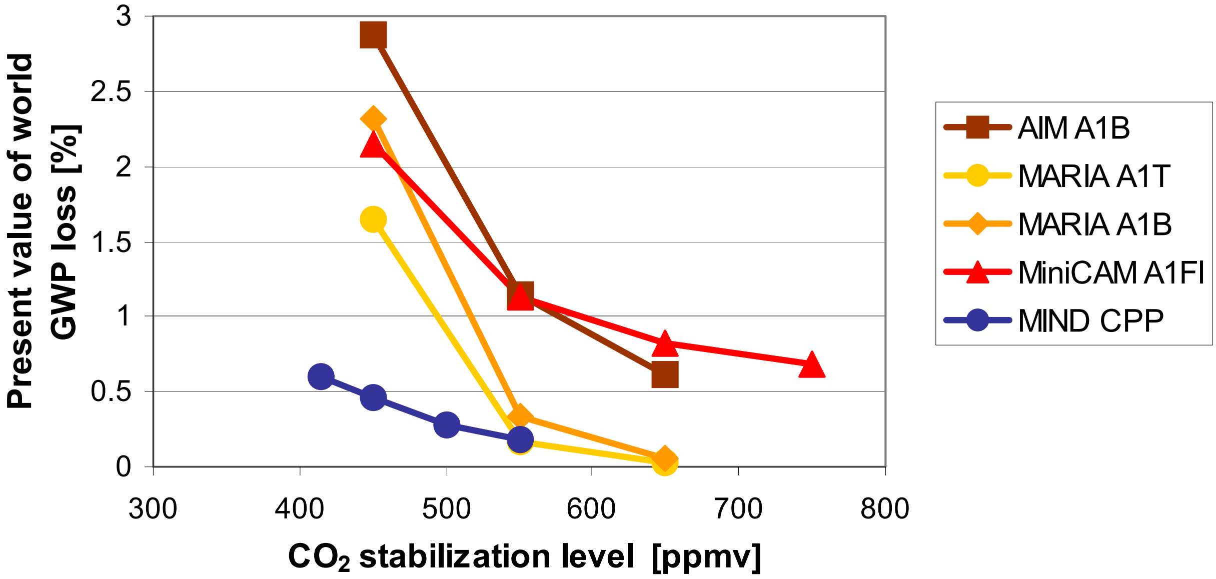
[68] Although it is theoretically conceivable to determine the "optimum" level of climate protection on the basis of global cost-benefit analyses, both estimating the costs of climate protection and estimating the costs of inaction are prone to serious methodological problems, such as the difficulty to quantify potential damage in monetary terms. Furthermore, it is very difficult from a methodological point of view to sensibly apply risk assessments in economic models to wide-spread, singular climate events with a low probability of occurrence, but a very high damage potential. Cost calculations are also strongly dependent upon the assumed discount rate, i.e. on the extent to which – based on the expected economic growth – future costs are valued lower than costs incurred today. Future and present costs should be generally equally valued in the case of generation-spanning considerations (i.e. time preference rate = 0). Otherwise we would unreasonably burden future generations with climate damage.

[69] WBGU 2003: Climate Protection Strategies for the 21st Century: Kyoto and Beyond, Berlin. For the period until 2100, cost estimates for one of the scenarios discussed (B2-400) range between 2 and 2.5% of the expected economic performance, but decline to below 2% in the long term. The sometimes significant differences between the estimates of climate protection costs are generally due to various factors, including, for instance, model assumptions concerning economic growth, social and political conditions (such as structure of world trade and boundary conditions for international policy) and technical change. The costs are, for example, higher the higher the greenhouse gas emissions assumed in the business-as-usual scenario and the lower the degree of international co-operation in climate protection.

[70] This is shown by the work of several teams of researchers within the Innovation Modelling Comparison Project (IMCP), such as Edenhofer, O., Schellnhuber, H. J. and Bauer, N. 2004: Der Lohn des Mutes. Gestaltungsspielräume für eine internationale Klima- und Energiepolitik, in: Internationale Politik, August 2004, No. 8.

inaction as estimated by the DIW for the year 2100 as a consequence of unchecked climate change.

Fig. 23: ***Global reduction costs for different stabilisation levels in 2100***



Results of model calculations using the MIND model at the Potsdam Institute for Climate Impact Research (PIK): The upper four curves of the diagram show the results of the AIM, MARIA and MiniCAM models concerning reduction costs of stabilisation scenarios (IPCC 2001, WG III). This diagram shows a significant increase in stabilisation costs at a level below 550ppmv of CO_2. The PIK's studies (dark, lower part of the diagram) show that these cost estimates will be much lower if induced technical change is considered in the models. Source: Ottmar Edenhofer, Hans Joachim Schellnhuber and Nico Bauer 2004: Der Lohn des Mutes. Gestaltungsspielräume für eine internationale Klima- und Energiepolitik, in: Internationale Politik, August 2004, No. 8.

In order to provide companies with a reliable basis for their investment decisions and help to avoid costly errors in the decision-making process, it will be necessary to reach long-term agreement with regard to a concrete global action target for environmental protection (i.e. an emission ceiling) and the related national contributions towards this target as a basis for sustainable and reliable climate protection. The Renewable Energy Sources Act (EEG) which was amended in 2004 is one example of boundary conditions capable of promoting investment on a national level. This Act offers investors the necessary investment security by providing for a purchase guarantee and guaranteed feed-in rates – declining over the course of time – for a term of usually 20 years.

Furthermore, the necessary technical innovation and investments also offer opportunities to modernise the economy and create jobs with high value potential. In the renewable energy sector alone, 130,000 people were already employed in Germany in 2004. This represents an increase of almost 80% in four years. Investment focused on plant operation and services. In the wind power industry, for example, the number of jobs rose to more than 50,000. The photovoltaic sector also shows a clear upward trend.[71] The use of renewable energy helped avoid around 70 million tonnes of CO_2 in 2004. This corresponds to Sweden's or Ireland's total greenhouse gas emissions in 2003.

Inventing and developing new technologies, such as renewable energies, must be followed by their practical application and dissemination. The general market introduction of technologies and their large-scale application[72] is an important factor when it comes to reducing costs. This includes the development of suitable infrastructures and integration into innovative organisation concepts.[73] Since this process often takes several decades, companies must today develop the technologies of tomorrow, if necessary, with the support of government subsidies for market introduction. For two decades, both public and private investment in energy technology research and development has been strongly declining in the OECD. Furthermore, the lion's share of public energy research budgets of the past three decades world-wide was spent on nuclear technology.[74]

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[71] Edler, D. et al. 2004: Aktualisierung der Beschäftigtenzahlen im Umweltschutz für das Jahr 2002, survey on behalf of the Federal Environmental Agency (UBA).

[72] Sijm, J.P.M. 2004: Induced Technological Change and Spillovers in Climate Policy Modeling: An Assessment, ECN-Report C-04-073.

[73] Sanden, B. A. and Azar, C. 2005: Near-term technology policies for long-term climate targets – economy wide versus technology specific approaches, Energy Policy, 33: 1557–1576.

[74] IEA/CERT 2004: Energy Technology: Confronting the Climate Challenge und DOE 2004: Adopting A Long View to Energy R&D And Global Climate Change; http://energytrends.pnl.gov/integrat/integ001.htm. Investment must be generally broadened and earmarked for renewable energy technologies. However, until renewable energies are able to significantly contribute towards world energy supply, increased investment in energy efficiency, energy saving and geological carbon dioxide capture and storage (CCS) will be necessary during a transitional phase. The latter technology is, in particular, required for demanding stabilisation scenarios for a limited period of time even though it is doubtful whether it will be part of a long-term approach because of its inherently high costs and liability risks.

Furthermore, enormous sums will be invested in the energy sector in the near future that will set the course for the forthcoming four decades. The International Energy Agency estimates the investment volume at around 16 trillion US dollar between today and the year 2030.[75] These money flows will have to be linked to climate protection requirements and the instruments used to this effect will have to include international financing systems for the climate-friendly development of the energy sector in newly industrialised and developing countries.

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[75] IEA, World Energy Investment Outlook 2003, OECD/IEA, Paris.

10. Further important, positive effects of climate protection, alleviating poverty and promoting renewable energies

> Climate protection pays off in multiple ways. Less air pollution and fewer conflicts regarding water and oil resources are important ancillary benefits. Establishing and modernising energy systems in a climate-friendly manner can make a valuable contribution towards fighting poverty and promoting economic development. Some of the world's poorest countries already have a keen interest in using renewable energy. A change in energy supply will be necessary in the foreseeable future because fossil fuels will become more expensive as supplies dwindle. Renewable energy thus grows more and more competitive. For reasons of climate protection this change simply has to happen earlier than the dwindling fossil fuel suggest. Renewable energy and a policy persistently aimed at energy efficiency are the two cornerstones of sustainable energy use.

An important ancillary benefit of climate protection is the reduction in air pollution by nitrogen oxides (NO_x), sulphur dioxide (SO_2), soot and carbon monoxide (CO). Especially in newly industrialised countries, air pollution in conjunction with rapidly growing industry, energy demand, population and traffic is a serious problem for human health and ecosystems. Climate protection which reduces this pollution has subsequently a very important role to play for these countries – alongside industrialised nations too – even beyond fundamental climate protection policy.
A study for the European Commission shows that a stabilisation of carbon dioxide concentration at 450ppmv could lead to a reduction of SO_2 pollution by 70% and NO_x exposure by 50% in 2050 compared to the business-as-usual scenario.[76]

Linking renewable energies and combating poverty

The "International Conference for Renewable Energies“ in Bonn (Renewables 2004) showed that these technologies are making an important contribution towards climate protection. Given the full implementation of the International Action Programme (IAP)

[76] Criqui et al. 2003: Greenhouse gas reduction pathways in the UNFCCC process up to 2025, report by CNRS (France), RIVM (Netherlands), ICCS (Greece), CES (Belgium) for the EU Commission, DG Environment, refer to Fig. A5 in the appendix.

agreed to in Bonn, 1.2 billion tonnes of CO_2 can be saved each year. This corresponds to around 5% of global CO_2 emissions estimated for the year 2015. The dissemination and increased use of renewable energies is a very promising approach in the field of development co-operation too. Renewable energies and decentralised energy systems help fight energy poverty in many developing countries. This triggers the development of new industries and the creation of jobs with a high value potential. Besides contributing towards climate protection, the use of renewable energies also reduces local environmental (air and water) pollution, dependency on costly raw-material imports and the risk of international conflicts for scarce resources. Many developing countries are showing a keen interest in using renewable energies. Projects funded from technical co-operation budgets should increasingly support initiatives aimed at sustainable energy supplies (renewable energies and energy efficiency).

Policymakers in developing countries often attach only minor importance to climate change and its risks. Highest priority is – understandably – attached to combating poverty and to fostering economic development The community of nations should respond to this in two ways. Firstly, nations must pursue a targeted approach towards identifying suitable climate protection measures which trigger positive economic effects or synergies with other development targets, for example, in the energy or water sectors.[77] Secondly, the community of nations must increasingly promote the development of the necessary scientific and administrative capacities, increase awareness of climate change as a risk and thereby create the basis for international co-operation in order to combat this very problem.

The international negotiation process is vitally dependent upon compilations of detailed information about necessary and planned investment projects – for example, in the energy sector of important developing countries – to serve as a basis for the

[77] For an in-depth description of such synergies, refer to: Saleemul Huq et al. (2004): Development and Climate: Results of Phase I; IIED London, www.developmentfirst.org. The authors show, for example, that regional co-operation yields many advantages and cost savings especially in the energy sector where modernisation and development have a central economic role to play in particular in newly industrialised countries. With regard to the establishment of regional alliances and networks, climate-friendly options (for example, gas rather than coal) must be supported with technical and material aid.

development of climate-friendly investment and analyses of financing and funding concepts.[78]

International security

Several researchers forecast violent conflicts for resources, such as water or oil.[79] These risks would be significantly lower if greenhouse gas concentrations were to be stabilised on a lower level. In view of the fact that global oil reserves are limited, and in light of current and foreseeable future price developments on crude oil markets, reduced dependency on oil imports would be a vital co-benefit of effective climate protection policy.

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[78] By presenting parts of an energy strategy in 2004 (a climate protection strategy is to follow soon), China, for example, created a good basis for analyses of this kind.

[79] Purvis, N. und Busby, J. 2003: The Security Implications of Climate Change for the UN System, Memo to the UN Foundation und
Schwartz, P. und Randall, D. 2003: An Abrupt Climate Change Scenario and Its Implications for United States National Security.

11. Integrating climate protection in other policy areas

Climate protection is not merely a task of environmental policy. Many measures in other policy areas – development, finance, land use, economic and industrial policies, agriculture, forestry, regional, energy or transport policies – can have serious implications for climate protection. This is why the goal of climate protection should be integrated to a much greater extent into these policies. Despite tight budgets, regional and local levels as well can do more for climate protection, for instance, through regional planning and by facilitating and initiating investment.

What would happen if current trends were to continue?

Climate protection is not only a global task. It also calls for efforts on a national and regional level which may not be restricted to environmental policy alone. Otherwise actions and developments counteracting climate protection could undermine past or future climate protection success. Furthermore, co-ordinated action is necessary in different social areas in order to achieve medium and long-term climate protection goals at the lowest cost possible and to exploit all positive effects, such as the creation of new jobs.

Climate protection must be integrated in all fields of policy

Between the years 1990 and 2000, a significant part of German climate policy consisted of isolated measures in specific areas as well as special effects, such as the modernisation of the east German economy. Comprehensive climate protection can, however, only be implemented at a reasonable cost if it is properly co-ordinated with other political aims, measures and instruments.

The sustainability strategy in Germany[80] draws on the concept of integrating climate protection in different areas of policy and shows that, besides other issues, climate protection also requires an integrated view.

[80] Refer to: Federal Government 2004: Fortschrittsbericht 2004 – Meilensteine für eine nachhaltige Entwicklung; as well as: Federal Government 2005: Wegweiser Nachhaltigkeit – cabinet decision dated 10 August 2005

All kinds of measures in political areas other then environmental policy can have far-reaching, negative or positive, consequences for climate protection. These sectors include, for example, development, energy, construction, transport, finance, economy and industry, agriculture and forestry, as well as regional policies. Greenhouse gas emissions are so closely linked to many areas of business and industry that the necessary emission reductions will only be possible with determined technical re-orientation, re-thinking and a change in behaviour. Relevant decisions in these policy areas must hence be examined with a view to compatibility with climate protection goals, and must be co-ordinated with climate protection policy. A suitable planning tool to this end is the strategic environmental assessment for plans and programmes.

Which measures and instruments are necessary for effective, long-term climate protection?

Climate protection not only concerns the international community; the European Union, the federal government, federal-state and municipal governments and administrations can also contribute towards this goal. Concrete programmes, strategies and action plans on these levels are important instruments for shaping policy.

Various processes and strategies for climate protection policy have a role to play in the European Union. The Federal Environmental Agency (UBA) recommends the following concrete steps:

- EU environmental policies (the 6th Environment Action Programme, the issue-related strategies and sustainability strategies) should identify concrete, medium-term and long-term goals for climate protection as well as measures and tools for the implementation of these goals.
- The so-called Cardiff process for integrating environmental aspects into other fields of policy should be revived and strengthened.
- The Lisbon strategy may not be narrowed down to the undifferentiated promotion of short-term economic growth. In order to achieve lasting economic growth, ecological buoys are needed that mark a binding course in the interest of future generations. These buoys must be defined not least by climate policy. Furthermore, the potential for innovation and employment resulting from climate policy is an important stimulus for the Lisbon strategy.

In order to master the challenges of climate protection in Germany, administrative organisations and decision-making processes will have to change too. First steps towards this end have already been laid down in the Federal Government's National Sustainability Strategy. This strategy contains, for example, indicators that are linked to medium-term goals and a review requirement. One question which still remains is which body or public authority will evaluate the contribution made by these decisions towards climate protection and, if necessary, submit proposals for further necessary decisions.

Within the scope of the sustainability strategy, the Federal Government is also pursuing the aim of promoting dialogue on climate protection and the public debate on this issue.

In order to examine the effectiveness of climate protection measures, budgetary principles can be applied to climate policy. This is, for example, foreseen in the "ecobudget" concept[81] where management of scarce money is replaced by management of scarce natural resources.

As further examples of the implementation of the processes and strategies mentioned earlier in this chapter, we will now outline settlement and traffic developments and the related decisions to be made by municipal administrations in this context.

The example of traffic and settlement development

Dense, mixed settlement structures that include recreation spaces and feature regional excursion destinations are capable of reducing traffic volumes. They improve the offering of environmentally compatible forms of transport, promote the use of trains and buses, walking or cycling, and thereby reduce greenhouse gas emissions. Together with improved public transport services, good possibilities for combining public transport with private cars and increased promotion of walking and cycling, these conditions also support environmentally friendly holiday and leisure behaviour.

[81] This so-called ecoBUDGET concept is already used by municipal administrations in several European countries. In Germany, the cities of Bielefeld, Dresden, Heidelberg and Kaiserslautern and the Nordhausen district have introduced this system. Detailed information can be found at: http://www.ecobudget.com/emp/envbud_ger.html.

Attractive holiday offerings in Germany and Europe and improved marketing of such destinations can also counteract the trend towards more and more long-distance travel.

A significantly reduced rate in the development of further transport infrastructures supports regional circulations and counteracts unchecked traffic growth, traffic-intensive outsourcing and just-in-time delivery. Studies show that new transport routes do not necessarily improve a region's economic performance. In fact, no or even adverse effects were found in some cases. Motorway access, for example, even tended to increase migration trends, especially in sparsely populated regions and in areas far away from conurbations.[82]

The example of municipal climate protection policy

The special potential of municipal climate protection policy is due to its "vicinity" to every day life and the local business community as well as its close integration into the local network of players. Public passenger transport operated by municipal organisations and decentralised energy supply, in particular, are fields of action for municipal climate protection under the direct responsibility of municipal bodies.

The federal-state administrations often support municipal authorities in their climate protection activities by providing favourable boundary conditions, pilot projects and financial assistance. The Federal Government focuses its support on research projects which supply scientific instruments for municipal climate protection. The Federal Government also grants all kinds of financial assistance because new challenges have to be mastered or new climate protection tasks addressed at district, city or municipal levels. The "Kommunaler Klimaschutz“ (municipal climate protection) guidelines are an important example. These guidelines were published as early as 1997, covering the vast range of possibilities for municipalities to act in the field of climate protection, and presenting good examples as well as the names of direct contact persons.

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[82] Verron, Hedwig: Determinanten des Verkehrswachstums, Entwicklungen, Ursachen und Gestaltungsmöglichkeiten; Report of the Federal Environmental Agency (UBA) dated 30 August 2004 (not yet published).

In 2005, the Öko-Institut conducted a study with financial assistance from the Federal Ministry of the Environment and technical support by the Federal Environmental Agency (UBA). This study used the city of Munich as an example in order to identify suitable measures for achieving the aim of a 50% reduction of CO_2 emissions. The study also describes boundary conditions necessary for a strategy oriented towards this end.[83]

Three scenarios were developed as a result of this study.

1. A reference scenario showing the foreseeable development without additional climate protection measures, with an assumed 21% reduction of CO_2 emissions by the year 2030.
2. A target scenario showing the path necessary to achieve a 50% reduction in CO_2 emissions for the different sectors of the city of Munich by the year 2030.
3. A scenario of measures including measures that can be implemented by the year 2030 and based on the assumption that around 40% of CO_2 emissions can be saved compared to 1990.

On this basis, 14 main fields of activity were selected and measures proposed designed to save a total of around 4 million tonnes of CO_2 by the year 2030, i.e. more than half the total savings aimed at.

One of the results of the study is that contracting is a particularly promising approach when it comes to financing and implementing energy saving measures. Falling tax revenue and growing expenditure on the part of municipalities call for an ever-growing share of private investment in the interest of climate protection.

The following measures for reducing CO_2 emissions were found to be particularly promising for the city of Munich:

- Rehabilitation measures for existing buildings (emission reduction potential: approx. 20.5%)

[83] Öko-Institut 2004: Kommunale Strategien zur Reduktion der CO_2-Emissionen um 50 % am Beispiel der Stadt München. The study can be downloaded from Öko-Institut's website at: www.oeko.de and from the website of the Federal Ministry of the Environment (BMU) at: http://www.bmu.de/klimaschutz/downloads/doc/7059.php.

- Use of biomass in urban energy supply (emission reduction potential: approx. 8.5%)
- Investment measures at a lower level for improving energy utilisation in the fields of commercial businesses, trade and services (emission reduction potential: approx. 5.2%)

The results of the study can, in principle, be applied to other cities too or are based on experience from other cities. In Berlin, for example, more than 300 buildings underwent rehabilitation with a view to energy savings and more than 30,000 tonnes of CO_2 emissions were avoided within the framework of the city's "energy saving contracting" programme.

12. Current status of Kyoto goals in Germany

Without further measures, Germany will not reach its climate protection goals by the year 2010. Although the latest forecast on greenhouse gas emissions underpins the success of climate protection measures to date in Germany, these measures do not reach the goal set in the Kyoto Protocol, not to mention the 40% reduction of greenhouse gas emissions by 2020 against the 1990 reference year as foreseen in the German government's climate protection programme. The potential to reduce emissions must be fully exhausted, particularly in those sectors not covered by emissions trading – including non-energy greenhouse gases (N_2O, CH_4, fluorinated greenhouse gases).

Together with the European Union, Germany has a pioneering role to play in international climate negotiations. Not least for this reason, adherence to the German emission reduction targets is of paramount importance.

Intermediate stock-taking – where does Germany stand with a view to the Kyoto target?

A study published by the Federal Environmental Agency (UBA) titled "Klimaschutz in Deutschland bis 2030" (Climate Protection in Germany until 2030) [84] analyses and evaluates the emission-reducing effects of climate protection measures implemented until the end of 2002. The basis for energy-related measures is the reference scenario of the Enquete Commission of the 14th German Bundestag on "Sustainable

[84] The research project titled "Politikszenarien für den Klimaschutz – Langfristszenarien und Handlungsempfehlungen ab 2012 (Politikszenarien III)" on behalf of the Federal Ministry for the Environment and the Federal Environmental Agency (UBA) was carried out by a working group made up of Deutsches Institut für Wirtschaftsforschung (DIW) Berlin, Forschungszentrum Jülich, Programme Group Systems Analysis and Technology Evaluation (STE), the Karlsruhe-based Fraunhofer Institute for Systems and Innovation Research (ISI) and the Berlin-based Öko-Institut. The final report titled "Umweltbundesamt 2005: Klimaschutz in Deutschland bis 2030 – Endbericht zum Forschungsvorhaben Politikszenarien III" was published in January 2005 in the "Climate Change" series of the Federal Environmental Agency (UBA) and can be downloaded at: www.umweltbundesamt.de.

Energy Supply"[85] which was modified in light of new developments. Although the study shows the success of climate protection policy achieved up to now, the results do not suffice when it comes to fulfilling the national Kyoto target and achieving more far-reaching emission reductions by the year 2020 (refer to statement 13). The Federal Government's climate protection programme includes measures designed to achieve the required emission reductions by 2012.

In order to evaluate the political measures implemented in the field of climate protection since 1998, the study compares a "with measures" scenario (i.e. the measures currently adopted) to a second "without measures" scenario. The study shows that greenhouse gas emissions in Germany "without measures" would be more than 100 million tonnes of CO_2 equivalents or around 10% higher than the level that can be expected with current climate policy.[86] Contributions towards reduction are particularly high in the case of the development of renewable energies (- 38 million tonnes of CO_2 equivalents)[87], the Energy Saving Ordinance (- 5 million tonnes), the ecological tax reform (- 12 million tonnes), building rehabilitation programmes (- 6 million tonnes), the ban on the disposal of untreated waste[88] (- 10 million tonnes) and the reduction of HFC emissions from refrigerating and air-conditioning systems as well as foams (- 9 million tonnes). In the "with measures" scenario, the authors of the study expect that by the year 2010 (representing the first Kyoto commitment period from 2008 to 2012) greenhouse gas emissions will decline up to nearly 20% compared to 1990 (refer to Fig. 14). In order to fulfil the target of the Kyoto Protocol – i.e. a 21% reduction of greenhouse gas reductions by 2008/2012 – close to 13 million tonnes of CO_2 equivalents or one percentage point would still be missing in the year 2010. This is why the National Climate Protection Programme

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[85] Final report by the Enquete Commission of the 14th German Bundestag on "Nachhaltige Energieversorgung unter den Bedingungen der Globalisierung und Liberalisierung“ (Sustainable Energy Supplies in View of Globalization and Liberalization), Bundestag publication 14/9400; reference scenario particularly in statement 4.

