

Concept for a Future Climate Policy

Plotting a New Course in 2009

Concept for a Future Climate Policy

Plotting a New Course in 2009

by

Guido Knoche, Benjamin Lünenbürger, Benno Hain, Klaus Müschen

with contributions from

Malin Ahlberg, Michael Bade, Ralf Becker, Rolf Beckers, Anja Behnke, Rosemarie Benndorf, Michael Bilharz, Michael Börner, Kathrin Bruhn, Andreas Burger, Achim Daschkeit, Marion Dreher, Christoph Erdmenger, Roland Fendler, Frank Gagelmann, Markus Geupel, Michael Golde, Evelyn Hagenah, Clemens Hasse, Simon Heine, Corinna Hornemann, Almut Jering, Judit Kanthak, Karin Kartschall, Helmut Kaschenz, Thomas Klaus, Katharina Koppe, Bernd Krause, Christoph Kühleis, Kai Kuhnenn, Martin Lambrecht, Daniel Lamfried, Harry Lehmann, Petra Mahrenholz, Michael Marty, Steffen Matezki, Jeannette Mathews, Kati Mattern, Birgit Mohaupt-Jahr, Lars Mönch, Hans-Guido Mücke, Werner Niederle, Ines Oehme, Christina Pickl, Wolfgang Plehn, Almut Reichart, Marianne Richter, Simone Richter, Anna Pia Schreyögg, Jens Schuberth, Dietrich Schulz, Gudrun Schütze, Sylvia Schwermer, Wolfgang Seidel, Till Spranger, Michael Strogies, Alfred Trukenmueller, Carla Vollmer, Ulrike Wachsmann, Wolfgang Wende, Stefanie Werner, Bärbel Westermann, Frank Wetzell

Umweltbundesamt

(German Federal Environment Agency)

UMWELTBUNDESAMT

This publication is only available online. It can be downloaded from
http://www.umweltbundesamt.de/uba-info-medien/mysql_medien.php?anfrage=Kennummer&Suchwort=3881.

Publisher: Federal Environment Agency (Umweltbundesamt)
P.O.B. 14 06
06813 Dessau-Roßlau
Germany
Phone: +49-340-2103-0
Fax: +49-340-2103 2285
Email: info@umweltbundesamt.de
Internet: <http://www.umweltbundesamt.de>

Edited by: Section I 2.1
Eric Fee, Juliane Berger, Guido Knoche
Section I 1.4
Benjamin Lünenbürger
Department I 2
Klaus Müschen

Dessau-Roßlau, July 2010

Introduction

Climate change is one of the greatest challenges facing humanity. Scientific knowledge about the impending threats as well as knowledge about possible options for action have increased considerably in recent decades. Particularly alarming, in view of expected climate change, is the IPCC's fourth assessment report, published in 2007. At the same time we are observing an increase in the global emissions of greenhouse gases – the cause of anthropogenic climate change.

This makes it all the more important today to set the necessary course for the future. There is a need for a permanent change in trends, favouring mitigation of and adaptation to climate change in the economy and our entire society. The politicians can and should also address the current challenges of the financial and economic crises while also taking mitigation and adaptation into consideration.

Although the situation is very serious, the framework conditions are not discouraging, since the technology is already available to reduce greenhouse gas emissions, to completely convert to domestic renewable energy technologies, and also to conduct sustainable agriculture and forestry. In view of the consequences of climate change, though the costs of mitigation are foreseeable, they are not decisive. Furthermore, regarding adaptation to climate change, the necessary knowledge and many technologies are already available, particularly in Germany.

The sooner we act, the more time we have to make the necessary technical and social adaptations – involving not only a fundamental change to our economy but also to our lifestyle. A start was made towards effective mitigation and adaptation with the UN Framework Convention on Climate Change and the Kyoto Protocol. Now, in the middle of the first commitment period of the Kyoto Protocol, the international community must reach a follow-up agreement under the UN Framework Climate Convention for the period after 2012 and thus establish an important milestone for a long-term policy for sustainable mitigation and adaptation. The German Federal Government has, in reaction to existing and possible future risks of climate change, adopted the German Adaptation Strategy in December 2008.

The German Federal Environment Agency (UBA) presents here a summary of its Ideas on climate policies. We wish to illustrate how we foresee the next steps towards an ambitious set of policies for energy, mitigation of and adaptation to climate change. These proposals are based on numerous UBA publications¹.

In the first chapter we describe climate change as has already been observed in Germany and the world, as well as further possible change in the future. Tying in with this, we address the potential consequences of continued climate change. Based on the scientific justification for the necessary limit on greenhouse gas emissions, we formulate objectives for climate change mitigation and adaptation and outline the measures and policy instruments which must be adopted in order to achieve the mitigation targets. In doing this, we take into account the costs and benefits of mitiga-

¹ For details visit: www.umweltbundesamt.de/klimaschutz-e/index.htm.

tion². Finally, we consider synergies and conflicts between an ambitious mitigation policy and other environmental objectives on the basis of selected examples, while also making relevant recommendations.

In view of the economic crisis, there are isolated voices calling for the postponement of mitigation measures. But those demanding this are ignoring the fact that many of the provisions of mitigation policies make economic sense and improve the competitive position of Germany and the European Union. These provisions help to modernise our infrastructure and buildings. Renewable energy technologies are an important future market and their promotion in Germany and Europe will make it possible for business to export the relevant technology and to create jobs. Finally, the transition to a more efficient energy sector on the basis of renewable resources, will make it possible to become more independent of energy imports. Climate change policies must be achieved as part of a long-term strategy – with patience but without hesitancy, even in times of economic crisis. The consequences of an economic crisis can be overcome in the short- or medium-term, but the consequences of climate change will remain as a long-term burden on people as well as on the economy.

Thanks to our current prosperity we can afford to invest in mitigating climate change. However, we cannot afford to allow the impacts of climate change to unabatedly come crashing down upon us.

² The authors are aware that there are grave differences in the implementation of instruments and measures in the core areas of adaptation and mitigation.

Contents

Introduction	1
<i>Climate change and its impacts</i>	<i>4</i>
1. Climate change and its impacts until the present	4
2. Future climate change.....	5
3. Climate change in Germany.....	6
4. Effects of climate change on the environment, society and economy of Germany	6
5. Regions of Germany particularly affected by the consequences of climate change	13
<i>Climate policy objectives</i>	<i>15</i>
6. Maximum warning of two degrees Celsius	15
7. Reversal of global greenhouse gas emission trends before 2020.....	17
8. Sustainable development and adaptation strategies	20
<i>Adaptation</i>	<i>22</i>
9. Adaptation in an international setting.....	22
10. National and regional adaptation: Instruments for implementation.....	23
11. Adaptation in the health sector.....	28
12. Adaptation in the protection of the environment and biodiversity, as well as in agriculture and forestry	30
13. Adaptation in the further sectors of the economy	36
<i>Reduction of greenhouse gas emissions</i>	<i>38</i>
14. International climate treaty starting in 2013	38
15. Emission reductions in industrialised and developing countries.....	39
16. National emission reductions and targets	44
17. Cross-sector mitigation instruments.....	47
18. Reductions in the power sector.....	53
19. Reductions in the heat sector.....	61
20. Reductions in the transport sector	63
21. Reductions in agriculture and with F-gas emissions.....	66
22. Environmental communication as an instrument for mitigation	68
23. Economic costs and benefits	70
24. Consequences for growth and employment	74
<i>Synergies and conflicts between climate policies and other environmental objectives</i>	<i>78</i>
25. Climate change mitigation, human health and ecosystems.....	78
26. Biomass utilisation and sustainable agriculture	81
27. Climate change mitigation and resource conservation	85
28. Climate change mitigation and adaptation policies within the context of other environmental policies.....	89
29. Developing sustainable energy supplies.....	91

Climate change and its impacts

1. Climate change and its impacts until the present

Anthropogenic climate change is becoming increasingly apparent. Over the century from 1906 to 2005 the global mean temperature rose by about 0.74°C. Greenhouse gas concentrations have risen markedly since industrialisation (about 1750) to about 445 ppm CO₂ equivalent in 2005, and have not been as high for thousands of years. The impacts on the environment are a reason of grave concern.

Climate change and its impacts are increasingly apparent worldwide. In Europe, the mean global surface temperature has risen by some 1°C since 1900, which is above the global mean. Average temperatures in the northern hemisphere in the second half of the 20th century reached the highest 50-year mean in the past 1300 years.

The Intergovernmental Panel on Climate Change (IPCC) concludes in its 4th Assessment Report 2007³ that with a very high probability (above 90 %) we humans have been responsible for the largest proportion of global warming since the middle of the 20th century. Our energy-intensive lifestyles together with extensive deforestation, farming and animal husbandry have been the main causes of the rise in atmospheric greenhouse gas concentrations since 1750. Ice core analysis has shown that concentrations of carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O) in the atmosphere today are far higher than the pre-industrial values over many millennia.

The mean global sea level rose between 1961 and 2003 at a mean rate of about 1.8 millimetres per annum. The total rise in the 20th century was 0.17 metres (range 0.12 to 0.22 m). There has also been a mean decrease in mountain glaciers and snow and ice cover both in the northern and southern hemisphere. The Greenland ice sheet is showing a significant loss of mass.

Anthropogenic climate change and its consequences are meanwhile not only apparent on a global scale and in terms of mean values. Changes are also being observed at the level of continents, regions and oceans. It becomes more and more obviously: Extreme weather events are becoming more frequent and more intensive.

Observations show that a number of physical and biological systems have already been appreciably affected by warming over the past three decades. The consequences for the natural and human environment are becoming increasingly evident, as following examples show: agriculture and forestry are affected by changes in spring sowing, forest fires and pest attacks; public health is influenced by increasing heat-related mortality and the transmission of infectious diseases. Due to the inertia of the climate system, the full impact of the greenhouse gases already accumulated in the atmosphere will only become apparent in the coming decades. Therefore, warming of the Earth's atmosphere will continue on the long term.

³ IPCC (2007a): Climate Change 2007 - The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the IPCC. Cambridge, UK.

2. Future climate change

Considerable global change in our climate is expected in the future, and it will have a rapidity and extent which is without comparison in human history. Climate model simulations for various emission scenarios show that by the end of the 21st century the global mean temperature could probably have increased by 1.8 to 4.0°C (range: 1.1 to 6.4°C) compared with the period 1980 to 1999. This will result in increases in other processes such as sea level rise and the decline in the ice sheet cover. The risks to people and the environment will grow with increasing warming, but they will be unevenly distributed.

In order to study possible future climate developments, scientists used a number of climate models on the basis of so-called SRES emissions scenarios⁴ to simulate possible global climate changes up until the end of the 21st century (2090 to 2099) compared with the end of the 20th century (1980 to 1999). The best estimate for warming over this period for the lowest emissions scenario was 1.8 °C (range 1.1 to 2.9 °C) and for the highest emissions scenario 4.0 °C (range 2.4 to 6.4 °C). The global mean temperature has already risen by about 0.5 °C between the beginning of industrialisation to the period 1980 to 1990, which must be taken into account when estimating the expected warming from industrialisation by the end of the 21st century. This means that even a low emissions scenario could lead to a global temperature change of some 2.3 °C above pre-industrial levels and a high emissions scenario could result in warming of about 4.5 °C.

Recent research findings comparing with previous assessments indicate an acceleration and intensification of some processes related to climate change⁵. For example, sea levels could rise by more than a metre by the end of the 21st century. This is almost twice the increase stated in the IPCC's 2007 report, although this had already drawn attention to the uncertainties of the model simulations. Even if greenhouse gas concentrations were stabilised, the sea level would continue to rise. If global warming is more than 2°C above the pre-industrial value then it is to be expected that the Greenland ice cap will continue to melt over centuries. This could lead to a sea level rise of some 7 metres.

In addition to gradual global warming, it is also possible that above certain magnitudes of warming the climate could change abruptly, which could implicate irreversible, long-term and strong changes and processes. These could include the melting of sea ice and the reduction of the albedo in the Arctic, resulting in a considerable increase in global warming. Such processes represent a particular danger because abrupt, drastic changes in climate may overstrain the possibilities of adaptation of human societies or may exceed their capacity to adapt⁶.

The impact of climate change will be felt most by those with the least opportunities for adaptation: poor countries and the poor people in developing countries. Seventy percent of the poor worldwide are women and this group is particularly at risk, because they depend on access to natural resources such as water, land and fuels for their livelihoods as well as for that of their families. They can hardly revert to purchased products. As a result of the gender division of labour, a climate-related scarcity of natural resources can increase the workload for women (e.g. longer

⁴ IPCC (2000): A Special Report on Emissions Scenarios (SRES) of Working Group III.

⁵ Richardson et al. (2009): Climate Change. Global Risks, Challenges & Decisions. Synthesis Report. University of Copenhagen. Climate Change Congress Copenhagen, March 2009. www.climatecongress.ku.dk

⁶ Federal Environment Agency (2009): Kipp-Punkte im Klimasystem : www.umweltbundesamt.de/uba-info-presse/hintergrund/kipp-punkte.pdf

travel), so that they have less time for education or political participation. Gender inequalities can be intensified by climate change⁷.

3. Climate change in Germany

The climate in Germany is changing rapidly and profoundly. Without mitigation measures, the warming trend will continue until the end of this century and beyond, most probably reaching 1.5 to 3.5°C above the level for 1961-1990. Winter precipitation could increase on average by up to 40%, and regionally by up to 70%. The summer rainfall would decrease by up to 40%. Extreme events such as heavy rain, heat waves or storms could occur more frequently.

Since 1901, the mean air temperature in Germany has risen by almost 0.9 °C. The decade 1990 to 1999 was the warmest in the 20th century. The observed increase in temperature has been particularly high in south-west Germany.

In the past century there were considerable regional differences in precipitation trends. Whereas precipitation in western Germany increased over the whole year, in eastern Germany the decrease in summer rainfall has been more or less equal to the increase in winter precipitation. No significant trend can yet be detected for wind speeds⁸.

Depending on the global development of anthropogenic greenhouse gas emissions,⁹ warming in Germany is expected to be between 0.5 and 2.0 °C for the period 2021 - 2050 and between 1.5° and 3.5 °C, for the period 2071 - 2100. An average increase in winter precipitation of up to 40 % is possible, or even up to 70 % in some highland regions in Rhineland-Palatinate, Hesse, or north-eastern Bavaria. The summer rainfall, in contrast, could fall nationwide by up to 40 %, with south-western Germany being particularly hard hit. It is very probable that there will be more frequent and more intensive extreme events such as severe rain storms or hot days with a maximum temperature above 30 °C. Climate variability may also increase from day to day or from year to year, for example with three successive very hot summers followed by two extremely cold-wet summers¹⁰.

4. Effects of climate change on the environment, society and economy of Germany

Climate change has an impact on the environment, economy, and society. Although climate change may offer certain benefits for regions or individuals, the net sum of the effects is negative. In addition, these effects reinforce other disadvantageous consequences such as loss of biodiversity, soil degradation and air quality problems. Particularly severe damage will be caused by extreme events.

⁷ Brody, et al. (2008): Gender and climate change: mapping the linkages. A scoping study on knowledge and gaps; FAO (2006): Gender: The missing component of the response to climate change.

⁸ DWD (2008) in: German Federal Cabinet (2008): German Strategy for Adaptation to Climate Change.

⁹ IPCC SRES (2000)

¹⁰ Federal Environment Agency (2008) in: German Federal Cabinet (2008): German Strategy for Adaptation to Climate Change

The impacts of climate change on public health

► **Extreme events such as high waters or heat waves can result in serious health impairment. Longer-term health risks are also to be expected from newly established pathogens and disease vectors.**

Global warming has numerous negative consequences for society and human health. In addition to the effects of extreme heat waves¹¹, injuries or diseases are to be expected as a result of extreme events¹². Urban climate effects such as higher temperatures and lower relative humidity can be exacerbated by climate change. There are increased health risks for people in hospitals, nursing homes, schools, and nurseries, as well as hotels or leisure centres, sports stadiums and venues for major events.

Summer high pressure areas with more intensive insolation could become more frequent and lead to an increased formation of low-level ozone. This would result in a higher risk of respiratory diseases. The resulting intensification of solar UV radiation also increases the risk of skin cancer. Longer exposure to airborne bio-allergens such as pollen and animal dander could present an additional burden for all people with allergies and respiratory problems.

There could be increased health risks in summer if the quality of bathing waters is impaired, for example due to toxins produced by blue algae (cyanobacteria). Higher temperatures of surface waters could also lead to the proliferation of potential pathogens, e.g. bacteria such as *Vibrio vulnificus*.

Climate change could affect the spread of infectious diseases by blood-sucking insects and other arthropods (vectors¹³). At higher temperatures, exotic viruses, bacteria, and protozoa could become naturalized vectors. The distribution of reservoir hosts such as rodents and birds is also dependent on the climatic conditions. In particular, the vectors react directly to changes in the biotope and the presence of hosts. This can also influence their potential for disease transmission.

Milder winters can increase survival rates of vector species, extend their activity periods and shorten generation times, and also make it possible for newly introduced species to survive and spread. Regionally, some vectors may be decimated if breeding biotopes dry out. But new infectious diseases could become naturalized in Germany, or existing pathogens could become more prevalent over wider areas.

Consequences of climate change for water management and flood protection

► **Climate change will cause changes in groundwater levels and extreme events, such as floods, low water levels and droughts, as well as increased regional differences in water availability.**

In regions with less permeable soils or soils with a lower water storage capacity, there can be a decline in accessible groundwater¹⁴. On the other hand, increased winter precipitation in regions with well permeable soils could improve groundwater replenishment. In individual areas this could lead to an increased available supply of groundwater, despite reduced summer rainfall and increased potential surface evaporation.

The changes in precipitation rates over the seasons create a change in the discharge

¹¹ Excessive heat can be fatal, affecting above all the cardiovascular system. For example, the 2003 heat wave in Germany led to some 7000 fatalities.

¹² Such as heavy rainfall, high-waters, storms, floods, avalanches, or landslides

¹³ Mosquitoes, midges, ticks, and mites

¹⁴ The available supply of groundwater for extraction as drinking water

into rivers. The specific conditions in the catchment area of each river determine to what extent discharge behaviour, probability of floods and the duration of low-water events will change. They will therefore have to be investigated individually.

The combination of rising temperatures, flow changes and increasing frequency in heavy rainfall events affects the water quality¹⁵ and thus also aquatic ecosystems. Especially organisms adapted to constant and low temperatures can be exposed to increased stress. Low oxygen concentrations during low water periods also lead to the uptake of pollutants and fertiliser from sediments in surface waters. Effluent from sewage treatment plants and other diffuse inflows can lead to elevated pollution levels during low-water periods. If these low-water periods are more frequent and longer-lasting, this can lead to disputes over the utilisation of surface waters, and may temporarily impede shipping and other uses. In regions which are dry in the summer, the additional use of groundwater for irrigation purposes can lower ground water levels in the long term.

High waters can often have a detrimental effect on water quality, e.g. due to the transport of contaminated sediments, flooding of industrial plant and water treatment plant, or by damaging private oil-furnaces. Heavy rainfall can also lead to overflow from mixed sewers¹⁶ finding its way into surface waters. This could contaminate bathing waters with faecal matter, increase costs for drinking water treatment, and raise pollution levels. These processes impact public health and run counter to the objectives of the EU Water framework directive.