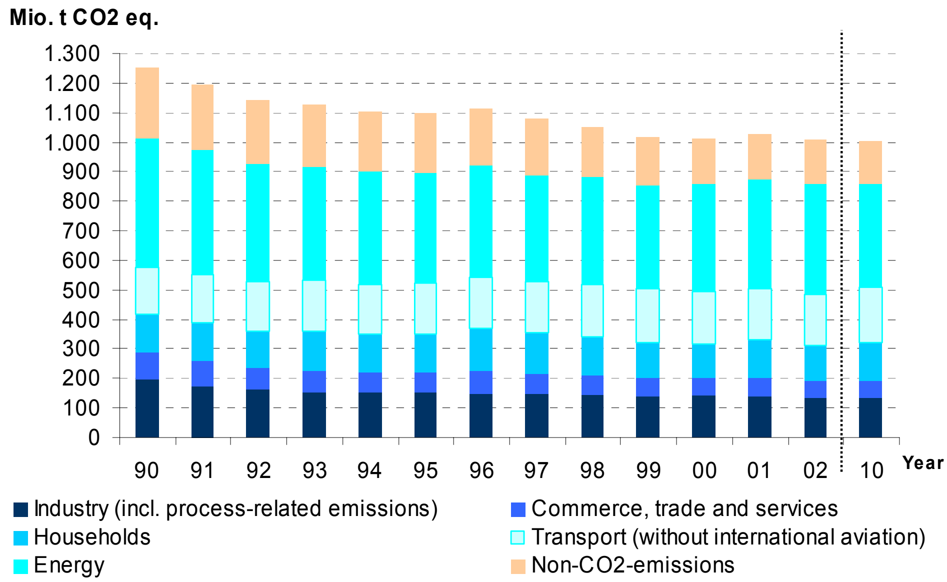
[86] Federal Environmental Agency (UBA) 2005: Klimaschutz in Deutschland bis 2030 – Endbericht zum Forschungsvorhaben Politikszenarien III, p. 278.

[87] The Federal Government assesses the values at 70 million tonnes in 2004, source: Arbeitsgruppe Erneuerbare Energien-Statistik (AGEE-Stat). This data is based on a different reference system and describes the total reduction.

[88] Ordinance on Environmentally Sound Disposal of Municipal Wastes and on the biological Treatment of Wastes (AbfAblV, amendment to the 1993 Technical Instructions on Municipal Waste).

2005 adopted by the Federal cabinet on 13 July contains quantified catalogues of measures for the transport and private households sectors. The aim is to ensure that the Kyoto target will be achieved. Quarterly monitoring is anchored in the Climate Protection Programme in order to determine to what extent emission reductions are achieved as a consequence of the measures.[89]

Fig. 34: Development of CO_2 emissions and non-CO_2 emissions by sectors "with measures"



Source: Federal Environmental Agency (UBA) 2004, Politikszenarien III

What do we have to do in Germany in order to achieve our greenhouse gas emission reduction targets by the year 2010?

In the event that the monitoring process shows that emission reductions are in fact lower – due to unforeseeable factors, for example – additional efforts would be necessary in order to achieve the 21% greenhouse gas emission reduction by the 2008-2012 period compared to 1990.

[89] Refer to the National Climate Protection Programme, Bundestag publication15/5931 dated 19 July 2005

Since the Kyoto Protocol is only a first step towards the necessary, long-term significantly stronger emission reductions, the study also explores the business-as-usual development between 2010 and 2020. Instead of the politically desired reduction by another 200 million tonnes of CO_2 equivalents (to – 40% compared to 1990)[90] – one even finds a slight increase in CO_2 emissions by around 15 million tonnes. The slight reduction in other greenhouse gas emissions does not compensate for this increase. The following chapters will address in more detail measures which can and are designed to contribute towards a medium-term and long-term reduction of greenhouse gas emissions in Germany.

[90] In its Climate Protection Programme, the Federal Government proposes "that the EU agrees within the scope of the international climate protection negotiations for the second commitment period of the Kyoto Protocol to reduce its greenhouse gases by the year 2020 by 30 percent (against the reference year). On this condition, Germany will aim for a contribution of - 40 percent." Loc. cit., p. 6

13. Reducing German greenhouse gas emissions by 2050 – CO_2, CH_4, N_2O and fluorinated greenhouse gases

An 80% reduction in greenhouse gas emissions by the year 2050 in Germany is both technically possible and economically viable. Promoting renewable energy and significantly increasing energy efficiency contribute greatly towards this. Thanks to climate-friendly technology, fluorinated greenhouse gases are to a large extent unnecessary. Affordable measures are at hand, so that the intermediate goal of a 40% CO_2 emission reduction by the year 2020 against 1990 can be reached without additional costs for the national economy. These measures include, for example, refurbishing existing buildings and boosting power station efficiency.

What would happen if the trend were to continue?

In 2002, the Enquete Commission of the 14th German Bundestag on "Sustainable Energy Supplies“ presented comprehensive data material on the long-term development of energy supply and greenhouse gas emissions in Germany.[91] In 2004, a study on behalf of the Federal Ministry for the Environment updated this data material.[92] The reference scenario is unable to fulfil the medium-term and long-term climate protection requirements. If the policy so far pursued together with current consumption and production patterns were to continue until 2050, total energy-related CO_2 emissions in Germany up to 2030 would remain approximately constant at the 2002 level of around 830 million tonnes per year. By the year 2050, CO_2 emissions would then decline to an annual 701 million tonnes, in particular, due to the strong decline in population expected.

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[91] Final report by the Enquete Commission of the 14th German Bundestag on "Nachhaltige Energieversorgung unter den Bedingungen der Globalisierung und Liberalisierung“ (Sustainable Energy Supplies in View of Globalization and Liberalization), Bundestag publication 14/9400; reference scenario particularly in statement 4.

[92] Federal Ministry for the Environment 2004: Ökologisch optimierter Ausbau der Nutzung erneuerbarer Energien in Deutschland (Ecologically Optimised Development of the Use of Renewable Energies in Germany).

First integrated emission reduction measures are foreseeable in the EU starting 2006/2007 in the case of non-energy greenhouse gas emissions, such as emissions of perfluorinated and partially fluorinated hydrocarbons (PFC, HFC) or sulphur hexafluoride (SF_6). As far as air conditioning systems for cars are concerned, even more far-reaching emission reduction measures can be expected. Emission reduction efforts must be continued in order to prevent an even higher increase in emissions of these greenhouse gases up to the year 2020 and beyond, for example, in new fields of application. However, the measures already implemented and planned till now will not be able to prevent a slight increase in emissions of perfluorinated and partially fluorinated hydrocarbons (PFC, HFC) and sulphur dioxide (SF_6) (in total) until the year 2020 (refer to Table 1).

Table 1: Development of greenhouse gas emissions by the year 2030 in million tonnes of CO_2 equivalents

	2000 [4)]	2010	2020	2030
CO_2 [1)]	863.0	836.0	851.0	816.0 [3)]
Of which:				
Energy sector	367.5	352.8	385.9	367.0 [3)]
Private households	131.7	129.8	127.0	177.0 [3)]
Commercial, trade and services sector	66.7	57.9	55.1	
Industry	118.4	110.5	105.7	101.0 [3)]
Transport	176.7	184.8	177.6	170.0 [3)]
CH_4 [1)]	86.5	70.4	65.3	64.9
N_2O [1)]	55.8	54.6	54.0	54.2
HFC [2)]	7.0	10.9	9.5	no data
PFC [2)]	1.5	0.6	0.6	no data
SF_6 [2)]	6.7	4.4	6.1	no data

[1)] Source: Klimaschutz in Deutschland bis 2030, Table 3.12-9, p. 284[93]
[2)] Source: Schwarz[94]
[3)] The CO_2 emissions in the year 2030 were taken, without modification, from the reference scenario applied by the Enquete Commission (refer to "Klimaschutz in Deutschland bis 2030", p. 305, Table 4.3-7). The emissions expected here are in total slightly lower.
[4)] Data for CO2 (individual sectors), PFC, HFC, SF6 in 1998

What must be done in future in order to achieve the medium-term and long-term emission reduction targets for greenhouse gases?

The Federal Environmental Agency (UBA) believes that by the year 2020 Germany's greenhouse gas emissions will have to be reduced by 40% against 1990. This corresponds to a reduction of another 20% or around 200 million tonnes of CO_2 equivalents compared to today's levels. The energy sector has a key role to play in this respect (refer to statement 17). Further emission reductions must follow after 2020 until emissions are reduced by around 80% in the year 2050. The study titled

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[93] Federal Environmental Agency (UBA) 2005: Klimaschutz in Deutschland bis 2030 – Endbericht zum Forschungsvorhaben Politikszenarien III.

[94] Schwarz, W.: Emissionen und Minderungspotenziale von H-FKW, FKW und SF_6 in Deutschland. Aktueller Stand und Entwicklung eines Systems zur jährlichen Ermittlung. Emissionsdaten bis zum Jahr 2001 und Emissionsprognosen für die Jahre 2005, 2010 und 2020. 4th intermediate report on the research project, on behalf of the Federal Environmental Agency (UBA), file reference 202 41 356, publication planned at: www.umweltbundesamt.de/uba-info-daten/daten/treibhausgase.htm.

"Klimaschutz in Deutschland bis 2030"[95] addresses different reduction scenarios in order to determine the implications for energy consumption and infrastructure in the different sectors. "Reduction scenario II" models a 40% CO_2 emission reduction for the year 2020 and a 50% reduction for the year 2030 (with 1990 as the reference year in both cases). The "industry" and "energy conversion" sectors are expected to contribute most of the emission reduction volume.

Table 2 gives an overview of the CO_2 emission trends.

Table 2: CO_2 reduction contributions by sectors under the reduction scenarios compared to the " model base scenario" (in million tonnes) [96]

	Historical data*		Development required from a climate protection perspective (reduction scenario II)			Deviation compared to the business-as-usual (model base) scenario			Change against 1990		
	1990	2000	2010	2020	2030	2010	2020	2030	2010	2020	2030
Industry [1)]	215	141	131	117	110	- 3%	- 9%	- 11%	- 39%	- 46%	- 49%
Commercial, trade and services sector[2)], private households	226	192	172	136	109	- 7%	- 23%	- 36%	- 24%	- 40%	- 52%
Transport [3)]	172	188	201	189	167	0%	- 4%	- 8%	17%	10%	- 3%
Energy conversion [4)]	407	342	235	164	120	- 19%	- 48%	- 61%	- 41%	- 59%	- 70%
Total	1014	863	739	607	507	- 9%	- 26%	- 35%	- 27%	- 40%	- 50%

* Temperature-adjusted [1)] Other conversion sector included [2)] Commercial, trade and services sector (agriculture, forestry and construction industry excluded) [3)] Agriculture, forestry and construction industry included [4)] Other conversion sector excluded
Sources: Enquete Commission 2002, calculations by Forschungszentrum Jülich (STE)

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[95] Federal Environmental Agency (UBA) 2005: Klimaschutz in Deutschland bis 2030 – Endbericht zum Forschungsvorhaben Politikszenarien III.
The medium-term scenarios of the study address CO_2 emissions only.

[96] Ibidem.
The assumptions of the "model base scenario" correspond to those of the reference scenario used by the Enquete Commission, even though the figures diverge slightly due to methodological reasons. Since the difference between the individual development paths is the central point of interest for shaping future policies, these publications do not compare the two scenarios. However, details are quoted in the study.

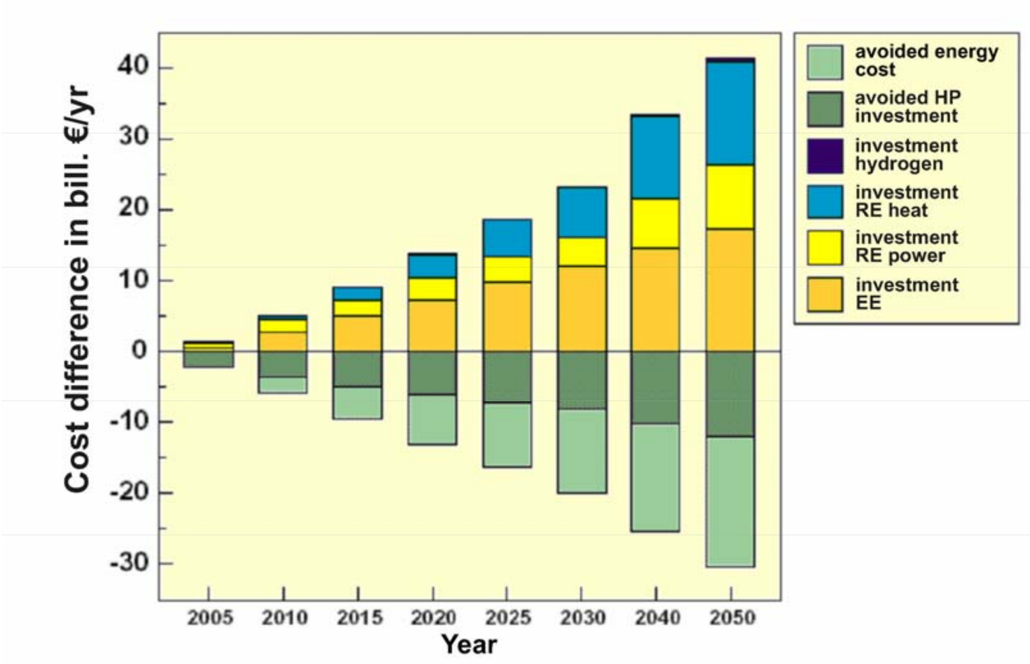
Beyond this development, an 80% reduction of CO_2 emissions by the year 2050 against 1990 is technically and economically feasible for Germany.

The study titled "Langfristszenarien für eine nachhaltige Energienutzung in Deutschland“ (Long-term scenarios for sustainable energy use in Germany) published by the Federal Environmental Agency in 2002 and the "sustainability scenario" developed in this study show a way towards achieving an 80% reduction in CO_2 emissions[97].

The authors calculate the costs of technical progress and show paths for the development of power stations and heat supply systems which Germany can embark upon its way towards climate-friendly production and consumption patterns. To this end, the authors compare the additional costs and savings of such an approach to the situation that would arise if the current trend were to continue. The upper part of Fig. 15 shows the additional cost of investing in renewable energies (REG) and technology for efficient energy use (RAT). The lower part depicts the savings due to avoidable energy costs (EK) of fossil fuels and avoidable investment in conventional power plants.

[97] The research project of the Federal Environmental Agency "Langfristszenarien für eine nachhaltige Energienutzung in Deutschland“ was carried out by the Wuppertal Institute for Climate, Environment and Energy and the DLR Institute for Thermodynamics (Stuttgart). The report was published by the Federal Environmental Agency (UBA) in 2002 (Climate Change Nr. 01/02 and 02/02). A short version is available under www.umweltbundesamt.de . The data of this study was reassessed by the research project „Ökologisch optimierter Ausbau der Nutzung erneuerbarer Energien in Deutschland“ (DLR, ifeu, Wuppertal Institute; 2004).

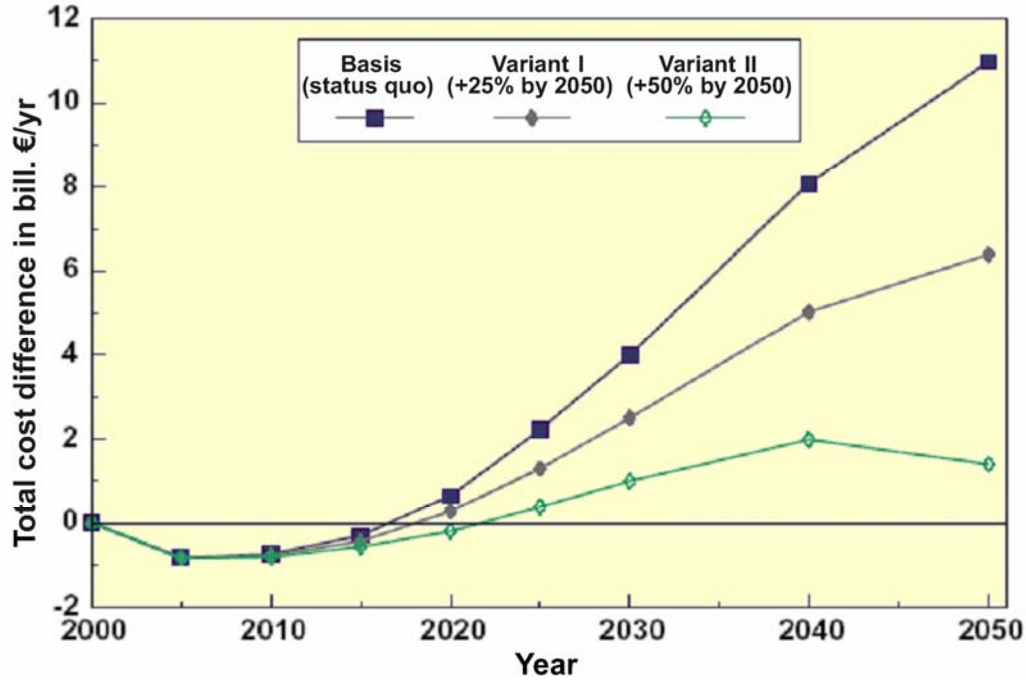
Fig. 45: Additional costs and savings of a scenario for sustainable energy use in Germany compared to the status quo (in billion euro)



Source: Federal Environmental Agency (UBA) 2002, Long-term scenarios of sustainable energy use, HP = heat and power, RE = renewable energy, EE = energy efficiency

The avoidance of fossil fuel costs constitutes a central parameter of the cost comparisons. These costs are dependent on the development of the future world market prices for oil, gas and coal. Fig. 16 shows how the balance changes as a function of the assumed energy price. The upper curve "Basis (status quo)" shows the cost development according to the development of energy prices until 2002. The two curves below, "Variant I" and "Variant II", show the costs resulting from a 25% or 50% increase in energy prices by the year 2050 as is already suggested by the figures for the years 2003 - 2005.

Fig. 16: Energy costs as a function of the assumed energy price development



Source: Federal Environmental Agency (UBA) 2002, Long-term scenarios of sustainable energy use

The additional costs for the entire period from 2002-2050 will at worse total around 200 billion euro.[98] This corresponds to extra costs of around 4 billion euro per annum. Allocated to all private households in Germany[99] , this means that every household would have to bear an additional burden of between 8.2 and 9.4 euro. The results of the Enquete Commission on "Sustainable Energy Supplies" suggest a similar order of magnitude.

A 30% reduction in emissions of fluorinated greenhouse gases in Germany is also technically and economically possible. [100] Technology already in place today

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[98] In 1998 prices. The Federal Environmental Agency (UBA) does not consider the discounting of these figures to be a permissible method. Discounting would mean that the fact that a sum to be spent in the future can, until spent, theoretically generate interest income on the capital market.

[99] The scenarios assume a total number of around 35 million private households in 2002. Due to the trend towards small households, this number then increases to 38 million in 2020 and subsequently falls to 34 million in 2050 due to declining population figures.

[100] Schwarz, W.: Emissionen und Minderungspotenziale von H-FKW, FKW und SF_6 in Deutschland. Aktueller Stand und Entwicklung eines Systems zur jährlichen Ermittlung. Emissionsdaten bis zum

indicates that these substances will be obsolete in almost all applications by the year 2030.

How can the medium-term and long-term emission reduction targets be achieved?

Greenhouse gas emissions can be reduced according to the above-mentioned targets without the need to use nuclear energy. Nor will costly CO_2 separation and storage measures with their unclear environmental effects be necessary. Sustainable forms of energy use increase supply security through reduced energy imports.

Affordable emission reduction potentials and a host of measures for opening up these potentials are available in order to achieve the intermediate greenhouse gas emission reduction targets by the years 2020 and 2030. The reduction scenarios addressed in the "Klimaschutz in Deutschland bis 2030" study show that, following expiration of the commitments under the Kyoto Protocol, even more far-reaching greenhouse gas emission reductions of 40% by the year 2020 and of 50% by the year 2030 against the reference scenario are possible and economically feasible in Germany. The following sectors provide substantial contributions under the reduction scenarios:

- In the power generation sector, electricity production will decline 12% by the year 2030 thanks to savings at the consumption end. Power generation from coal must be reduced and replaced with electricity generated in gas-fuelled Combined Cycle Gas Turbine Power Plants (CCGT). In addition to this, biomass and biogas/cogeneration plants will replace some of fossil-fuelled plants, and local heating as well as district heating systems will be developed further, also on the basis of natural gas and, above all, biogas. Power generation from wind energy and water power will reach its full development potential. (Refer to statements 17 and 18)
- Changing the energy source is of central importance in the industrial sector. The use of fuel oil is reduced by 45%, of lignite by 25%, and of hard coal by

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Jahr 2003 und Emissionsprognosen für die Jahre 2005, 2010 und 2020. 4th intermediate report on the research project, on behalf of the Federal Environmental Agency (UBA), file reference 202 41 356, publication planned at: www.umweltbundesamt.de/uba-info-daten/daten/treibhausgase.htm.

10%. At the same time, the use of biomass increases by 500%. Additional energy saving methods and technologies will be developed in a parallel effort (refer to statement 16). This concerns, first and foremost, capital goods, chemicals, cement, lime, brick, paper as well as the iron and steel industries.

- In the private households sector, the rehabilitation of buildings in terms of energy use and energy savings has a central role to play, with massively improved thermal insulation both for existing and new buildings. A change in energy sources, away from fuel oil (-65%) and natural gas (-25%) towards district and local heating from cogeneration plants and renewable energies +150%) as well as the more widespread use of condensing boilers will account for further improvements.
- In the commercial, trade and services sector, thermal insulation will contribute towards reducing CO_2 emissions with savings of 50%, whilst savings of 20% will be achieved in agriculture and forestry. Furthermore, district and local heating will substitute coal and oil heating (30% increase). Substances with a low global warming potential replace fluorinated greenhouse gases in almost all applications, with their total greenhouse contribution decreasing.[101]
- In the transport sector, more efficient vehicle types - especially in goods transport - and substituting fossil fuels by biofuels[102] will lead to CO_2 emission reductions.

Where do we have to start today?

Investment decisions have a particularly long-term effect in the case of buildings and energy supply systems. With the introduction of building energy performance certificates planned for 2006 under the Directive on the Energy Performance of Buildings[103] , building rehabilitation measures will be promoted which help to save energy. In this way, energy-efficient buildings will receive a documented, additional

[101] Federal Environmental Agency (UBA): Fluorierte Treibhausgase in Produkten und Verfahren – Technische Maßnahmen zum Klimaschutz. The report was published in 2004. It can be downloaded at: www.umweltbundesamt.de for free.

[102] This is subject to the reservation – as outlined in statement 19 – that, with a view to climate protection, if biomass is in short supply, these substances should be used more efficiently for stationary power generation rather than for the production of biofuels.

[103] Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the Energy Performance of Buildings.

quality feature which is relevant when the property is rented out or sold and which constitutes an incentive for owners to upgrade their properties to a more climate-friendly standard.

Furthermore, cogeneration plants must be promoted and encouraged further, and the CO_2 emission reduction programme by Kreditanstalt für Wiederaufbau (KfW) must be continued and expanded even further (refer to statement 16).

The adoption of the proposed EC Regulation and Directive on certain fluorinated greenhouse gases before the end of 2005 would be an important step towards reducing emissions of these substances. By the year 2010, the examinations – as already foreseen in the relevant revision clauses – for the inclusion of further substances and applications in legislation must then be pursued in a target-orientated manner and the results must be implemented in the short term, taking new technologies and processes into consideration.

The chapter on renewable energies (refer to statement 18) will address the host of options for supporting the further dissemination of renewable energies in more detail.

14. Consistent Climate Policy and Ecological Finance Reform

> In the interest of more balanced economic incentives to save energy among companies, private households and in the transport sector, taxes must be orientated more towards clear, environmental criteria. Environmental Finance Reform also includes a subsidy policy that pays tribute to environmental protection. Short-term measures necessary to this effect include taxation of kerosene fuel for aircraft, if possible, on an international level, abandoning German special allowances for home buyers and commuters, and a further reduction of electricity and mineral oil tax exemptions for industry, agriculture and forestry. Furthermore, environmental and climate protection aspects must be systematically integrated into public budget and procurement systems in order to achieve sustainable public expenditure and programmes.

Why do we need Ecological Finance Reform?

Ecological Finance Reform generates sector-spanning, economic incentives to reduce greenhouse gas emissions. It covers several modules, i.e. the further development of ecological tax reform, an environmentally and climate-friendly subsidy policy as well as the shaping of government spending and programmes with a stronger focus on the environment and climate. Consistent climate policy is not possible without Ecological Finance Reform.

Economic instruments, such as taxes on energy consumption, are a good means of keeping greenhouse gas emissions at bay. Higher prices create incentives for companies, private households and the transport sector to save energy and to improve the efficiency of energy use. The eco-tax is one such efficient and cost-effective instrument. Contrary to other measures, this tax is capable of influencing millions of decisions by consumers and producers and of triggering sustainable re-orientation of behaviour.

The success of such measures is now visible: Recent surveys on behalf of the Federal Environmental Agency (UBA)[104] show that around 50% of those polled are now keener to reduce energy consumption as a result of the eco-tax. Although the number of vehicles in Germany continues to increase, fuel consumption, which had increased steadily in the past, actually declined in the years from 2000 to 2003. Energy-saving technology and appliances enable more efficient use of electricity. Furthermore, the eco-tax puts innovative, energy-saving companies at an advantage and reduces the incidental wage costs borne by employers by around eight billion euro per annum. This strengthens companies and creates up to 250,000 additional jobs.

Which instruments are needed?

Further development of Ecological Tax Reform[105]

The economic incentives for companies, private households and the transport sector to boost energy efficiency and to save energy must be maintained and in some cases upgraded to efficient levels.