Most drinking water in Germany is derived from groundwater extraction and waterside filtration, and to a lesser extent from surface waters, dam reservoirs or direct extraction from rivers. Higher concentrations of pollutants, algae and pathogens in water can make it more difficult to prepare drinking water. In many regions of Germany the requirements for drinking water are met by local resources, augmented by long-distance water supplies. In general, the rate of replenishment of groundwater in Germany is higher than the extraction rate, so that even under changed climate conditions there will probably not be any fundamental problems with drinking water supplies. However, there may be regional exceptions during lengthy dry periods.

Consequences of climate change for the soil

► **Climate change affects the hydrologic balance and the transport and turnover of substances in soils. Impairments to natural soil functions have consequences for the diverse soil uses, for example for agriculture and forestry.**

An increase in precipitation intensities (extreme events), combined with drought-related gaps in the vegetation and drying out of surface soil due to increased summer temperatures will make soils more vulnerable to erosion by wind and water. This will result in the loss of humus and nutrients.

Frequent, severe rainstorms can lead to increased leaching of nutrients and pollutants, which are transported into surface waters and the groundwater.

In some regions with a low water table, the soil water reserves can be severely depleted as summers tend to become drier. The seasonal shift in precipitation – increasing in the winter, declining in the summer – will change the soil infiltration and influence the quality and the quantity of groundwater replenishment. With drier summer months and an in-

¹⁵ Including physical, biological and chemical parameters, e.g. turbidity, solute levels, and pH-value

¹⁶ Mixed sewers carry both storm water and local sewage.

creasing intensity and frequency of heavy rain events there is more surface run-off, which can have an effect on the probability of floods.

The increase in winter precipitation means that there is more percolation, so that there can be an increase in the leaching of nutrients and pollutants, e.g. nitrates, which may potentially have a harmful effect on the groundwater.

Under certain site conditions, climate change leads to an accelerated loss of soil humus. For example, the expected rise in winter temperatures and sufficient soil moisture levels can accelerate the mineralization of organic substances. But humus is very important for the fertility of soil due to its storage and filter functions. Soil fauna and micro-organisms such as bacteria and fungi play a key role in nutrient flows, turnover and availability. Heavy precipitation events, drought and frost cycles will influence microbial activity in the soil and impact on the habitats of the soil organisms.

Soils form important components in the global carbon cycle. The amounts of organic matter contained in soils in certain regions are currently declining under certain land-uses¹⁷. This is presumably due to the rise in mean annual temperatures and the changing distribution of precipitation. The loss of organic substances has negative consequences for the regulation of the global carbon cycle, the fertility of soil and its water retention capacity, and will also be detrimental for soil communities.

Impacts of climate change on ecosystems

► **Due to the additional stress of climate change, ecosystems will probably be limited in their ability to maintain their natural functions, affecting key ecosystem services such as the production of food and wood, filtration of rainfall water, the self-cleansing of flowing waters and the formation of soil humus.**

Climate change interacts with soil systems, the hydrologic balance, exposure and substance loads to influence the variety of ecosystems, the species living in them, and the genetic information these species carry. This influences the stability of ecosystems and impact on their supply and regulation services, such as the production of human food-stuffs and wood production, climatic balance, and the formation of humus. In particular, there is a threat to terrestrial ecosystems which are dependent on the ground water level, such as flood-plain forests and wetland meadows. Vegetation zones are altered by climate change and migration routes can be affected, for example bird migration. Global warming can endanger species which prefer cold conditions, and lead to increased risks for local species due to encroachment by invasive species. An increase in the global temperature by more than 2.5°C could increase the risk of extinction for some 20 - 30 % of all species previously studied.

Impacts of climate change on agriculture and forestry

► **Conditions in the mid-German highlands and parts of northern Germany could improve for the cultivation of maize, fruit and wine. In south-west and north-east Germany yields could decline. Increased climate variability and extreme events are particularly critical, because they reduce the reliability of yields.**

Regions which are currently too cool or too wet for agricultural use, such as the *Mittelgebirge* or northern Germany, could benefit from a gradual warming and the longer vegeta-

¹⁷ EU Commission (2008): Results of the EU Conference: Climate change – Can soil make a difference? Brussels. Document IP/08/924, 12.06.2008 under http://ec.europa.eu/environment/soil/conf_en.htm

tion periods by being able to grow crops for which these locations were previously too cold¹⁸. In warmer regions, above all south-western Germany, and in regions at risk of drought-stress, e.g. in north-east Germany, climate change could be particularly critical. Depending on the strength of the CO₂-fertilisation effect¹⁹, it could compensate or even overcompensate for the negative effects of rising temperatures and increasing water shortages. However, the higher atmospheric CO₂ concentration leads to higher carbohydrate contents and to relatively lower concentrations of other nutrients and substances such as nitrogen compounds and thus to a lower protein content²⁰.

Considerable harvest losses could become more frequent due to increased heat and drought stress, particular during sensitive phases such as the flowering period. In addition, there could be increased damage due to the early onset of spring, leading to early blooming and an increased risk of frost damage (particularly for fruit trees), increased heavy rainfall and hail, and reduced winter heartiness. New pests and pathogens as well as increased infestations strengthen the pest-related damage, the consequences of which are still difficult to assess in detail²¹. Changing soil characteristics, in particular reduced humidity during the vegetation periods and an increased threat of waterlogging in the autumn present further challenges for farmers, particularly regarding humus maintenance.

In animal husbandry, global warming can reduce stall heating costs and mortality in the winter months. However, higher summer temperatures can reduce fodder intake and lower productivity, leading to significant production losses. Climate change can also be responsible for the spread of new livestock transmitted diseases, such as blue-tongue disease in ruminants.

► With sufficient supplies of water and nutrients, longer vegetation periods and the CO₂ fertilisation effect can increase wood production in forests. There are, however, also considerably increased risks due to climate change.

In forests, increasingly warm and dry summers lead to heat stress. In areas which already have low levels of precipitation, a further impairment of the hydrologic balance can lead to the break-up of intact forest structures. The risks of forests fires increase considerably, particularly in pine monocultures. The drier or warmer regions of eastern and south-west Germany are at most risk. Trees stressed by drought also become more vulnerable to pest attacks. In particular, the combination of storms and rising temperatures can considerably increase losses due to pests, because uprooted and fallen trees offer ideal breeding sites, e.g. for bark beetles.

Many stands of trees are in a poor state already due to air pollution and in particular high nitrogen inputs. This weakens the resilience of forests to the additional pressure resulting from climate change.

Stands containing tree species which are not appropriate for the location are on the whole more susceptible. This is particularly the case for spruces because their flat root

¹⁸ E.g. maize, fruit or wine

¹⁹ A higher CO₂ availability can lead to an increased photosynthesis rate. The photosynthesis optimum shifts to higher temperatures and plants make more efficient use of water (Kimball (1983): Carbon Dioxide and Agricultural Yield: An Assemblage and Analysis of 430 Prior Observations. *Agronomy Journal* 75: 779-788).

²⁰ Idso, S.B. and Idso, K.E. (2001): Effects of atmospheric CO₂ enrichment on plant constituents related to animal and human health. *Environ Exp Bot* 45: 179–199; Loladze, I. (2002): Rising atmospheric CO₂ and human nutrition: towards globally imbalanced plant stoichiometry? *TREE* 17:457–461.

²¹ PIK (Potsdam-Institut für Klimafolgenforschung e.V.) (Ed.) (2005): Verbundvorhaben Klimawandel – Auswirkungen, Risiken, Anpassung (KLARA). Analyse spezifischer Verwundbarkeiten und Handlungsoptionen. 200 p.; SAG (Senatsarbeitsgruppe) (2007): Koordinierung der Klimawirkungsforschung im Geschäftsbereich des BMELV. Part 2. Empfehlungen zur künftigen Forschung zu zentralen Fragen der Auswirkungen des Klimawandels und mögliche Massnahmen zur Anpassung der Land- und Forstwirtschaft. 15.05.2007. 43 p.

system makes them susceptible to windthrow. Species which prefer cool, moist conditions such as fir and larch, and to a lesser extent the beech, could decline. In contrast, species which prefer warm conditions and can tolerate drought, such as oak, hornbeam and large-leaved Linden could be better suited to the changing conditions²².

Impacts of climate change on the fishing industry

► **The spectrum of species in the North Sea and Baltic Sea is changing. Climate change is intensifying the ecological impact of overfishing.**

Invasive species are becoming increasingly common in the plankton and benthos²³ of the North Sea and Baltic Sea – mostly introduced by shipping. The warmer water allows their survival and reproduction, and as a result marine ecosystems are changing.

This can affect the food chains and competition for food, with consequences for the reproduction of fish stocks and thus for fishing yields. Fish which prefer colder conditions, such as cod, migrate northwards. Species such as sardines, anchovy and striped red mullet are able to migrate into the North Sea as this becomes warmer. Increased jellyfish blooms can potentially reduce the biodiversity especially of fish. The natural enemies of jellyfish, such as herring or sardine, have been decimated by the fishing industry. Jellyfish not only compete with many fish larvae for food, but in part also feed directly on fish eggs and larvae²⁴. Due to the reduced predation pressure, the increased availability of food and the rise in water temperatures, the proliferation of cnidaria and comb jellies could continue further²⁵.

The fishing industry is clearly having a greater overall impact on fish stocks than climate change. Stocks depleted by overfishing are likely to be more vulnerable to the effects of climate change than sustainably fished stocks²⁶. Genetically diverse populations and species-rich ecosystems have a greater potential to adapt to climate change²⁷.

Impact of climate change on the finance and power industries

► **Climate change will have long-term effects on the security of investments in power stations and thus also on energy supplies. Extreme events can cause very high levels of damage to industrial plants.**

With the increasing probability of extreme events, insurance against damage to property will become more expensive, and certain insurance coverage may no longer be provided, e.g. against flood damage.

Statistical methods and the simple extrapolation of past trends no longer allow reliable conclusions to be drawn about future developments. Climate conditions which have often

²² Kölling (2007): Bäume für die Zukunft. Baumartenwahl in den Zeiten des Klimawandels. LWF aktuell 60/2007: 35-37; Zebisch et al. (2005): Klimawandel in Deutschland. Vulnerabilität und Anpassungsstrategien klimasensitiver Systeme. UBA Texte 08/05, Federal Environment Agency, Berlin.

²³ Plankton refers to the minute animals and plants floating in seas, rivers and lakes. Benthos is the collective term for the sedentary animals and plants living on the sea bottom.

²⁴ Barz and Hirche (2007): Abundance, distribution and prey composition of scyphomedusae in the southern North Sea. *Marine Biology* 151(3): 1021-1033.

²⁵ Purcell (2004): Predation on zooplankton by large jellyfish, *Aurelia labiata*, *Cyanea capillata* and *Aequorea*. In: Prince William Sound, Alaska. *Marine Ecology Progress Series* 246: 137-152; Purcell, J. E. (2005): Climate effects on formation of jellyfish and ctenophore blooms. *Journal of the Marine Biological Association of the UK* 85: 461-476.

²⁶ FAO (2004): *The State of World Fisheries and Aquaculture 2004*.

²⁷ Secretariat of the Convention on Biological Diversity (2003): *Interlinkages between biological diversity and climate change – Advice on the integration of biodiversity considerations into the implementation of the United Nations Framework Convention on Climate Change and its Kyoto Protocol*. CBD Technical Series No. 10.

been regarded as constant are becoming increasingly difficult to calculate. There will probably be increased demand for property insurance coverage against damage caused by events of nature. However, the insurance companies will also have to revise their calculations of risks, insurance premiums, and possible insurance benefits. This could mean that insurance companies may no longer be able to offer cover in regions which are particularly at risk (e.g. low-lying areas exposed to flooding), and insurance cover may no longer be offered at all for certain risks.

Thermal power stations require large volumes of cooling water in order to redirect excess heat. Where the warm water is then returned to an adjacent river, its maximum temperature is specified by water regulations, and depends on the flow and temperature of the water in the river. If surface waters become too warm this affects the oxygen levels and disturbs their natural balance. Frequent low water levels may require power companies to reduce their power output more often in future.

More frequent High-water and low-water levels can limit the operations of water-driven generators. In addition, higher air temperatures affect the degree of efficiency of power generation, in particular in gas turbine power stations.

Warmer summers could lead to increased demand for electricity, e.g. for air conditioning. Increased generation of power from renewable sources tends to reduce dependence on cooling water. Where fuel is shipped to conventional power stations by waterways, flooding or lengthy periods of low-water levels could lead to critical supply bottlenecks. More frequent and more severe atmospheric phenomena – such as lightning, wind or icing – can damage power lines and also lead to blackouts, and this would involve considerable delivery and production risks for the economy.

Impacts of climate change on transport and traffic infrastructure

► More frequent and more severe extreme events could damage transport infrastructure and impede transport by road, rail, and water and in the air.

Heavy rainfall can cause landslides and subsidence, leading to the destabilisation and destruction of roads and railway tracks. Storms can directly hinder traffic, and high winds can lead to obstructions of road and rail connections, or bring down power lines. Heat-waves can damage road infrastructure and increase the likelihood of trackside woodland fires.

Flowing inland waterways provide either extremely limited use or are completely unpassable by freight ships or passenger ships when water levels are very low or very high. More frequent extreme water levels could therefore affect the reliability and safety of inland waterway navigation and impair the competitiveness of sectors which rely on the transport of bulk loads.

Impacts of climate change on other sectors

► Climate change presents risks for businesses but also offers market opportunities.

Companies can make use of opportunities if they take account of information about global climate change and its consequences in their business models, e.g. if the building sector makes use of new materials and insulation techniques. The construction industry could also benefit from orders to repair structural damage as a result of weather extremes.

However, in addition to opportunities, climate change also presents risks for companies. Heavy rainfall, droughts, storms, floods or high waters could directly affect or impede the

operations of industrial plants and commercial buildings. In addition, operations can be impeded by interruptions to supplies and deliveries. Sectors such as the food industry, textiles and clothing, building materials, paper industry, and metal industry could be severely affected²⁸.

Economic assessment of the consequences of climate change

► **The impacts of climate change will also be felt by the Germany economy. Measures to adapt to climate change could reduce possible damages.**

For a variety of reasons, monetary estimations of the costs of climate change show a very broad bandwidth. It is not possible to reach more reliable conclusions about the possible impacts of climate change and the economic consequences because: The damage estimates depend on the assumptions made about possible adaptation measures. In addition, the global impacts, will continue until far into the future, and are in many cases irreversible. Furthermore, in many cases the consequences of climate change cannot be fully expressed in monetary terms.

According to a first rough estimate of the German Institute for Economic Research (DIW), the accumulated costs until 2050 could be up to EUR 800bn²⁹. However, adaptation measures can significantly reduce the anticipated damage.

5. Regions of Germany particularly affected by the consequences of climate change

The vulnerability of individual regions to the effects of climate change varies, depending on the regional landscape structures and the utilisation of natural resources. Areas which could prove particularly vulnerable are the central areas of eastern Germany, the hill ranges on both sides of the River Rhine, the Upper Rhine plain, the Alps and the coastal regions. Large centres of urban concentration are also affected. These areas are thus focal points for regional adaptation.

Figure 1 shows the regions of Germany which are particularly affected by climate change at present. The evaluation draws on all sectors of the environment, economy and society which are impacted by climate change. Where vulnerability is currently high and could increase further in the future, some significant improvements are achievable in the long-term by ambitious mitigation measures and in the short- to medium-term by suitable adaptation measures³⁰.

Significant warming in south-western Germany presents challenges for the health sector as well as for agriculture and forestry. The region may also be subject to an increased danger from spring floods³¹.

The central areas of eastern Germany can be increasingly affected by a decrease in water availability. Droughts, above all in summer, bring risks for farming and forestry. Low water levels can have a negative influence on shipping on inland waterways, as well as

²⁸ Deutsche Bank Research (2007): Climate change and sectors: Some like it hot! www.dbresearch.de/PROD/DBR_INTERNET_EN-PROD/PROD0000000000212401.pdf

²⁹ Kemfert, C. (2008): Kosten des Klimawandels ungleich verteilt: wirtschaftsschwache Bundesländer trifft es am härtesten. Wochenbericht des DIW Berlin, 12/13 2008, pp. 137-142.

³⁰ Cf. Sections 10 to 13

³¹ KLIWA "Lastfall Klimawandel" als praktizierte Form der Anpassung. www.kliwa.de

drinking water extraction and power generation. The experience of summer 2003, with low water levels in many of Germany's major rivers shows that there will very probably be increasing competition for water utilisation, possibly resulting in conflicts between the various interest groups and/or regions.



Figure 1: Current vulnerability of natural regions in Germany³². Red indicates particularly high vulnerability, orange high, and yellow moderate.

The Alps are vulnerable due to the more intense impacts of climate change in the region. Especially the endemic flora and fauna will have little options for adapting if habitats are restricted or lost (e.g. because moving to higher altitudes is no longer an option). Less reliable snow cover will have harmful consequences for the tourism industry.

The coastal regions are increasingly threatened by sea level rise and possible changes in the storm patterns. A high level of protection using coastal management measures is important in determining the current vulnerability as well as the possibly increasing future vulnerability. Outstanding importance is attached to the possible threats to wetlands and lowland areas, as well as threats in regions where damage could be very high (such as the harbour in Hamburg).

In addition to these regions, wetlands are particularly vulnerable. Especially water management and nature conservation are affected in wetlands.

In conurbations, the added burden of extreme heat events will have an effect on public health. Infrastructure (above all transport infrastructure) is particularly vulnerable.

³² Cf. Zebisch et al. (2005)

Climate policy objectives

6. Maximum warning of two degrees Celsius

The UBA fully supports the objective of limiting global warming to a maximum of 2°C above pre-industrial levels. The risks for people and the environment above this range are now regarded as being graver than in the past. It is therefore good that the German Federal Government has taken the two degree target as the basis of its national and international climate policy.

The UNFCCC climate change convention³³ signed at the Rio Summit in 1992, which came into force in 1994, corresponds to the principle of sustainable development³⁴, but relates exclusively to the climate system and the consequences of disturbances to this system:

In Article 2 of the Framework Convention on Climate Change member states set the objective of "... stabilization 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."

The objective of the convention is specified by reaching a social understanding on the basis of sustainable development concerning which risks will be tolerated and which will not.

Targets for mitigation and adaptation to climate change, characterised by a specific limit to the rise in temperature, are not only based on scientific knowledge about growing risks accompanying the worsening of climate change, but also on normative social values.

The consequences of climate change projected in Figure 2 for rising global mean temperatures are selected examples of risks which the UBA considers relevant for people and the environment. It is clear that serious damage must be anticipated even if the temperature rise is below 2°C. However, with a warming of more than 2°C the impacts on natural, biological and social systems increase dramatically, with high costs for society and the economy³⁵.