In order to improve the efficiency of emission-related steering measures and the level of acceptance among the general public, the eco-tax should be orientated more than ever towards clearly understandable, environment-related criteria and should include all fossil energy sources. Far-reaching tax reductions and special conditions are today available to producing companies and to the agriculture and forestry sector. These reductions and special conditions must be eliminated or redesigned as quickly as possible because economic steering effects in the interest of efficient energy use and energy savings are very weak in the favoured sectors. The Federal

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[104] Federal Environmental Agency (UBA), FKZ 204 41 194: "Quantifizierung der Effekte der Ökologischen Steuerreform" [Quantifying the effects of the ecological tax reform].
The publication can be downloaded from the Internet at: www.umweltbundesamt.de for free.

[105] Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (Federal Ministry for the Environment, Nature Conservation and Reactor Safety and Radiation Protection) 2004: Die Ökologische Steuerreform: Einstieg, Fortführung und Fortentwicklung zur Ökologischen Finanzreform [The Ecological taxreform, introduction, continuation and further development to the Ecological Finance Reform], updated version dated October 2004.

Environmental Agency (UBA) recently submitted proposals to this effect.[106] One particularly helpful approach would be to grant preferential conditions for producing companies and agriculture on condition that the companies concerned implement an energy management system and at least those energy saving measures which will pay off within a reasonable period of time considering the economic conditions of the company in question.

Unlike EU emissions trading which began in 2005, the eco-tax is capable of addressing "diffuse" CO_2 emission sources in small businesses, the services and transport sectors, as well as private households. As long as a comprehensive upstream emissions trading scheme for the marketing[107] of fossil fuels and the related CO_2 emissions is not in place[108] and as long as the quantitative target of the national allocation plan is not very demanding (refer to statement 15), the eco-tax with its broad incentive effect will remain a central instrument for climate protection in the foreseeable future. Once first experience with emissions trading becomes available, both instruments must be suitably co-ordinated and harmonised. In order to avoid double burdening, the Federal Environmental Agency (UBA) suggests the following procedure. In as far as a company suffers a net burden due to the eco-tax at its location – after deduction of the reduced pension insurance contributions – the installations which take part in emissions trading are to be exempt from the eco-tax, however, on condition that this does not lead to a net advantage for the company.

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[106] Federal Environmental Agency (UBA), FKZ 203 14 106: "Ökologische Steuerreform: Energieintensive Prozesse / Energieaudit" [Ecological tax reform: energy-intensive processes / energy audit].

[107] Such a system could be installed on different levels, and has yet to be explored in more detail. One conceivable option is, for example, a certificate obligation for all producers and importers of fossil fuels, such as coal, oil and gas: A party marketing these fuels must surrender a number of certificates corresponding to their carbon dioxide content. The quantity of tradable certificates issued is limited in such a manner that the climate targets can be achieved. The costs of the certificates are passed on via the prices and lead to more efficient use and savings of fossil fuels on all downstream levels of the economy.

[108] Refer to the related discussion in statement 15 and the 2002 Environment Report by the German Advisory Council on the Environment, "Für eine Vorreiterrolle" [Towards a New Leading Role], Bundestag publication 14/8792, in particular, number 473 on p. 233.

Elimination of climate-damaging subsidies

Several studies conducted on behalf of the Federal Environmental Agency (UBA) demonstrate that many direct and indirect subsidies exist which favour climate-damaging production patterns and attitudes.[109] These subsidies concern different sectors, such as the transport and energy sectors, housing, agriculture and the producing industry. In the short term, climate protection reasons – and the need to reduce other environmental burdens – require the elimination of the exemption of aviation fuel (kerosene) from mineral oil tax, as well as abandoning German special allowances for home buyers and commuters, and a further reduction of electricity and mineral oil tax exemptions for industry. Abandoning the special allowances for home buyers alone would generate annual savings of around 11 billion euro for the federal, federal-state and municipal budgets in the medium term, i.e. after the settlement of "old cases".

Identifying and removing climate-damaging subsidies can only be a first step within the framework of subsidy policies geared towards environmental protection. Generally speaking, environmental protection and sustainability aspects must be addressed more than before in subsidy policy. Regular effect and success controls are particularly necessary for existing subsidies, along with environmental impact analyses when it comes to introducing new subsidies. In the long term, all climate-damaging subsidies must be eliminated or at least redesigned in such a manner that an end is put to their climate-damaging effects. One important precondition for this is the systematic identification and examination of subsidy regimes at federal, federal-state and municipal level in as far as these are counter-productive to climate protection.

If the privileges of climate-damaging fuels and users are successfully abandoned, the funds released thereby should be used to consolidate public budgets and, in part, invested in programmes to promote and subsidise energy-saving and efficient energy uses in order to support the ecological steering effect of abandoning subsidies. It may also be advisable in certain cases and for a limited period of time to compensate

[109] Federal Environmental Agency (UBA) 2003: Berücksichtigung von Umweltgesichtspunkten bei Subventionen [Consideration of environmental aspects with subsidies], published in the UBA Texte series, Nos. 30/03, 31/03 and 32/03, with a background paper dated June 2003.

for social hardships which may arise as a consequence of eliminating climate-damaging and environmentally harmful subsidies.

In order to avoid slashing subsidies across the board, it will also be important not to eliminate subsidies for favourable conditions and regulations which are designed to compensate for competitive disadvantages of climate-friendly alternatives and which trigger off or reinforce steering effects which are desirable from a climate protection perspective.

Sustainability of government spending and programmes[110]

In order to retain the credibility when demanding the protection of climate and natural resources, governments must make full use of the enormous CO_2 emission reduction potentials in the public sector. Another point in favour of increased energy saving measures is the fact that these measures often mean a significant easing of the burdens on government budgets.[111] Economic incentives – not least as a consequence of efforts to modernise public administrations – have an ever more important role to play on the road towards more environmental protection in public administrations.[112] So-called fifty-fifty models, for instance, are already very successful where individuals or communities are granted success bonuses if they help administrations to save energy consumption costs by more environment-centred behaviour. The introduction of an environmental management and controlling system is a particularly suitable way of systematically opening up savings potentials in the public sector.[113] Besides this, external environmental protection services – above all,

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[110] Federal Environmental Agency (UBA) 2003: Ökonomische Anreize für den Umweltschutz im Bereich der öffentlichen Hand [Economic incentives for environmental protection in the public sector], published in the UBA Texte series, No. 86/03.

[111] For a summary of estimates concerning environment-related savings potentials in the public sector, refer to the study titled "Umweltcontrolling im Bereich der öffentlichen Hand" [Environmental controlling in the public sector], TEXTE 8/99.

[112] In 2003, the Federal Ministry for the Environment and the Federal Environmental Agency (UBA) published a comprehensive synopsis of strategies and examples of economic incentives for the implementation of environmental protection projects in the public sector in a brochure titled "Umweltschutz lohnt sich für öffentliche Verwaltungen" [Environmental protection pays off for public administrations].

[113] Federal Ministry for the Environment, Nature Conservation and Reactor Safety and Radiation Protection / Federal Environmental Agency (UBA) 2001: Handbuch Umweltcontrolling für die

energy saving contracting – can be used in order to achieve substantial savings[114] (refer to statement 11).

Furthermore, public spending decisions must consider climate protection aspects even more than before. In the medium to long term, systematic integration of these aspects into public budget systems is necessary, for example, in the case of investment in transport and traffic, as well as in procurement decisions concerning, for instance, electricity, vehicles and in the construction sector (refer to statement 21).[115]

Where do we have to start today?

Abandoning climate-damaging subsidies can start immediately by eliminating the tax exemption on kerosene, as well as the German special allowances for home buyers and commuters. Preferential treatment with regard to the electricity and mineral oil tax for producing companies, for agriculture and forestry must be abandoned or redesigned in order to boost the incentives to save energy and to use energy efficiently which are so far of a minor nature only. Once first experience with emissions trading becomes available, the economic climate protection instruments must be suitably co-ordinated and harmonised. The public sector too can already do a lot for climate protection. When it comes to modernising the administrations,

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öffentliche Hand [Environmental controlling manual for the public sector] as well as Federal Ministry for the Environment, Nature Conservation and Reactor Safety and Radiation Protection) / Federal Environmental Agency (UBA) 2003: "Umweltschutz lohnt sich für öffentliche Verwaltungen" [Environmental protection pays off for public administrations]. The German Bundestag also expects "that systematic and uncompromising environmental commitment on the part of public administrations will relieve the environment and government budgets" (Bundestag publication 14/2907, http://dip.bundestag.de/btd/14/029/1402907.pdf). The Bundestag hence calls upon the Federal Government to introduce an environmental controlling system for all federal authorities and properties and an environmental management system along the principles of the EU Environmental Audit System Ordinance (EMAS) and/or the international ISO 14001 environmental management standard for all larger properties and organisational units.

[114] Federal Environmental Agency (UBA) 2000: Energiespar-Contracting als Beitrag zu Klimaschutz und Kostensenkung [Energy saving contracting as a contribution towards climate protection and cost reductions].

[115] Federal Environmental Agency (UBA) 1999: Handbuch Umweltfreundliche Beschaffung [Environmentally friendly procurement manual].

economic incentives should be increasingly used, for example, with fifty-fifty models, energy saving contracting and environment-friendly procurement.

15. Emissions trading

Emissions trading can become the central instrument of climate protection. In the European Union (EU) it started in 2005. The EU should develop this instrument further by defining ambitious goals for subsequent trading periods, harmonising national rules for the implementation of emission trading, involving all major emitters in emissions trading, exempting facilities with minor emission levels from emission trading, and reducing administrative and technical processes even further. The European emissions trading system is linked to the project-based mechanisms of the Kyoto Protocol – in Germany this is done with the Project Mechanisms Law [Projekt-Mechanismen-Gesetz (ProMechG)]. Emissions trading can also be considered for sectors not covered up to now by the Kyoto regime, such as international aviation and shipping. A research project by the Federal Environmental Agency (UBA) already submitted proposals for the aviation sector.

Emissions trading during the first trading period from 2005-2007

On 1 January 2005, emissions trading was introduced as a new instrument for climate protection. A certain share of companies in Europe – from the energy and industrial sectors – are compelled to remain below an absolute annual limit for CO_2 emissions and are entitled to trade allowances to emit climate-damaging CO_2. The avoidance of one tonne of CO_2 is given a value that is determined by the market. The idea is that trading should steer the necessary reductions in greenhouse gas emissions in the direction where they are least expensive.[116]

The German Greenhouse Gas Emissions Trading Act (TEHG) and Allocation Law 2005-2007 (ZuG 2007) made EU emissions trading binding in Germany. In the first trading period, 499 million emission allowances – including a reserve for new installations – will be allocated free of charge to installations in the energy and industrial sectors. This corresponds to an annual emissions reduction in the period

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[116] Details of EU emissions trading and implementation Germany can be found on the homepage of the German Emissions Trading Authority (DEHSt) at the Federal Environmental Agency: www.dehst.de and at www.bmu.de/emissionshandel.

from 2005 to 2007 of an average of 2 million tonnes or 0.4% compared to CO_2 emissions in the period from 2000 to 2002 that serves as the reference period.

Consolidation of emissions trading with a view to the 2008-2012 trading period and beyond

The decision to introduce EU emissions trading was an important and innovative step in European environmental policy which took place at remarkable speed not just in terms of the political decision-making process but also with a view to practical implementation in the member states. In order to be able to assess the implications of this new instrument of climate protection, emissions trading in Europe now requires a phase of consolidation. Many effects – such as the investment incentive that may result from special allocation rules or the analysis of emission reduction potential for certain industries – must be examined carefully. All players in business, politics and society are now called upon to gain experience with trading, so that they can then establish strategies for trading on this basis. In many cases, market activities cannot be evaluated until the data from the first year of trading in 2005 has been analysed.

This means that meticulous planning is needed for the further development of emissions trading. At the same time, however, the allocation procedures that have now been almost completed in the individual member states and the national allocation plans developed for this purpose[117] have already highlighted that there is a need for harmonisation in Europe for the further development and shaping of plans.

In many cases, the further development of emissions trading requires comprehensive harmonisation and decision-making processes, particularly on the European level. In light of the deadline which is less than 12 months for the final version of the National Allocation Plans for the second trading period from 2008-2012, expectations for the further development of emissions trading should remain reasonable. Moreover, many important further-development and shaping proposals must be understood and examined with a view to a perspective for 2012 and beyond.

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[117] The member states have set forth in the National Allocation Plans (NAPs) the total number of emission certificates to be allocated in each trading period and how these certificates are to be allocated to the individual installations.

The following aims should be decisive in EU-level negotiations for the further development of emissions trading in the following trading periods:

- Agreement on demanding emission reduction targets for the national allocation plans and transparent testing methods (if possible, starting 2008-2012)
- Standardisation of the term "installation" and simplification for small installations (de-minimis rules, if possible, starting 2008-2012)
- Examination of the need for harmonisation with individual allocation rules for emission allowances (if possible, starting 2008-2012)
- Examination of expansion to other sectors (e.g. transport) and greenhouse gases (after 2012)
- Competent integration of project-based Kyoto mechanisms.

In their national allocation plans for the first trading period from 2005 – 2007, the EU member states set forth relatively undemanding emission reduction targets. In the forthcoming trading period, many EU member states will have to achieve much greater emission reductions so that commitments from individual member states laid down in the EU Burden Sharing Agreement and hence the EU's total commitment can be achieved.

In the trading periods following 2012, much more demanding targets will be required from the point of view of climate protection, i.e. demands that go beyond the scope of the Kyoto commitments. For instance, in Germany where, contrary to the 2005-2007 national allocation plan, the number of certificates will have to be reduced by at least another 30% by 2020 in order to achieve in a cost efficient manner the German climate protection target for 2020 that was established in 2002 in the German government's coalition agreement. However, both Germany and many other member states have a particularly large and cost-efficient potential to reduce emissions in the energy sector. These reductions in emissions require long-term investment. This is why the shaping of emissions trading must consider the investment cycles of the main types of installations (refer to statement 17).

For the first trading period, the EU member states have different definitions for the group of installations obliged to participate in emissions trading. The reason for this is that the EU member states differed in their interpretation of Annex 1 to the Emissions Trading Directive that is applicable to the definition and in how they anchored this in their respective national legislation. The harmonisation of the term "installation" is one of the urgent tasks needed in order to avoid a distortion of competition. Furthermore, the cost efficiency of the emissions trading system can be improved considerably without having any significant, adverse effects on climate protection efficiency if only those installations that reach a certain minimum size participate in emissions trading. Simplification must be agreed on for small installations taking part in emissions trading. The shaping of this so-called de-minimis rule can be rooted in different criteria. What is important for a decision that should already come into force in the second trading period is that all the member states find a joint position as quickly as possible. The EU member states have employed very different allocation rules during the first trading period. In the case of existing installations, allocation varied between different forms of "Grandfathering“ and "Benchmarking“.[118] Generally speaking, both experts in the EU member states and representatives of the industries affected are of the opinion that in the interest of more comparable competition conditions benchmarking should play a greater role for the future allocation of emission rights to existing installations. Harmonising national benchmarking methods would constitute an important step towards the harmonisation of allocation rules.

A particularly high degree of variance between EU member states can be found in the case of allocation rules that should consider the dynamic nature of economic developments. These are the rules for new installations, shut-downs and the rules for transferring rights from old to new installations. These rules are particularly important for the climate-protection efficiency of the system because they determine how certificates are allocated. At the same time, they pose a high risk of distorting competition. This is why their impact and effect must be carefully examined and – where necessary – attempts must be made to achieve European harmonisation.

[118] In the case of Grandfathering, certificates are allocated on the basis of historical emissions from a previous basis period. In the case of benchmarking, allocation takes place on the basis of production and output-related data. Different forms of these approaches are conceivable, such as average emission volume per output unit or Best Available Technique (BAT) per output unit.

The introduction of emissions trading is ultimately also conceivable for the aviation and shipping industries which are not covered by either the Kyoto regime or the EU emissions trading system, particularly since a further significant increase in emissions can be expected here. According to calculations by the Federal Environmental Agency (UBA), CO_2 emissions by German air traffic alone including international air traffic departing from Germany will more than double by 2020.[119] Proposals for the inclusion of air traffic in emissions trading are already available from a research project carried out by the Federal Environment Agency.[120] The study shows that a possible trading system should not only cover CO_2 but also the entire climatic effect of air traffic. Preference should be generally given to an open, i.e. a trading system linked to the installation-based EU system, at least with regard to CO_2, whilst emissions could be allocated to the airlines in proportion to the routes flown.

It can make sense to include other greenhouse gases in emissions trading in order to open up the potential for greenhouse gas emission reductions beyond the scope of CO_2 and to make use of the synergies that result from reducing several greenhouse gases at the same time. This requires that recognised recording methods exist for monitoring each of the gases in question.

In addition to emissions trading, the Kyoto Protocol foresees two more flexible mechanisms which countries can use to have the greenhouse gas emission reductions that result from projects carried out in other countries credited to their emission reduction commitments: In the case of Joint Implementation (JI), projects are carried out in other countries with their own emission reduction goals and in the case of the Clean Development Mechanism (CDM), emission reductions are achieved primarily in newly industrialised and developing countries without these countries having their own emission reduction goals. Although the first Kyoto

[119] Federal Environmental Agency (UBA) 2002: Updated data and calculation model: "Energieverbrauch und Schadstoffemissionen des motorisierten Verkehrs in Deutschland 1980-2020" [Energy consumption and pollution by motor-driven traffic in Germany 1980-2020], final report, UFOPLAN No. 201 45 112, Berlin, unpublished.

[120] Study by the Öko-Institut on behalf of the Federal Environmental Agency, 2004: Cames, M.Deuber, O. "Emissionshandel im internationalen zivilen Luftverkehr" [Emissions trading in international civil aviation], Berlin, unpublished.

commitment period for these mechanisms does not begin until 2008, it does make sense to already use these project-based mechanisms in the first trading period of the EU system because they can make an important contribution towards climate protection.[121] Using the CDM also promotes the later expansion of the Kyoto regime to countries without their own emission reduction commitments. Above all, in the least developed countries, CDM could be an important assistance in the transition to sustainable development (renewable energies and energy efficiency).[122] When using the CDM – and also the JI starting in 2008 – in EU emissions trading, care must be taken to ensure that the project-based mechanisms are only used in order to supplement emission reductions in one's own country so that no industrialised nation can "buy its way out" of the need for ecological structural change at home. Furthermore, demanding criteria for approving projects must be established and applied since failure to do so could threaten the ecological integrity of the Kyoto regime.

Supplementing installation-based emissions trading with an upstream emissions trading scheme after 2012

Emissions trading introduced at European level in 2005 covers CO_2 emissions at the source of emissions: Certain larger installations in industry and the energy sector are obliged to present certificates for their CO_2 emissions and these certificates can be traded with other installations (so-called downstream approach). During the course of expanding certificate trading after 2012 to sectors not yet covered with many smaller emitters, the approaches that could make sense are those that foresee a certificate obligation for the distribution of fossil fuels. This would mean that fossil fuels would

[121] In the research project on the "Langfristige Nutzung der Kyoto-Mechanismen" [Long-term use of the Kyoto Mechanisms] (due to be completed in January 2006), the Federal Environmental Agency is also examining the potential of project-based mechanisms when it comes to achieving long-term climate protection targets.

[122] For 2005-2006, the Federal Environmental Agency is planning a research project on "Förderung erneuerbarer Energien in Industrie- und Entwicklungsländern zur Umsetzung des Kyoto-Protokolls" [Promoting renewable energies in industrialised and developing countries in order to implement the Kyoto Protocol] in order to examine possibilities for using the CDM to promote renewable energies.

then already be made scarce at the marketing level[123] and this would then lead to avoidance incentives on all levels of the value chain (so-called upstream approach).

Generally speaking, the introduction of an upstream emissions trading scheme at EU level is legally possible. In this case, it must be ensured that no double rules and hence no double burdens arise as a result of installation-related emissions trading and upstream emissions trading. The decision as to whether to introduce such an instrument requires careful consideration of the costs and effects of other instruments already introduced. How upstream emissions trading can be best organised must also be examined in detail.

Emissions trading can make a considerable contribution towards achieving climate protection goals. The experience gained with this new instrument should be used to boost its efficiency and to include other areas, if possible.

[123] Cf. in this respect 2002 Environmental Report by the German Advisory Council on the Environment "Für eine Vorreiterrolle" [Towards a New Leading Role], Bundestag publication 14/8792, in particular, No. 473, p. 233.)

16. Reducing energy consumption

> Primary energy consumption in Germany is to be halved by the year 2050. This will require efficiency improvements in energy conversion as well as lower total final energy consumption. Energetic refurbishment of existing buildings could cut German CO_2 emissions by as much as 5 to 7%. Improving energy efficiency – including avoidance of no-load and standby power consumption - can reduce electricity consumption in Germany by more than 12% by 2020 as compared to business as usual projections.

What would happen if the trend were to continue?

Annual primary energy consumption[124] in Germany since 1990 has remained almost at the same level, and in 2001 totalled just under 14,600 petajoules. The individual sectors accounted for the following shares:

- Private households: 19.5%
- Transport sector: 18.6%
- Industry: 16.4%
- Commerce, trade and services sector: 10.5%
- Energy conversion sector: 35.0%

Since 1990, the shares of the transport and households sectors rose whilst those of the industry, commerce, trade and services, and conversion sectors declined.

According to the scenario by the Enquete Commission of the German Bundestag ("reference scenario“)[125] , end-use energy consumption[126] up to 2050 (compared to

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[124] Primary energy consumption is the sum of primary energy fuels extracted and generated in a country (coal, mineral oil, gas, nuclear power and renewable energies), the change in stocks and the sum of procurements and deliveries. It includes the energy required for conversion as well as end-use consumption.

[125] Final report by the Enquete Commission on "Sustainable Energy Supplies in View of Globalization and Liberalization", Bundestag publication 14/9400, June 2002.

[126] End-use energy consumption describes the consumption of primary and secondary fuels (e.g. petrol) by end consumers (industry, transport, small consumers). This results from primary energy consumption minus consumption and losses in the energy conversion sector and non-energetic consumption.

1998) will decline by around 13%. The most significant reduction of around 20% will take place in the household sector; this decline is primarily due to the decline in population. This scenario shows a continuation of politics and consumer behaviour up till now whilst all emission reduction targets would not be reached.

How will energy consumption have to develop with a view to climate protection goals?

The study commissioned by the Federal Environmental Agency (UBA) on "Long-term scenarios for climate protection" showed that primary energy consumption can be cut by half by the year 2050 compared to 1998 without any adverse effects on prosperity.[127] In the "sustainability scenario", end-use energy demand is reduced by 46%. This effect is boosted even further by an additional improvement in efficiency in electricity generation, so that primary energy demand can decline by 54%. This figure confirms the findings of the Enquete Commission on "Sustainable Energy Supply“ that current primary energy demand can be cut by more than 50% by the year 2050.

In the study by the Federal Environmental Agency "Climate protection in Germany until 2030"[128] , a reduction scenario II was developed (refer to statement 13). This scenario describes, among other things, the development of end-use energy consumption in individual sectors by the year 2030 that is necessary in order to achieve the emission reduction target set by the Federal government (a reduction of 40% by 2020 compared to 1990). Furthermore, a 50% reduction in emissions by the year 2030 was also modelled (refer to Table 3).

[127] Federal Environmental Agency (UBA) 2002: Langfristszenarien für eine nachhaltige Energienutzung in Deutschland [Long-term Scenarios for Sustainable Energy Use in Germany].

[128] Federal Environmental Agency (UBA) 2005: Klimaschutz in Deutschland bis 2030 – Endbericht zum Forschungsvorhaben Politikszenarien III [Climate Protection in Germany until 2030 – Final Report on the Research Project Political Scenarios III].

Table 3: End-use energy consumption according to sectors (in petajoules)

	Historical values*	Reduction scenario II		
	2000	**2010**	**2020**	**2030**
Industry	2459	2543	2427	2392
Commerce, trade and services	1610	1567	1492	1307
Households	2961	2678	2266	2090
Traffic**	2506	2790	2654	2426
Total	9536	9577	8839	8216

Note: * Temperature-adjusted ** Without foreign air traffic
Source: Klimaschutz in Deutschland bis 2030 [Climate Protection in Germany until 2030]. Table 4.4-5, p. 313

Today, a host of technical and organisational solutions are already known that could considerably reduce energy consumption whilst offering the same benefits, more often at the same or lower cost. The future is also likely to continuously bring with it new methods of saving energy that will then be available on the market. However, a considerable amount of time can sometimes lapse between the development and successful market launch of a new technology. Shortening this time is an urgent requirement. One successful example of this is the use of IT technology for the intelligent and energy-efficient control of techniques of power engineering.

Kommentar [js1]: Grammatik korrekt??

This chapter restricts itself to possibilities as to how annual energy savings of 1% can be achieved over the next 20 years in the industry, trade, services and private household sectors. Savings in energy conversion (refer to statement 17) and in the transport sector (refer to statement 19) supplement these measures and instruments. When nothing to the contrary is noted, the data used was taken from the study titled "Klimaschutz in Deutschland bis 2030".[129]

Industry

For 38 energy-intensive industry processes alone, accounting for half of all industrial end-use energy applications, the technical end-use energy savings potential currently totals around 16% whilst the economic savings potential totals around 5 to 7%. Amortisation periods of up to five years form the basis for the economic savings potential.

[129] Cf. loc. cit.

Electricity

In the case of cross-sector technologies[130] , there is partly a very large economic potential to save electricity: 48% in the case of compressed-air systems, 25% for pumps and fans, 11% for electric drives and 77% for lighting.

Since more than one third of Germany's entire electricity demand is used for industrial and commercial cross-sector technologies with electric drives, it is particularly important that this enormous potential to save electricity will be exploited. This could mean that electricity consumption in industry until 2020 could be maintained at the same level as in 2000. In contrast to this, the reference scenario until the year 2020 shows an 11% increase.

Heating

Heat consumption (including space heat: 10%, process heat: 66%) determines energy consumption in industry. In the heating sector, the greatest energy saving potential of 30% can be found in thermal cross-sector technologies (e.g. steam generation). Possibilities to save energy in process-specific applications are much more difficult to exploit. Taking 1998 as the reference year, there is currently a total technical savings potential of 20% by the year 2020. The economic savings potential totals 7 to 10%.

With regard to all end-use energy consumption in industry, a total of around 40% of industrial end-use energy consumption could be saved over the next two decades compared to the reference scenario by exploiting the technical solutions already available today. Half to two thirds of this can be regarded as economic potential (with an amortisation period of five years).

Commerce, trade and services

More than 30% of end-use energy consumption could be saved over the coming two decades compared to the reference scenario in the commerce, trade and services sectors by exploiting the technical solutions directly available today. Around one fifth

[130] Cross-sector technologies are used in different economic sectors and industries. Examples include compressed air, pumps, drives, etc.

(i.e. 6% of end-use energy savings) of this is also of an economic nature (with an amortisation period of less than five years).

Electricity

Electricity accounts for 30% of end-use energy consumption and the trend is rising. Significant economic electricity saving potentials exist in some areas (for instance, lighting: 77%, office machines and infrastructure: 25%). Just like in the industrial sector, there is also potential for savings with regard to cross-sector technologies, such as electric drives (motors) as well as pumps and fans.

Heating

The heating of non-residential buildings offers a particularly large potential for saving end-use energy consumption. Improving the sealing of building envelopes offers a technical saving potential of 60% whilst the use of small cogeneration plants offers 74%. These are individual potentials that cannot be added together.

Private households

Electricity

Electricity consumption in private households until the year 2020 can be reduced by around 15% through economic measures (i.e. with amortisation periods of up to five years) compared to the status-quo development.

The technical saving potential is somewhat higher: The greatest saving effect of more than 70% can be achieved for lighting and no-load losses. Savings for household appliances, water heating systems and consumer electronics range between 25 and 50%.

Heating

Private households use 76% of end-use energy to heat buildings. Together with end-use energy consumption for heating water, this then totals 87%.

Improving insulation offers considerable potential for savings in existing buildings. The greatest potential offered here can be found in the large number of buildings that were built in the 25 years after World War II.

If current residential buildings were to undergo complete energetic rehabilitation, this would reduce current heating demand by almost 60%. Economic interests dictate that heat-related rehabilitation should be carried out within the scope rehabilitation measures that are due to be carried out anyway. This would save the costs of scaffolding a building twice, for instance.

Despite how easy it is to exploit this potential, Germany currently has a considerable bottleneck in energy saving rehabilitation measures. Although the general rate at which residential buildings are being rehabilitated is currently around 2.5% annually, only every fifth measure is designed to improve thermal insulation.

Which instruments are needed in order to reduce end-use energy consumption?

Ecological Finance Reform is a central instrument designed to boost energy efficiency. By making energy consumption more expensive and at the same time offering financial relief in other areas, this instrument creates economic incentives across all sectors for greater energy efficiency (refer to statement 14).

A second, comprehensive instrument is "Energy-saving contracting".[131] This is understood to be the exploitation of energy-saving potentials by an external contractor. The contractor conveys the potential to save energy and exploits this under his own economic responsibility. The necessary investments and services of the contractor are financed by the energy costs saved. This is interesting for both public institutions and for industrial companies since they thus acquire the contractors' know-how and do not have to burden their own budgets with investment costs in the short term.

Industry and business

Heating

New and improved self-commitments are needed on the part of industry as well as financially supported energy consultancy for companies in order to boost the efficiency of the many industrial heating processes, including the use of waste heat.

[131] Cf. statement 21.

Companies and municipalities should improve and increase their co-operation within the scope of a co-operative cogeneration economy.

Financial support for energy consultancy (energy audits) is important particularly for small and medium-sized enterprises (SMEs). This makes it possible to exploit energy saving potentials – above all with the many heating processes in the textiles and food industries as well as with drying processes and industrial steam and hot water generation in many industries. This support should be granted to SMEs in the form of direct subsidies for initial consultancy services, and quality standards must be set for consultancy services (e.g. orientated towards the VDI guideline 3922 "Energy consulting for industry and business“). Compared to the status-quo development, emission reductions of 8 million tonnes of CO_2 by the year 2020 and 10 million tonnes of CO_2 by 2030 would be possible.

Electricity

"Electricity efficiency programmes" – as part of an EU-wide co-ordinated electricity efficiency programme (compressed air, pumps, fans, other electric drives and lighting) – could contribute towards reversing the increase in electricity consumption and hence towards reducing CO_2 emissions. These programmes should comprise a series of supplementary instruments so that energy consumption can be definitely cut by half by the year 2050. Such instruments include regulatory law, economic incentives, market transformation programmes, self-commitment on the part of producers of electricity-powered equipment, energy consumption comparisons within industries, support for energy consultancy and the promotion of business co-operations for the joint erection of energy supply installations[132]. Compared to 1998, this would mean savings of around 22 TWh (terawatt hours) of electricity in 2020 and around 28 TWh in 2030. CO_2 emissions from electricity generation (assuming the

[132] Regulatory law can, for instance, include minimum efficiency standards. Improving terms and conditions for loans by KfW could create economic incentives. Market transformation could be achieved, for instance, through technology procurement or market procurement. Using suitable IT-supported offers, individual businesses would be able to compare and hence better estimate their energy consumption with other businesses in the same industry or similar energy consumption patterns. If necessary, they could also provide recommendations for action.

current electricity mix) in 2020 would decline by around 13 million tonnes annually and by around 17 million tonnes a year in 2030.

Private households

Heating

In old buildings alone, boosting efficiency and energy savings in building heating and hot water supply together with improved heat insulation standards would mean that annual CO_2 emissions could be reduced by between 50 and 70 million tonnes.[133]

The Energy Saving Ordinance (EnEV) introduced requirements for the energy demand permitted for new buildings that were approx. 30% stricter than the previous standards. In addition to this, effective regulatory control and supplementary economic incentive programmes for existing buildings are needed.

The Energy Saving Ordinance cannot fully exploit the potential for huge CO_2 emission reductions which existing buildings offer, because up to now it has not been possible, for legal reasons, to impose a general obligation to retrofit existing buildings, above all due to the economic efficiency requirement of the Energy Saving Act [Section 5 of the Energy Saving Act]. The Energy Saving Act must be improved in this respect.

Attention should hence also be given to other effective measures for the energetic rehabilitation of existing buildings, in particular, to measures designed to alleviate the so-called investor-user dilemma. Rent law provides one way of creating incentives for investment in energy-saving rehabilitation measures in existing buildings. For instance, a higher deduction rate for investments in energetic building rehabilitation than the current 11% per year should perhaps be examined as an incentive for investments purely in the interest of saving energy. Including the heating system properties of a building as a criterion in the German rent index could be another way

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[133] Almost 75% of Germany's buildings were built before 1985. On the basis of the approximately 4 billion square metres of building space that existed in 2002, where 39 million apartments accounted for around 3 billion square metres, boosting efficiency and energy savings in building heating and hot water supply together with improved thermal insulation standards permits the assumption of a realistic CO_2 savings potential in the old building sector of 50 to 70 million tonnes of CO_2.

of creating investment incentives. The EU Directive on the "Energy Performance of Buildings“[134] sets forth new requirements here. Starting in 2006, an "energy certificate" is likely to be required for each apartment to be bought or to be rented out. This will create market transparency and provide incentives for energetic rehabilitation.

The introduction of a so-called "warm rent“, i.e. rent including heating costs, is another possibility. In this case, heating costs are broken down into "basic heating costs" and "use-dependent heating costs". "Basic heating costs" are understood to be the share of heating costs needed to heat the building to a certain minimum temperature. Any heating costs in excess of this are largely tenant-dependant and must be borne by the tenant. The charm of this kind of regulation is that both tenant and building owner are interested in measures to reduce heating costs because both parties would directly benefit financially from energy savings. Assuming the clarification of all the questions yet to be answered, a "warm rent" does appear to be a suitable approach in order to trigger energetic rehabilitation measures on a large scale in existing buildings.

Electricity

Electricity consumption in private households can be reduced significantly. One important instrument here is the introduction of an ordinance that covers those properties of new appliances that determine energy consumption (e.g. power consumption, switching times, control programs, etc.). These requirements would have to be regularly adapted to technological developments. This ordinance would have to go far beyond the method selected in Japan, for instance, to determine maximum consumption values (referred to as the Top-Runner Program) because this

[134] In the interest of improving environmental protection through measures for the efficient use of natural resources and in order to boost energy efficiency, the EU adopted and published a Directive on the Energy Performance of Buildings (Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the Energy Performance of Buildings). The Energy Saving Ordinance (EnEV) already sets forth many of the requirements of the EU Directive. The complete transposing of this Directive into German legislation by January 2006 will mean that the housing sector will be obliged to draft energy demand certificates for existing buildings. The necessary transparency which these energy certificates will create poses a considerable challenge for the rehabilitation of old buildings.

method fails to consider all the influences on energy consumption[135]. Analogous requirements must also be developed for office equipment.

The efficient use of electricity in households and offices is at times hindered or even prevented by unsuitable equipment; for instance, by the fact that the number of devices without a real Off button is increasing. Unnecessary and all in all huge no-load losses can be avoided in the case of electrical and electronic equipment by a power switch that is always necessary, clearly visible and identified and which ensures that once a device is switched off it does not consume any electricity. Since electrical and electronic equipment is increasing in private houses, especially IT equipment, it is becoming more and more difficult to reduce energy consumption. For instance, for many households digitised television means buying another electrical device (satellite decoder) that causes additional no-load losses.

It is up to the EU to ensure that it is easy for consumers to identify energy-efficient electrical equipment when shopping. The EU's labelling obligation for the energy consumption of large household appliances features a classification that frequently corresponds to a state of the art that was valid more then ten years ago. This should be updated regularly and at shorter intervals. In addition to this, the EU should introduce an obligation to mark equipment values that are relevant to the energy consumption of office equipment and consumer electronics.

Governments should support the spread of voluntary labelling for energy efficient appliances, for instance the GEEA energy efficiency label [136] for office equipment and consumer electronics, as a well as the "Blue Angel" eco-label, e.g. by considering these labels more in public procurement. The requirements of the Energy

[135] Refer to "Neues zum Thema Leerlaufverluste" [Newsletter on no-load losses], edition 2004/1 (No. 22), pages 5 and 18 seq., Press Office of the Federal Environmental Agency (UBA).

[136] The GEEA (Group for Energy Efficient Appliances) is an alliance, above all, of national energy agencies in Europe. It awards an energy efficiency label to electrical appliances and equipment with low no-load losses. In Germany, this label is awarded by Gemeinschaft Energielabel Deutschland (GED). More information is available on the Internet at: "http://www.efficient-appliances.org" (GEEA) and "http://www.energielabel.de" (GED).

Star[137] for office equipment currently offer no suitable selection aid because they do not go far enough and are already fulfilled anyway by many of the devices available on the market.[138]

In addition to this, an energy efficiency fund can also help to reduce electricity consumption in private households. This fund finances and organises programmes for the promotion and market launch of energy efficient technologies, for motivating consumers and for training and further education. This can, for instance, take place in the form of financial support for the use of highly efficient heating recirculation pumps.

Information campaigns that target a change in behaviour patterns are doomed to fail unless technology has been developed to the extent that it promotes energy-saving user behaviour[139].

Where do we have to start today?

As described, a very large potential for energy savings can be exploited in existing buildings. Measures designed to improve thermal insulation are particularly effective in this case. The rehabilitation cycle of buildings must be considered for economic reasons. This means that measures for the energetic rehabilitation of building

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[137] The Energy Star is an energy efficiency label that is awarded by the US-EPA (U. S. Environmental Protection Agency, USA), for instance, for electrical appliances. Pursuant to an agreement with the US-EPA, the Energy Star is also awarded in the European Union, however, only for office equipment in this case.

[138] Refer to "Neues zum Thema Leerlaufverluste" [Newsletter on no-load losses], edition 2003/1 (No. 17), page 7 seq., Press Office of the Federal Environmental Agency (UBA).

[139] This means, for instance:

- when electrical appliances have an easy-to-access, clearly marked Off switch that fully disconnects the appliance from the mains. This is the only way the user can conveniently and safely disconnect the appliance from the mains.
- when copying machines switch between copy mode and energy-saving mode without inconvenient waiting times. This is the only way to ensure that users will be willing to accept (now hardly perceivable) waiting times and to switch the machine to energy-saving mode (in the first place).

As long as there is no suitable technology freely available, following the instructions for use that are usually issued during campaigns means inconvenience for users. And this means that campaigns will fall on deaf ears.

envelopes which are not carried out within the scope of rehabilitation measures that are due anyway are unlikely to be carried out for several decades afterwards due to the long life of many building parts. This is why the obstacles that hinder the energetic rehabilitation of existing buildings should be eliminated as quickly as possible through suitable measures, for example, rent law reform.

17. Upgrading power plant fleet

> The forthcoming upgrading of the power plant fleet by the year 2020 should be used for investing in efficiency and reducing the share of coal in power generation. Declining energy demand as a result of energy-saving technology and better management in industry, private households and public administrations will save investment and fuel costs. State-of-the-art natural-gas cogeneration plants as well as plants generating electricity from renewable energy sources must be given preference over coal-fired power plants in order to cover any excess demand. Compared to natural gas CO_2 emissions caused by coal are around twice as high per unit of energy. Economically feasible processes for carbon capture and storage (CCS) are unlikely to be available to the desired extent over the next 20 years.

What would happen if the trend were to continue?

Although overall electricity demand would be likely to decline considerably if the path described in statement 16 were to be followed, power plants with an electrical capacity of around 40 GW (gigawatt) would have to be replaced by 2020 in Germany. This figure includes the shutting down of most nuclear power plants and replacement investments – above all, for old coal-fired power plants – and corresponds to the capacity of 50 large power plants or 5,000 decentralised power stations (for example, small combustion power stations and wind turbines) or one million small installations in the household sector (e.g. combined heat and power units and photovoltaic installations).[140]

Plans currently exist in Germany to build almost 20 new large power stations each with a capacity of 200 to 1,200 MW (megawatt). Although only a few cogeneration plants are foreseen, the efficiency of these plants – compared to today's power plants

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[140] The figures referred to here merely serve to highlight the dimensions. In reality, there are very differently sized models on the market compared to the plant types referred to here. Moreover, in the case of wind and photovoltaic installations, not only must their nominal capacity be considered but also their availability which is weather-dependent and limited and which cannot be planned with complete certainty.

– is much higher. This will result in a perceivable reduction in specific CO_2 emissions. This is supplemented by plans to expand renewable energies (refer to statement 18).

If the effects of replacing nuclear power plants with power plants fired by fossil fuels are deducted from the improvements in efficiency referred to above, this means that CO_2 emissions from the power plant fleet would decline by 7% between 2000 and 2010 only to rise again by 5% in the years up to 2020.[141]

With climate protection goals in mind, how should the power plant fleet of the future be?

When it comes to achieving the climate protection goal of a 40% reduction in greenhouse gas emissions in 2020 compared to 1990, the energy sector has a key role to play. Compared to today's level, CO_2 emissions can be cut by half in this sector and this corresponds to a reduction of 180 million tonnes of CO_2 annually. In order to achieve this goal, electricity consumption must decline by 12% (refer to statement 16) and the share of renewable energies will have to increase from today's 9% to 20% of electricity generation (refer to statement 18). These two developments would then lead to an emissions reduction of around 22% compared to today's level.

Significant improvements are also required in the power plant fleet. In the field of fossil-fired power plants, CO_2 emissions can generally be reduced in two ways:

- First of all, the efficiency of these power plants must be improved. Table 4 shows the potential for such improvement. For instance, an average efficiency of 35% can be assumed for coal-fired power plants currently in operation. Today's state of the art, however, enables an efficiency of 43% for lignite-fired power plants and 44% for hard coal-fired power plants. For instance, the hard coal-fired power plant in Rostock operates with an efficiency of more than 43%. The status of research today even goes significantly beyond these

[141] This data is based on the “Reference scenario” prepared within the scope of the study on "Klimaschutz in Deutschland bis 2030“ [Climate Protection in Germany up to 2030] (cf. Umweltbundesamt 2005: Klimaschutz in Deutschland bis 2030 – Endbericht zum Forschungsvorhaben Politikszenarien III, [Climate Protection in Germany up to 2030 – Final Report on the Research Project Political Scenarios III] p. 305. With regard to the period from 1990 to 2020, CO_2 emissions will decline by just under 80 million tonnes.

values. In the case of IGCC (Integrated Gasification Combined Cycle) power plants, efficiency levels of 55% are conceivable. In the field of hard coal-fired power plants, an efficiency of 50% is said to be possible in the future. In the case of gas-fired power plants too where average efficiency is currently in the range of 50%, several projects (Lubmin and Hürth) have reached the implementation phase with an efficiency level of just under 58%. Efficiency levels of 60% can be reached under experimental conditions.

- Secondly, a transition to low-carbon natural gas must take place. With natural gas, the high hydrogen share in methane leads to lower CO_2 emissions during combustion. In the case of imported natural gas and looking only at combustion (i.e. omitting upstream processes) in the lifecycle, 0.20 kg of CO_2 is produced for every kWh (kilowatt hour) of fuel. In the case of hard coal, this figure is 0.33 kg of CO_2 per kWh, and even 0.40 kg of CO_2 per kWh in the case of raw lignite.

In order to be able to secure safe grid management when expanding wind power, gas turbines designed for flexible use must be additionally used. At the same time, if the expansion of wind power is continued in the period up to 2020, the capacity of the conventional power plant fleet can be reduced by almost 6% of the wind power capacity installed.[142]

[142] Cf. Federal Government 2005: Wegweiser Nachhaltigkeit 2005 – Cabinet decision dated 10 August 2005

***Table 4: Efficiency and specific equivalent CO_2 emissions per kilowatt hour (kWh) for different types of power plants.*[143]**

Fossil fuel	Today's power plant fleet	Today's state of the art	Today's state of the research
	Efficiency (%) g of CO_2 equiv. per kWh	Efficiency (%) g of CO_2 equiv. per kWh	Efficiency (%) g of CO_2 equiv. per kWh
Lignite	35% 1,183	43% 963	55% 753
Hard coal	35% 1,114	44% 886	50% 780
Natural gas	50% 492	58% 424	60% 410

By combining both effects, highly efficient, natural-gas fired gas and steam plants could operate at the same capacity but producing up to 65% less CO_2 than today's coal-fired power plants. When calculating CO_2 reduction, it must be remembered that today's coal-fired power plants account for around 50% of electricity supply. If the nuclear power plants that are to be phased out and 70% of today's coal-fired power plants were instead to be replaced by natural-gas power plants, this would still mean a reduction in emissions of more than 30%.

A complete change to natural gas would, however, make it difficult to distribute the risk of rising primary energy prices in the fuel mix. Both natural gas resources and other sources of fossil fuels are available from certain regions only – primarily Russia and the Arab region – and are also ultimately finite. This is why it makes no sense with a view to a long-term supply strategy to focus solely on one of these limited resources. Instead, the share of natural gas in electricity generation should increase considerably whilst some efficient coal-fired power plants should remain in operation.

All in all, with the steps described up to now, CO_2 emissions in electricity production could be reduced by around 50% by 2020 compared to today's level. This is

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[143] Cf. Umweltbundesamt 2003: Anforderungen an die zukünftige Energieversorgung - Analyse des Bedarfs zukünftiger Kraftwerkskapazitäten und Strategie für eine nachhaltige Stromnutzung in Deutschland [Requirements for future energy supply – analysing the demand of future power plant capacities and a strategy for sustainable electricity use in Germany], p. 28, Berlin.
These values cover the entire lifecycle – i.e. including the erection of the power plants and the production of raw materials.

supplemented by the heat generated by energy conversion which is only part of the small percentage of district heating within the energy sector and is hence not included in the figures calculated in this chapter. Tomorrow's power plant fleet could, however, use the fossil fuels needed during the transition phase more efficiently if heating were to be included. Expanding cogeneration offers a special opportunity here. Using this technology, fuel in power plants is not only used to generate electricity but also to generate heat or cold that can be used to heat or cool buildings or in industrial processes.[144] Up to now, cogeneration accounts for just around 10% of the generating capacity installed in German electricity supply. In Denmark and Holland, on the other hand, this accounts for up to 50%. A significant increase in the share of cogeneration can hence make a considerable contribution towards achieving climate protection goals in Germany.

Moreover, energy conversion processes that can be used on a decentralised level require a much lower investment volume for each overall capacity installed than conventional power stations and thus offer opportunities for small and medium-sized utilities.

Which instruments are needed in order to achieve medium-term climate protection goals?

Emissions trading is a central climate protection instrument for the energy and industry sector. In order to achieve the goal of a 50% reduction in CO_2 emissions in

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[144] Cogeneration is today possible in the majority of combustion power stations. In the case of large central plants, however, there are often not enough heat consumers in the vicinity of the plant. This is why smaller, decentralised power plants and small cogeneration plants supplying a small number of households with electricity and heat have a key role to play in future, climate-friendly power supply. Besides combustion techniques, stationary fuel cells are becoming more important. The fuel cell converts the chemical energy in fuels – such as natural gas, biogas, bioethanole or hydrogen – directly into electrical energy. Fuel cells can hence achieve much higher efficiency than conventional combustion machines. In addition to this, the heat that is produced when operating the cell can be used for heat supply to the consumers connected. The predominant methods used for decentralised cogeneration today, however, are petrol or diesel combustion engines that run on gaseous or liquid fuels (combined heat and power units). The electric efficiency is between 30 and 40% and the fuel utilization factor reaches values of up to 90%, however, these values are usually lower on an annual average (due to restrictions in heat use). An annual fuel utilization factor of more than 75% can be regarded as good.

the energy sectors referred to here by the year 2020, the quantity of certificates in Germany's current allocation plan must be reduced by at least 30% across the two sectors.[145] This would mean that the price-efficient potential to reduce emissions that exists in this sector could be used – due to the investment that must be made anyway in the power plant fleet – and the climate protection goal as a whole could be reached with the lowest costs (refer to statement 15).

What is difficult here, however, is that the emissions trading period and the underlying emission reduction goals are based on much shorter time cycles than the investment periods for power plants. This is why demanding, long-term emission goals must now already be defined for this sector. Otherwise there would be a risk that large power plants that do not permit any combined use – for instance, waste heat – will continue to be planned as a replacement for today's power plants. Another risk here is that in the coming year, extensive capacities will exist in the form of large power plants that will, however, no longer be needed in the future.

In order to shape the decisions on power plant investment in a climate-compatible manner, the following instruments will have to be developed or enhanced:

- First of all, an instrument is needed that will promote the fast expansion of cogeneration (CHP promotion measure). The goal pursued by Germany's Combined Heat and Power (CHP) Act [146] is to reduce annual CO_2 emissions by 2005 compared to the 1998 base year by at least 10 million tonnes and by 23 million tonnes by the year 2010.[147] In 2005, the Federal Ministry of

[145] Emissions trading today not only covers the greater part of the energy sector, but also industrial installations with high energy consumption. On the whole, certificates for almost 500 million tonnes of CO_2 were foreseen for the current 2005 – 2007 trading period. With a view to the contribution which the energy sector alone must make to reduce CO_2, this figure would have to be reduced by 180 million tonnes, i.e. more than 30%.

[146] Act on the Preservation, Modernisation and Expansion of Combined Power and Heat Generation of 11 March 2002, Federal Gazette I 2002, 1092.

[147] This goal is to be achieved through the temporary protection and modernisation of existing heating power stations, the expansion of electricity generation in small cogeneration plants (combined heat and power units) and the market launch of fuel cells. This Act obliges grid operators to include the named cogeneration plants in their grids and to buy the CHP electricity generated there. The price to

Economics and Labour and the Federal Ministry for the Environment are examining the success of this Act within the scope of a joint monitoring measure. The current public data available shows that the expansion of cogeneration up to now is not sufficient. The emission reduction targets will not be reached in this way.[148] This is the reason why the Federal Environmental Agency (UBA) is currently examining other instruments to promote cogeneration.[149]

- Secondly, the fuel utilization factor[150] must be optimised for each power station planned and also examined in order to check whether existing instruments are sufficient and have been implemented effectively.[151] When it comes to upgrading the power plant fleet, electric unit efficiency[152] and fuel utilization factors according to best available techniques must be achieved.[153] Large power plants should only be approved in areas where heat consumption is also certain. Only justified exceptions should be possible to these rules, for

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be paid for this is the price agreed between the CHP plant operator and the grid operator plus a surcharge set forth in the CHP Act on the basis of the type of plant in question.