³³ United Nations Framework Convention on Climate Change. Cf. Document under <http://unfccc.int/resource/docs/convkp/conveng.pdf>

³⁴ World Commission on Environment and Development (1987): Our Common Future (Brundlandt Commission); www.un-documents.net/wced-ocf.htm

³⁵ Cf. Section 7

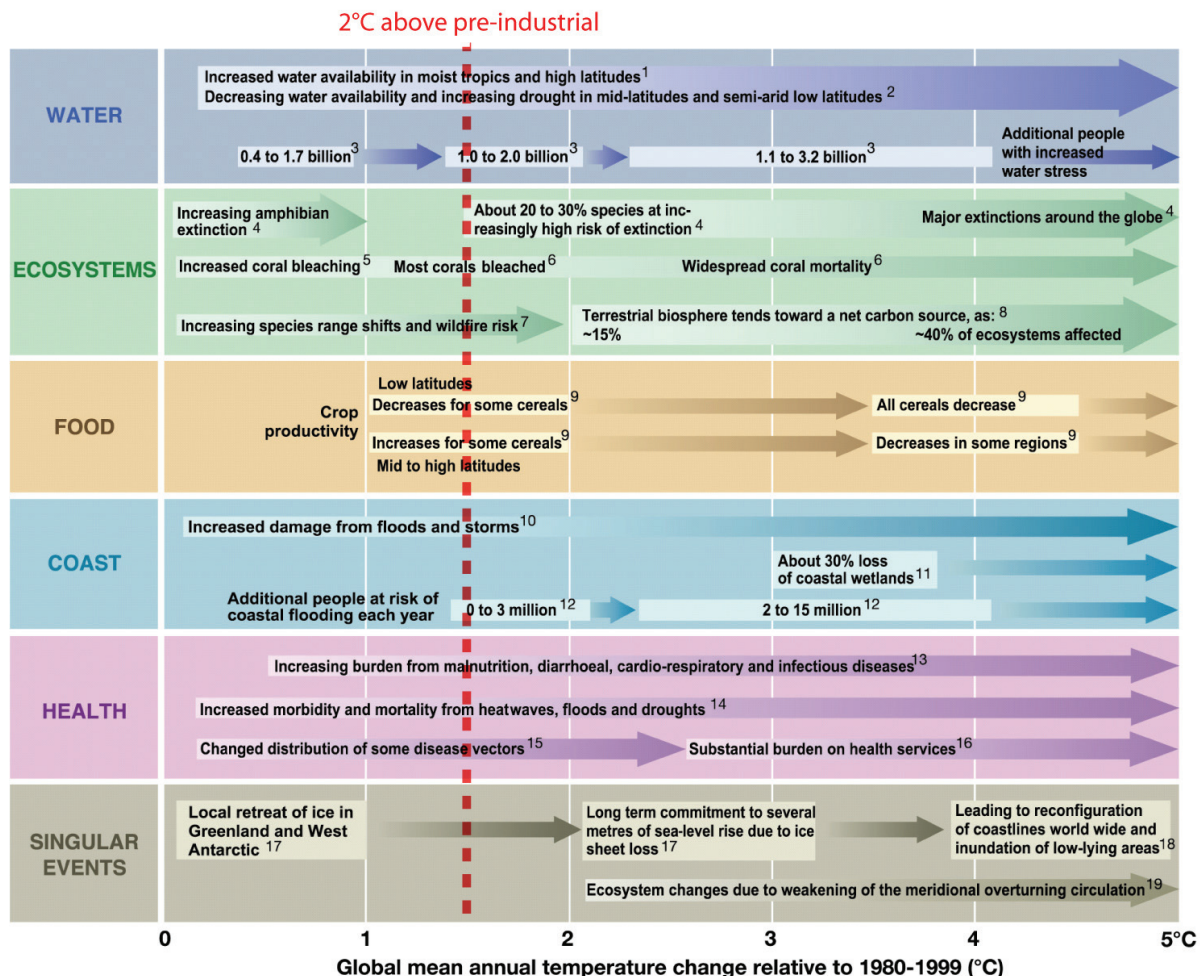


Figure 2: Examples of the global impacts in various sectors associated with different levels of climate change in the 21st century³⁶. Arrows indicate increasing impacts with warming. The red broken line shows the two-degrees objective.

Considering the global and regional climate impacts outlined by the IPCC in 2007, as the basis for the criteria listed in Article 2 of the UNFCCC, it is necessary to determine a strict upper limit for global warming of 2°C in comparison with the pre-industrial period. In this context, the costs of climate impacts must be taken into consideration against the costs of mitigation and adaptation measures.

► Two-degree target should continue to be the major objective

The Federal Government should definitely adhere to the two-degree target, aware that even a 2°C increase would already lead to dramatic worldwide losses of flora and fauna and ecosystems as well as their associated functions and services.

► Improve acceptance for the level of quality in the global climate system

The Federal Government should increase the international acceptance of the need to remain below the two-degree target. This requires a clear communication of the target and its scientific justification.

³⁶ EU Climate Change Expert Group (EU EG Science) (2008): The 2°C target. Background on Impacts, Emission Pathways, Mitigation Options and Costs. Information Reference Document. Cf. IPCC (2007b): Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK.

7. Reversal of global greenhouse gas emission trends before 2020

According to the latest findings, the current concentration of greenhouse gases in the atmosphere will probably lead to 2°C of warming. In order to achieve the two degree target, humanity must stop the rise in annual global greenhouse emissions at the latest within the period 2015 to 2020 and then reduce this without delay by 5 % annually. By the middle of the 21st century the annual emissions must have been reduced to half the levels observed in 1990, followed by further reductions.

Global greenhouse gas emissions and atmospheric greenhouse gas concentrations continue to rise. Global greenhouse gas emissions in 2004 were approximately 49 gigatonnes (Gt) of CO₂-equivalents³⁷, which equates to an increase of about 25% over the reference level of approximately 40 Gt CO₂-equivalents in 1990³⁸. Publications since the 2007 IPCC Report show that the window of opportunity, within which global warming can still be limited to a maximum of 2°C, is rapidly closing. Further delays in implementing necessary mitigation policies will most likely not only increase costs, but also make it more likely that global change will exceed our capacity to adapt.³⁹

The 'Stern Review'⁴⁰ attempts to provide aggregate monetary estimates for the total impact of climate change on the economy, although such estimates naturally involve considerable uncertainties. Stern estimates that the costs of unabated climate change would be equivalent to a reduction of global per capita GDP by between 5 and 20%. This estimate is calculated based on the negative impacts on non-market goods, such as those on the environment and human health, as well as on a weighted global distribution of income in favour of the less developed countries.

There are many possibilities for preventing an unabated climate change and adapting to all of the residual consequences. The IPCC sees substantial economic potential for various mitigation options⁴¹. Stern argues that the costs of stabilising emissions are merely moderate since they amount to approximately 1% of gross domestic product. The IPCC and the EU conclude that the costs of actions to mitigate climate change are small when compared to the costs of impacts due to inaction.⁴² The existing findings and estimates of the calculable damages are therefore sufficient economic justification of the measures necessary for maintaining the two-degree target, based on the precautionary principle. In view of the irreversible changes of climate change, it is furthermore irresponsible to delay climate policies until more well-grounded scientific findings are available about the exact level of damages caused by climate change.

In view of the inertia of the climate system and of many social processes, climate change calls for immediate and decisive actions.

³⁷ 1 gigatonne is a billion tonnes.

³⁸ IPCC (2007c): Climate Change 2007 - Synthesis Report. Cambridge, UK; p. 6.

³⁹ Perry et al. (2008): Squaring up to reality. Nature Reports Climate Change. Vol 2. June 2008. 68-69.

⁴⁰ Stern (2007): The Economics of Climate Change - The Stern Review. Cambridge, UK; New York. Cambridge University Press

⁴¹ IPCC (2007c)

⁴² EU EG Science (2008)

Cost effectiveness approach

Theoretically it would be possible to use global cost-benefit analyses to determine an “optimal” level of climate protection for the global climate objective. However, estimating the costs of mitigation and adaptation in contrast to the costs of proceeding as usual presents considerable methodological problems, such as how to monetarise possible damages. It is also problematical, in an economic model, to include major climate events which are very unlikely to occur but which could potentially cause very high levels of damage⁴³.

Therefore the UBA finds it appropriate to adopt a “Cost effectiveness approach” in which the most efficient strategy is developed in order to achieve the international humanitarian environmental quality target of a global temperature rise of less than 2 °C compared with the pre-industrial era.

Converting greenhouse gas concentrations into trends of greenhouse gas emissions involves uncertainties, among other things because of the dynamics of the global carbon cycle. At the lower edge of the mitigation scenarios considered by the IPCC in its 4th Assessment Report⁴⁴, greenhouse gas concentrations reach peak values for which the probability of remaining below the two degree level is meanwhile in the order of 50%. These calculations are based on the assumption that after reaching the peak concentration there will be a long-term decline in greenhouse gas concentrations. However, according to the IPCC, this requires immediate investments in the infrastructure as well as rapid de-carbonisation of the energy system, as a result of which greenhouse gas emissions would be reduced between 2015 and 2020.

Figure 3 shows the global development of greenhouse gas emissions up to 2060 in scenarios (SRES) both with and without mitigation policies⁴⁵.

⁴³ Cost calculations often assume a discount rate, i.e. future costs are taken to be lower than current costs to allow for economic growth. But in order to avoid placing an irresponsible burden on later generations, the future and current costs of climate change should be treated equally (i.e. time-preference rate=0).

⁴⁴ IPCC (2007d): Climate Change 2007 – Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK

⁴⁵ EU EG Science (2008)

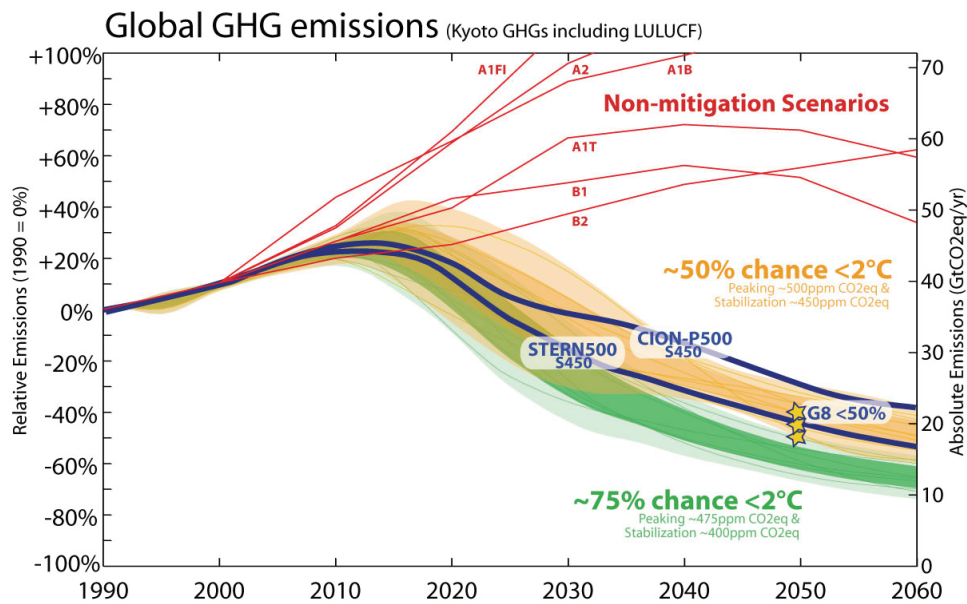


Figure 3: Global greenhouse gas emissions in non-mitigation scenarios (red) and with mitigation policies (blue) in the period until 2060⁴⁶. The green band marks emission paths for stabilisation at 400 ppm⁴⁷ CO₂-equivalents with the greatest probability of limiting warming to 2°C⁴⁸; the orange band marks paths to stabilisation at 450 ppm CO₂-equivalents with a peak concentration of 500 ppm CO₂-equivalents. Yellow stars show the long-term target of halving global emissions set at the G8 Summit held in Heiligendamm in 2007⁴⁹, depending on the reference years 1990 (bottom), 2000 (middle) or 2005 (top).

According to results of recent research, the current GHG concentration can already lead to 2°C warming⁵⁰. Thus the two-degree target can only be achieved with immediate, ambitious reductions of GHG emissions by 60 to 80%. Alternatively, reduction rates will have to exceed 5% per annum as of 2020.

By the middle of the century, the annual global greenhouse gas emissions must be at least 50 % below the emissions in 1990, i.e. they must fall from about 40 Gt CO₂equivalents per annum to less than 20 Gt CO₂ equivalents per annum.

⁴⁶ EU EG Science (2008)

⁴⁷ ppm = *parts per million*

⁴⁸ An atmospheric concentration of 400 ppm CO₂-eq corresponds roughly to a concentration of 350 ppm CO₂. In view of the dire situation of the coral reef ecosystems the TEEB Report (2009, update September 2009. The Economics of Ecosystems and Biodiversity) calls for urgent further action. New studies are cited which show that the rate of loss of the coral reefs has accelerated as a result of temperature-related coral bleaching. Increasing amounts of CO₂ dissolved in sea water and the resultant acidification of the seas hinders the regeneration of the coral reefs. Scientists agree that the long-term survival of the coral can only be secured by a reduction of atmospheric CO₂-concentrations to a value well below 350 ppm (Conference of the Royal Society, July 2009).

⁴⁹ G8 (2007): Chair Summary in Heiligendamm, 08.06.2007. www.g-8.de

⁵⁰ Richardson et al. (2009).

Accumulated CO₂-emissions

In a new study, Meinshausen et al.⁵¹ calculate the probabilities of remaining below the two degree limit depending on the accumulated CO₂-emissions in the period 2000 to 2049.

In so doing they assume that between 2000 and 2006 approximately 234 Gt CO₂ had already been emitted. In order to achieve an 80% probability of remaining below 2°C, the total CO₂ emissions from 2000 to 2049 may not exceed 890 Gt CO₂. Thus, humankind can only produce a further 656 Gt of CO₂ emissions until 2049. If a lower probability were accepted, such as 75% or 50%, the remaining emissions budget until 2050 would be 1000 Gt CO₂ or 1440 Gt CO₂ respectively. Considering the 234 Gt CO₂ already emitted between 2000 and 2006, and assuming constant annual emissions of 36.3 Gt CO₂, Meinshausen et al. point out that these budgets would already be exhausted by 2024 (890 Gt CO₂), 2027 (1000 Gt CO₂) or 2039 (1440 Gt CO₂). A drastic decrease in the annual amount of CO₂ emissions is therefore necessary as soon as possible, especially in developed nations.

► Reduction of at least 50% in annual global greenhouse gas emissions by 2050

Climate policies must aim at reaching a high probability of remaining below the two-degree limit. Therefore the international community must reduce annual global emissions in comparison to the 1990 levels by at least 50%. This goal is also necessary and achievable from an economic perspective.

► Timely initiation of greenhouse gas emissions reduction measures

Recent studies on stabilisation levels below the categories investigated in the 4th IPCC Assessment Report show that the required reduction in annual greenhouse gas emissions necessary to remain below the two degree target increases with time unless immediate drastic mitigation measures are adopted. Therefore, considerable investments in a low-carbon economy are now necessary – in particular in infrastructure and other durable economic goods.

8. Sustainable development and adaptation strategies

Even a global temperature rise of less than 2°C will lead to worldwide impacts. Depending on the emission trends and the reactions of the climate system, these will intensify. The UBA is adamant that climate change adaptation activities in Germany, as well as internationally, should support the goals of sustainable development.

Article 4 of the UN Framework Convention on Climate Change specifies the climate policy commitments of the Parties. They are obliged to cooperate in preparing for climate change adaptation and to develop appropriate integrated adaptation plans.

► Gearing adaptation targets in Germany towards supporting sustainable development

The sustainable development of society is also the declared goal of the Federal Government. Environmental protection, economic capacity and social responsibility should be brought together so that decisions taken under these criteria remain sustainable.

⁵¹ Meinshausen et al. (2009): Greenhouse-gas emission targets for limiting global warming to 2°C. *Nature*, Vol 458; April 2009; 1158-1164.

Both the foreseeable and the already observed global and regional impacts of climate change could make it difficult or impossible to achieve the goals that have been set both in Germany as well globally. The climate impacts currently observed are already leading to major ecological, economic and social problems, above all in poorer countries with lower adaptive potential. Although Germany is, in comparison, affected to a much lesser extent by climate change, we too are already experiencing clear regional and sectoral impacts⁵². The German federal government responded in 2008 with the development of the German Adaptation Strategy (DAS)⁵³, setting a framework for nationwide activities to adapt to climate change. This has brought the development of an adaptation action plan by 2011 into action. According to this action plan:

- The adaptation measures must minimise the expected damages to our protected assets to such an extent that the achievement of Germany's objectives for sustainability is not threatened by climate change⁵⁴;
- These guidelines shall be reviewed on the basis of indicators (starting in 2013);
- Management rules for sustainability should be observed during implementation.

► **Adaptation policies should support sustainability objectives worldwide**

The German Adaptation Strategy also shows how Germany can fulfil its international responsibility for global sustainable development by adaptation, e.g. with additional financial support and capacity building for countries which are and will be particularly affected by climate change.

⁵² Cf. Section Climate change and climate consequences

⁵³ German Federal Cabinet (2008): German Strategy for Adaptation to Climate Change.

⁵⁴ The German Adaptation Strategy contains no further specific targets apart from the orientation towards sustainability and reducing the vulnerability of Germany. However, there are sectoral targets for all 14 fields of action, e.g. for agriculture these include secure food supplies, support for healthy nutrition, ensuring the competitiveness of farming, forestry and fisheries, as well as rural development and coping with demographic change. The specification of the Adaptation Strategy by 2011 will document on the basis of defined criteria and principles how the Federal Government proposes to support the actors in the individual fields of action to reach their yet to be defined adaptation targets.

Adaptation

9. Adaptation in an international setting

Germany must more strongly integrate climate change into a multidiscipline oriented international development policy than it has in the past. In addition to contributing 0.7 % of gross domestic product (GDP) towards international development until 2015, Germany should already be spending an additional 0.2 % of GDP annually on adaptation activities in developing countries which are most vulnerable to climate change.

Climate change will very likely have a much greater impact on the societies and economies in other parts of the world than in the western developed world. This applies in particular to developing countries, because climate change is having a greater impact in the lower latitudes⁵⁵ and these countries are particularly vulnerable due to their limited capacity to adapt. Therefore, in addition to a significant reduction in greenhouse gas emissions, adaptation to climate change forms a central pillar of the negotiations for a new climate regime under the UNFCCC after 2012. This topic is also of importance for Germany's international development, security, migration and environmental policies. Since Germany committed itself to support the adaptation measures of other, more vulnerable countries when it ratified the convention, the question of how Germany will fulfill this obligation is raised.

► Clearer German position in UNFCCC negotiations

It is now necessary for Germany to adopt a clear stance in the UNFCCC negotiations and to make a visible and effective contribution towards supporting vulnerable countries.

Funds, such as the Kyoto Protocol Adaptation Fund, could be used for this purpose. This fund is intended to finance adaptation measures in developing countries, beginning its activity in 2009. Due to the uncertainty in estimating the extent to which future impacts of climate change, estimates vary about the overall funding required for adaptation in developing countries.

In its foreign relations, Germany has a responsibility to help those hardest hit by climate change, including many developing countries such as in Africa as well as the small island developing states. People in these developing countries are those most severely affected by climate change, which has primarily been caused by the industrialised countries. This especially applies for poor population groups in rural areas, and particularly for women. Their ability to adapt to climate change impacts is limited by their restricted access to resources such as land, money or loans⁵⁶. It is clear that the impacts of climate change will adversely affect the desired progress in combating poverty and achieving the millennium development goals in many countries. At the same time, people in vulnerable regions of developing countries already have to adapt to the consequences of climate change today⁵⁷. The knowledge of these population groups⁵⁸ should be collected and used by the Subsidiary Body for Scientific and Technological Advice of the UNFCCC, so that adaptation can be conducted as effectively as possible. Only by linking efforts to

⁵⁵ Broadly, the areas around the equator between the tropics of Cancer and Capricorn

⁵⁶ Brody et al. (2008)

⁵⁷ For example, women living on the Ganges have reacted to the increasingly unpredictable floods by sowing different crops or shifting to fish farming. Cf. Brody et al. (2008), Terry, (2009).