[148] The study on "Klimaschutz in Deutschland bis 2030“ [Climate Protection in Germany until 2030] assumes that at best a reduction of 5 million tonnes by 2010 will be achieved (cf. Umweltbundesamt 2005: Klimaschutz in Deutschland bis 2030 – Endbericht zum Forschungsvorhaben Politikszenarien III, [Climate Protection in Germany up to 2030 – Final Report on the Research Project Political Scenarios III] p. 182 seq.

[149] Parallel to monitoring cogeneration, the Federal Environmental Agency has commissioned a study that explores the economic potential of cogeneration against the background of current price developments on the energy market as well as the instruments to improve the promotion of cogeneration further.

[150] The fuel utilization factor describes the overall efficiency of a CHP plant during the processing of fuel to electricity and heat.

[151] On EU level, this is the IPPC Directive ("Directive 96/61/EC of the Council of 24 September 1996 on Integrated Pollution Prevention and Control"); on national level, the Federal Immission Control Act (BImSchG) (in particular, Section 5 (1), No. 4), as well as its rules of procedures, there, in particular, Section 4d of the 9th Federal Immission Control Ordinance that governs approval procedures as well as the new Section 7 (Implementing measures of combined heat and power generation) of the new Large Combustion Facilities Ordinance (13th Federal Immision Control Ordinance).

[152] When defining unit efficiency, the entire power plant block unit must be taken into consideration. Unit efficiency is then the ratio between net electric performance and the energy introduced with the fuels.

[153] Cf. Best Available Techniques Reference Document for Large Combustion Plants (BREF LCP).

instance, peak-load electricity plants that cannot supply heat and which must be geographically positioned at certain points of the grid.

Where do we have to start today?

The Federal Environmental Agency is of the opinion that action is most urgently needed in order to promote cogeneration more effectively. The promotion instruments used to date have failed to trigger sufficient new investment.

Within the scope of the Initiative for Medium-sized Businesses in the Coalition Agreement of the Government Factions in the German Bundestag (2002), a special campaign programme is to be developed for business start-ups in this field. In order to do so, experience and existing instruments for promoting medium-sized businesses will be used. This concerns, in particular, advisory and information services, the issuing of guarantees and the granting of liquidity loans by the Federal government's subsidy bank, Kreditanstalt für Wiederaufbau (KfW).[154]

Technical progress in the fields of renewable energies, the use of cogeneration, as well as increasing the efficiency of fuel cell technology must be promoted further with the help of targeted research. The Federal Environmental Agency considers the Federal government's new energy research programme to be an ideal measure here.[155] The programme foresees both an absolute and pro-rata increase in the research budget for renewable energies by 2008. Fuel cell technology is a separate focus of research in the Energy Research Programme. The improved benefit of cogeneration – above all, the basic and organisational aspects of heat use – should in the future be given greater support.

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[154] Cf. Umweltbundesamt 2003: Anforderungen an die zukünftige Energieversorgung - Analyse des Bedarfs zukünftiger Kraftwerkskapazitäten und Strategie für eine nachhaltige Stromnutzung in Deutschland [Requirements for future energy supply – analysing the demand of future power plant capacities and a strategy for sustainable electricity use in Germany], Berlin.

[155] BMWA 2005: Innovation und neue Energietechnologien – Das 5. Energieforschungsprogramm der Bundesregierung [Innovation and new energy technologies – The 5th Energy Research Programme by the Federal Government].

18. Renewable energy's contribution towards energy supply

> By the year 2050, renewable energy is to account for 50% of energy supply. All renewable energy sources must be developed further. Wind (onshore using larger turbines at existing sites and offshore using new sites), biomass and solar thermal are to be the focus of development until 2020. Geothermal energy and solar power generation must already be introduced to the market today if they are to be developed to their full potential after 2020 at a reasonable cost.

The increased use of renewable energies avoids the release of climate-relevant gases which are produced by the combustion of fossil fuels. Furthermore, renewable energies increase supply security by reducing import dependence and the consumption of oil, gas and coal resources. At an international level, the use of regionally available, renewable energy sources can help reduce political conflicts and combat poverty in less developed countries by reducing imports of fossil fuels.

What would happen if the trend were to continue?

The study titled "Langfristszenarien für eine nachhaltige Energienutzung in Deutschland“ [Long-term scenarios for sustainable energy use in Germany][156] shows that by the year 2050 renewable energy can account for 50% of Germany's energy supply, along with a simultaneous, significant reduction in primary and end-use energy demand.

However, this aim can only be achieved if the necessary decisions are made in time. Merely implementing the measures currently adopted – such as the Renewable Energies Act and the market incentive programme for promoting renewable energy – would not be sufficient. The reference scenario by the Enquete Commission on "Sustainable Energy Supplies" describes this development under the conditions of

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[156] Federal Environmental Agency (UBA) 2002: Langfristszenarien für eine nachhaltige Energienutzung in Deutschland [Long-term scenarios for sustainable energy use in Germany].

globalisation and liberalisation.[157] With this scenario, renewable energy would account for just 4.4% of primary energy consumption in the year 2020. More far-reaching instruments will have to be used and measures adjusted to technical developments. The sustainability scenario of the study "Langfristszenarien für eine nachhaltige Energienutzung in Deutschland“ [Long-term scenarios for sustainable energy use in Germany] foresees a share of 10.5% by the year 2020, 16.7% by the year 2030 and 37.1% by the year 2050.[158]

Which aims should be defined for developing the individual energy sources?

Electricity and heat generating potentials based on regenerative energies should be developed in an economically justified order. In view of their technical maturity, development will initially focus on biomass, solar thermal and wind energy. In a parallel effort, technical development in the fields of photovoltaic and geothermal energy will have to be pushed ahead until these forms of energy can significantly contribute towards energy supply starting in 2020. In 2004, renewable energy as a whole accounted for 9.3% of end-use energy consumption for electricity generation and 4.2% for heating. Germany's total end-use energy consumption in 2004 totalled around 2,600 TWh.[159]

Biomass:

Energy from biomass has so far supplied the largest share of renewable energy in Germany, with heat use accounting for a particularly large percentage. In 2004, more than 67 TWh of energy was generated from biomass, 9.4 TWh of this in the form of electricity with an installed electricity generating capacity of 2,061 MW (end of

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[157] Report by the Enquete Commission of the German Bundestag, "Sustainable Energy Supplies in View of Globalization and Liberalization". Bundestag Publication 14/9400. Berlin 2002.

[158] The updated version of this study (Federal Ministry for the Environment (BMU) 2004: Ökologisch optimierter Ausbau der Nutzung erneuerbarer Energien in Deutschland [Ecologically optimised development of the use of renewable energies in Germany] calculates a share of 12.7% for the year 2020, 22.2% for the year 2030, and 43.6% for the year 2050 (efficiency method).

[159] Federal Ministry for the Environment, Nature Conservation and Reactor Safety: Erneuerbare Energien in Zahlen [Renewable energies in numbers], June 2005. Published at: www.erneuerbare-energien.de.

2004).[160] Biomass could offer the greatest potential if its expansion were pursued with determination. In this way, the annual generation potential from biomass would amount to 320 TWh in 2020 and 415 TWh in 2030. The energy stored in biomass can be used in different forms and, as required, employed for electricity generation, heat/cold generation and as a fuel basis.

In view of the direct link with soil and landscape protection, nature conservation and food production, the requirements of these sectors limit the potential of biomass as an energy source. Even if soil protection, nature conservation and landscape protection interests set high demands – for example, cultivation requirements – for biomass use, the overall technical potential for biomass in 2050 can still be expected to total 276 TWh, i.e. more than four times higher than in 2004.

Important steps for developing the potential of biomass are:

- Further development of cogeneration of heat and power and investment in heating grids with the aim of establishing biomass-fuelled cogeneration plants for distributed energy supply
- Determined use of all biogenous residues as energy sources
- Development of a system to ensure biomass supplies on a regional basis and with maximum environmental compatibility
- Improved efficiency of the energy conversion process in biomass plants through targeted promotion and support of research and development
- Avoidance of adverse effects of the further development of biomass use, in particular, on a cultivation level (soil quality, biodiversity, nutrient circulations, water balance, etc.)
- Further development of biomass support measures within the scope of the Renewable Energy Sources Act
- Further development of biomass support measures within the scope of the market incentive programme for promoting renewable energy
- Development of further instruments and measures to promote biomass in the heat market, for example, payment or bonus systems, quotas, regulatory instruments

[160] Ibidem

Wind energy:

By the end of 2004, plants with an installed capacity of 16,629 MW were on stream, generating around 25 TWh of electricity.[161] This means that only part of the available potential was put to use. Researchers estimate the technical potential of using wind energy on the German mainland to be 237 TWh per annum with an annual average wind speed of more than 5.5 metres per second (at an altitude of 50m).[162] Further analyses suggest an additional generating potential of 60 TWh in the range of wind forces below 5m/s (at an altitude of 10m). Even beyond this, there will be a much higher technical potential which as yet cannot be efficiently developed in economic terms. Once the related technologies break even, the Federal Ministry for the Environment expects a potential of 80 TWh per annum in the North Sea and Baltic Sea regions.[163]

Important steps for developing the potential of wind energy are:

- Further development of the technical standard of wind energy plants, especially in terms of operating reliability (shorter downtimes, early fault warning)
- Replacing many small installations by a small number of large, state-of-the-art installations whilst at the same time increasing the total capacity installed (repowering)
- Opening up the potential in regions with a wind velocity of below 5 metres per second (at an altitude of 10m)
- Exploiting the offshore wind energy potential
- Improved integration of wind energy by applying technology already available (including, for example, conductor temperature monitoring, load and generation management, compressed-air energy storage, short-term wind forecasts) as well as technology to be further developed in the medium term

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[161] Ibidem

[162] Refer to Kaltschmitt, M. et al. (eds.) 2003: Erneuerbare Energien [Renewable energies], Heidelberg, p. 327.

[163] Refer to Federal Ministry for the Environment, Nature Conservation and Reactor Safety (ed.) 2004: Ökologisch optimierter Ausbau der Nutzung erneuerbarer Energien [Ecologically optimised development of the use of renewable energies], Berlin. p. 31.

(including, for example, storage solutions, further development of plant technology).

- (Further) expansion of onshore and offshore electricity grids for transporting electricity from offshore wind farms and balancing of wind energy supplies across long distances.

Hydropower:

Alongside wind energy, hydropower currently plays the most important role when it comes to generating electricity from renewable sources of energy in Germany. With an installed capacity of 4,660 MW, a total of 21 TWh of electricity was generated in 2004.[164] The technical potential of hydropower use is considered to be largely exhausted in Germany. It will, however, be possible to open up additional potential by revamping existing plants.

Photovoltaics:

At the end of 2004, grid-integrated plants with a capacity of 708 MW were installed in Germany, generating 0.5 TWh of electricity.[165] Compared to other technologies for the use of renewable energy sources, photovoltaics should be seen as a long-term option. Photovoltaics offers substantial technical and economic development possibilities.

The technical potential of photovoltaics depends on the radiation supply per unit of module surface, on the available space for erecting plants and on their annual utilisation rate.

The authors of the study titled "Ökologisch optimierter Ausbau der Nutzung erneuerbarer Energien in Deutschland“ [Ecologically optimised development of the use of renewable energies in Germany] estimate the surface area available for

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[164] Federal Ministry for the Environment, Nature Conservation and Reactor Safety: Erneuerbare Energien in Zahlen [Renewable energies in numbers], June 2005. Published at: www.erneuerbare-energien.de.

[165] Loc. cit.

photovoltaic modules to be 700 square kilometres.[166] This estimate is based on the assumption of a sensible integration of photovoltaic installations in existing settlements. This includes, for example, the use of roofs, facades and noise protection walls. The fact that photovoltaic installations compete with solar collectors for space was also taken into consideration. The available space of around 700 square kilometres translates into an power generation potential of 105 TWh per annum. The additional use of suitable free space, such as fallow sites, will enable a significant increase in the technical potential.

Important steps for the further development of the potential are:

- Further development of the technical standard of photovoltaic installations, above all, the further development of thin-film cells and cells on an organic basis, increasing efficiency
- Elimination of administrative obstacles to the installation of photovoltaic systems on buildings[167]
- Securing ongoing, strong support for photovoltaics by the Renewable Energy Sources Act with a long-term perspective.

Solar thermal:

At the end of 2004, a total collector surface of around 6.2 million square metres was installed in Germany. The capacity of the solar thermal installation installed in Germany on this surface area totals 4,365MW, with an end-use energy output of 2.6 TWh.[168]

Hot-water supply is the primary application of solar thermal. Around 80% of installations serve this purpose. The remaining 20% support both heating and hot-water supply systems. Most installations are found on the roofs of detached or semi-

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[166] Refer to Federal Ministry for the Environment, Nature Conservation and Reactor Safety (ed.) 2004: Ökologisch optimierter Ausbau der Nutzung erneuerbarer Energien [Ecologically optimised development of the use of renewable energies], Berlin. p. 34.

[167] For example, approval requirements under federal-state construction codes or within the framework of communal requirements for the design of listed buildings.

[168] Federal Ministry for the Environment, Nature Conservation and Reactor Safety: Erneuerbare Energien in Zahlen [Renewable energies in numbers], June 2005. Published at: www.erneuerbare-energien.de.

detached homes. Apartment buildings are at present still under-represented even though larger installations on apartment buildings enable more favourable specific heat costs.

The technical potential of solar thermal installations will depend on the further development of the technical standard of the installations and the space available for this purpose. Usable spaces are primarily roofs, noise protection walls or covered parking lots. The authors of the study "Ökologisch optimierter Ausbau der Nutzung erneuerbarer Energien in Deutschland“ [Ecologically optimised development of the use of renewable energies in Germany] estimate the total available space at 970 square kilometres.[169] If the solar collector surface can be increased by 273 square kilometres by the year 2050, this would mean an annual yield of 78 TWh from solar thermal installations.

Important steps for developing the solar thermal potential are:

- Improving the technical standard of solar thermal installations, in terms of both technical components (collectors, pumps, controllers, storages) and the installation as a whole (optimising controllers and the solar fraction).
- (Further) development of local heat networks in order to make the heat generated by large installations available to a larger number of consumers
- Expansion of the use of solar-powered refrigerating systems
- Development of instruments for promoting the use of renewable energy in the heat market, harmonised with the market incentive programme.

Geothermal energy:

Until 2003, geothermal energy was used in Germany exclusively for heat generation. Since November 2003, a geothermal cogeneration plant with an installed capacity of 210 kW_{el} has been operating in Neustadt-Glewe within the scope of a pilot project. Further pilot projects are in preparation.

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169 Refer to Federal Ministry for the Environment, Nature Conservation and Reactor Safety (ed.) 2004: Ökologisch optimierter Ausbau der Nutzung erneuerbarer Energien [Ecologically optimised development of the use of renewable energies], Berlin. p. 54.

The technical potential of geothermal electricity generation is estimated to be 300 TWh per annum.[170] Taking the electricity consumed in 2004 (527.7 TWh) as a reference, this would mean a share of close to 57%. The additional potential of thermal energy (using the heat from cogeneration) totals around 1.5 times the electricity potential if no heat pumps are used. If heat pumps are used, the potential would be in the order of 2.5 times.

Important steps for developing the geothermal potential are:

- Improving the data situation in the search for suitable sites
- Improving the efficiency of drilling and simulation methods
- Improving the efficiency ratios of electricity generating installations and heat pumps
- Expanding the local heat networks in order to enable the use of geothermal energy by cogeneration (power generation with both heat and cold production) plants
- Promoting geothermal electricity generation within the framework of the Renewable Energy Sources Act with a long-term perspective
- Development of instruments for promoting the use of renewable energy in the heat market, harmonised with the market incentive programme.

The Federal Government's aims are important milestones on the road towards sustainable energy use: by the year 2010, the share of renewable energy in electricity generation is to increase to at least 12.5% (doubling of the 2000 share of 6.25%) and to at least 20% by the year 2020. Related to primary energy consumption, the share of renewable energy is to double from 2.1% in 2000 to 4.2% in 2010.

Where do we have to start today?

In order to ensure that renewable energies will achieve a 50% contribution towards energy supply by the year 2050, suitable instruments and measures must be

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[170] Refer to Jung, R. et al. 2003: Wie groß ist das Potential geothermischer Stromerzeugung? [How big is the potential of geothermal electricity generation?] In: Paschen, H. et al.: Möglichkeiten der geothermischen Stromerzeugung in Deutschland [Possibilities of geothermal electricity generation in Germany]. TAB work report No. 84, Berlin, p. 56.

implemented in order to establish renewable energies in the electricity and heat market.

The Renewable Energy Sources Act is an instrument that significantly improves the framework for renewable energies in the electricity market and which has already triggered a substantial growth in the number of installations for electricity generation from renewable energy. The promotion and support instruments in the form of a purchase guarantee and a minimum-price scheme anchored in the German Act on the Sale of Electricity to the Grid have proven their value. In 2000, this system was introduced as a principle to the Renewable Energy Sources Act. 2004 saw a comprehensive revision of this Act. However, the purchase guarantee and the minimum-price scheme continue to be its cornerstones. The long-term effectiveness of the Renewable Energy Sources Act must be ensured.

Whilst the Renewable Energy Sources Act primarily promotes renewable energy in the electricity market, an analogous instrument does not exist for the heat market. In order to increase the share of renewable energy in this field too, cost-effective and market-conforming instruments are needed to provide the funds necessary for market access and to ensure equitable distribution of costs to energy consumers.

The following types of instruments generally fulfil these criteria:

- A payment or bonus system for each kilowatt hour of heat generated
- A quota system with tradable certificates
- Regulatory instruments which demand that a binding share of the heat supply for new and rehabilitated buildings is generated from renewable energies.

In order to increase the share of renewable energy in energy supply to 50% by the year 2050, it is also necessary to reduce primary energy consumption through improved energy efficiency and behaviour-based energy saving measures (refer to statements 16 and 17).

19. Achieving permanent CO_2 emission reductions in the transport sector

Compared to the past 60 years, CO_2 emissions from road traffic in Germany fell for the first time ever since the turn of the century. However, greenhouse gas emissions from transport as a whole continue to increase. CO_2 emissions by the transport sector could be significantly reduced by a host of measures and instruments. In order to reach this goal, vehicle fuel consumption must be reduced, climate-friendly driving behaviour supported, environmentally compatible transport systems strengthened, the use of climate and environment-friendly fuels promoted, as well as traffic growth and the effect of air traffic on climate limited, to mention but a few.

What would happen if the trend were to continue?

In contrast to other sectors, CO_2 emissions in Germany's transport sector rose on the whole by approx. 9% between 1990 and 2002. This meant that the transport sector's share in overall CO_2 emissions in Germany increased in this period from 16 to around 21%.[171]

This is first and foremost due to the increase in transport demand, which in freight transport alone rose by around 27% between 1991 and 2002.[172] Growth in passenger transport during the same period totalled 4% (measured in kilometres per person). Since 2000 a slight decline in transported-related CO_2 emissions was recorded. However, this does not mark a turnaround. Instead, the Federal Environmental

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[171] Unless otherwise specified, the transport data stated in this chapter was taken from "Klimaschutz in Deutschland bis 2030 – Politikszenarien III" [Climate Protection in Germany up to 2030 – Political Scenarios III] and the emissions data from TREMOD (Transport Emission Estimation Model). Sources: Federal Environmental Agency (UBA) 2005: Klimaschutz in Deutschland bis 2030 – Endbericht zum Forschungsvorhaben Politikszenarien III [Climate Protection in Germany up to 2030 – Final Report on the Research Project Political Scenarios III]. Some of the data from TREMOD is also contained in: Federal Environmental Agency (UBA) 2003: CO2-Minderung im Verkehr, Berlin [CO2 reduction in transport, Berlin]

[172] For the year 1990, official transport statistics do not contain transport demand data for Germany as a whole because this data was not recorded in the former GDR.

Agency expects that as the economy recovers transport demand is also likely to increase once again and along with it CO_2 emissions in the transport sector. Of all the forms of transport, air transport currently accounts for by far the highest growth rates in transport demand and is today the second-biggest emitter right behind road transport. Air transport demand in Germany more than doubled between 1990 and 2000.[173]

Emissions of halogenated fluorohydrocarbons (HFCs) caused by cooling and air-conditioning systems in vehicles rose between 1995 and 2003 from 0.2 to 2.6 million tonnes of CO_2 equivalents. This is largely due to the higher number of vehicles fitted with air conditioning, particularly passenger cars. If no measures are taken in Germany, emissions can be expected to increase by a further 5 million tonnes of CO_2 equivalents by 2010.[174]

Transport demand can be expected to rise significantly by 2020. Under the current boundary conditions and without additional instruments to dampen transport growth, passenger transport is likely to rise by approx. 28% compared to 1997.[175] Even much greater growth can be expected in freight transport, with 73% more tonne-kilometres than in 1997. The growth rates forecast for 2020 are distributed very differently to the different forms of transport. In the field of passenger transport, by-far the greatest increase in growth will be in air transport where person-kilometres are likely to more

[173] Measured in kilometres per person according to the location principle (air kilometres from Germany to the first landing), BMVBW (Federal Ministry for Transport) 2003: Verkehr in Zahlen 2003/2004 [Traffic in Figures 2003/2004], Hamburg.

[174] Schwarz, Winfried: Emissionen und Minderungspotenziale von H-FKW, FKW und SF_6 in Deutschland. Aktueller Stand und Entwicklung eines Systems zur jährlichen Ermittlung. Emissionsdaten bis zum Jahr 2003 und Emissionsprognosen für die Jahre 2010 und 2020. 4. Zwischenbericht zum Forschungsvorhaben, [Emissions and potential for the reduction of HFHC, FHC and SF_6 in Germany. Current status and development of a system for annual statistics. Emission data up to 2003 and emission forecasts for the years 2010 and 2020. 4th intermediate report on the research project] issued on behalf of the Federal Environmental Agency, file reference: 202 41 356, Berlin.

[175] The forecast in the study on "Climate Protection in Germany up to 2030" assumes that population will decline slightly by 2020 and annual GDP growth rates will also decline from 1.9% to 1.3%. However, oil prices were stated to increase from $16 per barrel in 2000 to $22 per barrel in 2020. In light of today's price developments, these forecasts must be regarded with caution.

than triple between 1997 and 2020. During this period, motorised private transport will rise by 28% and rail transport by 22%. Compared to this, non-motorised transport as well as public road transport will even decline slightly. In freight transport, the Federal Environmental Agency expects the highest growth rates of more than 90% by the year 2020, whilst inland waterway transport is expected to grow by 49% and rail transport by around 30%. In 2020, air freight transport will be even six times higher than in 1990. Whilst air transport in 1990 accounted for 9% of transport-related CO_2 emissions, this figure will increase to 18% by 2020 if no countermeasures are introduced. Emissions of NOx, steam and other factors (for example, condensation trails) resulting from air transport contribute two to four times more towards the greenhouse effect than CO_2 emissions from the same form of transport. Table 5 shows a list of the above-mentioned forecasts.

Table 5: Development of transport demand from 1997 to 2020

	Development until 2020 (Basis: 1997)
Long-distance haulage	**+ 73%**
HGV	+ 90%
Inland waterway transport	+ 49%
Rail	+ 30%
Air transport	+ 600%
Passenger transport	**+ 28%**
Air transport	+ 300%
Motorised private transport	+ 28%
Rail	+ 22%
Non-motorised transport	Slight decline
Public road transport	Slight decline

Sources: Federal Environmental Agency (UBA) 2005: Klimaschutz in Deutschland bis 2030 [Climate Protection in Germany up to 2030]; TREMOD

This means that if current developments continue, transport-related CO_2 emissions can be expected to increase, totalling around 13% compared to 1997, however, this increase will be somewhat below growth in transport due to technical improvements in vehicles.[176] Road freight transport and air transport will account for the greatest share in this increase. This means that transport could only contribute to the climate

[176] Ibidem.

protection goal of a 40% reduction in greenhouse gas emissions in Germany by 2020 (refer to statements 6, 8, 12, 13) if additional measures are taken and instruments used to boost technical efficiency, to slow down transport growth and to shift to more environmentally compatible forms of transport.

With climate protection goals in mind, how should future mobility be?

In the long run and in view of the growth rates forecast and the longer-term need for emission reductions, transport must make an overproportionate contribution towards reducing CO_2 emissions. The Federal Environmental Agency (UBA) considers it to be necessary to define a 40% reduction in CO_2 emissions compared to 1990 as the minimum target for 2020 also for the transport sector. This target can be reached if the efficiency of vehicles – measured in CO_2 emissions per vehicle kilometre – is significantly improved compared to the current trend, if transport efficiency – measured in CO_2 emissions per person or tonne-kilometre – is boosted by shifting to the most efficient forms of transport and if traffic growth is stopped.[177]

A realistic scenario is as shown below: With technical measures and fuel-saving driving, at least 40% of specific CO_2 emissions from passenger cars can be saved by 2020 compared to 2000. In the case of commercial vehicles, buses, diesel train engines and ships, this is just under 20%. In the case of aircraft turbines, we believe that fuel consumption can be reduced by almost 20%, and by 25% in the case of electric trains. If all of this specific potential were to be exhausted, traffic-related CO_2 emissions would decline by almost 20% compared to 1990 without any influence on traffic distribution or traffic growth.

More far-reaching emission reductions require limiting traffic growth and shifting to more energy-efficient forms of transport. Passenger car transport demand, measured in person-kilometres, must be stabilised at the 2000 level. The only growth permitted should be in bus and rail transport, as well as in bicycle and pedestrian transport. Stabilisation must also be attempted for air transport. The growth that can be expected for freight transport on roads must be shifted to rail and inland waterway

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[177] Scenario according to the Federal Environmental Agency 2002: Nachhaltige Entwicklung in Deutschland [Sustainable Development in Germany], Berlin.

transport. Assuming that transport demand in road and air transport does not exceed the level reached in 2000 and that the potential to reduce vehicle energy consumption is fully implemented, transport-related CO_2 emissions by 2020 would fall 40% below the 1990 level.

By the year 2030, an attempt should be made to reduce transport-related CO_2 emissions by 50%.

In order to achieve this, it is necessary to continue improving vehicle efficiency beyond the scope described above and to achieve a turnaround in transport growth. With the implementation of its sustainability strategy, the Federal government is also demanding that the need for mobility be fulfilled with lower transport intensity and by improving the efficiency and environmental performance of the transport system by best linking the different forms of transport.[178] Specific fuel consumption in passenger cars must be reduced by half from around 8 litres per 100 km in 2000 to around 4 litres per 100 km by the year 2020, by 26% in the case of commercial vehicles, buses, ships and diesel train engines, by 40% in the case of air traffic and by 36% in the case of electric train engines. Furthermore, the efficiency of freight transport must be increased by 20% through better utilisation and the choice of the best suited means of transport. Transport demand in passenger cars and air transport must decline by 20%.[179]

To this end, the measures introduced must be continued and intensified, particularly those measures that contributed towards shifting and dampening traffic growth.

Which measures and instruments are needed in order to achieve medium-term climate protection goals?

Due to the complexity of the transport system, a host of interacting measures and instruments are needed in order to reduce climate gas emissions.

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[178] Federal Government: Wegweiser Nachhaltigkeit 2005 - Bilanz und Perspektiven [Sustainability 2005 Roadmap – Stock-taking and Prospects]. Cabinet decision dated 10 August 2005

[179] Federal Environmental Agency (UBA) 2002: Nachhaltige Entwicklung in Deutschland [Sustainable Development in Germany], Berlin.

The measures and instruments described affect mobility behaviour, however, they do not necessarily restrict mobility. Mobility must nevertheless be designed more efficiently with an improved offering of more environmentally compatible forms of transport and shorter routes as a consequence of compact, mixed settlement structures. Together with this, explanatory measures concerning the changes, their effect and their benefits for the general public and for individuals as well as a comprehensive promotion of acceptance are necessary (refer to statement 21). All in all, more efficient mobility is not only necessary in order to reduce CO_2 emissions – it also strengthens Germany as a business location. Because more efficient mobility results in lower costs – both for businesses and for consumers.

Supporting the introduction of technical measures, driving behaviour

There are no limits for CO_2 emissions from motor vehicles. Assuming the success of the self-commitment entered into by the car industry in the EU, Japan and Korea[180] , stricter emission target values must be agreed to by 2008/2009 pursuant to the EU strategy: The Council, European Parliament and Commission have agreed to a target value for 2010 of 120g of CO_2 per kilometre for new passenger cars.[181] In the event, however, that the self-commitment goal is not reached in 2008/2009, the Council resolutions dictate that the EU Commission will have to immediately submit a draft law that would ensure that the target value is reached. Furthermore, the Commission must propose further-reaching measures, so that the Community goal of 120g of CO_2 per kilometre can be reached.

Besides the self-commitment on the part of the car-making industry to reduce specific CO_2 emissions from passenger cars, supplementary measures for fuel-saving driving are also needed and low-fuel vehicles must be developed and used. For instance, easy running oils and low resistance tyres reduce inner friction in the engine and roll resistance, thus saving fuel. The widespread use of easy running oils could be stepped up by defining a quality standard (for instance, the "Blue Angel", familiar in Germany). Low resistance tyres should be a series feature in new vehicles and their engines should be filled with easy running oils. The Federal Environmental Agency

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[180] Commitments were negotiated with the car industries in Europe (umbrella organisation of European car manufacturers – ACEA), in Japan (Japan Automobile Manufacturers Association - JAMA) and Korea (Korean Automobile Manufacturers Association - KAMA).

[181] KOM (1995) 689, final.

(UBA) estimates the potential to reduce fuel consumption here at 10.2 million tonnes of CO_2 in 2020.[182]

With fuel-saving driving, fuel consumption can be reduced by up to 25%. Since 1999, it is mandatory to address fuel-saving driving skills in driving instruction and driving tests. Together with fitting vehicles with consumption and gear-changing displays as standard features, around 6.5 million tonnes of CO_2 could be saved in 2020.[183]

A CO_2-based motor-vehicle tax would accelerate the introduction of fuel-saving vehicles to the market. Current motor-vehicle tax is still fixed until 2005, so that the introduction of a CO_2-based element will be possible starting in 2006. This would make it possible to reduce CO_2 emissions by around 6.5 million tonnes for passenger cars and light commercial vehicles.[184] The costs of this instrument are very low compared to the emission reductions that can be achieved because all that revenue-neutral shaping requires is a change in the calculation basis for motor-vehicle tax.

When tendering and awarding public transport services, consideration must be given to energy efficiency and CO_2 emission reductions for buses and trains. Through fairer competition conditions[185] between different forms of transport, Deutsche Bahn AG must be supported in its more far-reaching goal of achieving a 25% reduction in its specific CO_2 emissions by 2020 which corresponds to an annual reduction of 2.2 million tonnes.

If a speed limit (80 kph outside cities and towns, 120 kph on motorways) was introduced and if 80% of motorists adhered to these limits, around 5.2 million tonnes of CO_2 could be saved compared to current emission levels.

In order to limit HFC emissions from cooling and air-conditioning systems in vehicles, the measures proposed in the EC Directive on Emissions from Air-conditioning

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182 Federal Environmental Agency (UBA) 2003: CO2-Minderung im Verkehr [CO2 reduction in transport], Berlin

183 Ibidem.

184 Ibidem.

185 For instance, air transport currently benefits from significant competition advantages compared to rail transport due to mineral oil exemption and VAT exemption in foreign air transport.

Systems in Motor Vehicles[186] must be expanded to include other vehicles (buses, trains, etc.).

The use of biofuels in transport would mean savings of around 3.0 million tonnes of CO_2 equivalents.[187] These savings, however, are only valid in relation to a reference scenario where agricultural resources for energy plant production lie fallow. This scenario does, however, appear to be unrealistic because growing competition for space between food and bio mass production for energy-related use can already be observed today. One element of this competition is particularly the stationary energetic use of biomass for power and heat generation versus the use of biofuel in the transport sector. Current research deals with this topic under the motto "Competing forms of use". From the point of view of climate protection, the Federal Environmental Agency estimates that the stationary, energetic use of biomass will be considerably more favourable in the foreseeable future.

Dampening transport growth

Since the technical measures and instruments needed to achieve the climate protection goal, transport growth will have to be dampened. Additional transport demand must be avoided and greater mobility[188] made possible with less transport. In this context, key determinants of transport growth must be influenced, i.e. settlement structure, trading networks, changed lifestyles and the transport infrastructure

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[186] The draft EU Directive on Emissions from Air-conditioning Systems in Motor Vehicles foresees maximum leakage rates for air conditioning systems in certain motor vehicles (M1, N1) starting in 2007, and from 2011 (new vehicle models)/2017 (new vehicles) a ban on HFC refrigerants with a GWP (greenhouse warming potential) of > 150.

[187] Federal Environmental Agency (UBA) 2005: Klimaschutz in Deutschland bis 2030 – Endbericht zum Forschungsvorhaben Politikszenarien III [Climate Protection in Germany up to 2030 – Final Report on the Research Project Political Scenarios III].

[188] Spatial mobility refers to the possibility to perform activities at different locations. The mobility of an individual increases the further apart the destinations are that this individual can reach. Mobility is not the same as transport. Mobility does not increase the longer the route, otherwise, this would mean that every detour would promote mobility. High or low transport levels can be related to the same degree of mobility. The nearer the place of departure and the place of destination lie, the less transport generated with the same degree of mobility.

available. However, it is not possible to state the concrete potential for CO_2 emission reductions here due to the many boundary conditions.

Multi-functional cities where people not only work and shop but which are also attractive as residential and leisure areas contribute towards more compact development and hence low-transport settlement structures. Tax incentives can help avoid undeveloped space being used for settlement purposes, promote the reuse of fallow land and boost structural density. For instance, the distance-related tax allowance – that promotes living at long distances from the workplace – should be gradually phased out (refer to statement 14). In addition to this, a transport-avoiding settlement policy and trans-municipality planning are needed in order to bring commercially and residentially developed areas together and to attract commercial businesses that can help to shorten delivery routes by serving as suppliers for existing business (refer to statement 12).

Reducing intra-industrial trading so that similar products are purchased from regional suppliers offers a relatively large potential for transport avoidance in the case of freight transport. Part of this potential can be utilised by increasing transport costs through a stronger internalisation of external costs (for instance, mineral oil tax, HGV toll). Supporting regional marketing and the introduction of a transport label[189] could also help reduce transport distances. The possibilities which today's logistics offer when it comes to improving efficiency have also to be exhausted. Foregoing export-promoting and traffic-generating subsidies within the scope of regional and so-called structural subsidy programmes and supporting decentralised forms of distribution for companies help to decouple economic growth from transport growth.

Around 15 to 20% of transport growth is due to the expansion of the transport infrastructure. In freight transport, this expansion is resulting in falling transport costs which means, for instance, that the spatial separation of operating units and "rolling warehouses" is now more likely to pay off. In passenger transport, the travel time saved as a result of improved infrastructure means that investments are once again being made in transport. In addition to this, there are also considerable shifts

[189] A transport label can, for instance, state the distances over which or the means of transport with which a product was transported during the course of its processing and marketing.

between the different types of transport due to the expansion of infrastructure. One key motivation for expanding infrastructure is usually to improve regional development. Empirical studies[190] , however, show that the improvement of the economic performance of a region as a consequence of new transport routes is frequently over-estimated. The EU Commission[191] has also evaluated infrastructure projects subsidised by the so-called Structural Funds, and came to the conclusion that it is not possible to statistically establish any correlation between improved infrastructure and a related improved economic strength of the region subsidised. This is why the further expansion of transport infrastructure should be largely abandoned and instead attention should be given to maintaining and expanding existing transport routes. In future, the methods used to evaluate infrastructure measures will also have to give more adequate consideration to the problems of induced transport as well as the question of regional development.

Surveys by the Ecologic Research Institute and Deutsches Institut für Wirtschaftforschung (DIW) carried out in September 2004 on behalf of the Federal Environmental Agency (UBA) showed that for around half of those polled eco-tax was a strong or very strong motivation to reduce energy consumption, for instance, through fewer trips or also by changing to public transport.[192] Model calculations show that the eco-tax on fuel alone would be likely to lead to a reduction in emissions of around 9.44 million tonnes of CO_2 by 2010 than would be the case if this tax were not imposed.[193] If the eco-tax continues to be imposed for another 5 years, estimates

[190] Verron, Hedwig: Determinanten des Verkehrswachstums, Entwicklungen, Ursachen und Gestaltungsmöglichkeiten [Determinants of transport growth, developments, causes and design options]; Report by the Federal Environmental Agency (UBA) dated 30 August 2004 (not yet published).

[191] EU Commission, 2000, quoted in Ifo – Institut für Wirtschaftsforschung 2002: Entlastung der Umwelt und des Verkehrs durch regionale Wirtschaftskreisläufe [Lessening environmental and transport burdens through regional economic cycles], UBA Texte series 67/02. Berlin.

[192] DIW 2004 Deutsches Institut für Wirtschaftsforschung, ecologic: Quantifizierung der Effekte der Ökologischen Steuerreform auf Umwelt, Beschäftigung und Innovation [Quantifying the effects of ecological tax reform on the environment, employment and innovation].

[193] Frohn, J.; Meyer, B.; Hillebrand, B. 2002: Ökonometrische Modellierung der Wirkungen umweltpolitischer Instrumente [Econometric modelling of the effects of environmental-policy instruments]. Bielefeld, Bonn, Essen.

foresee an additional potential to reduce emissions of around 4 million tonnes of CO_2 annually (refer to statement 14).

Strengthening more environmentally compatible forms of transport

Shifting demands for transport to those forms of transport that specifically emit less or no CO_2 can contribute significantly towards climate protection. In this context, all areas of life and business must be involved.

Walking or cycling are by far the most environmentally compatible forms of transport and are also CO_2-free. Considering the results of various studies and international comparison values, it does appear possible to increase the share of bicycle transport in overall passenger transport demand from today's 2.4% to approx. 7% by 2020. If bicycles were used instead of cars for 30% of trips of less than 6km in densely populated areas, this alone would reduce annual CO_2 emissions by around 5.8 million tonnes. These reductions in CO_2 emissions could be raised to almost 10.5 million tonnes annually if 30% of trips of less than 10 km were made on bicycles rather than by car; this is an ambitious goal, but in the long term one that can certainly be reached. In addition to this, the measures proposed in the National Bicycle Transport Plan must be implemented with determination and quickly at all levels and supported with investment programmes and measures within the scope of the Community Transport Financing Act. Priority must be given to the faster expansion of infrastructure, greater support for accompanying measures – in particular, PR work – and the comprehensive integration of bicycle and pedestrian transport into transport and settlement concepts.

A well-developed pubic transport network, state-of-the-art and efficient vehicles as well as high-quality, customer-oriented transport services are necessary in order to shift part of motorised private traffic to public transport and to reduce CO_2 emissions.

On average, Germany's public passenger transport service accounts for just around one third of the CO_2 emissions of a passenger car generated per person-kilometre and with an average utilisation rate of 20-25%. The Federal government spends billions in subsidies on public passenger transport every year. The pending reform of the confusing and inefficient financing of public passenger transport also means that more transport demand must be shifted to public transport. Every percent that is shifted from inner-district passenger car transport to public passenger transport reduces CO_2 emissions by around 230,000 tonnes compared to the current trend – in relation to the year 2020.[194]

Rail passenger transport causes on average less than half as much CO_2 emissions per person-kilometre as car transport or air transport. More efficient trains and higher utilisation (the utilisation rates for long-distance rail transport are between 37 and 45%) improve the environmental benefits of rail transport. Besides rail reform and the introduction of improved competition in rail passenger transport, the framework conditions for rail transport must be improved further. This includes lower VAT on train tickets just as much as the equal consideration of rail transport in the Federal government's investments in transport infrastructure. The potential for savings by shifting to rail are estimated at 7.7 million tonnes of CO_2 in 2020.

In addition to dampening leisure-related transport through good and diverse leisure services in settlement areas, the share of this transport in non-motorised and public transport must be upheld and expanded. Rail transport must win more holidaymakers by making it possible to travel all the way to a destination without the need for a car, combined with flexible mobility services on site. With attractive holiday offers in Germany and Europe as well as with better marketing of environmentally friendly offers, the trend to long-distance travel – above all air travel – can be reversed. In order to achieve environmentally compatible holiday transport, the overall economic costs of air transport must be allocated specifically to the causer (see below).

On average, freight traffic on roads causes almost six times more CO_2 emissions per tonne-kilometre than rail transport and almost double the amount caused by inland waterway transport. The HGV toll supports the goal of shifting freight transport more to rail and inland waterway transport, particularly if toll revenue were also to be used to improve rail and waterway networks. As a consequence of the HGV toll that was introduced on 1 January 2005, CO_2 emissions are likely to decline by 0.05 tonnes per year. This relatively small contribution to CO_2 reduction could be increased significantly if the HGV toll were to be expanded to the entire road network and raised

[194] Federal Environmental Agency (UBA) 2003: CO2-Minderung im Verkehr [CO2 reduction in transport], Berlin

to 20 cent per km (and 30 cent for upwards of 18 tonnes). If rail transport services were also improved, this would reduce CO_2 emissions annually by around 1 million tonnes compared to the reference scenario. Given a HGV toll similar in design and price to the performance-related heavy-load tax that has been in place in Switzerland since 2001, annual CO_2 could even be reduced by between 1.5 and 3.2 million tonnes – depending on the development of transport services in rail freight transport.[195] This shifting from road to rail transport could be improved even further by developing and supporting the interfaces between road and rail through greater co-operation and by linking the different forms of transport, for example, by expanding combined load transport – i.e. combining different means of transport on one route. All in all, the potential to reduce emissions by shifting from HGVs to rail transport totals around 7.5 million tonnes of CO_2 in 2020.[196]

Limiting the climate effects of air transport

The greenhouse gas emissions from international air transport are not considered in the emission reduction commitments of the Kyoto Protocol. This is why the Federal government has subscribed to supplementary international regulations to limit greenhouse gas emissions from aircraft. In future, the EU should handle inner-European air transport like national transport and include this in its emission reduction commitments under the Kyoto Protocol.

Measures that allocate the cost of air transport specifically to the causer and that eliminate preferential conditions and subsidies in air transport not only contribute towards climate protection, but also help to create fair competition between the different forms of transport. Air transport currently enjoys tax benefits and additionally profits from the publicly financed link to the road and rail transport network. With a view to fair competition conditions for the different forms of transport, kerosene should no longer be exempt from mineral oil tax and VAT must be charged on flights abroad. In order to reduce competitive advantages that result from the preferential tax treatment for air transport, which cannot be justified from the point of view of

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[195] Rothengatter, W.; Doll, C. 2001: Anforderungen an eine umweltorientierte Schwerverkehrsabgabe für den Straßengüterverkehr [Requirements for environmentally orientated heavy-load tax for road freight transport], Texte series of the Federal Environmental Agency (UBA), 57/01, Berlin.

[196] Federal Environmental Agency (UBA) 2003: CO2-Minderung im Verkehr [CO2 reduction in transport], Berlin

climate policy, the Federal government has decided to no longer exempt flights to other EU countries from VAT and to continue to speak out in favour of kerosene taxation on a European level. A joint European solution must be sought because the introduction of kerosene tax for flights between individual European states by amending the respective bilateral agreements would only affect local airlines and would hence be questionable from a legal perspective. This is why the first step should entail introducing kerosene tax for domestic flights. This could be carried out by different European states at the same time for their domestic air transport. In order to reduce the emission of greenhouse gases, the Federal Environmental Agency is in favour of the introduction of a European flight-route-based emissions duty, which creates the incentive to reduce greenhouse gas emissions and accelerates the modernisation of aircraft fleets that is desirable from the point of view of climate policy. This also holds true for the introduction of an air ticket duty that is currently being discussed at European level as long as this is effectively designed with a view to climate protection criteria. Alternatively, greenhouse gas emissions from air transport could be included in the EU's emissions trading system as long as this means that effective limitation to emissions can be expected. An emissions duty amounting to €30 per tonne of CO_2 and to €3.6 per kg of NO_x could reduce emissions by a total of 9%.[197]

Even improved organisation of air transport, for instance, by introducing a flight safety regime on a European level ("Single European Sky“) as well as other operating measures (approach control, wing modifications), could reduce specific fuel consumption by air transport in the medium term by up to 10% and this would reduce air transport's contribution to the greenhouse effect. Furthermore, the climate effects could be reduced further by optimising flight routes and with lower flying altitudes.

[197] Wit, R.C.N., Dings, J.M.W. (CE Delft) 2002: Economic Incentives to mitigate greenhouse gas emissions from air transport in Europe. Delft.
Federal Environmental Agency (editor.) 2001: Maßnahmen zur verursacherbezogenen Schadstoffreduzierung des zivilen Flugverkehrs [Measures for causer-related emission reductions in civil air transport]. Texte series of the Federal Environmental Agency, 17/01, Berlin.

Where do we have to start today?

Essentially, all measures must be implemented as quickly as possible, because it takes a number of years in most cases before the effects can be felt. For instance, a new technology has to gain a significant foothold in existing vehicles.

There is a particularly urgent need for action in the case of those measures that affect the main influences and their implications for mobility behaviour, i.e. the frequency and length of a journey as well as the choice of transport. This includes, for instance, promoting more compact settlement structures, regional business cycles, rail and regional public passenger transport. If the right signals are not set here, then transport-inducing factors would prevail that allow transport to grow further and give preference to road transport. It would not be possible or very difficult to reverse these developments at a later point in time. It would then not be possible to reduce CO_2 emissions in the fields of measures to "Reduce transport needs" and "Shift transport".

20. Agriculture’s contribution to climate protection

Organic farming and improvements in conventional agriculture contribute greatly towards climate protection. Important elements here include more widespread use of biogas, optimised fertilisation methods for greater nutrient efficiency in order to reduce N_2O emissions, and greater use of the enormous potential in agriculture and forestry for cultivating energy plants.

Agriculture accounts for around 7% of Germany's total greenhouse gas emissions.[198] Besides the greenhouse gases carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (= laughing gas, N_2O) that have a global effect, ammonia (NH_3) is emitted as a gas with an indirect effect on climate.[199]

Use of fertilisers and cattle stock are the most important agricultural sources of methane and N_2O as climate-relevant gases. In 2000, methane accounted for around 8% and laughing gas for around 5% of Germany's total greenhouse gas emissions. Cattle farming (fermentation processes in paunch) and, to a lesser extent, storage of fertilisers, account for the largest part of methane emissions from agriculture which account for around 40% of total emissions.

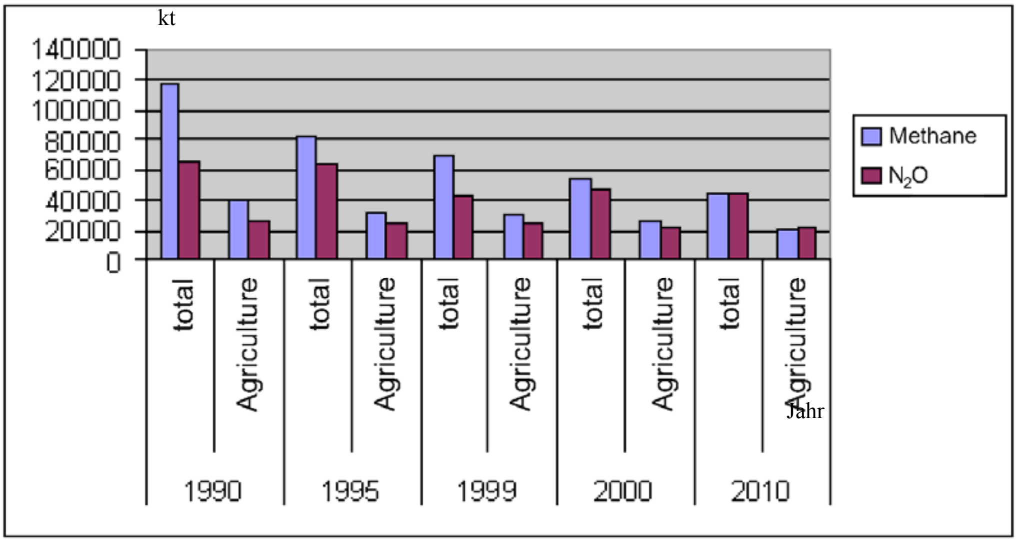
N_2O emissions from agriculture are responsible for around 50% of total laughing gas emissions (refer to Fig. 17). These are primarily due to nitrogen-related processes (nitrification and denitrification) in the soil. Both of these processes use laughing gas as an intermediate product, with anaerobic conditions being a major factor favouring the release of N_2O. Around 90% of N_2O emitted are formed in soils by these

[198] Federal Ministry for the Environment (BMU) July 2002: Third Report by the Government of the Federal Republic of Germany in accordance with the Framework Convention of the United Nations. Available at: http://unfccc.int.

[199] Ammonia is a precursor substance for laughing gas (N_2O) which is released in the soil from ammonia compounds during nitrification. Ammonia emissions are at present not yet counted in conjunction with N_2O emissions. This is why separate consideration of ammonia emissions is necessary even though ammonia itself does not have any greenhouse effect.

processes. This means that there is a direct relationship between farming intensity (nitrogen supply from fertilisers) of agricultural soils and emission levels.

Fig. 57: Share of agriculture in total methane and N_2O emissions in CO_2 equivalents (in kilotonnes) in Germany



Source: Federal Ministry for the Environment (BMU) 2002, 3. Nationalbericht Klimaschutz [3rd National Communication to the UNFCCC]

CO_2 emissions from agricultural soil account for 4.5%[200] of total CO_2 emissions in Germany and hence play a less important role than other sectors of the economy. However, additional agriculture-related CO_2 emissions are due to the energy consumption of upstream operations (synthesis of fertilisers and plant protection agents) as well as agricultural operations themselves (such as the use of agricultural machinery) and transports. These additional emissions are addressed and evaluated elsewhere.

With regard to ammonia emissions, agriculture accounts for 90% where fertilisers represent a share of 10%, the largest part being caused by animal husbandry and fertiliser management (type of storage, method and time of application).

[200] Federal Environmental Agency (UBA) 2004: Nationaler Inventarbericht 2004 – Berichterstattung unter der Klimarahmenkonvention der Vereinten Nationen [National inventory report 2004 – reporting under the United Nations Framework Convention on Climate Change], Federal Environmental Agency (UBA), Berlin.