⁵⁸ Also in gender-specific categories

combat poverty, improve women's education levels, and reduce vulnerability to change, will it be possible to provide effective, long-term aid and to improve the general capacity of societies to withstand extreme meteorological events as well as the capacity for mitigation and adaptation. Climate change must be incorporated into international development policies as a key, cross cutting issue⁵⁹.

► **0.2 % of GDP for adaptation activities in vulnerable countries**

In addition to contributing 0.7 % of gross domestic product (GDP) towards international development, Germany should spend at least an additional 0.2 % of GDP on adaptation activities in vulnerable countries.

This could be achieved through contributions to the climate-specific funds of the Global Environmental Facility (GEF), in particular the adaptation fund under the Kyoto Protocol of the UNFCCC. Additional incentives for private businesses could stimulate this process. These could include the transfer of technology and processes for better adaptation or direct contributions to the adaptation fund.

► **Effectively implementing the EU White Paper on adapting to climate change**

In April 2009 the European Commission presented a White Paper on adaptation measures which opened a debate on policies to reduce the European Union's vulnerability to the impacts of climate change. The Federal Government should pursue the following targets in this process:

- The European Union must formulate "climate-proof" joint policies, in particular for agriculture and water management.
- Synergies and conflicts must be clearly specified amongst various adaptation measures as well as between adaptation measures and EU policies in other fields, (i.e. mitigation policies and the Lisbon Strategy), in order to minimise risks and utilise opportunities.
- The EU Commission must involve civil society, the business sector and the public sector in the development of coordinated adaptation strategies.

10. National and regional adaptation: Instruments for implementation

Identifying suitable adaptation measures requires the collection and modelling of suitably robust data on regional climate change and its consequences, as well as the presentation of these in a user-friendly manner. The implementation of adaptation measures should utilise existing instruments, develop new ones, and strengthen independent activities.

Collecting and modelling data on climate change and impacts

The impacts of climate change will differ considerably between regions and sectors. Although major advances have recently been made in the fields of climate change and climate change impact research, there are still gaps in our knowledge, especially concerning the interactions between environmental elements, or the interactions between environmental and social developments. There is a lack of knowledge about the consequences of adaptation measures for the environment and society. Measures are needed

⁵⁹ FAO (2006)

at various levels in order to generate reliable data for the identification of suitable adaptation measures:

► Securing and networking monitoring programmes for the longterm as well as improving access to their data

The long-term future of the various relevant monitoring programmes must be secured and access to the data improved. It is essential that the Federal Government and the Laender make joint efforts to secure the existing monitoring systems, to make better use of these, and to improve networking.

In many sectors, the data from monitoring programmes provide a key basis for the identification of climate change and for assessing and quantifying future climate change impacts⁶⁰. For soil monitoring and surveys of soil status, long-term field trials (BDF), the Forest Soil survey (BZE II), the Forestry Environment Monitoring (Level II), and the data of the soil estimates as well as the Federal Environment Sample Bank (UPB) make important contributions towards documenting how soils are impacted by climate change. Additionally, monitoring is a prerequisite for describing and evaluating the effects of adaptation policies.

► **Sectoral and integrated modelling of climate change and climate change impacts**

The Federal Government should work together with the Laender to strengthen sectoral and above all integrated climate change and climate impact modelling, focussing on practical aspects of climate policies.

Monitoring data is a key source for validating climate change models and climate change impact models. In order to be able to describe and evaluate the above-mentioned interactions, it is necessary to use complex models or modelling chains. For example, in order to improve the assessment of climate change impacts on the hydrologic balance and the consequences for river-basin management, work is currently focussed on the refinement of the modelling chains⁶¹.

► **Evaluating the implementation of adaptation measures by means of indicators**

It is important to have indicators to depict the extent of and the interrelationships between climate change impacts. The Federal Government, Laender and local authorities bear responsibility for the implementation of an integrative, cross-sector approach to the development of indicator systems. Since knowledge of optimised and efficient adaptation strategies is still inadequate, more research is needed in and between sectors, as well as throughout the various regions.

For the formulation of adaptation policies and the identification and implementation of adaptation measures it is necessary to evaluate the results of monitoring, models, and indicator systems. However, climate change impacts can be evaluated in very different ways. For example, companies assess climate change differently from environmental organisations, and members of the public also have their own opinions about the importance of climate change. This means, firstly, that conclusions about climate change must be transparent⁶² and secondly, that assessments of climate change impacts must clearly show the criteria on which they are based, e.g. personal involvement or monetary dam-

⁶⁰ For example, environmental and health-related information and monitoring systems, and hydrological, hydro-chemical and typological monitoring systems.

⁶¹ Regional climate models and water budget models for run-off and groundwater coupled with models for water quality, morphology, ecology etc.

⁶² Climate models used, accuracy of model results, etc.

age. An integrated analysis and evaluation of climate change is thus dependent on the transparency of scientific statements⁶³ and the transparency of evaluation criteria for the assessment of the impact of climate changes.

Instruments for adaptation measures

► Systematically harmonising and implementing suitable instruments for the implementation of adaptation measures at various levels

Adaptation measures should be implemented at various levels: firstly in the different sectors, (health, forestry, water management, etc.⁶⁴); secondly cross-sectorally, as with spatial planning (federal government, Laender, local authorities) and the civil protection and disaster control (above all with relation to critical infrastructure); thirdly with the private precautions for businesses and the general public. All three levels must be coordinated with one another.

► Government should encourage individual precaution

Individual precaution is an important element of adaptation policies. In the past, state aid dominated in clearing up and paying compensation after natural disasters, which in part has led to insufficient willingness to take individual precaution. For example, floods or local rainstorms often also lead to damage in the private sector. Knowledge of potential risks, e.g. by means of flood risk maps, makes it possible to prepare for the occurrence of damage. Public bodies should make relevant information available and help to raise awareness. The introduction of obligatory elementary damage insurance is a further way to increase private precaution.

► Improving and developing mitigation measures and instruments for adaptation to climate change

Spatial and sectoral planning and its legal foundations should promote adaptation to climate change and also make a contribution to climate change mitigation. Spatial planning authorities should attach increased importance to mitigation and adaptation and make corresponding planning requirements more legally binding in nature.

The impact of global climate change will differ considerably from region to region. As a result, spatial planning in each region will have different points of approach. Given their cross-sectional character, regional planning, urban land use planning and environmental surveys are able to effectively integrate departmental policies such as global climate change mitigation and adaptation policy.

Spatial planning should support climate change mitigation and adaptation. Given natural dangers such as high-waters, flash floods, landslides, storm floods, and also droughts, planning must be able to take pro-active precautions and designate risk zones⁶⁵. The water management authorities must quickly specify potential flood risk areas and when assessing flood risks in future or designating flood areas they must take into account increasing flood risks as a result of climate change. Spatial planning and land-use planning authorities are responsible for ensuring that buildings and sensitive infrastructure are not constructed in endangered zones, or that the designs make these less vulnerable to the impacts of climate change, e.g. by means of special building regulations in flood areas. Formulating regional planning targets is essential if existing provisions for keeping inappropriate sites clear of buildings are to be enforced and if necessary strengthened. Mitigation and adaptation measures should be coordinated, synergies used, and conflicts

⁶³ Model assumptions, reliability of models and data, limit errors, etc.

⁶⁴ Cf. Sections 11 bis 13

⁶⁵ Potential flood areas or areas at risk from drought or forest fires

resolved⁶⁶. Synergies include supporting compact (greater energy efficiency), while at the same time creating shaded areas to reduce thermal burden (climate adaptation). Environmental assessments can include climate adaptation targets as benchmarks for an alternative development in the planning process.

Spatial planning has proven its value for climate change mitigation in some respects, but regarding adaptation to climate change, efforts are needed to expand its contribution. Spatial planning allocates areas for wind-power generation or photovoltaic arrays in harmonisation with other land uses, such as housing, recreation, tourism, nature conservation and farming. It prepares the re-establishment of networks of habitats, or the creation of far-reaching migration corridors for wildlife and protects these against incursions by other potential users. In cities and conurbations, spatial planning serves in coordination with landscape planning, to preserve green belts and fresh-air corridors, which in particular help to avoid overheating in the summer.

It is very important that the instruments for adaptation to climate change are subjected to regular reviews. Such inspection cycles make it possible to promptly integrate advances from the field of climate impact research.

► The Federal Government and Laender should make information about adaptation measures available to planning authorities at regional and local levels and should support the orientation of sectoral planning towards regional priorities.

Spatial planners are accustomed to dealing with uncertainties when making decisions about the future – but the impacts of climate change will introduce a further aspect of uncertainty. In order to make planners at the various levels aware of the scope and limitations of model predictions, the Federal Government and Laender should provide extensive information to the planning authorities at regional and communal levels. Planning authorities should align their spatial and sectoral planning with regional priorities.

Due to the shortages of water in the eastern German lowlands during the summer, precautions must be taken against drought and forest fires. Spatial planning can help to ensure and improve groundwater replenishment in these affected regions, but in the future it will have to be supported by specific water management strategies and programmes specifying targets and measures to adapt to the changed availability of water.

In the Upper Rhine plain, additional phenomena of heat waves must be expected in the summer as well as increased flood damage. The coordination of the efforts of spatial and land-use planning authorities offers adaptation opportunities, for example by protecting or developing fresh-air corridors, or open and green spaces which can help to buffer climate impacts. In the future, green spaces will increasingly have to be tailored to meet the needs of climate adaptation.

The Alpine region will be characterised by an increase in landslides and local flooding events, as well as a decline in biodiversity. Here too, the instruments of spatial planning can be used to implement precautionary measures, e.g. by specifying requirements for catchment areas where flooding conditions originate, or providing protection for vegetation stands. In cooperation with landscape planning authorities, wildlife migration corridors will need to be developed in regional and national biotope networks.

Changes of high-water flows must be expected along river courses. Spatial planning again offers entry points for adaptation to climate change, e.g. by establishing new potential flooding areas and designating reserve areas for dike relocation.

The coastal regions in Germany will be affected in the medium- to long-term by rising

⁶⁶ Cf. Sections 25 to 27

sea levels and, in the second half of the 21st century, possibly by more frequent and severe storm floods as well. Coastal protection is on the one hand another spatially demanding land use, occurring alongside others such as tourism or nature conservation. On the other hand coastal protection is also essential if key buildings and infrastructures located in coastal flood areas are to remain in these locations in the long-term. As part of an integrated coastal management strategy (IKZM), planning officials must decide:

- Where sensitive uses should be located, and what protection they require,
- How buildings, infrastructure and other uses can be restructured so that they are less sensitive and therefore require less protection, and
- Areas in which future uses should be restricted or not permitted at all.

In light of increasing competition for land use, coastal protection should, in addition to the protection of life and property, take ecologically important coastal ecosystems into consideration, which face increasing pressure due to climate change.

► **Compulsory insurance coverage of climate change related natural hazards**

If suitably organised, compulsory insurance cover against climate related natural hazards provides incentives for real-estate purchasers to avoid risks, and for property owners to take precautionary measures against damage. It also reduces government transfer payments. It is important that insurance premiums be classed according to risk, take precautionary measures into account and avoid government responsibility as a last resort insurer by involving reinsurance or liability limits. The Federal Government should introduce compulsory insurance requirements which take such factors into account.

Critical infrastructure

► **Operators of critical infrastructure and facilities must protect these against risks associated with climate change.**

The operators of critical infrastructure and facilities in which dangerous substances are contained must be held legally responsible for the implementation of precautionary measures in order to minimise risks arising directly or indirectly from the impact of climate change.

Civil protection and disaster control organisations cope with and prevent the occurrence of loss events, an area where civil protection, disaster control and adaptation policy all converge. In the future, more frequent and severe weather- and climate-induced catastrophes could present new challenges for the government's responsibilities in civil protection and disaster control. At the same time, climate change will increase the need for the public to protect themselves.

Especially vulnerable are critical infrastructures (KRITIS)⁶⁷, such as energy and water procurement, traffic and transport, information and telecommunications technology, as well as other essential functions which serve as vital lifelines for society. They are particularly vulnerable because of their inter-dependence upon one another. In addition, the public and emergency services rely on this infrastructure to a considerable extent when faced with catastrophes, e.g. hospitals, power supplies, telecommunications. Only a small part of the critical infrastructure is directly under state control. More than 80 % is operated or controlled by private or privatised companies. Thus, the functionality of the

⁶⁷ 'Critical infrastructures' are, as defined by the Federal Government, organisations or facilities of major national significance, the failure of or damage to which would cause sustained supply bottlenecks, considerable disruptions of public security or other dramatic consequences.

facilities lies within the bounds of these operators' responsibilities.

Facilities which store, process or produce hazardous substances are particularly important. Natural hazards which are influenced by climate change could under certain circumstances lead to the release of such substances, posing additional risks for the population and the environment above and beyond those posed by the natural event.

Extreme meteorological events such as heavy precipitation, storms and droughts are relevant for the security of facilities. They can either be of direct threat for facilities, or indirectly threaten them via secondary events such as floods, or forest or bush fires.

Operators must receive better information from the relevant authorities about possible threats. In addition to improved predictions of extreme events, public and private weather forecasting services should cooperate with the media to test, introduce and optimise scientifically-based risk communication of (extreme) events. These communication strategies must especially include operators of facilities with hazardous substances.

It is necessary to develop suitable methods and criteria for the design of facilities with such hazardous substances so that they can cope with (extreme-) events and secondary threats. The Federal Environment Ministry (BMU), the Commission for Plant Security (KAS) and the UBA must develop and implement suitable codes of practice for fields of application of the Hazardous Incident Ordinance. The Federal Environment Ministry and the UBA must also work with the relevant Bund-Laender working group to develop a code of practice for plants operating with substances which are hazardous to water. Through use of the sublegal framework, law-makers must ensure that regulations for operators to check and update their emergency plans are adapted to the impacts of climate change. The requirements placed by the Laender on disaster control plans must also be updated in order for an adequate coordination of the facility operators' updated emergency plans to be possible. The Laender should ensure they have sufficient numbers of well-qualified personnel to implement these requirements.

11. Adaptation in the health sector

By means of screening and early warning systems it is possible to identify health impacts at an early stage and thus effectively reduce the associated risks. The Federal Government and the Laender should cooperate to establish or improve observation systems for climate-related health risks. Planners and users should *climate proof* buildings and structures.

► **The Federal Government and the Laender should increase the surveillance of health impacts and establish effective early-warning systems or improve existing systems.**

Climate change has implications for public health. In order to recognise health threats more quickly and to be able to adopt counter-measures, the Federal Government and Laender must pay increased attention to relevant factors which can impact public health as a consequence of climate change. Decision-makers must be placed in the position to be able to identify health threats more rapidly, and early warning systems should be installed and improved to allow rapid responses.

Some environmental and health-related information and supervision systems have already been introduced, such as a heat-warning system and a solar UV index and ozone

forecast, but systems are not yet in place for the increasingly problematic non-infectious diseases such as allergies or asthma. Efforts should be made to develop suitable strategies for early recognition and early warning, as well as to develop a national monitoring system for airborne bio-allergens which can cause non-infectious diseases, e.g. as part of the German Strategy for Adaptation to Climate Change. It should be linked up with the “Allergies Action Programme” of the Federal Government.

The situation is similar for the early recognition and monitoring of animal vectors of diseases. The existing reporting systems in accordance with the Infection Protection Act only take account of pathogens of notifiable diseases, but not the vectors.

► **The Federal Government should further develop the regulations of the Energy Saving Ordinance (*Energieeinsparverordnung*).**

There are already numerous ways of ensuring that buildings remain sufficiently comfortable despite a warming climate so that it is possible to minimise the use of conventional air-conditioning. Tackling summer overheating with conventional electric air conditioning systems would be too short sighted in view of climate change, because their power consumption not only involves additional energy costs but also additional greenhouse gas emissions.

Measures which could significantly reduce the need for air conditioning include: very good thermal insulation of all parts of the building shell, small windows, external sun shades, lighting and appliances which generate less heat, compact designs, and increased structural thermal mass. Intensive night ventilation, underground thermal sinks, combined heat and power generation or evaporative air coolers are climate friendly options for ensuring sufficient comfort.

The current technical provisions of the Energy Conservation Ordinance are inadequate for these purposes⁶⁸. It is essential that summer thermal insulation should already be considered when a building is being designed⁶⁹. Therefore, in order to take into account the increasing demands on buildings in a changing climate, the Federal Government is faced with the challenge of further developing the regulations of the Energy Conservation Ordinance as well as the related requirements in technical standards.

⁶⁸ Voss und Pfafferoth (2007): Energieeinsparung contra Behaglichkeit? Forschungen des BBR 121; 92 p. Bonn

⁶⁹ Brunner et al. (2008): Bauen, wenn das Klima wärmer wird, Empfehlung Nachhaltiges Bauen.
www.topten.ch/uploads/images/download-files/Faltblatt_WaSo_def.pdf

12. Adaptation in the protection of the environment and biodiversity, as well as in agriculture and forestry

Measures for adaptation to climate changes should be flexible and effective over a wide range of scenarios. In addition, they should develop scenarios with other (political) goals over a broad spectrum. Legal instruments, particularly environmental laws, should take climate change into account in order to remain effective under changing climate conditions.

Water management and flood prevention

► **Planning and water management authorities should include current and future impacts of climate change in integrated river basin management.**

Integrated river basin management⁷⁰ is regulated in the EC Water framework directive (WFD 2000/60/EC) and in the EC Directive on the assessment and management of flood risks (Directive 2007/60/EC). The Water framework directive requires authorities to implement integrated programmes of action and management plans, serving the objective of ensuring “good water conditions”.

In order to address the potential conflicts between water conservation and other water uses early enough⁷¹ in terms of the ecology, quantities and quality of available water, water management authorities should develop strategies together with the various user associations and other interest groups which also take into account the conservation targets for the Natura 2000 protected sites. These strategies should take the future consequences of climate change into greater consideration. The regional and local planning authorities must also take these into account when granting water use related permits.

Water management authorities should examine the measures they take to implement the objectives of the Water framework directive⁷², and assess how these can make a contribution to adaptation. Management plans should reflect the consideration of climate change.

The Flood risk management directive contains explicit consideration of the consequences of climate change for dealing with inland and coastal flooding. Every six years, the water management authorities must update their risk analysis, the classification of threats and risks and the flood risk management plans. The planning authorities must integrate into the latest knowledge on climate change. In the event that older risk assessments and flood action plans and programmes are still being used, these should be examined to check if they are “climate proof”.

Water management authorities should waste no time in designating flood areas in which only appropriate uses will be permitted. When specifying these flood areas, a climate-related increase in flooding risk should be taken into account.

⁷⁰ Integrated river basin management (IRBM) is the process of coordinating conservation, management and development of water, land and related resources across sectors and national borders.

⁷¹ E.g. water as a habitat, as drinking water resource, water for farming and industry, hydroelectric power, or the use of water for shipping

⁷² Maintaining or improving good water quality

► **Planning authorities and official bodies should give preference to flexible adaptation measures.**

Planning authorities and official bodies should choose adaptation measures which are robust enough to enable the efficient achievement of objectives under a wide range of climate impacts, while taking into account existing uncertainties and allowing flexible adjustments when necessary. This applies in particular to long-term investments such as flood prevention measures. Such measures may be intended to reduce the impact of extreme events, whether floods or low-water situations. They could involve improving the hydromorphology, e.g. by reconnecting abandoned river courses, or relocating dikes.

► **Management agencies should increase the natural adaptation capacity of surface waters, particularly by using synergy effects with other political goals.**

Retaining water on flood plains increases the formation of groundwater and makes an important contribution to reducing flow rates during floods. Authorities should maintain a near-natural landscape when developing on shorelines and floodplains, ensure the decentralised infiltration of precipitation, and encourage the unsealing of areas while restricting new sealing to a minimum. Adapted farming methods, e.g. intercropping, mulching, and contour farming, also contribute to natural water retention by reducing erosion and supporting soil conservation.

► **Water and wastewater managers and the respective supervising agencies must ensure that the infrastructure is “climate proof”.**

Water supply and wastewater treatment managers and the relevant supervising agencies must make existing infrastructures “climate proof”. For example, sewage systems should be designed so that heavy rains do not have a negative influence on water quality. Water pipe networks should be laid out to ensure that there are no supply shortages during dry periods or microbial contamination because the pipe diameter is too small or the water temperatures are too high. Preparation of drinking water and flood protection measures must be able to cope with future requirements.

The operators of plants and networks as well as the relevant authorities must consider processes in close combination with other long-term transition processes such as demographic shifts and land-use changes. Water suppliers can continue to secure the supply of drinking water by cooperating in the form of associations.

► **Water should be used efficiently.**

During droughts and low water periods there may be conflicts of interest over the use of surface waters and over the extraction of groundwater. In these cases, management of water consumption is necessary which also allows for the prioritising of individual water uses. Especially industry and manufacturing, as well as the energy and agriculture sectors should further reduce water consumption. Increased intensity of hydrologic cycles means more intensive nutrient cycles. This calls for increased investments in water treatment technology, otherwise there is the danger of a build up in contaminants.

Because water shortages often lead to a worsening of water quality, river basin management authorities should pay increased attention to quantitative status of water in accordance with the WFD directive.

The efficient use of water includes grey water, harvested roof run-off, and process water for technical and industrial purposes. Water conservation should be encouraged in particular in manufacturing processes. Provisions should also be made to avoid losses in water pipes, to increase the efficiency of power station cooling systems, and to reduce losses in agricultural irrigation, including the use of treated, microbiologically acceptable wastewater.

Soil conservation

► **The existing rules for good agricultural practice and usage appropriate for the site in question should be made more specific, further developed and implemented consistently.**

All current measures to prevent or reduce soil erosion and harmful soil compaction and to conserve organic matter serve to preserve the ecological functionality of soils and are therefore appropriate for adaptation to climate change. There is a need to step up soil conservation with regard to the risks of erosion and declining humus content⁷³. The existing rules of good farming practice to ensure site-appropriate land use in accordance with Section 17 Soil Conservation Act, Section 1a Fertiliser Act (DMG), Section 6 Plant Protection Act (PflSchG) and Section 5 Nature Conservation Act (NatSchG) should take this objective into account. In particular the provisions for preserving organic matter and grassland are inadequate. Wetland soils should be completely excluded from use or preserved as grassland or converted to this.

► **Current discrepancies in the draft EU Soil conservation directive**

In September 2006, the EU Commission adopted a thematic strategy on soil conservation and presented this to the European Council and the EU parliament. The European Parliament passed a resolution at the first reading which included various suggestions and which urged the Commission to take into account the important role of soil policies, measures and best practices in both the mitigation of climate change and adaptation to the impacts of climate change. The soil conservation strategy proposed targets and measures to reduce soil degradation and to maintain or improve soil fertility. The proposal for an EU Soil Framework Directive includes basic requirement for soil conservation and offers Member States a scope for formulating their own approaches or applying their own soil legislation. The lack of a soil conservation directive could lead to short-sighted soil conservation policies in some regions of the EU that could increase the pressure on soil management in other countries.

Maintaining biological diversity

With the aim of maintaining biodiversity and using this in a sustainable manner, the National Biodiversity Strategy (NBS) describes objectives and Germany's undertakings under the UN Convention on Biological Diversity (CBD). Many of the measures in the fields of nature conservation and environmental protection aimed at achieving the requirements of the NBS strategy contribute towards promoting the adaptive capacity of biodiversity to climate change.

► **Biotope management should achieve interconnected habitat networks.**

Biotope networks must be considered as particularly worthy of protection in regard to agri-environmental measures and environmental impact assessments. Site-appropriate land management and suitable conservation measures contribute to climate change adaptation. In order to avoid fragmentation effects, administrative bodies must allow for ecological permeability of landscapes in traffic and infrastructural planning and make suitable provisions along existing roads, rail lines, and waterways.

⁷³ German Federal Cabinet (2008)

► **The Federal Government and Laender should take climate change into account during the development of requirements to prevent negative impacts of encroachment.**

In order to avoid encroachment regulations which are to be expected as a result of adaptation measures and competing uses, it is necessary to identify changing sensitivity of species to pollution and thermal stress as well as to rising sea levels and geographic displacement. The responsible authorities should create controls and incentives for a balanced choice of locations for biotope conservation and for priority areas for nature conservation. Taking climate change into account, they should examine and adapt maintenance and development plans for protected areas and for yet to be established buffer zones.

The restoration of wetlands, which is also specified in the National Strategy on Biological Diversity, not only helps to stabilise and regulate hydrologic conditions, but also reduces the release of greenhouse gases from drained areas. By reversing drainage measures in grasslands and restoring the dynamic conditions of river flood plains it is possible to react to regional summer droughts.

The creation of new woodland areas, as called for in the NBS strategy, can not only increase the capacity of CO₂-sinks, but also offers alternative options and additional habitats for protecting biodiversity.

► **EU, German Federal Government and Laender should implement broad adaptation measures to ensure biodiversity.**

The EU, the Federal Government and Laender should implement measures in all fields of nature conservation and environmental protection including cooperation with other sectors in order to allow for the adaptation of biodiversity to climate change.

The reduction in elevated nitrogen pollution levels required nationally and internationally in the NEC directive⁷⁴ and the UN ECE⁷⁵ air pollution convention, mostly from the agricultural sector, not only protects sensitive ecosystems, but also helps to avoid the degassing of climate-relevant nitrogen compounds into the atmosphere. The implementation of the WFD directive can at least partially compensate for the harmful impacts of climate change on biodiversity in surface waters. Among other things it is aimed at increasing the diversity of underwater habitats and continuity of waterways for migrating species.

► **Halting the drastic decline in marine species diversity**

Rising sea temperatures also have a negative impact on biodiversity and the resilience of ecosystems. This can only be effectively countered by setting up sufficiently large, well-managed protected areas. Under the Helsinki Convention⁷⁶ and OSPAR Convention⁷⁷, the Federal Government and Laender have already specified a number of protected areas as part of the mutually agreed network of well-managed areas to be established by 2010. All countries must ensure in joint responsibility that outside the protected areas the seas are managed sustainably with integrated strategies, because protected areas alone are not sufficient to halt the loss of marine biodiversity.

International fishery agreements and the European Common Fisheries Policy must reduce fishery related impacts, such as the drastic reduction of marine biomass and the decline in species diversity.

⁷⁴ National Emission Ceilings (NEC directive 2001/81/EC)

⁷⁵ Convention on Long-range Transboundary Air Pollution, UN Economic Commission for Europe.

⁷⁶ HELCOM Convention on the Protection of the Marine Environment of the Baltic Sea Area.

⁷⁷ Convention for the Protection of the Marine Environment of the North-East Atlantic.

The Federal Government and Laender should take measures in all fields of nature conservation and environmental protection, including cooperation with other sectors, in order to allow the adaptation of biodiversity to climate change.

Due to the multiple impacts of fisheries on marine ecosystems, including the destruction of habitats from nutrient and toxin deposition and further anthropogenic effects, marine ecosystems are under ever growing stress and their ability to recover is diminishing. Climate change is having a growing impact on the oceans. Therefore, not only must greenhouse gas emissions be effectively reduced, but the resilience of the seas must also be increased. Genetically varied populations and species-rich ecosystems have a greater potential to adapt to climate change. Marine conservation must ensure that the marine ecosystems as a whole are not heavily burdened and that they retain long-term stability. The measures include the creation of a wide-spread network of protected areas. The EU Marine Strategy directive is an important instrument to this end.

Agriculture

► Implementing a broad spectrum of adaptation measures

Agriculture in Germany can adapt to gradual climate changes with a range of measures, for example by changing farm management and crop sequences, by producing new breeds of plants and livestock, by providing more agricultural advice on adaptation, and also at the level of policy-making (operator obligations, subsidy programmes). Adapting to weather extremes is more difficult. In the future, economic measures might be required such as multiple-risk insurance policies for agricultural operations.

Because of the regional differences in climate change there cannot be a single one size fits all adaptation strategy for agriculture in Germany. On the contrary, climate change requires various tailor-made combinations of measures, depending on region and location. For example, farmers should adapt fertilisation, pest control and cropselection to suit the changing conditions. Ploughless soil tillage and organic farming will become increasingly important. The Federal Government should also implement effective legislation of plant variety conservation which puts breeders in the position to adapt plant species and possibly also to develop new crops.

► The Federal Government and the Laender should incorporate adaptation into support measures.

Water retention should be improved by measures such as rainwater seepage and by adapted farming methods, for example conservative soil working. The Federal Government and Laender should promote water retention in drought-threatened farming landscapes via the Bund-Laender Joint Task "Improvement of the Agricultural Structure and of Coastal Protection" (GAK). This also applies for the irrigation infrastructure. For example, old water storage systems could be re-used, or dam management amended. Increasing natural water retention by restoring wetlands should be considered on a case-by-case basis, taking epidemic control into consideration. This is already possible under the principles for the promotion of water management measures. Farmers should give priority to water-conserving irrigation techniques.

Minimal soil disturbance methods, which conserve soil organic matter, improve the crumb structure and reduce evaporation, should be promoted more strongly within the framework of agricultural environment measures. This requires increased funding for rural development ("the second pillar of CAP") at both the European and national levels, because these measures have to be co-financed.

► **The Federal Government, Laender and breeding organisations should work towards the conservation of agricultural genetic resources.**

Breeding organisations should pay special attention in breeding and management measures to maintaining stable, high-level performance of livestock under sub-optimum temperature conditions (heat). This factor should be included in examinations and breeding assessments, and thus also in the further breeding procedures. These measures contribute to adaptation to climate change.

An important precondition in animal husbandry is the conservation of genetic resources and their sustainable use for adaptive breeding as conditions change in the future. Laender and breeding organisations could support this by extending the Bund-Laender Joint Task (GAK) "Animal genetic resources". The same applies for crop farming. Cooperation in both sectors should be intensified within the EU.

► **Federal government and Laender should encourage sustainable farming systems.**

From the point of view of water quality protection and nature conservation, it should be noted that the cultivation of energy crops and adaptation measures can exert increased pressure on natural resources. When considering extended irrigation measures or the more intensive use of fertiliser and plant protection substances, nature conservation concerns should be taken into consideration. The protection of aquatic communities may come into conflict with efforts to increase farmland irrigation. It is also necessary to retain strict risk examinations before the use of genetically-modified organisms.

The Federal Government and Laender should promote agricultural systems such as multi-cropping and agroforestry which offer synergies between nature conservation, soil protection, water conservation, as well as mitigation and adaptation.

Forest management

Mixed, site-appropriate forest stands have a greater resilience and are more able to adapt to changing climate conditions. A near-natural species composition with great genetic diversity reduces tree loss and if any gaps occur it helps to fill these more quickly. Simply a few broadleaf trees in a conifer forest can even considerably improve the stability of the conifers⁷⁸. The mixture of needles and leaves in the litter layer leads to enhanced transformation rates of the organic matter and improves the supplies of water and nutrients to the trees.

► **Foresters should establish species-rich, mixed woodland and use seed sources that are able to adapt to changing ecological conditions.**

When selecting tree species and seed sources, foresters should consider whether they will be able to adapt to future site conditions. If a tree species is already in a marginal situation at a certain site because of its requirements, for example concerning temperatures or water supplies, then the forester should very carefully consider which alternative tree species could cope better with the changing conditions. Trees take a relatively long time to reach maturity. At the same time, the uncertainty of climate projections increases with the length of the time horizon.

In places where native species reach the edge of their ecological niche, tree species come into question which originate from southern Europe where current conditions match the expected future conditions in Germany. The careful, small scale establishment

⁷⁸ Knoke and Wurm (2006): Mixed Forests and a Flexible Harvest Strategy: A Problem for Conventional Risk Analysis? European Journal of Forest Research/25, pp. 303-315.

of such tree species would equate to a support and acceleration of a migration which is to be expected in the long term⁷⁹.

► **The Federal Government and the Laender should ensure that adaptation considerations are included in funding support principles and that additional stress factors are avoided where possible.**

The Bund-Laender Joint Task (GAK) already supports various measures which aid the adaptation of forestry to climate change, e.g. the conversion of monocultures and site-inappropriate stands into stable, deciduous or mixed stands. There are also measures to avoid and cope with yield losses, e.g. due to pest infestation. The Federal Government and Laender should consider whether additional measures could be adopted to promote water retention in areas with a very negative hydrologic balance. Measures should also be implemented to reduce air pollution with the aim of avoiding a further deterioration in soil status and the health of forests due to acidification, eutrophication and ozone damage, and in this way increasing the stress tolerance of trees.

13. Adaptation in the further sectors of the economy

All sectors of the economy should address the risks posed by on-going and future climate change, and should develop and implement measures to adapt to this. This will not only help to avert risks, but will also make it possible to make use of new market opportunities. Among other things the companies should reevaluate their business models in light of the new factor “climate change”.

► **Financial service providers should re-evaluate climate risks for investments and develop adaptation measures.**

Financial service providers, such as banks, insurance companies and financial advisers, play a key role in market economies. They should help businesses to identify and reduce the risks of climate change.

In the insurance industry the risk models are already being adapted to the changing situations. Passive and active adaptation strategies are being pursued. Passive measures include limiting cover and increasing charges for particularly high risks, but also refusing to provide cover for risks or regions which are classed as uninsurable. Active adaptation strategies motivate customers in vulnerable sectors to take precautionary measures to limit damage. For example, German reinsurers now demand that the construction industry reassess weather risks for existing procedures, and they are offering technical and organisational advice on how to evaluate the risks and how best to cope with them.

For the energy industry it is of key importance to analyse the specific consequences of climate change for each individual company depending on the type of generation of electricity. In order to adapt to climate change, companies should reduce their dependence on the availability of cooling water and import of raw materials. The power sector must

⁷⁹ Goethe University Frankfurt is cooperating with Research Institute Senckenberg (FIS), Institut für sozial-ökologische Forschung (ISOE), and ECT Flörsheim GmbH to test drought-resistant oak species from south and south-eastern Europe for suitability in Germany.

take fully into account the effects of extreme weather conditions on the infrastructure for power transmission and distribution. In addition to the development of alternative supply strategies it is also necessary to develop and improve prediction and early-warning procedures.

Technical infrastructure measures, for example in transport or in power station construction, will require alterations to industrial standards and building regulations to take future climate conditions into account. New, heat-resistant materials in road and rail construction, a possible redesign of drainage infrastructure and measures to provide protection against extreme events, such as landslides could contribute to adaptation. Moving tracks and roads away from flood areas further reduces vulnerability.

The consequences of climate change can also affect federal waterways. Where changes to basic conditions affect the number of navigable days and reduce the transport capacity, e.g. due to reduced summer rainfall, then this must be reflected in decision-making processes regarding further infrastructure measures. These aspects must also be included in the cost-benefit calculations for water engineering projects.

The companies should examine their business model based on new and altered constraints associated with climate change. The necessary adaptation to climate change offers new, worldwide market potential, in particular for mechanical engineering (e.g. HVAC, irrigation technologies) and electrical engineering (e.g. energy control systems).

► Many sectors of the economy can make a contribution towards tackling the negative impacts of climate change and secure market opportunities.

Thinking ahead about the implications of climate change can secure enormous growth opportunities. For example, many sectors have developed and are using ways of conserving energy and water in production and processing, or operating in closed cycles which generate no wastewater. With the prospect of drier summers in future, water-intensive chemical, paper and textile industries can use such processes to make themselves less dependent on water as a raw material and coolant.

Strategic cooperation in research and development can also help to meet the challenges of global markets and the new demands these raise.

Reduction of greenhouse gas emissions

14. International climate treaty starting in 2013

The UN Climate Conference in December 2009 in Copenhagen must conclude a comprehensive climate agreement with ambitious reduction targets for the world's major emitters of greenhouse gases beginning in 2013. The agreement must show the way towards global, climate-friendly developments in the coming decades, so that the two degree target remains achievable.

The United Nations Framework Convention on Climate Change and the Kyoto Protocol form the basis for international efforts to reduce emissions of greenhouse gases and to adapt to the impacts of climate change.

The framework of action for global mitigation efforts is provided by Article 2 of the Framework Convention on Climate Change, which sets the objective of the stabilisation of greenhouse gas concentrations in the atmosphere at a level that would avert irreversible damage due to climate change. For the EU and more than 100 countries this means that the temperature must not increase by more than 2°C⁸⁰.

The latest scientific findings presented in the IPCC 4th Assessment Report and more recent publications⁸¹ show the urgent need for global action. Against the background of the current world economic crisis it is particularly important that future climate agreements establish a sustainable balance of interests between the industrialised and developing countries on key questions of economic development well into the 21st century.

► **The global development of greenhouse gas emissions and the commitment to the two-degree target**

The new international climate agreement must contain binding commitments such as a reduction in global greenhouse gas emissions by the middle of the century to a level at least 50% below the 1990 level including the necessary peak in global greenhouse gas emissions by 2020 at the latest. The two-degree target must be established as a long term limit⁸². By 2050, industrialised countries must reduce their greenhouse gas emissions by at least 80 % to 95 % below 1990 values.

► **Differentiated contributions of countries to mitigation**

With the exception of the poorest developing countries, from 2013 all countries must contribute to the global mitigation efforts in accordance with the common but differentiated responsibilities and their respective capabilities. Concerning the reduction of greenhouse gas emissions, the major greenhouse gas emitters⁸³ (both industrialised and developing

⁸⁰ IPCC (2007c)

⁸¹ Cf. Section 7

⁸² Cf. Section 6

⁸³ World Resources Institute (2009): Climate Analysis Indicator Tool under www.cait.wri.org (as of 03.06.2009): Ten largest GHG emitters in 2005 without LULUCF in absolute figures t CO₂-e, in brackets % of global GHG emissions and annual per capita emissions: 1. China 7.219 bn. t (19.1 %; 5.5 t/cap.); 2. USA: 6.963 bn. t (18.4 %; 23.5 t/cap.); 3. EU-27: 5.047 bn. t (13.3 %; 10.3 t/cap.); 4. Russia: 1.960 bn. t (5.1 %; 13.7 t/cap.); 5. India: 1.852 bn. t (4.9 %; 1.7 t/cap.); 6. Japan: 1.342 bn. t (3.5 %; 10.5 t/cap.); 7. Brazil: 1.014 bn. t (2.6 %; 5.4 t/cap.); 8. Germany: 977 m. t (2.5 %; 11.9 t/cap.); 9. Canada: 731.6 m. t (1.9 %; 22.6 t/cap.); 10. Great Britain: 639.8 m. t (1.6 %; 10.6 t/cap.)

countries) must reconsider their positions and adopt a cooperative and constructive approach in the negotiations.

15. Emission reductions in industrialised and developing countries

As of 2013, industrialised countries must commit themselves to ambitious greenhouse gas reductions by 2020 to at least 30% below 1990 levels, doing justice to both their ambitions to play a leading role in combating climate change and their historical responsibility. At the same time, the considerable potential for reductions in developing countries must be released with suitable instruments including international support, with the goal of reducing their greenhouse gas emissions by 15 to 30 % below the projected reference development in 2020.