Organic farming is not just an ecological business model, but also subjects the striving for economic efficiency and profit maximisation to ethical principles which are designed to ensure a balanced approach towards the natural subsistence basis. The reduced use of nitrogen per surface area unit not only reduces nitrate leaching, but also lessens emissions of climate-relevant N_2O. Furthermore, organic farming requires significantly less energy than conventional farming.[201]

The share of ecologically cultivated farmland (as defined in the Council Regulation on Organic Production of Agricultural Products)[202] in Germany increased from around 272,000 hectares in 1994 to around 734,000 hectares in 2004. This corresponds to around 4% of agricultural land. In this respect, Germany ranks midfield in the EU because other countries (such as Italy) recorded stronger increases.

Besides organic farming, many farmers on conventional or integrated farms are also increasingly trying to implement aspects, results and elements of organic farming. The Plant Protection Act, for example, demands integrated plant protection as best practice with prioritary consideration given to biological, biotechnical, plant breeding as well as cultivation and agricultural measures in order to restrict the use of chemical plant protection agents to the minimum level necessary. The Federal government's programme for reducing chemical plant protection is an attempt to define in more detail and to practically disseminate these approaches. Organic farming hence also influences conventional farming and thereby increases its

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[201] However, the system limits must be taken into consideration when drawing up comparative eco-balances of this kind: Within the framework of the Kyoto process, international agreements provide, for example, that CO_2 emissions from the production of mineral fertiliser are treated as originating from the chemical industry rather than from conventional farming (source reference).

[202] Council Regulation (EEC) No. 2092/91 of 24 June 1991 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs (OJ No. L 198 dated 22 July 1991, p. 1). In Germany, the Organic Farming Act (Act on the Transposition of Legislation of the European Community in the Field of Organic Farming (Organic Farming Act of 10 July 2002)) sets forth administrative details and responsibilities for the transposition of the EU Regulation on Organic Production of Agricultural Products as well as penal and administrative fine regulations in the case of violations.

contribution towards the Federal government's[203] and the EU's sustainability scenarios. In view of the large share of farmland used by this form of use, progress in conventional farming towards more environmental protection is particularly important.

What would happen if the trend were to continue?

The current reform of European agricultural policy was designed with the long-term goal of transforming agricultural production from purely production-orientated farming to ecologically compatible, sustainable agriculture. With the political goal of expanding the share of organic farming in Germany's total farmland to 20% by the year 2010, farming based on natural cycles and the protection of resources are to be given a stronger focus in agricultural production.

The reform of European agricultural policy, such as the instruments of decoupling and cross compliance (the obligation to maintain ecological minimum standards as a precondition for qualifying for direct payments) will primarily affect conventional animal production. Organic farmers are likely to benefit more from the reform in the longer term. When, starting 2010, direct payments will be gradually replaced by a regionally uniform land premium, one can expect that the once relatively more favourable treatment of conventional farmers will decline which was so far due to the silage maize and bull fattening premiums (which will then be abandoned and no longer hidden in the farm premium).[204] In general, the trend away from small farms towards larger agricultural units will continue. It is at present not possible to finally assess how the reform of agricultural policy and structural development in agriculture will affect the emission situation.[205]

[203] German Federal Government (2002): "Perspektiven für Deutschland - Unsere Strategie für eine nachhaltige Entwicklung." [Perspectives for Germany – our strategy for sustainable development] (Short title: Nachhaltigkeitsstrategie der Bundesregierung [Federal Government's National Sustainability Strategy])

[204] Häring, A., Offermann, F. and Dabbert, S. 2005: "Auswirkungen von Maßnahmen der 1. und 2. Säule der EU-Agrarpolitik auf ökologische und konventionelle Betriebe.“ [Effects of 1st and 2nd pillar measures of EU agricultural policy on organic farms and conventional farms] Ländlicher Raum, March/April 2005, pp. 16-18.

[205] Osterburg, B., Federal Agricultural Research Centre, personal communication in February 2005.

The Federal Agricultural Research Centre (FAL) estimates that conventional cattle farming will be hardest hit by these changes.[206] In its forecasts, the Federal Agricultural Research Centre expects that suckler cow management will decrease by one third and bull management by 17% by the year 2010. This could help reduce ammonia emissions and lower Germany's ammonia emissions from the current level of around 650 kilotonnes to 550 kilotonnes per annum by the year 2010. The related obligation is based on the Multi-component Protocol within the framework of the UN ECE Convention on Long-range Transboundary Air Pollution[207] and the EU's National Emission Ceilings Directive for certain air pollutants.[208] Likewise, the trend towards larger stocks can be expected to continue in dairy farming too. The share of stable husbandry with liquid-manure methods is set to increase whilst the share of pasture farming with a more favourable ammonia emission situation will decrease.

Forecasts in the 3rd National Climate Protection Report[209] suggest that in 2010 agriculture will still account for 49% of N_2O and 48% of methane emissions. Cattle farming is the largest source of methane in agriculture. Methane emissions are a direct function of live weight and animal performance. Lower animal performance[210] (in organic farming, for instance) causes a higher specific methane production related to the same production level. From a climate protection perspective, this means the consumption of animal products must be reduced rather than introducing less intensive forms of farming. Italy, for example, is demonstrating that this is possible without adverse effects in the quality of life. Although meat accounts for around 25%

[206] Kleinhanß, W., Bertelsmeier, M., Manegold, D., Offermann, F., Osterburg, B. and Salomon, P. 2003: "Folgenabschätzung der Legislativvorschläge zur Halbzeitbewertung der Agenda 2000." [Assessing the consequences of the proposed legislation for the half-time evaluation of Agenda 2000] Joint report 02/2003 by the Institute for Farm Economics and Rural Studies and by the Institute for Market Analysis and Agricultural Trade Policy of the Federal Agricultural Research Centre.

[207] Multi-component (Gothenburg, 1999) within the framework of the UN Convention on Long Range Transboundary Air Pollution (LRTAP).

[208] Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants (NEC Directive).

[209] Federal Ministry for the Environment (BMU) July 2002: Third National Communication of Germany to the UNFCCC. Available at: http://unfccc.int.

[210] The term "animal performance" as used herein refers to the production of meat, milk and other desired animal products.

of the daily calorie intake in Italy (Germany: 39%), the Mediterranean cuisine is becoming increasingly popular also among German consumers.

With climate protection goals in mind, how should future agriculture be?

Since organic farming saves energy and resources, the Federal Environmental Agency considers organic farming to be an increasingly important option in order to reduce energy demand and pollutant emissions. However, considering the large share of conventional agriculture and integrated production in total farmland use, further environment-relevant progress in these areas will continue to be more important for environmental protection in the foreseeable future.

There is general agreement that organic farming is the superior option under environmental aspects in terms of soil and water protection.[211] Furthermore, organic farming also supplies good points for climate protection. The urea in liquid manure, for example (common with conventional animal husbandry) is converted more quickly to ammonia and CO_2, whilst increased solid manure management (spreading method, typical of ecological animal husbandry) could be capable of reducing ammonia emissions. Moreover, cattle density is lower and the supplies used are less energy-intensive (no synthetic fertilisers and plant protection agents). Fertiliser production included, organic farming consumes more than 60% less fossil energy than conventional farming per unit of area. This is also due to significantly reduced fodder transports because 50% of the fodder used in organic farming must be grown on the farms where it is consumed. However, first measurements suggest that at least straw-spreading methods have a negative effect with regard to their N_2O emissions.

The yield – i.e. agricultural production per unit of area – can be another parameter which is important for climate protection. Organic farming records yield levels that are around 30% below those of conventional agriculture. This applies, above all, to animal products because the performance of the individual animal is lower and

[211] Haas, G. and Köpke, U. 1994: Vergleich der Klimarelevanz Ökologischer und Konventioneller Landbewirtschaftung [Comparison of the climate relevance of organic and conventional farming]. Bonn.

fattening times are longer. There is, however, no evidence that this means higher climate-relevant emissions per product unit. A comprehensive evaluation by the Federal Agricultural Research Centre (FAL)[212] of studies from the past 30 years failed to definitely demonstrate whether organic or conventional farming and husbandry methods have a more adverse effect on climate.[213]

The Federal Environmental Agency (UBA) considers the promotion organic farming to be a strategy which will not be evaluated as negative ("no-regret strategy") in future. This strategy has many positive effects which also include potential climate relief. This is why the Federal Environmental Agency (UBA) explicitly advocates ongoing subsidies and promotion for organic farming within the scope of agri-environment programmes, not least for climate protection reasons too.

In order to achieve Germany's aim of a 20% share of organic farming by the year 2010, around 3.4 million hectares of farmland must be used for organic farming by that time. If an annual increase in area by 2% to 3% and hence a doubling of organic farmland is to be achieved by the year 2020, the necessary incentives for this must be created today. This especially means increasing demand for organic products in order to create an attractive market for domestic producers. Nation-wide organic farming would be theoretically possible in Germany. Food supplies for the German population would nevertheless remain ensured with relatively small changes in diet. However, this would not be possible at current growth rates and without additional measures by the year 2020.

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212 FAL Agricultural Research, Federal Agricultural Research Centre (FAL) 2000: Bewertung der Verfahren der ökologischen und konventionellen landwirtschaftlichen Produktion im Hinblick auf den Energieeinsatz und bestimmten Schadgasemissionen [Evaluation of the methods of organic and conventional agricultural production with a view to energy input and emissions of certain harmful gases]. Special issue 11. Study as a special report on behalf of the Federal Ministry for Consumer Protection (BMVEL).

213 However, the subsidy-worthiness of organic farming as an agricultural measure of environmental protection is beyond doubt due to the positive implications for soil and water protection which were already mentioned earlier and for which ample scientific and practical evidence is available. This is also why the Federal government's sustainability strategy foresees the goal of a 20% share of organic farming in Germany by the year 2010.

The Federal Environmental Agency (UBA) also recognises the potential contribution by conventional agriculture towards climate protection, all the more so since conventional farming will continue to account for the largest part of Germany's agriculture in the foreseeable future. Conventional agriculture will hence initially have to make greater contributions towards environmental and climate protection, for example, in the form of energy savings through special fodder production on the farm, increased nutrient efficiency through precision farming, and feeding patterns adjusted to the animals' protein demand. The Federal government's ammonia reduction programme[214] is designed to achieve a further reduction of ammonia emissions. Researchers are currently exploring ways to use so-called urease inhibitors which should delay the release of ammonia from urea.

Furthermore, several technical emission reduction measures are currently being discussed in conventional farming. The Federal government has adopted the above-mentioned ammonia reduction programme which is due to be implemented in the years to come. In accordance with international commitments (Multi-component Protocol, NEC Directive), annual ammonia emissions in Germany must be reduced from the current level of around 650,000 tonnes to 550,000 tonnes by the year 2010 in order to substantially improve the protection of delicate ecosystems against acidification and eutrophication as well as ground-level ozone. It must, however, be noted that certain measures which reduce NH_3 (ammonia) emissions can lead to increased N_2O production.

Agriculture can contribute towards achieving the Federal government's climate protection goals by producing solid biomass (renewable raw materials) and biogas for producing electric energy, heat and biofuels[215]. All resources both available and capable of being developed must be employed in order to achieve the energy supply targets set by the EU Commission (minimum share of 12.5% of renewable energies in total electricity supply by the year 2010 and at least 20% by the year 2020 in

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[214] Federal Ministry of Consumer Protection, Food and Agriculture, 2003: Federal government's programme to reduce ammonia emissions from agriculture.

[215] As explained in statement 19, the Federal Environmental Agency (UBA) does not consider subsidies for the introduction of biofuels at the expense of stationary uses of biomass to be a sensible measure at this point in time given the short supply of solid biomass.

Germany, a biofuel share of 5.75% by the end of the year 2020 on an EU-wide level). By growing renewable raw materials, agriculture and forestry can significantly contribute towards achieving these goals whilst at the same time reaping economic benefits.

Replacing climate-damaging and finite fossil fuels to the extent necessary is not possible without trade-offs. However, if disadvantages arise for other natural resources in the interest of climate protection, this must be justified and plausible. Secure food supply must be ensured. Renewable resources should hence be grown primarily on land which is either not suitable (contaminated sites) or necessary (fallow sites) for food or fodder production.

Also in the interest of farmers, cultivation must be based on best-practice standards and consider the interests of the assets to be protected. Precautionary requirements for the protection of the individual environmental media (including, for example, soil protection, water protection, air quality management) must be fulfilled throughout the entire chain of use. This is also applicable to transport, further processing and use. The aims are:

- To secure the regional value chain (jobs)
- To minimize the degree of processing
- To ensure efficient energy conversion and maximum energy exploitation (cogeneration of heat and power)
- To employ suitable processes and technology in order to reduce emissions (including particulate matter from installations subject to the 1st Federal Immission Protection Ordinance (BImSchV))
- To recycle residues in agriculture and forestry whenever this is possible
- To avoid contamination of the environment by pollutants and/or pests (such as fungus, mould, viruses).

Agricultural biomass production can have a significant influence on land use and landscapes, so that the development of agricultural biomass production requires ecological and economic optimisation. Incentives for growing "energy plants" should be restricted to cultivating methods which are committed to permanently environment-compatible production. This also means that cultivation of maize and sugar beet should not be expanded further and that cultures that are less problematic from an environmental protection perspective, such as wheat or triticale[216] , be increasingly cultivated. Finally, guidelines for growing energy plants must be developed and uncompromisingly applied in the sense of "good practices". Genetic engineering in the field of renewable raw materials should be subject to the same strict requirements which also apply to food production. With a view to the effects on the environment, it does not matter whether certain plants are grown for food or fodder production or for other purposes. Furthermore, mixing up of plants can never be fully ruled out during marketing or further processing. With the Renewable Energies Act (EEG 2004), Germany created the legal basis for suppliers to use biomass and hence renewable raw materials in a cost-effective manner and with a high degree of planning reliability. With the revised obligation for grid operators to buy, transmit and pay for electricity from renewable energies and to use renewable raw materials, the use of biomass was given a boost especially in agriculture and forestry and a reliable source of revenue was opened up for farmers.

Which measures and instruments are necessary in order to achieve the medium-term climate protection targets?

The most important measures which contribute towards reducing climate-damaging emissions from agriculture are:

- Reducing nitrogen imissions from agriculture into the environment by implementing the nitrogen reduction programme adopted by the Conference of the Ministers of the Environment[217] and subsequent programmes based thereon (such as the Federal government's Ammonia Reduction Programme)
- Devoting more farmland to organic farming
- Optimising biomass production and biomass use in agriculture

The most important measure is the implementation of the nitrogen reduction programme adopted by the Conference of the Ministers of the Environment which is

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[216] Triticale (an artificial name) is a crop that was developed by crossing wheat (triticum aestivum) and rye (secale cereale).

[217] NNA 1997: Stickstoffminderungsprogramm [Nitrogen reduction programme], report by the working group of representatives of the Joint Conference of Ministers for the Environment and for Agriculture. NNA report, Vol. 10 (1997), issue 4. Alfred Toepfer Academy for Nature Conservation.

long overdue and sets forth concrete measures as well as the related emission reduction potential. One important step is optimised use of fertilisers in terms of time and quantities. This includes efficiency improvement instruments in conventional agriculture in addition to the fertiliser ordinance which is currently being revised. This also includes measures in the field of animal husbandry and liquid manure storage and application as an essential part of the Federal government's ammonia reduction programme. Feeding patterns adjusted to the animals' protein demand reduces the urea content in excretions and hence the nitrogen content of the liquid manure to be spread or fermented in a biogas plant. Scientists are currently exploring the potential use of urease inhibitors designed to delay the release of ammonia from urea.

Increasing the area used for organic farming generally contributes towards environmental protection. The "Federal Organic Farming Programme“[218] in particular, must be continued in this context. At EU level, it will have to be checked to what extent funds from the so-called second pillar of agricultural policy can be made available to boost the efficiency of implementing the EU Action Plan for Organic Farming[219] which so far exists in terms of contents, but without any funds earmarked for it.

In conjunction with minor changes in diet (for example, reducing meat consumption), organic farming may even substantially contribute towards achieving climate protection goals. Concrete instruments for stimulating the demand end include education measures and campaigns designed to promote sustainable consumption patterns (for example, diet education in schools and kindergartens). Sales of organic products, for example, in public canteens, hospitals, schools should be increased in the first place.

Agricultural biomass production and use should be optimised mainly with the help of strategies for sustainable biomass production. Before energy plants are grown to a significantly increased extent, the potential consequences of such a measure should

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[218] Federal Ministry of Consumer Protection, Food and Agriculture, 2001: Bundesprogramm Ökologischer Landbau [Federal Organic Farming Programme]. Further information is available at: http://www.bundesprogramm-oekolandbau.de

[219] European Commission, 2004: European Action Plan for Organic Food and Farming

be examined within the scope of an environmental impact assessment which the Federal Environmental Agency (UBA) always demands in conjunction with renewable raw materials.

The suitability of applications varies for different types of biomass. Generally applicable solutions should not be expected. However, the "most favourable" paths of use of different types of biomass and technical applications should be identified, and stationary and mobile uses (biofuels) should be compared. The central questions in this context are the following. What does an overall concept for sustainable energy, raw material and food supplies for Germany and the EU look like, and which type of land use can be considered to be sustainable in central Europe in the long run? The need for research and development work on quality improvement, efficiency increases and savings potentials must be addressed in this context just as much as the identification of suitable indicators for classifying environmental effects. The Federal Environmental Agency is working on these subjects.

21. Concepts for climate-protecting behaviour – taking the public sector as an example

> Communicating successful models helps to show how we can sustain a high standard of living whilst protecting the climate. The Federal Environmental Agency (UBA) is determined to provide opinion-makers, in particular, with concepts for attractive and climate-friendly lifestyles. The Federal Government's self-commitment to reduce CO_2 emissions in its operative sphere has an exemplary function that should be implemented as quickly as possible in building management, vehicle fleet management, and in procurement. The Federal Environmental Agency is determined to set an example here.

Environment-friendly and climate-compatible lifestyles must be made more attractive in order to encourage citizens to make them a part of their everyday life. Climate-compatible lifestyles are elements of environmentally compatible life.

What do the current lifestyles of the majority of Germans mean for climate?

Today's lifestyles – in all their forms – should become sustainable in future. Considering, for example, the increase in residential floor space and the use of different forms of transport, it can be recognised that behavioural change will be necessary in order to avoid or help restrict long-term damage to the climate. According to the Federal Office for Building and Regional Planning, the trend towards owner-occupied homes will increase until the year 2010, followed by stabilisation resulting from demographic trends.[220] More detached homes outside current settlement areas will lead to higher energy consumption, especially heating, and a greater dependence on passenger cars. In the transport sector, the trend towards passenger cars continues unabated. Alternative solutions, for example, in public passenger transport, are not being met with sufficient support. Per-capita CO_2 emissions are one indicator for the lack of sustainability in our lifestyles. These

[220] Federal Office for Building and Regional Planning 2001: Wohnungsprognose 2015 [2015 home forecast].

emissions total around 10 tonnes per year in Germany.[221] Looking beyond Europe's borders, one sees that other industrialised nations have much heavier burdens to shoulder as in the US where per-capita emissions are around twice as high.[222]

How should our lifestyles change?

Within the framework of an effective climate protection strategy, per-capita CO_2 emissions should decrease by around 40% by the year 2020.[223] In order to achieve this ambitious climate protection goal, this issue must be communicated both to the general public and to decision-makers in the business community, in associations and to policymakers. Climate protection and sustainability must be anchored in everyday life. This will be the only way to show that climate-friendly industry and behaviour are compatible with a high standard of living. The first key issue in this context is to provide understandable information on the greenhouse gas relevance of everyday behaviour. Secondly, concrete role models are needed in order to show what sustainability can mean in everyday life, irrespective of whether behaviour is motivated by climate protection, general awareness of environmental issues, financial thrift, technical interest or the individual's self-presentation.

Model projects, such as the use of the former soldiers' quarter of Vauban in Freiburg, Germany, show concrete ways of implementing sustainable lifestyles. In Vauban, an urban quarter which was previously used as a military barracks was converted to a new part of the city. One important sub-aspect of the project was the option of "car-free living" which was implemented on 35% of the total space (36 hectares).[224] The project shows that passenger cars are not necessary even if the space concerned is

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[221] Federal Ministry for the Environment (BMU) July 2002: Third Report by the Government of the Federal Republic of Germany in accordance with the Framework Convention of the United Nations. Available at: http://unfccc.int.

[222] World Resources Institute, CAIT, http://cait.wri.org., July 2005 revison.

[223] German Council for Sustainable Development 2004: Ziele zur Nachhaltigen Entwicklung in Deutschland – Schwerpunktthemen – Dialogpapier des Nachhaltigkeitsrates [Goals for sustainable development in Germany – focal issues – dialogue paper issued by the German Council for Sustainable Development].

[224] Öko-Institut 2002: Nachhaltige Stadtteile auf innerstädtischen Konversionsflächen – Stoffstromanalyse als Bewertungsinstrument [Sustainable city districts on urban conversion areas – material flow analysis as an evaluation instrument].

as large as a whole city district. In this case, mobility is achieved by an environment mix (walking, bicycle, public passenger transport) supplemented by a car sharing system.

The Swiss example demonstrates that car sharing is a fully fledged alternative in the area of motorised private transport. Whilst car sharing growth rates are levelling out in Germany, Switzerland as the "homeland" of car sharing is recording growth rates of 50% per year. The current potential of car sharing schemes is in the order of 8.1 million people, i.e. almost 21% of driving license holders. If this potential were to be fully exhausted in Germany, up to 1.3 million tonnes of CO_2 could be saved every year. Shifting transport away from private cars and – given the use of car sharing vehicles – a sensible selection of the appropriate vehicle types will contribute towards these savings. Furthermore, better utilisation of vehicles also means more efficient use.[225]

In tourism too, broad-based establishment of sustainable lifestyles will be necessary. Enormous climate protection effects can be achieved through a stronger use of regional holiday offers which at the same time also fulfil sustainability criteria. The Viabono project supported by the Federal Environmental Agency (UBA) is dedicated to establishing an umbrella label for travel companies committed to sustainability. Climate-compatible travel behaviour is promoted and CO_2 emissions are reduced thanks to shorter travel distances to destinations as well as through climate-protecting local offers.

Both "sustainable city quarters" and "sustainable tourism" can serve as role models for players – i.e. policymakers, service companies, businesses and consumers – when it comes to implementing lifestyles and economic patterns geared towards sustainable climate policy.

[225] IZT - Institut für Zukunftsstudien und Technologiebewertung: Car-Sharing Nachhaltige Mobilität durch eigentumslose Pkw-Nutzung? [Car sharing – sustainable mobility through the non-ownership-based use of passenger cars], 2000.

Which measures and instruments are necessary in order to achieve the medium-term climate protection targets?

In order to communicate the role models and thereby induce a change in lifestyles, citizens, policymakers and the business community will have to rethink. In so far as private households are concerned, two potential forms of climate-friendly, sustainable lifestyles have been outlined earlier in this study.

The following measures can help achieve these goals.
Model projects for climate protection can combine several benefits for climate protection. Within the framework of such models, players can carry out projects which formerly existed as theoretical concepts only and which can now be put to the test. At the same time, the projects serve as examples both for users (such as citizens, travellers) and for external parties who can benefit in their own projects. The National Climate Protection Programme 2005 mentions several measures in different sectors of the economy. One important aspect includes information and education measures by the Federal government, such as on-site advice by engineers concerning the energy saving potential of existing buildings within the framework of a programme funded by the Federal Ministry of Economics and Labour. A total number of 7,000 advisory talks were held in 2004. The programme is to be continued until 2006. In 2004, the Federal Ministry for the Environment, Nature Conservation and Reactor Safety redesigned its climate protection campaign and, besides existing communication paths, is increasingly using the Internet as a path for disseminating contents.[226]

Different levels of government, in particular, are expected not just to give examples but also to recommend concrete action for everyday routines at public agencies. The "Leitfaden Nachhaltiges Bauen" [Guideline for Sustainable Building], for example, explains the integrated climate protection principles with regard to construction, operation and maintenance of government properties and buildings.[227]

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[226] Federal Government 2005: National Climate Protection Programme – Resolution by the Federal government of 13 July 2005

[227] Federal Ministry of Transport, Building and Housing (editor): Leitfaden Nachhaltiges Bauen [Guideline for Sustainable Building], 2001.

The guideline foresees the so-called "ecological initial assessment" as a qualitative method for evaluating the ecological status of buildings. Applicability was tested in the new building of the Federal Environmental Agency (UBA) in Dessau. In a parallel step, the Federal Environmental Agency, in co-operation with the faculty of civil engineering at Technische Universität Dresden, conducted a study that analyses the general applicability of testing, evaluation and steering instruments for sustainable building.[228] The result is a re-classification of the given criteria of the "ecological initial assessment" for the different object planning phases pursuant to Section 15 of the Fee Regulations for Architects and Engineers [§ 15 Honorarordnung für Architekten und Ingenieure (HOAI)], as well as a proposal for the weighting of the criteria.