The UBA determined that, as of summer 2009, the aggregate proposals made in the negotiations on a new climate agreement for the reduction of greenhouse gas emissions by industrialised countries amount to a reduction of approximately 12.5 % below 1990 levels by 2020⁸⁴ and are not adequate to meet the necessary reduction of greenhouse gas emissions in industrialised countries⁸⁵. The unambitious offers of the industrialised countries cast doubt on the possibility of a breakthrough at the UN climate negotiations in December 2009 in Copenhagen.

► Revising reduction obligations for Annex-I countries in accordance with the current scientific state of knowledge

In a new climate agreement beginning in 2013, the industrialised countries must commit themselves to a reduction target which will make it possible to remain below the two-degree limit. The IPCC has defined an indicative reduction corridor for the group of Annex-I countries of 25% - 40% below 1990 levels⁸⁶. The EU should revise its negotiating offer (30 % below 1990 levels by 2020)⁸⁷ and should emphasise that this as a minimum target for the group of Annex-I countries, especially since this is only in the lower third of the IPCC corridor. The UBA recommends that the German government immediately calls for a more ambitious EU target in the negotiations with the other EU member states. In this context, the aim of the German government to reduce emissions in the same period by 40 % relative to 1990 levels must relate solely to domestically reduced emissions, without the use of international compensation mechanisms (CDM⁸⁸ and JI⁸⁹).

⁸⁴ Federal Environment Agency (2009), own calculations. Cf. AOSIS (2009): Aggregate Annex-I reductions for 2020. Non-paper from 11.06.2009 for negotiations of the ad-hoc working group under the Kyoto Protocol. Values between -8% to -14% in 2020 vs. 1990. The results depend on whether LULUCF (see below) is included in the calculation or not. Cf. UNFCCC, 2009: Compilation of information relating to quantified emission limitation and reduction objectives as submitted by Parties. Informal note, version 12.06.2009.

⁸⁵ IPCC (2007d)

⁸⁶ IPCC (2007d), Box 13.7, p. 776

⁸⁷ EU-Umweltrat (2007): EU Ziele zur Weiterentwicklung des internationalen Klimaregimes post 2012 (Schlussfolgerungen des Vorsitzes).

⁸⁸ Clean Development Mechanism

⁸⁹ Joint Implementation

► **Transparent criteria for future targets**

Already in 2007, the EU Council first accepted a 30% emissions reduction target by 2020, in comparison to 1990 levels, within a new comprehensive climate change agreement. In the EU strategy debate⁹⁰ in Spring 2009, the EU Council presented a proposal for the distribution of emissions allowances among industrialised countries in the new climate agreement. The proposal is based on a combination of criteria which take account of economic capability, reduction potential, emissions reductions already achieved, population development, and the development of greenhouse gas emissions. The UBA supports this approach and calls on the Federal Government and the EU to actively promote this in negotiations for a new climate change agreement.

Climate change mitigation efforts in developing countries

The UBA asserts that the limitation of global warming to a maximum of 2 °C in comparison with pre-industrial levels can now only be achieved if developing countries participate in the worldwide efforts to reduce emissions. The developing countries must make strenuous efforts to achieve reductions by 2020 in the order of 15 to 30 % below the current expected emissions trend.

► **Emissions reduction targets taking national conditions into account**

A new climate agreement must address the potential for greenhouse gas reductions⁹¹ in developing countries with high emissions and lead to a significant reduction of emissions up to and beyond 2020 in comparison with the development trend. Questions of equity should also be considered, such as the polluter pays principle, the financial capacity, as well as development priorities. The UBA recommends that, since they account for a large proportion of overall emissions, the larger developing countries, at least the more economically developed countries and the MEF participants⁹², should commit themselves to ambitious reduction efforts until 2020 compared with the development trend.

► **Supporting the implementation of national climate action plans**

The governments of many developing countries are currently in consultations of national climate action plans or have already concluded this process. A first evaluation of the climate plans of Brazil, China, India, Mexico, South Africa and South Korea show that the full implementation by 2020 would lead to a substantial reduction in greenhouse gas emissions compared with trends⁹³. This reduction represents about a quarter of all the emissions of the countries in question⁹⁴. Therefore, the UBA recommends that the Federal Government should support the developing countries to formulate and implement

⁹⁰ EU Council (2009): Climate change: EU strategy debate on development of the EU position on a comprehensive post-2012 climate agreement. Summary by the Czech Presidency.

⁹¹ Höhne et al. (2008): Proposals for contribution of emerging economies to the climate regime under the UNFCCC Post 2012. Federal Environment Agency, Climate Change No.15/08. www.umweltDaten.de
The authors show considerable potential for reducing emissions in Brazil, China, India, Mexico, South Africa and South Korea. Lower GHG emissions can lead to synergy effects such as improved air quality. About one tenth cut in total emissions in the countries investigated could be achieved without additional net costs. A further 10 % reduction could lead to other positive side-effects at moderate costs, such as the creation of jobs. Not included were the sectors land-use and forestry, or REDD.

⁹² The Major Economies Forum includes the G8 countries, Brazil, China, India, Mexico, and South Africa.

⁹³ Moltmann et al (2009): Proposals for quantifiable emission reduction contributions of emerging economies. Research project of Federal Environment Agency No. 360 16 022. Part 1. (in print).

⁹⁴ Without emissions from land-use changes and forestry

national climate policies and measures.

Mechanism for clean development

► Extending the mechanisms for environmentally-friendly development in the new climate agreement

In its current form, the clean development mechanism (CDM) serves primarily to meet the reduction obligations of the Annex-I countries under the Kyoto Protocol⁹⁵. The CDM should continue to play an important role in a new climate agreement, but improvements must be made. The international community must reinforce the environmental integrity of CDM projects and their contribution to sustainability, and ensure that more countries are involved. In addition, CDM measures must lead to an increased technology transfer in the future.

► Working towards net emission reductions by discounting CDM certificates

In order to achieve emissions reductions in emerging markets and developing countries and to create a strong global carbon market in the long term, it is no longer sufficient simply to use CDMs in the current form⁹⁶. By discounting CDM certificates⁹⁷, CDM projects would contribute to emission reductions and no longer only be a compensation instrument for emissions in industrialised countries⁹⁸. A discounting factor could be introduced for selected project types, or for countries which have already reached a certain level of development. If selected types of projects are discounted, then CDM projects could be made relatively more attractive if they contribute significantly to sustainable development in the host country, or are located in a country without a discounting factor. UBA recommends the further development of the clean development mechanism by introducing discounting factors.

► Generating net emission reductions by innovative project-based CDMs

Another way to reduce emissions with the existing CDM set up is to introduce an ambitious, internationally-agreed baseline for certain CDM project types. This would mean that CDM allowances would not be provided for every tonne of reduced greenhouse gas emissions, but only for the additional part of the reduction beyond the predicted emissions development⁹⁹ of the current CDM. The UBA recommends the introduction of ambitious baselines for specific project types.

► Buying and cancelling CDM allowances

In order to boost CDM net-emission reductions in developing countries, one option would be to require industrialised countries to buy large quantities of CDM allowances. It would not be possible to trade these allowances or use them to cover greenhouse gas emissions in industrialised countries, but they would have to be "cancelled"¹⁰⁰. The purchase could be financed with public funds or revenues from the auctioning of emission rights.

⁹⁵ As well as promoting sustainable development in the host countries.

⁹⁶ Cf. Section 17

⁹⁷ Schneider (2008): A Clean Development Mechanism with atmospheric benefits for a post-2012 climate regime. Berlin, 25 September 2008

⁹⁸ With a discounting factor of 20%, a CDM project reducing emissions by 100 t CO₂ would only receive a certificate for 80 t. The remainder would be booked as a net emissions reduction.

⁹⁹ That is, the reference development of the regular CDM project.

¹⁰⁰ The further use as compensation or the sale to third parties (on the free market) would be excluded.

The use of public funds is justified for various reasons. The CDM market mechanism offers the advantage of identifying cost-effective emission-reduction potential. Also it is possible to quantify the required emissions reduction accurately. The introduction of such an obligation would lead to increased demand for CDM allowances from certain developing countries (e.g. African countries), or for certain types of projects, e.g. clean energy projects. The UBA therefore recommends introducing an obligation to purchase CDM allowances for cancellation.

Sector-specific market mechanisms

► Introducing new sector-specific market mechanisms in the new climate agreement

With two new sector-specific market mechanisms, emerging economies can reduce their growing greenhouse gas emissions to their own advantage.

For sectoral allowances¹⁰¹ on the basis of a no-lose¹⁰² target such a country sets itself an internationally agreed reduction target for a suitable sector¹⁰³ in which it will reduce its emissions below the predicted emissions development¹⁰⁴. When the agreed target can be shown to have been exceeded, then the additional reductions can be sold as emission reduction certificates.

In the case of sectoral emissions¹⁰⁵, a binding, internationally approved reduction target is agreed for a chosen sector in a certain country and covered by a budget of emissions certificates. If the reduction target is exceeded, the country can sell the surplus certificates to other countries¹⁰⁶. If the target is not achieved due to inadequate reduction measures, then additional certificates must be purchased on the international carbon market in order to compensate for the shortfall.

The mechanisms of sectoral allowances and sectoral emissions trading can smooth the path for countries to participate in the global carbon market, and compared with conventional mechanisms they offer advantages for developing countries¹⁰⁷. The UBA recommends that at least the large emerging markets should use sectoral market mechanisms and pro-actively propose suitable sectors and present plausible reduction targets in these sectors. In order to ensure the environmental integrity of both instruments, ambitious reduction targets must be set at the UNFCCC level and the performance validated internationally.

Land use, land use change and forestry

► All emissions sources and sinks should be taken into consideration

In the first commitment period of the Kyoto Protocol from 2008 to 2012, parties can use LULUCF¹⁰⁸ provisions to make it easier to achieve national reduction measures. A com-

¹⁰¹ For an introduction see www.oecd.org/env/cc/sectoral

¹⁰² Failing to achieve an agreed sectoral target has no negative consequences.

¹⁰³ The data situation regarding emissions in the sector must be good and the structures transparent.

¹⁰⁴ Baron, Buchner and Ellis (2009): Sectoral Approaches and the Carbon Market. Paris: OECD and IEA.

¹⁰⁵ Sectoral trading.

¹⁰⁶ Trade in assigned amount units (AAU)

¹⁰⁷ For example increased flexibility or reduction of transaction costs

¹⁰⁸ Landuse, landuse change and forestry

plex accounting system was created for this purpose. However, the system offers few incentives to create additional carbon sinks and reservoirs or to further reduce emissions, because of the tight restrictions it imposes. In addition, countries can choose which activities they include. In a new climate agreement the international community must therefore work towards a more consistent accounting system, while making it mandatory to include the sources from this sector.

Reducing deforestation in developing countries

► Halve deforestation worldwide by 2020 and stop forest loss by 2030

The greenhouse gas emissions due to deforestation and degradation (REDD¹⁰⁹) of tropical rain forests account globally for some 20 % of anthropogenic greenhouse gas emissions. It is urgently necessary to reduce the emissions caused by deforestation and degradation and to include this aspect in a new climate agreement.

► Financial incentives for avoiding deforestation and forest degradation

The UBA recommends the development of a mechanism which provides incentives for the reduction of deforestation¹¹⁰ and for sustainable forestry in developing countries. The mechanism should provide financial rewards for successful, proven emissions reductions and avoided deforestation in comparison with an ambitious national reference level. Biodiversity, sustainable land-use and the local population should also profit from such a mechanism. Measures should be included for sustainable forestry, including reforestation, which contribute to reducing deforestation in a wider sense. Broad participation in this mechanism must be ensured in order to avoid the shift of deforestation to countries which had previously not been affected.

Maritime and aviation emissions

► Emissions from aviation and from shipping should be included in a new climate regime

Aviation accounts for the annual emission of some 632 million t CO₂¹¹¹ and shipping accounts for about 1 046 million t¹¹². These values correspond to about 2.3%¹¹³ and 3.3% of anthropogenous CO₂ emissions, respectively. In view of the disproportionate growth of emissions, it is urgently necessary to include both sectors in an international climate agreement. In addition, the climate impact of the non-CO₂-effects of air traffic, for example due to emissions of nitrogen oxides (NO_x) or condensation trails, at least double the impact of the above-mentioned CO₂-emissions.

► New responsibilities for reducing GHG emissions in civil aviation and shipping

Under the Kyoto Protocol, responsibility for the reduction of greenhouse gas emissions was entrusted to the International Civil Aviation Organisation (ICAO)¹¹⁴ and International

¹⁰⁹ Reducing Emissions from Deforestation and Degradation

¹¹⁰ And thus the reduction of greenhouse gas emissions

¹¹¹ ICAO www.icao.int/env/meetings/2009/GIACC_4/Docs/GIacc4_ip01_en.pdf

¹¹² Second IMO GHG study 2009. MEPC 59/INF.10

¹¹³ Our calculations on the basis of ICAO data (reference 2006)

(www.icao.int/env/meetings/2009/GIACC_4/Docs/GIacc4_ip01_en.pdf) and IEA data (reference 2007)

(www.iea.org/textbase/nppdf/free/2008/key_stats_2008.pdf)

¹¹⁴ International Civil Aviation Organization

Maritime Organisation (IMO)¹¹⁵. However, neither institution has presented effective proposals for emissions reductions over the past twelve years, nor do they seem likely to do so in the near future. In the negotiations on a new climate agreement, Germany should therefore seek the inclusion of aviation and shipping in a Kyoto follow-up agreement with quantitative reduction targets.

Careful consideration should also be given to the future role of the ICAO and IMO. Another 12 years should not be allowed to pass without results.

► **Emission limits and emissions trading for international shipping**

Together with Norway and France, Germany has already submitted a proposal to the IMO for international marine emissions trading. Germany must ensure that this is implemented as quickly as possible – with a sectoral reduction target. This would provide economic incentives to utilise the technical and operational reduction potentials of shipping.

► **Examining the potential of the EU**

The EU has decided that aviation will be included in EU Emissions trading from 2012, but only CO₂-emissions will be considered. Germany should argue for the inclusion of non-CO₂ effects, for example by means of a multiplication factor.

In shipping, the EU should continue to exert pressure on the IMO to implement a global solution. If no progress has been achieved at the international level by 2011, the EU should take its own measures, such as integrating shipping in the EU Emissions trading, and thus exert pressure for global measures.

16. National emission reductions and targets

Since 1990, Germany has reduced greenhouse gas emissions considerably and should continue along this path with strict mitigation goals through 2050. By 2020, German greenhouse gas emissions must have fallen 40 % below 1990 levels, with a continued reduction of at least 80% to 95% by 2050.

German greenhouse gas emissions have fallen considerably since 1990, and were 22.4 % lower in 2007¹¹⁶. This was already below the reduction target of a mean reduction of 21 % for the period 2008 to 2012 compared with 1990 levels to which Germany committed itself under the EU burden sharing commitments. However, it is not certain that Germany will comply with the reduction undertakings at the end of the period, because the lower emissions calculated for 2007 also reflected special conditions¹¹⁷. Figure 4 shows the progress of greenhouse gas emissions in Germany and targets and projections for the reduction of greenhouse gas emissions¹¹⁸.

¹¹⁵ International Maritime Organization

¹¹⁶ Based on the greenhouse gas emissions inventory from the 2009 report in accordance with the UNFCCC and the Kyoto Protocol.

¹¹⁷ Special effects resulted from the unusually mild winter 2006/2007 and early fuel purchases in 2006 prior to an increase in value-added tax.

¹¹⁸ Projection report of the German Federal Government 2009 in accordance with 280/2004/EC, http://cdr.eionet.europa.eu/de/eu/ghgpro/envsgwza/Projektionsbericht_DE_2009.doc

► **The Federal Government should set a long-term goal of reducing greenhouse gas emissions by at least 80% by 2050.**

The targets of individual countries for reducing greenhouse gas emissions must be derived on the basis of global targets. The IPCC therefore views it as necessary for industrialised countries to aim at emissions reductions of 80 to 95% by 2050 in comparison with 1990 levels¹¹⁹. The UBA agrees with this assessment and recommends that the Federal Government sets a target for Germany of a reduction of greenhouse gas emissions by 2050 of at least 80 % compared with 1990.

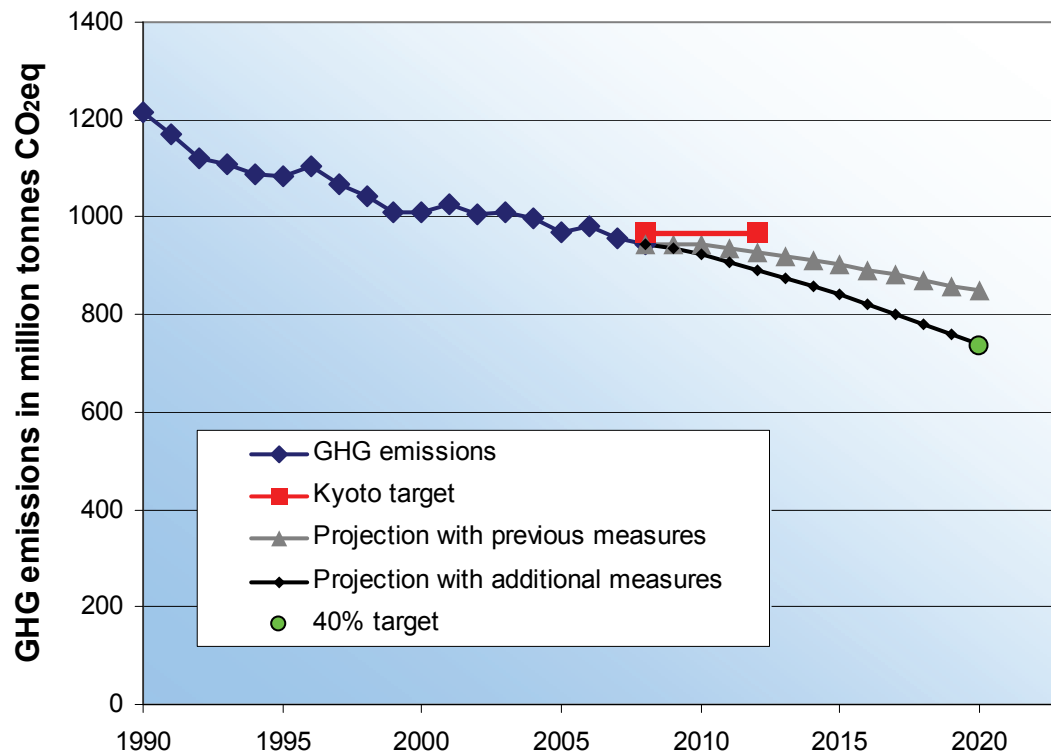


Figure 4: Development of greenhouse gas emissions in Germany, targets and projections¹²⁰

► **The Federal Government should continue to pursue the goal for 2020 of a domestic reduction of greenhouse gas emissions of 40 % compared with 1990.**

In December 2008, the EU concluded a climate change package with targets for 2020: a reduction of greenhouse gas emissions of at least 20 percent by 2020 compared with 1990, which could be scaled up to 30 percent in the event of an ambitious new global climate change agreement.

The EU decided to establish EU-wide emissions limits for the emissions trading sector and to limit national reduction obligations to other sectors¹²¹. There are therefore no na-

¹¹⁹ The range of necessary reductions apply for a stabilisation level of 450 ppm CO₂-equivalents. Cf. IPCC (2007d) Chapter 13.

¹²⁰ Ibid

¹²¹ Germany must reduce emissions in the non-emissions trading sector by 14%.

tional reduction obligations for the emissions trading sector. However, the territorial principle, which clearly allocates reduction obligations to nation-states, remains in place for the non-emissions trading sector.

In the emissions-trading sector, in particular power generation and industrial plants, Germany should act as a role model. It is the only major industrial country which is highly dependant on coal/lignite in its power sector, and has at the same time set very ambitious mitigation targets for itself. If Germany is able to demonstrate the compatibility of climate change mitigation and successful economic development, other countries with CO₂-intensive power generation will find it easier to commit to ambitious climate programmes. Studies show that this dual strategy can work¹²².

It is necessary to completely restructure the power supply sector without delay, so that Germany can achieve a greenhouse gas emissions reduction target of at least 80 % by 2050 in comparison with 1990 levels. For these reasons, the UBA continues to see considerable benefits in reduction requirements based on the territorial principle. It therefore supports the target announced by the Federal Government on 26 April 2007 of a 40% reduction in greenhouse gas emissions in Germany by 2020¹²³.

► The Federal Government should implement mitigation instruments above and beyond its Integrated Energy and Climate Programme (IEKP) and strengthen existing provisions, with the goal of an additional 10% reduction in emissions on top of the effect of current legislation (30 to 35%).

The measures in the government statement were specified by the Federal Government on 23 August 2007 in the form of the Meseberg Criteria of the IEKP programme. This is an important step towards the further reduction of German greenhouse gas emissions.

Assessments in the IEKP show different reductions in greenhouse gas emissions¹²⁴. However, none of them show a reduction of more than 40%, even with optimum assumptions. However, numerous other studies show that this target can be reached with ambitious climate policies¹²⁵. In order to achieve a total reduction of 40% with a safety margin (and thus independent of variables influencing the energy sector) the Federal Government should fully implement all the previously agreed measures (30 to 35%) and also develop and quickly implement new measures. These must lead to a further 10% reduction in emissions.

In the following Sections, proposals are made for utilising previously unexploited emission-reduction potentials.

¹²² Cf. Section 23 and Section 24

¹²³ Statement on climate policy to the German Bundestag by the Federal Environment Minister Sigmar Gabriel on 26 April 2007 in Berlin.

¹²⁴ Estimates range from 31 % (Projection Report of the Federal Government 2009) to 37 % (Effect of Meseberger Decisions, 23 August 2007 on greenhouse gas emissions in Germany in 2020, Federal Environment Agency, 2007)

¹²⁵ Cf. Federal Environment Agency (2007): Politikszenerarien für den Klimaschutz IV - Szenarien bis 2030 (Policy scenarios for climate protection IV – scenarios for 2030) or Projektionsbericht der Bundesregierung 2009.

17. Cross-sector mitigation instruments

Greenhouse gases are emitted in all sectors of the economy, in private households and in the public sector, so that mitigation is a cross-sectoral task. Germany and the EU should be ambitious in developing further cross-sectoral instruments such as emissions-trading and energy taxes, and should extend these to include areas which have hitherto been neglected, such as the taxation of kerosene for air travel. At the same time, more effective and efficient mitigation requires continual harmonisation of available instruments.

Cross-sectoral economic mitigation instruments are particularly suitable for reducing greenhouse gas emissions effectively and efficiently. This is why emissions trading policies were introduced and energy taxation developed. However, additional sector-specific instruments are also necessary which stimulate specific, climate-friendly innovations, support their market penetration and help to overcome obstacles such as information deficits which hinder the spread of climate-friendly technologies and lifestyles. This includes the German EEG Act which stimulated the reorganisation of the power system.

Emissions trading

EU emissions trading, which began in 2005 is administered in Germany by Section E of the UBA ("German Emissions Trading Centre"). The EU emissions trading covers some 40 percent of European carbon dioxide emissions¹²⁶ registered from the emission-intensive power and manufacturing sectors. In addition to the absolute reductions and the effects of certificate costs on the price of electricity and the products of the other affected sectors, emissions trading can indirectly improve energy efficiency throughout the economy¹²⁷. Whether a company adopts its own CO₂-reduction measures will depend on economic considerations. If the costs of internal emission reductions are lower than the market price of certificates, companies will prefer these measures to reduce CO₂-emissions. In this way, emissions trading will direct emission reduction measures to wherever they are most cost-effective.

► Establishing an ambitious reduction pathway

The key goal in the further development of emissions trading is to establish an ambitious, long-term reduction pathway. The EU Climate and Energy Package agreed on in 2008 envisages a reduction of the upper limit for emissions which is oriented towards the EU 20-percent reduction target by 2020 in comparison with 1990 levels. With regard to 2020, after conclusion of the climate negotiations in Copenhagen at the end of 2009, the EU should without delay realign the emissions cap on the basis of an emissions reduction of 30 % compared with the base reference year 1990. This is an important and necessary step towards the long-term objective of reducing emissions by at least 80% by 2050 (see Section 16).

¹²⁶ In Germany about half of all CO₂-emissions are registered.

¹²⁷ The costs of certificates act as an incentive to replace energy-intensive products and components; there are also incentives for suppliers of fuel and raw materials and plant manufacturers to alter the products they offer.

► Introducing full auctioning in the near future

An important experience with emissions trading is that the free allocation of emissions allowances has considerable disadvantages. It leads to so-called windfall profits¹²⁸ and requires complicated allocation rules, which can give wrong incentives to the companies involved. The EU and the member states are therefore to begin to auction all emissions allowances as soon as possible.

► Benchmarks and targeted instruments against carbon leakage

Where auctioning is not possible, the distribution of emissions allowances – whether for the manufacturing industry or for heat from combined heat and power generation plants (CHP plant) – should in all cases be based on demanding benchmarks which are defined independently of fuels and technologies. Otherwise, in particular for new plants, there will only be optimization of efficiency within the individual technology, but not with relation to the best available technology.

Fears have often been raised that emissions trading could be subject to ‘carbon leakage’¹²⁹. As a unilateral counter-measure, the new EU Emissions trading directive envisages free allocation of emission allowances to endangered companies. In the opinion of the UBA this should be restricted to a minimum, coupled with an effective rule on closures.

► Limited use of flexible mechanisms

Only substantial reductions of own greenhouse gas emission in the EU will lend credibility to its ambitious climate policy. Therefore with respect to the 30 percent reduction target of the EU by 2020, the use of the project-based mechanisms of the Kyoto Protocol (JI and CDM) in emissions trading should only be allowed to account for markedly less than 50 % of the additional reduction undertaking.

► Promoting innovative renewable energy technologies by means of the new plant reserve

The revised EU Emissions Trading Directive envisages that up to 300 million emission allowances from the reserve of certificates for new plants should be used to promote demonstration plants for Carbon Capture and Storage (CCS) and for innovative renewable energy technologies. Their allocation has to follow general and strict criteria. Public financial support for CCS must not impair research and development work on sustainable climate measures. Therefore innovative renewable energy technologies have to be given at least an equal standing under these provisions¹³⁰.

¹²⁸ In particular the power companies had additional profits of billions of euros annually.

¹²⁹ This refers to relocations of manufacturing and the associated CO₂-emissions outside Europe, in regions with laxer climate requirements. Carbon leakage could thus reduce the effectiveness of climate policies in Europe and weaken the economy. In fact, high costs due to emissions trading and strong international competition, two factors which could lead to carbon leakage and reallocation of production capacities, actually affect only a small part of the German economy, accounting for less than 1% of GDP. Cf. Graichen, V. et al (2008): Impacts of the EU Emissions Trading Scheme on the industrial competitiveness in Germany, Federal Environment Agency, “Climate Change” 10/08. www.umweltdaten.de/publikationen/fpdf-l/3625.pdf

¹³⁰ See also the Box on CCS in Section 18.

Global carbon market

There are currently numerous initiatives aiming to introduce emissions trading systems outside the EU. This raises the issue of linking the EU emissions trading to other emissions trading systems, and creating an international carbon market. By extending the scope of emissions trading, additional potential will be accessed for cost-effective reductions of emissions. Linking emissions trading systems can step by step lead to a global carbon market with a uniform price for CO₂-emissions, thus eliminating international market distortions.

However, avoidance cost savings are only one consideration when it comes to linking emissions trading systems. For example, there can also be positive effects for international climate policies, since countries with favourable emissions avoidance options will be able to benefit from the linkage to the international carbon market.

Requirements for linking emissions trading systems

When linking the EU emissions trading system with other emissions trading systems it is important to ensure that the environmental integrity of EU emissions trading system is not compromised. In the view of the UBA it is therefore essential that the entire emissions trading system has a clear cap on emissions after linkage. Some measures are incompatible with the European system, e.g. "safety valves" which above a certain certificate price offer plant operators the option of paying a 'penalty' instead of submitting permits. In this case there is no longer any guarantee that emissions of the overall system are capped. Other options may also threaten the limit on emissions and they should be examined carefully before any linking. Problematic consequences for the environmental integrity of emissions trading can also result from 'borrowing' certificates from future trading periods. CO₂-reductions from projects outside the emissions trading system can also cause problems if the standards for such climate projects are lax.

The UBA is in favour of worldwide standards for monitoring and for the quality of emissions reports which are comparable in their results with those of the European Union.

International Carbon Action Partnership (ICAP)

On the initiative of California and Germany, the International Carbon Action Partnership (ICAP) was founded in October 2007. This partnership of countries and regions that have implemented or are actively pursuing the implementation of a carbon market aims at harmonizing and linking these systems to create a global carbon market. ICAP is currently organised as a network of experts from various countries and regions. Germany has provided the project manager since 2008. As a platform for the exchange of experience, ICAP will in future play an important role in the introduction of trading systems and in establishing a consistent regulatory framework.

► Options for augmenting plant-related emissions trading by using an upstream-approach

Emissions trading is in principle suitable for achieving the necessary emissions reductions of at least 80% by 2050 at lowest costs. Therefore the Federal Government has to examine how additional sectors with large numbers of small emitters can be included in the emissions trading – e.g. by obliging extractors and importers of fossil fuels to purchase certificates. Fossil fuels would then already be restricted at the level of market introduction. This would generate incentives to avoid fossil fuels at all stages of the value creation chain (the upstream approach), including sectors not previously covered, such as private households. When implementing this approach it is important to avoid double burdens by plant-related emissions trading and requirements for certificates upstream.

Energy taxes

In the absence of comprehensive emissions trading, energy taxation remains an essential instrument for climate protection in view of the wide-ranging incentives generated. The environmental tax reform internalises environmental costs and promotes the development and marketing of energy-conserving innovations. The first reform steps from 1999 to 2003 created some 250,000 new jobs in Germany. Shifting the burden of social payments from the wage-pocket onto energy also made it possible to reduce pension insurance payments by 1.7 percentage points¹³¹.

► Developing climate-friendly energy taxation

Energy taxation should contribute to internalising the external costs of energy consumption in Germany. There are, however, depending on where fuel is used, considerable differences in the tax burden on a certain amount of CO₂ emissions. An efficient climate policy requires a more direct link between the rate of taxation and the CO₂-emissions emitted by the fuel. The Federal Government should therefore continue to develop energy taxation in this regard. Energy tax privileges for manufacturing, agriculture and forestry sectors should also be reduced in stages.

Climate damage resulting from subsidies

In the sense of a sustainable fiscal policy, environmental compatibility should be a key criterion for all political decisions on revenues and expenditures. Within the framework of an environmental fiscal reform, the Federal Government should eliminate subsidies which can lead to climate damage. There are currently many subsidies in Germany with negative impacts on climate and environment. In 2006, these subsidies totalled about EUR 42 bn¹³². Above all the subsidies in the sectors Traffic and transport (EUR 19.6 bn) and Energy sector (EUR 11.6 bn) have direct climate implications. The most urgent steps involve the removal of the tax concessions for aeroplane kerosene, tax rebates for business vehicles, commuter rebates, and the rebates on electricity and mineral oil for companies in the manufacturing, agriculture and forestry sectors.

Climate Change Act

Despite its growing importance, German climate legislation is still split up into a numbers of individual laws, making it heterogeneous and confusing. This not only makes it difficult to improve legislation, but also to find and apply specific provisions. The UBA therefore approves of the creation of a general climate change act.

Such a law would provide a framework for the entire climate change legislation. The act itself should contain general principles and provisions which would apply for all climate regulations – including those which remain outside the act itself. For example, it would require climate-friendly administrative acts. The law could harmonise concepts and contain general provisions relating to procedures and enforcement. It is also conceivable to include specific mitigation and adaptation targets, on which the Federal Government would be required to report at regular intervals.

¹³¹ Federal Environment Agency (2004): Quantifizierung der Effekte der ökologischen Steuerreform auf Umwelt, Beschäftigung und Innovation. www.umweltbundesamt.de/umweltoekonomie/index.htm

¹³² Federal Environment Agency (2008): Umweltschädliche Subventionen in Deutschland. www.umweltdaten.de/publikationen/fpdf-l/3659.pdf

Climate protection and spatial planning

Spatial planning offers considerable scope for the reduction of greenhouse gas emissions. It can contribute to energy conservation when developing settlements and traffic infrastructure, and secure areas for renewable sources of energy. The key instruments involved are the Federal Spatial specifications for the spatial planning principles, the development programmes for the Federal Laender, regional plans for the regions, and also the urban land-use planning provisions at local authority level¹³³.

► Developing Federal climate change policies

The Federal Government should specify land-use planning regulations with climate change in mind. This would allow local authorities and regions to create stable, long-term framework conditions for mitigation and adaptation measures.

► Ways of using strategic environmental assessment (SEA)

Planners at all levels should use the mandatory strategic environmental assessment measures to give greater weight to climate protection measures in Land development programmes, regional plans and land-use and zoning plans. The environmental authorities, but also the regional planning offices and construction authorities should include climate protection as a SEA criterion in planning procedures.

► Developing specific planning instructions

Some local authorities may lead the way with positive examples, but in general there is only basic awareness about how existing planning categories can be drawn on to aid the creation of low-energy spatial structures. Therefore policy-makers are to support the development of specific planning instructions for spatial and construction planners.

Local authority climate protection and national climate initiatives

Local authorities, as self-administering bodies under public law, can do a lot for climate protection on their own initiative. Good examples include the town Münster, which had reduced its CO₂-emissions by 21 % in 2006 and has now decided on a CO₂-reduction of 40% by 2020, or Munich, which intends to be emission-free by 2050, or Hanover, which by 2020 will have reduced its greenhouse gas emissions by about 1.9 million t carbon dioxide. In addition to climate benefits, the reduced use of fossil fuels also has direct advantages for the municipalities: it reduces the burdens on both the urban environment and on the public purse.

► Local and regional strategies for a sustainable energy supply

In order to systematically increase the contribution of renewables and combined heat and power generation and to make full use of available efficiency potentials, local authorities and regions should work together with relevant actors to develop strategies for a sustainable restructuring of energy supplies. In addition to offering a vision of the future energy supply system, a presentation of the starting situation and the potential for increased energy efficiency and renewables, such a strategy must also include specific steps for implementation – such as objectives, schedules and individual projects. It is to be approved by the political representatives.

¹³³ As noted in the chapter on adaptation, spatial planning can contribute to mitigation and adaptation requirements.

► **Continue national climate protection initiative – for the benefit of the local authorities**

The Federal Government should continue the climate initiative started in 2008. It can already be booked as a success that hundreds of local authorities have for the first time developed climate strategies and projects and begun to implement them. The positive results will also convince more reticent authorities to make their own efforts. Local authorities which are under budget constraints or budget supervision should be given easier access to additional funding.

Coordination of climate change instruments

Sector-specific instruments have a range of important functions in addition to climate change mitigation. They complement cross-sectoral instruments such as emissions trading and can economically tap considerable emission reduction potential¹³⁴.

► **Creating a coherent instrument-mix**

For a coherent instrument-mix it is important that the various instruments are appropriately harmonised in terms of their potential contributions to climate change mitigation. The specific objectives of the instruments must also be taken into consideration. Caps for emissions trading must therefore be determined so that they take other climate instruments into account. It is helpful and necessary to inspect sectoral emission trends regularly as well as the effects that the various climate change mitigation measures have on the emissions of the emissions trading sector.

► **Linking legislation on renewable sources of energy with emissions trading**

The law on renewable sources of energy (EEG) serves to promote renewable sources of energy and the development of a sustainable energy supply¹³⁵. Its scope is therefore much broader than promoting short- or medium-term reductions of greenhouse gas emissions. The emission reductions anticipated as a result of the EEG were already taken into consideration when determining the caps for emission trading until 2020¹³⁶. The EEG Act and emissions trading are therefore well harmonised. Only if renewables were to exceed projections for the period 2013 to 2020 could the law lead to the unintended effect of reducing the certificate price¹³⁷. However, in view of the many imponderables it is very doubtful whether this could reach a relevant dimension, so that no amendments to emissions trading provisions are necessary in the opinion of the UBA.

► **Making full use of energy-efficiency potential**

Neither rising energy prices nor emissions trading have so far fully overcome the barriers to exploiting the economic potential for reducing energy consumption. In many cases businesses and consumers lack sufficient information. Additional information and regulatory instruments are therefore needed if scope is to be created for further lowering caps for EU emissions trading.

¹³⁴ The UBA does not agree that such instruments are ineffective and inefficient with no effects beyond the emissions trading, as is sometimes claimed.

¹³⁵ Cf. Section 18.

¹³⁶ Commission of the European Communities: Annex to the Impact Assessment. Document accompanying the Package of Implementation measures for the EU's objectives on climate change and renewable energy for 2020. Commission Staff Working Document, SEC(2008) 85, VOL. II, Brussels, 27.2.2008.

¹³⁷ Kemfert und Dieckmann (2009): Förderung erneuerbarer Energien und Emissionshandel – wir brauchen beides. DIW Wochenbericht 11/2009, www.diw.de/documents/publikationen/73/96062/09-11-1.pdf

► No action needed on the links between emissions trading with energy taxation

Emissions-trading companies can find themselves directly subject to a number of overlapping regulatory instruments. However, investigations have shown that there is no general need for action on this¹³⁸. The EU Energy Tax Directive already allows tax exemptions for emissions-trading companies¹³⁹. On the other hand, there are also gaps in regulation, e.g. neither emissions trading nor energy taxation apply for shipping.

End consumers of electricity face an indirect consequence as costs are passed on in the form of higher prices. However, the overall burden in Germany – even with a multiple burden – is still much lower than the threat posed by climate change impacts due to CO₂-emissions, so that there is no need for action here either.

18. Reductions in the power sector

With a combination of energy saving, increasing demand- and supply-side energy efficiency, and the use of energy from renewable sources, Germany can reduce its greenhouse gas emissions from the power sector in accordance with the long-term mitigation requirements. This will require a structural change in the power sector and a suitable mix of instruments.

The structural change towards a sustainable power supply system must be continued. Key elements are the reduction in electricity demand by increasing efficiency, the expanded use of renewable sources of energy, and the reduction of specific greenhouse gas emissions from fossil-fuel fired power stations. New fossil power stations should therefore preferably be high-efficiency natural gas power stations with combined heat and power generation.

There is potential for a sustainable power supply both nationally and globally¹⁴⁰. Therefore it is possible in the long term to do without non-sustainable forms of power generation¹⁴¹.