However, the Guideline for Sustainable Building is limited to new buildings and, from a climate protection perspective, has hence a much less important role to play compared to the potential related to the rehabilitation of existing buildings. The project of creating a "Guideline for Sustainable Maintenance and Rehabilitation" should hence be pushed ahead. All buildings owned by federal institutions must be systematically examined with a view to the potential for savings, and a procedure must be defined for identifying and rehabilitating buildings. The measures should aim at an energy consumption coefficient to be defined in advance. Furthermore, at least 15% of total energy demand should be covered by regenerative energy sources. The practical implementation of this self-commitment must be accompanied by further training measures for the government's construction administrations as well as the public agencies using the buildings. These initiatives are also likely to influence the construction sector in general.

The properties and buildings used by the Federal Ministry for the Environment are examined with a view to their energy parameters and the possibility to implement measures for efficient energy conversion and energy saving and for the use of

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The "Leitfaden Nachhaltiges Bauen" was developed by an inter-ministry team and forms an attachment to the "Richtlinie für die Durchführung von Bauaufgaben des Bundes im Zuständigkeitsbereich der Finanzverwaltungen (RBBau)" [Guidelines for the performance of building projects by the Federal government within the sphere of responsibility of the finance administrations].

[228] Technische Universität Dresden: Öko-Design – Analyse von Bewertungsinstrumenten des nachhaltigen Bauens [Eco-design – analysis of evaluation instruments for sustainable building], 2001.

renewable energies and cogeneration techniques.[229] Energy concepts were developed and energy controlling programmes introduced at 13 sites within the framework of the study. Besides the success which these projects ideally record, the results can also serve as important role models.

Another form of triggering and implementing exemplary projects is the integration of different players who can draw on their respective strengths and thereby generate quick success. Public private partnership (PPP) models, for example, enable a stronger than ever use of energy saving potentials at municipal properties and buildings.[230] These models offer potential solutions when it comes to finding a compromise between cost effectiveness, climate protection and tight budgets. One example of successful co-operation between public sector and private business is the outsourcing of technical building management for the Berlin-based high-tech properties and buildings of the Federal government as well as energy saving contracting measures.[231] An enhanced energy consumption situation can also be expected if buildings used by the public sector were completely financed, planned and operated by private companies under public private partnership (PPP) schemes. In their own economic interest, companies tend to minimise operating costs which are to a significant extent due to energy consumption. The Federal Ministry of Transport, Building and Housing is preparing so-called PPP guidelines and plans to establish a competence centre in order to support public administrations and companies.

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[229] Research project: Optimising energy supply in the sphere of responsibility of the Federal Ministry for the Environment

[230] Public private partnership models are designed to involve external service providers. "The Federal government is determined to increasingly draw on the know-how and capital of private companies in order to exploit energy saving potentials at properties and buildings of the Federal government." (Tilo Braune, Permanent Secretary at the Federal Ministry of Transport, Building and Housing, at the "Private meets Public - European Conference on Public-Private-Partnership for Energy Efficiency" Congress in Berlin on 8 September 2003).

[231] Federal Environmental Agency (UBA) 2000: Energiespar-Contracting als Beitrag zu Klimaschutz und Kostensenkung (Energy saving contracting as a contribution towards climate protection and cost reductions).

(Refer to statements 14 and 16).

In the area of public administrations, the systematic establishment of various environmental controlling or environmental management instruments is a cost-effective way of reducing greenhouse gas emissions. This relieves the environment and public coffers alike. Public procurement has a central role to play in this context. The "NABESI" project sponsored by the Federal Ministry of Education and Research has identified a substantial greenhouse gas emission reduction potential within the scope of procurement projects for public administrations. An uncompromising programme for purchasing so-called green electricity by the public sector, for example, would enable savings of 23.8 million tonnes of CO_2 equivalents per year at a total purchasing volume of 38,000 gigawatt hours, whilst the use of energy-saving PCs and monitors (500,000 units) would save 150,000 tonnes of CO_2 equivalents per year.[232]

However, one precondition for exploiting the above-mentioned environmental relief programmes is the - preferably nation-wide – application of environmental protection criteria during the purchasing process beyond the currently still isolated activities of some pioneers. For this purpose, environmental protection criteria must be made simpler and, if possible, applied on a pan-European scale, also in interest of suppliers. In this respect, the Procura$^+$ campaign for sustainable procurement offers a good starting point.[233]

What is the Federal Environmental Agency (UBA) already doing today?

The Federal Environmental Agency provides multipliers with concepts and detailed information for their own communication activities. Target groups include, for example, federations of manufacturers and service providers in the field of energy

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[232] Comprehensive estimates and detailed analyses of environmental relief potentials in the field of public procurement were prepared within the NABESI project sponsored by the Federal Ministry for Education and Research and conducted by Technische Universität Dresden, the Darmstadt-based Öko-Institut and the ICLEI city network. For further information, please visit: http://www.iclei.org/procurement/nabesi.

[233] This campaign was launched by ICLEI – Local Governments for Sustainability and combines a management model for the gradual introduction of environment-friendly procurement practices ("Procura$^+$ Milestones") with radically simplified environmental criteria ("Procura$^+$ Criteria") that can be applied throughout Europe. Information can be downloaded at: www.procuraplus.org.

and consumer protection as well as municipal associations, the technical press in the respective sectors, and local Agenda 21 groups.

With its new headquarters in Dessau, the Federal Environmental Agency (UBA) implemented a model project which created a new public space in Dessau on a derelict site in the centre of the city. The revitalisation of this site and the establishment of the Agency's headquarters at a central location that can be easily reached with public transport contribute towards environmentally compatible urban development. The concept of the new building considers all "phases of life" – from its construction via its use right through to its later demolition. The building fulfils the standard between a low-energy building and a passive building, minimising heat and cold demand as well as power consumption as a key parameter for an office building. The building, for example, outperforms the specifications of the Thermal Insulation Ordinance by 50%[234], which is still applicable to new buildings, with the share of regenerative energy in total energy consumption totalling at least 15%. Compared to the two office buildings which will be abandoned in Berlin, CO_2 emissions in the new headquarters building in Dessau are expected to drop by 52%.

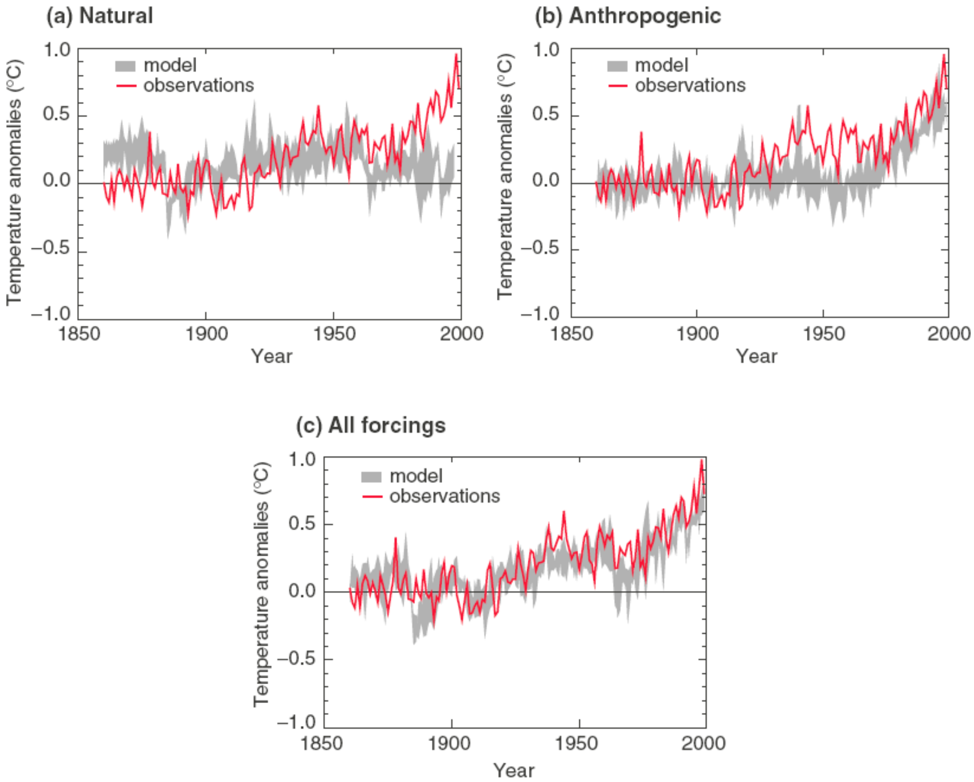
Furthermore, the Federal Environmental Agency has proposed precise criteria which are also realistic under contract awarding law with regard to the procurement of green electricity for properties and buildings of federal institutions. The procurement criteria ensure that the procurement of green electricity not only means that respective consumers can record in their balance electricity which is generated anyway from regenerative sources, they additionally ensure that additional green electricity is generated during the term of the supply contract. In the short to medium term, significant CO_2 savings will be achieved thereby at a relatively low cost.[235]

[234] The specifications of the Energy Saving Ordinance in its currently applicable version are outperformed by more than 30 percent.

[235] The Federal Ministry for the Environment (BMU) and the Federal Environmental Agency are currently preparing the publication of a guideline for other Federal authorities on the basis of the criteria applied and the experience gained. In a first step, it will be examined whether the criteria developed are also suitable for use by smaller administrations, for example, at municipal level, or whether the criteria developed by the Procura$^+$ campaign for sustainable procurement are a better option in such cases.

Appendix

Fig. A 1: ***Simulated annual global mean surface temperatures***



Source: IPCC – Intergovernmental Panel on Climate Change (editor) (2001): Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the IPCC. Cambridge: Cambridge University Press.

Table A 1: Examples of the risk of abrupt, large-scale events

Warming of less than 1°C*	Warming of 1-2°C	Warming of > 2C°
Significant rise in sea level	carbon cycle feedbacks lead to further increases in temperatures; Increased risk of melting of the Greenland ice sheet in conjunction with a rise in sea level of up to 7m over 1000 years	Weakening or shut-down of the thermohaline circulation leads to a northern Europe that is still warm, but with severe implications for weather in the north Atlantic low-pressure zone; collapse of the west Antarctic ice sheet with a rapid increase in sea level by 4 to 6m, severe coastal damages; the release of destabilised methane hydrates into the deep sea would lead to a feedback in the direction of a substantial rise in temperature.

** Temperature increase compared to pre-industrial levels (temperature already increased by 0.7°C since then until 2000); own compilation from Hare 2003: Assessment of knowledge on impacts of climate change – Contribution to the specification of Art.2 of the UNFCCC: impacts on ecosystems, food production, water and socio-economic system. External expertise for "Climate Protection Strategies for the 21st Century: Kyoto and beyond", report by the German Advisory Council on Global Environmental Change, Internet: http://www.wbgu.de/wbgu_sn2003_ex01.pdf. Berlin: WBGU 2003, 104 S. and Parry, Arnell, Michael, Nicholls, Kovats und Livermore et al. 2001: Millions at Risk: Defining Critical Climate Change Threats and Targets. Global Environmental Change 11:3, 1-3.*

Table A 2: Examples of effects on ecosystems

Warming of less than 1°C	Warming of 1-2°C	Warming of 2-3°C
Risk of extinction for highly sensitive amphibians and mammals (south west Australia) and several species in the south of Africa; habitat restrictions for various species; high risk of severe damages, for example, for coral reefs, highland tropical forest in Australia.	15-20% of all ecosystems shift with severe consequences, for example, habitats for salmon (US), collared lemming (Canada) as a key species of the Arctic; many animals in the south of Africa and the fauna in Mexico; threat to the polar bear; threat of a 50% loss of the World Heritage Site in the Kakadu wetlands (Australia) and Sundarban (Bangladesh).	More than 20% of all ecosystems shift with severe consequences, including the loss of some species, (honeycreeper (Hawaii), Australian flame bowerbird (4 species in South Africa)); 50% loss of Baltic and Mediterranean migratory bird habitats; complete loss of the Kakadu and Sundarban territories.

Source: refer to Table A1.

Table A 3: Examples of effects on food supply and water

Warming of less than 1°C*	Warming of 1-2°C	Warming of 2-3°C	Warming of 3-4°C
10 million more people exposed to the risk of hunger and malnutrition; slight, but significant yield losses in many tropical developing countries; benefits for almost all industrialised countries.	Around 30 million more people exposed to the risk of hunger and malnutrition.	Up to 75 million more people exposed to the risk of hunger; level of rice production in Asia threatened; yield losses in north America, Russia and eastern Europe; up to 5.5 billion people live in regions with serious losses in grain production; general increase in food prices.	80-120 million more people exposed to the risk of hunger (55 to 75 million of these people in Africa); given a 4°C warming, complete regions of Australia unsuitable for food production.
2020: Up to 800 million more people exposed to the risk of scarce water supply.	2050: Up to 1.5 billion more people exposed to the risk of scarce water supply; significant outflow changes world-wide with poorer possibilities for irrigation; poorer water quality; salt water penetrates into coastal aquifers.	More than 3 billion people additionally exposed to the risk of scarce water supply (especially in mega cities in India and China).	

** Temperature increase compared to pre-industrial levels (temperature already increased by 0.7°C since then until 2000), source: refer to Table A1.*

Table A 4: Examples of the effects on human health

Warming of less than 1°C	Warming of 1-2°C	Warming of 2-3°C	Warming of 3-4°C
Around 70 million more people exposed to the risk of malaria.	Around 150 million more people exposed to the risk of malaria.	Around 250 million more people exposed to the risk of malaria.	Up to around 330 million more people exposed to the risk of malaria.
A few million more people exposed to the risk of coastal flooding.	Up to 8 million more people exposed to the risk of coastal flooding.	Up to 20 million more people exposed to the risk of coastal flooding.	Up to 75 million more people exposed to the risk of coastal flooding.

Source: refer to Table A1.

Table A 5: Examples of the effects on economy

Warming of less than 1°C	Warming of 1-2°C	Warming of 2-3°C
Some developing countries record more than just insignificant GDP losses: Africa: 4%, India:1.7%.	Developing countries record GDP losses of a few to several percentage points; incomes among poor farmers decline.	Global net GDP losses; losses in developing countries rise by up to 5% .

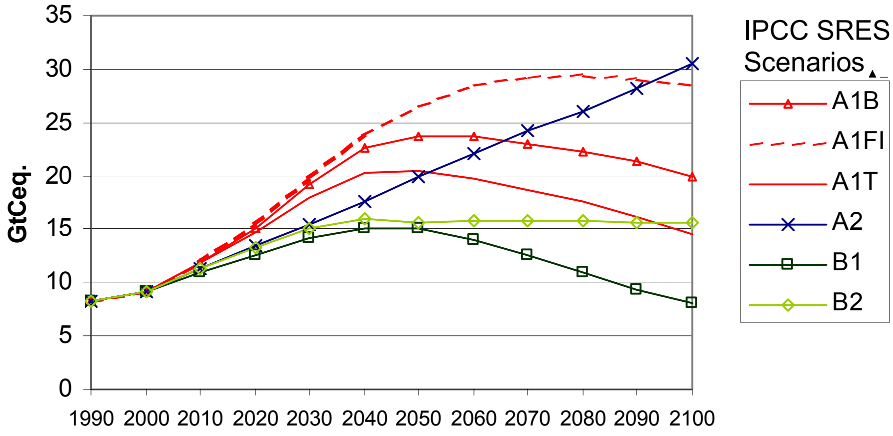
Source: refer to Table A1.

Overview A 1: Ethical priority rules relevant for climate change: [236]

- It is better to avoid a "bad" than to create a "good", given that the amount of bads and goods are (almost) equal ("double-effect")..
- One should not favour solutions which make the life prospects of the poor and of the disadvantaged worse in the future. One should, instead, favour solutions which improve their life prospects even if this brings about some losses in the overall sum of material welfare.
- One should not favour any solution of a problem which (probably) will bring about more serious problems in times to come.
- One should not favour solutions which are more feasible under contemporary power relations but could lead to heavy social conflicts and disruptions in the future.
- Long-term-solutions should be prevail over short-term-solutions.
- One should favour solutions which (probably) bring about rather smooth than more rapid changes because smooth changes are less risky to the overall resilience of ecological and social systems.
- Solutions which keep many decent options open should prevail over solutions which endanger future capacities to solve problems.
- If adverse consequences cannot be avoided, they should be reversible.
- If uncertainties are high, it will be better to slow down than to accelerate.

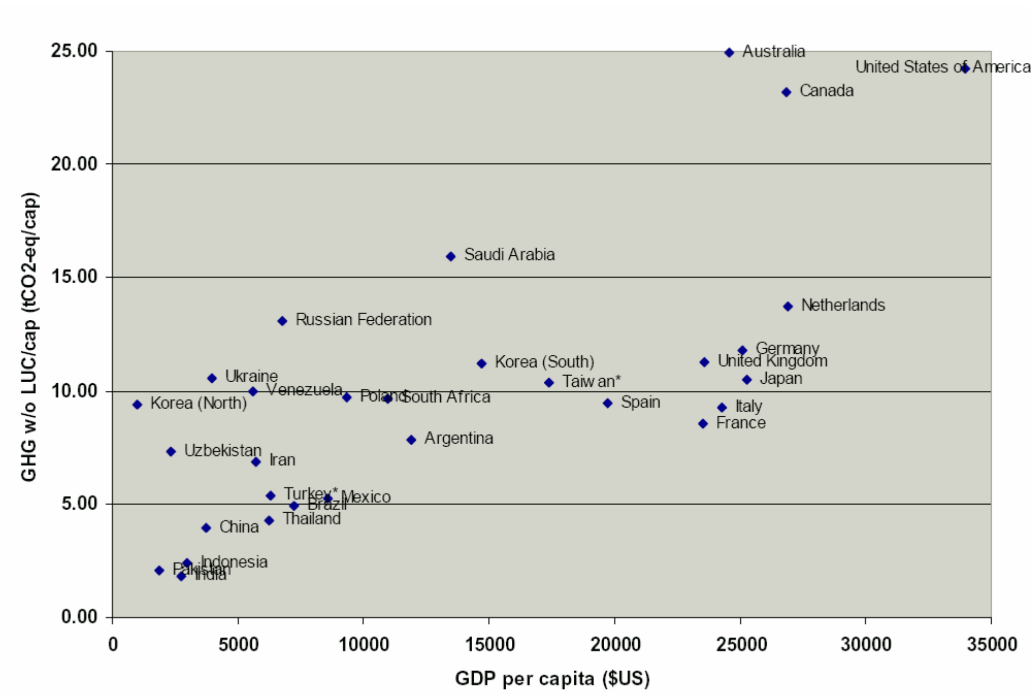
[236] Konrad Ott et al. 2004: Reasoning goals of climate protection. Specification of Art. 2 UNFCCC. Umweltbundesamt Berlin, FKZ 202 41 252.

Fig. A 2: Business as usual emissions for all Kyoto gases



Source: Höhne et al. 2005: Umweltbundesamt Berlin, Climate Change 2/05, FKZ 203 41 148/01.

Fig. A 3: Per-capita income and per-capita emissions

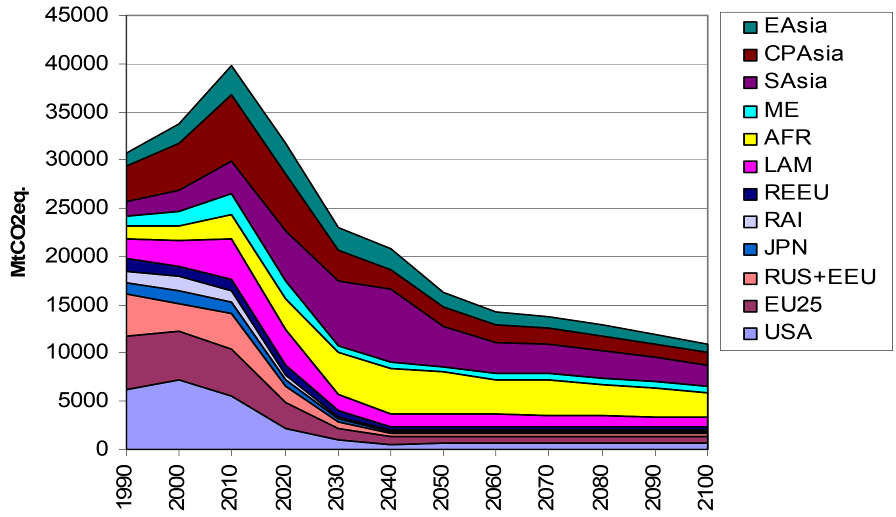


Source: Data taken from CAIT 1.5, http://cait.wri.org.

Overview A 2: Possible types of future climate protection commitments

Goal	Description
Quantitative goals	• Annex B of the Climate Protocol contains binding and absolute emission reduction goals for all six climate gases for all the signatories of the Kyoto Protocol. These goals have been strongly criticised due to their lack of flexibility with regard to unforeseen economic developments. However, such goals are the ideal precondition for emissions trading which is an important factor for the global cost-efficiency of emission reduction measures. • In principle, such binding quantitative goals can also be defined as relative (and hence dynamic) goals on the basis of other parameters, for instance, GDP, energy consumption or population. However, the disadvantage of such definitions of environmental goals is that they are less strictly action-related - because the extent and speed of the greenhouse effect depend directly on the concentration of greenhouse gases in the atmosphere - and hence directly on the absolute, annual emissions of greenhouse gases.
Activity-based goals	• Greater co-operation and the agreements on financial contributions towards technology research and development. In the medium term, these contributions should reduce the cost of climate-friendly technology and hence indirectly help to reduce emissions. • Co-ordination of instruments and measures in order to avoid distortion of competition, such as CO_2 taxes, regulatory technical standards.
Activities by industrialised countries to reduce emissions in developing countries	• Binding financial contributions to funds (for measures to reduce emissions or for adaptation measures) and technology transfer. • Determined orientation of all relevant activities in development co-operation towards climate protection requirements, re-channelling necessary investments, for example, in the energy sector.
Goals specifically for developing countries	• Gearing development strategies to climate protection requirements (sustainable development). • Increased use of the clean development mechanism (CDM) in extended form as a source of investment for climate protection.

Fig. A 4: Example of emission allocation under the four-stage convergence approach and stabilisation at 400 ppmv of CO_2



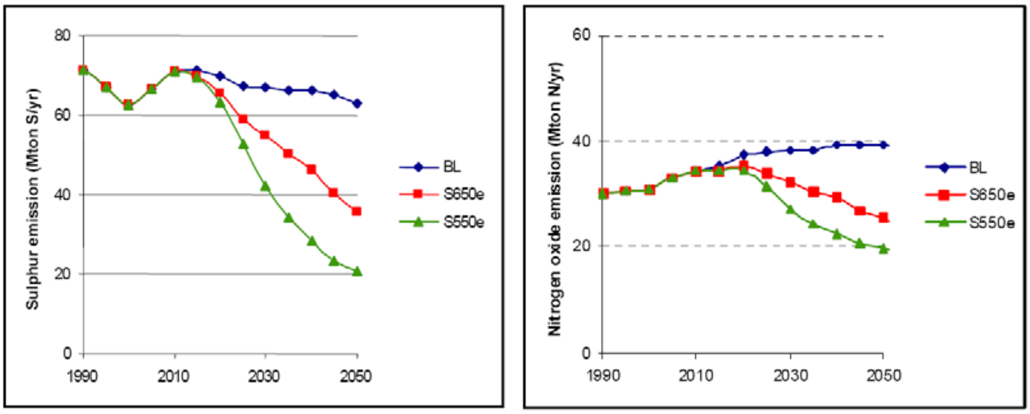
Source: Höhne et al. 2005 : Options for the second commitment period of the Kyoto Protocol, Umweltbundesamt Berlin, Series on Climate Change 2/05, FKZ 203 41 148/01.The diagram shows, for example, that by the year 2040 the US and the EU25 (the two bottom curve sections) will have to reduce their greenhouse gas emissions to less than one quarter of today's level if stabilisation of carbon dioxide levels at 400 ppmv is to be achieved within the scope of a multi-stage approach. On the other hand, greenhouse gas emissions in south Asia (S Asia) are likely to continue rising up to 2050 and will probably return to today's level by the end of this century.

Table A 6: Emission reduction compared to 1990 in order to achieve different CO_2 concentration levels

		2020	2050
400 ppmv CO_2	**Global**	+10%	-60%
	Annex I	-25% to -50%	-80% to -90%
	Non-Annex I	Substantial deviations from the reference scenario for Latin America, the Middle East, Central and East Asia	Strong deviations from the reference scenario in all regions
450 ppmv CO_2	**Global**	+30%	-25%
	Annex I	-10% to -30%	-70% to –90%
	Non-Annex I	Deviations from the reference scenario for Latin America, the Middle East, Central and East Asia	Significant deviations from the reference scenario in all regions

Source: Höhne et al. 2005 : Options for the second commitment period of the Kyoto Protocol, Umweltbundesamt Berlin, Climate Change series 2/05, FKZ 203 41 148/01.

Fig. A 5: ***Positive side effects of climate stabilisation by reducing sulphur dioxide and nitric oxide emissions***



Source: Criqui et al. 2003: Greenhouse gas reduction pathways in the UNFCCC process up to 2025, report by CNRS (France), RIVM (Netherlands), ICCS (Greece), CES (Belgium) for the EU Commission, DG Environment. The S550e scenario approximately corresponds to a stabilisation of CO_2 levels at 450 ppm (S650e corresponds to 550 ppm CO_2), BL (baseline) represents the reference scenario.