Reducing the electricity consumption

The electricity generation in Germany, of which just under 60 % is fossil fuel based, accounts for some 40 % of total German CO₂-emissions. The steep rise in electricity consumption by 20 %¹⁴² between 1993¹⁴³ and 2007 has counteracted all successful mitigation measures in the power sector. The manufacturing industry and the commerce, trade and services sector together consume some 70 % of electricity. Their combined power consumption has increased over the above mentioned time period by about 25 %. Private households consume about a quarter of electricity, while their increase in electricity

¹³⁸ Federal Environment Agency (2008): Weiterentwicklung des Emissionshandels – national und auf EU-Ebene; Federal Environment Agency-Texte, No. 03/08.

¹³⁹ Non-manufacturing energy using plant operators receive no tax exemptions, but they are very few in number.

¹⁴⁰ Cf. Section 29

¹⁴¹ Cf. Nitsch et al. (2008): Leitstudie 2008. Weiterentwicklung der "Ausbaustrategie Erneuerbare Energien". (for Federal Environment Ministry). The study shows how Germany can reduce GHG emissions by 2050 by about 80 % compared with 1990 while withdrawing from nuclear power and without CCS. Cf. Greenpeace/EREC (2008): Energy (r)evolution. This study has a scenario in which by 2050 global CO₂-emissions can be reduced by 50% compared with 1990 without nuclear power or CCS.

¹⁴² AG Energiebilanzen e.V. (2008): Auswertungstabellen für D. 1990 - 2007.

¹⁴³ www.umweltdaten.de/publikationen/fpdf-l/3191.pdf: Analyses of energy efficiency expressed relative to 1993, after the collapse of the east German economy.

consumption during the same time period was below average.

Numerous studies show that there are economical ways to reduce power and fuel consumption in Germany¹⁴⁴. If full use were made of these opportunities in all consumption sectors then, in addition to offering economic benefits to the end consumers, greenhouse gas emissions could be reduced by between 110 and 130 million t CO₂-equivalents by 2020.

More than half of the reductions, about 70 million t CO₂-equivalents, are attributable to cost-cutting electricity savings totalling about 110 terrawatt-hours (TWh) per annum¹⁴⁵. If consumers immediately were to begin making full use of these opportunities to reduce power consumption, then they could achieve these electricity reductions in about ten years, with annual financial savings of nearly EUR 10 bn. Since there are various barriers to the reduction of electricity consumption, a coherent instrument mix is required.

► Integrating ambitious energy efficiency standards in the Ecodesign Directive

The Federal Government should endeavour to ensure that ambitious, dynamic efficiency standards (top-runner principle) are developed for electric equipment in the implementation of the EU Energy-related products Directive (2009/125/EC). These efficiency standards should always be based on the most effective and efficient products and technologies, and they should be unbiased towards specific technologies. The efficiency standards should be re-examined regularly according to a product-specific schedule and upgraded where appropriate. These dynamic efficiency standards should be linked to the energy label.

► Improved energy labelling

The Federal Government should work within the EU for clear, consumer-friendly energy consumption labelling. The objective should be:

- To adapt the implementing regulations for the energy labelling of domestic appliances, taking into account technological developments;
- To improve synchronisation of the Labelling and Energy-related products directives;
- To introduce energy labelling for further energy related products, by means of implementing measures
- To allow dynamic, clear and user-friendly energy labelling, with regular updating so that the most energy efficient appliances are in the best efficiency class.

► Improving market surveillance

The efficiency requirements of the Energy-related products Directive must be enforced effectively¹⁴⁶. In addition:

- The Federal Government should extend the mandate of an existing institution (e.g. *Stiftung Warentest* – consumer association) or establish a new institution;
- This institution should then support the Federal Laender with information;

¹⁴⁴ Cf. Wuppertal Institut für Klima, Umwelt, Energie (2006): Optionen und Potenziale für Endenergieeffizienz und Energiedienstleistungen. For E.ON AG, 23 May 2006; McKinsey & Company (2007): Kosten und Potenziale der Vermeidung von Treibhausgasemissionen in Deutschland. For BDI, September 2007; Prognos AG (2007): Potenziale für Energieeinsparung und Energieeffizienz im Lichte aktueller Preisentwicklungen. For the Federal Economics Ministry, 31 August 2007.

¹⁴⁵ This represents about a fifth of total electricity consumption, or the output of some 20 new 800 MW base load coal-fired power stations.

¹⁴⁶ The Federal Laender will be responsible for the enforcement in Germany. The budgetary constraints and poor precedents suggest that few inspections will be carried out and the public will receive little information about non-compliance. The ICSMS (www.icsms.org) does inform about market surveillance, but only limited amounts of information can reach the public. Consumers (and the media) can not find out which products do not satisfy which requirements, so they cannot exert any pressure on the market.

- The institution should also regularly publish test results, naming manufacturers and products.

► Encouraging environmentally-friendly public procurement

The public sector should make full use of opportunities to acquire environmentally-friendly products in accordance with EU acquisitions directives and national acquisition legislation¹⁴⁷. To this end, the Federal Government, Laender and local authorities should make detailed information available for the relevant personnel and offer them further training. In the view of the UBA, the expenditure of at least a part of the public budgets at all levels of administration should be made dependent on compliance with demanding environmental criteria.

► Introducing obligatory energy management

The Federal Government should begin step-by-step to introduce obligatory energy management systems for all manufacturing companies¹⁴⁸. A demanding "Energy efficiency Act" could oblige companies to make up for existing information deficits and to critically review their energy efficiency measures. It is reasonable to expect at least large manufacturing companies to employ energy experts to carry out the necessary energetic analyses of operating locations. As soon as reliable energetic analyses are available for an individual location, including possible energy conservation measures and their amortisation periods, the companies will implement measures which seem to them to offer direct economic benefits. These can be expected to lead to a reduction by about 10%¹⁴⁹ of the greenhouse gas emissions due to industrial power and fuel consumption.

► Fully implementing all further power conservation measures of the IEKP

The Federal Government should fully implement all electricity saving measures contained in its Integrated Energy and Climate Programme (IEKP) in Section 7 "Support programme for climate protection and energy efficiency". It covers support for energy efficiency consultancy in various sectors, improved risk cover for energy conservation contracting and the marketing of highly efficient and climate-friendly technologies for use in appliances and the transport sector.

Expanding power generation from renewable sources

The most important instrument in Germany for the expansion of renewable sources of energy is the Renewable Sources of Energy Act (EEG). Among other things it is intended to allow the sustainable development of energy supplies, to reduce the macroeconomic costs of power generation and to promote the development of energy technologies for the using renewable energy sources. In the EEG 2009, legislation set the target for 2020 to at least 30%, after which there will be continued expansion. The EEG makes a key contribution to climate change mitigation. In 2008 it led to the reduction of CO₂-emissions by about 56 million t. The law also provides important economic impulses. In 2008, the sector employed 278,000 people and generated revenues of EUR 28.7 bn.

In the long-term, the provision of power from renewable sources will cross the profitability threshold and will therefore no longer be dependent on EEG-support. The *Leitstudie*

¹⁴⁷ This has a triple benefit: It acts as a model, significantly reduces electricity consumption, and boosts the market availability of highly-efficient electrical appliances.

¹⁴⁸ CEN has developed an EU standard for energy management systems, (EN 16001) which is to be compatible with environmental management systems in accordance with ISO 14001. At ISO, work has begun on an international standard for energy management systems.

¹⁴⁹ According to energy consultants and contractors, some of whom guarantee to reduce energy costs by at least 10% (e.g. www.koflerenergies.com).

2008¹⁵⁰ expects this for wind power in 2019 and for biomass in 2023.

► **Market integration of renewable sources of energy by accelerating further development in the EEG.**

An efficient integration of renewables in the power supply not only requires considerable adapting the network infrastructure (see below), but also requires adapting the fossil-fuel power stations. In order to generate the necessary price signals, renewable energy sources must be integrated into the markets. This must at the same time ensure the necessary growth of the renewable energy sector.

A current problem is the lack of transparency in the “refinement” from a largely fluctuating renewable energy supply, to a steady “monthly band”, as part of the distribution mechanism¹⁵¹. This obscures market signals generated for example by the fluctuations in wind power, so that there is a lack of stimulus for necessary complementary investments, e.g. in highly-flexible peak load power stations or storage power stations.

The amended EEG Act is intended to eliminate the weaknesses in the compensation mechanism¹⁵². The power to pass relevant ordinances should be used effectively and without delay. In addition, the Federal Government should create financial incentives for the ‘feed in’ of electricity generated using biomass, in particular during power short-ages¹⁵³.

► **Accelerating the use of offshore wind by developing the EEG legislation**

The difficult offshore conditions – distance from the coast, deep seas and difficult conditions for maintenance of wind turbines– result in lengthy project development phases and high investment and insurance costs which continue to delay the offshore wind-power generation. The improved provisions of EEG 2009 seem to make the projects economically viable. The Federal Government should continue to observe this development, in order to be able to introduce further amendments to the EEG Act or to improve the instruments accompanying the expansion of the power network.

► **Using the scope of regional planning and construction planning regulations to expand wind-power use on land**

Planning authorities must give up restrictive attitudes and rigid methods by allocating sufficient numbers of suitable sites for land-based wind-power generation, while still taking into account the interests of local residents and other environmental concerns. For example, there should not be strict limitations on the height and spacing of wind power generators nor should forest land generally be excluded for potential wind parks. Instead such decisions should be taken on a case-by-case basis.

► **Introduce regional underground planning with priority for sustainable uses**

There is considerable potential for the use of geothermal energy in Germany. In particular, the ability of geothermal electricity and thermal energy to provide base load, means geothermy could play an important role in the future German energy mix. Certain geo-

¹⁵⁰ Nitsch (2008)

¹⁵¹ The distribution mechanism (*Wälzung*) implemented the obligation of the transmission system operator to accept power from renewable sources. This is passed on proportionately to all power supply companies at constant monthly rates. The trading of transmission system operators with dealers to establish monthly bands is not transparent and the EEG power is withdrawn from the general power market.

¹⁵² Instead of the “physical” transfer of power from renewable sources to the power supply companies, the transmission system operator or third-parties are to take on responsibility for the direct marketing of EEG-power on the energy exchange.

¹⁵³ In contrast to the fluctuations of renewable sources of energy, biomass can be stored and used to generate power when required.

logical regions such as the north-German basin are suited in various places for both CO₂-storage as well as for geothermal use. The Federal Government should solve the problem of competing uses by means of regional underground planning on the basis of geological features, infrastructure and various economic and environmental criteria. Such planning decisions would require much more detailed knowledge of subterranean conditions. Giving priority to sustainable uses, as the UBA recommends, would mean that sites suited for geothermal power generation would only be available for CO₂ storage to a limited extent, if at all¹⁵⁴.

Network integration of energy from renewable sources

The integration of greater proportions of energy from renewable sources into the power supply will require increased involvement of both supply and demand sides in the load distribution as well as in the preparation of standby energy. Widespread European equalisation offers considerable potential for balancing out fluctuations in supplies of energy from renewable sources. It is also necessary to expand the European and regional power grids and construct highly-flexible low-emission fossil-fired power stations to cover the residual load¹⁵⁵.

The key question is not how much energy from renewable sources can the electricity system cope with, but rather how can power from renewable sources be integrated as effectively and cost-efficiently as possible?

► Increased use of load management¹⁵⁶

Demand management by means of increased short-term price elasticity makes it possible to smooth out demand and reduce peak loads. This offers macroeconomic advantages in comparison with investments in new power stations.

The two key preconditions for the increased use of load management are time-variable, demand-related consumer tariffs and the introduction of an appropriate metering, information and communications infrastructure ('smart metering'). The on-going technological and regulatory changes in metering systems make it possible for consumers of power to respond more directly to market influences. The Federal Government should accelerate this process.

► Supporting increased power storage

The integration of fluctuating supplies of power from renewable sources can be improved by means of additional storage capacities. The Federal Government should provide support for research into new storage technologies which are not yet economically viable, such as compressed-air energy storage.

► Expanding the national and European power grids

National and European power grids must be expanded and bottlenecks eliminated in order to ensure the continued integration of power from renewable sources, and to create a European electricity market. This would make it possible to reduce overcapacity while lowering the necessary reserve capacity. It would also offer considerable potential

¹⁵⁴ Wuppertal Institut et al. (2007): RECCS – Strukturellökonomisch-ökologischer Vergleich regenerativer Energietechnologien (RE) mit Carbon Capture and Storage (CCS). Projektbericht. Federal Ministry for the Environment, Nature Conservation and Reactor Safety, Berlin (ed.).
www.bmu.de/files/pdfs/allgemein/application/pdf/reccs_endbericht_lang.pdf

¹⁵⁵ The "residual load" covered by conventional power stations is the difference between the total load and the energy provided from renewable sources.

¹⁵⁶ Load management is already used in the manufacturing sector. There is further potential in trade and commerce, and private households, particularly for refrigeration and heating applications.

to equalise fluctuations in the power fed in from renewable sources, and thus increase their contribution to the energy sector.

Network operators should expand the power grid in accordance with public interests and environmental considerations. Underground cable should be used where possible, even if the costs are higher than for overhead power lines, provided that this leads to a significantly lower environmental impact.

An important reason for the slow progress in setting up the inner-German grid is the lengthy planning application procedures and the resistance of local residents, who see their quality of life threatened. The Electricity Grid Expansion Act¹⁵⁷ is intended to simplify and accelerate planning approval procedures. If the expansion of the power grid fails to proceed at the necessary speed after the act comes into force, then suitable amendments must be considered.

► Establishing a transcontinental power network

Power generated from renewable sources¹⁵⁸ also offers regions in North Africa and West Asia considerable potential for climate change mitigation and opportunities for economic development. A transcontinental grid will be required in order to integrate this power in the long-term into European power supplies. This offers great potential for equalising regional fluctuations in power from renewable sources, and the Federal Government should support the necessary multinational cooperation.

Adapting fossil-fired power plants

According to a recent UBA study, there will be no need in the next decade for additional fossil-fired power plants without combined heat and power generation beyond those already under construction¹⁵⁹. This applies even given withdrawal from nuclear power and conservative assumptions about the expansion of power from renewable sources, combined heat and power, as well as about the development of power consumption in the near future. There is no need to increase power station capacity in the coming years in order to ensure the security of supplies. The existing fossil-fired power plants should therefore be adapted primarily in order to meet the requirements of climate policies and sustainable development.

The further expansion of power from renewable sources and the demand for increased energy efficiency means that the conventional power plant will face new challenges to cover the residual load. For example, although the fluctuating feed from wind-power generation does not represent base load capacity, it does considerably reduce the residual base load, i.e. the part of the base load which has to be covered by conventional power stations. The overall expansion of renewables will significantly reduce the future need for conventional base load power stations – that is power stations with high utilisation periods, such as nuclear power stations or new coal-fired power stations. This means that in the long-term there will be additional demand above all for peak-load and reserve power stations, and possibly also for medium-load power stations as a replacement for existing plants.

¹⁵⁷ The Electricity Grid Expansion Act was passed by the Bundestag on 7 May 2009.

¹⁵⁸ E.g. solar-thermic power stations in North Africa or wind power generation in west Siberia

¹⁵⁹ Klaus et al (2009): Klimaschutz und Versorgungssicherheit. Federal Environment Agency, in "Climate Change" No. 13/2009. www.umweltdaten.de

Carbon Capture and Storage (CCS)

There is considerable need for research and development throughout the CCS chain, and industrial applications are not expected before 2020 at the earliest. The UBA favours proceeding only after most careful scrutiny of suitable storage sites. Only then will it be possible to make reliable statements about the extent to which CCS can reduce CO₂-emissions.

Even if technically feasible, the CCS technology has some disadvantages:

- CCS occupies underground space permanently, so that this is no longer available for other uses such as geothermal power or compressed-air energy storage.
- The additional fuel consumption depletes fossil fuel resources more quickly.
- Even in the best case, throughout its process chain, CCS impacts public health and the environment, e.g. by requiring additional mining activities, and depending on the method of capture used, it can also require additional cleaning agents and water.
- Leaks, displaced formation water, ground disturbances, and accidents along the process chain can pose risks for groundwater, oceans, soils, flora and fauna, and humans. Even small leaks can offset the climate benefits of CCS.
- CCS is most suited for large power stations fuelled by coal or lignite, which are mainly operated or planned as base load power stations. But CO₂-capture will reduce the limited flexibility of the coal-fired power stations even further. In the future, however, flexibility will be necessary, in particular for new plants, in order to maintain security of energy supplies.
- Given the lack of experience with the CCS chain, the unknown relationship between costs and climate benefits, and the aversion to the above-mentioned risks, it is to be expected that there will be public acceptance problems.

For these reasons, the UBA finds it doubtful whether the capture and storage of CO₂ can make a significant contribution to climate change mitigation. CCS with fossil fuels is not sustainable, rather is a transition technology at best¹⁶⁰.

In order to meet long-term climate targets, however, it is also necessary to achieve drastic emissions reductions in the manufacturing sector. The limited potential CO₂ sinks should therefore be used primarily to reduce process-related emissions (e.g. from steel and cement production) and possibly for a decarbonisation of the atmosphere, in accordance with the precautionary principle, until more is known about the capacity of CO₂-sinks.

In future, fossil fuels will have to be used more efficiently, with a shift to less CO₂-intensive fuels. Efficiency can be increased in particular with combined heat and power generation. This allows utilisation efficiency of up to 90%¹⁶¹. This plays an important role for climate change mitigation, economic efficiency and resource conservation.

Most existing and planned power stations, however, are dedicated to power generation. A review of long-term European climate targets and the specific CO₂-emissions of these power stations shows: 1) The average specific CO₂-emissions in 2050 should be less than a third of current levels, i.e. below 150 g/kWh_e. 2) Although new coal-fired power stations are much more efficient than older plants, and therefore have lower CO₂-emissions per kilowatt-hour generated, the CO₂-reductions are not of the magnitude required for climate change mitigation. 3) Of the fossil-fuel alternatives without CCS, only the replacement of old coal and lignite power stations by new high-efficiency natural gas-fired gas and steam-turbine power stations can offer sufficient CO₂-reductions in the medium term.

¹⁶⁰ Federal Environment Agency (2009): CCS – Rahmenbedingungen des Umweltschutzes für eine sich entwickelnde Technik. www.umweltdaten.de/publikationen/fpdf-l/3804.pdf

¹⁶¹ With a coincidence of power and heating demand.

The European emission trading scheme offers economic incentives for the increased use of less CO₂ - emitting fuels¹⁶². It limits the EU-wide emissions of fossil-fuel power stations and industry. However, companies have to decide for themselves which measures they adopt to reduce emissions. Therefore, the EU emission trading scheme ensures that emission reduction targets are achieved at the EU level, but not necessarily at the national level¹⁶³.

► **Intensifying information on the modernisation of CHP plant**

Since the utilisation of thermal energy is a key limiting factor for the combined generation of heat and power, older CHP plants should be replaced by more efficient ones in order to increase the level of power generated in relation to the heat energy produced. Industrial CHP plants which went into operation before 1979¹⁶⁴ typically have a power to heat ratio of only about 0.35, whereas modern CHP plant can achieve a ratio of approximately 1. If it is possible to exploit this potential through the new Act to Promote combined heat and power generation (CHP Act), it would almost triple the CHP-power generated by these plants. The Federal Government should provide more information about the CHP technology and the new support offered under the CHP Act.

► **Examining the effects of the CHP Act and making necessary adjustments**

In the opinion of the UBA, the CHP Act in its current form may not ensure that cogeneration accounts for 25% of the power generated in 2020. The Federal Government must monitor developments in order to be able to make timely adjustments to the conditions under which support is provided, as necessary. This also applies for smaller district heating power stations up to 50 kW_{el} which, according to the guidelines for the support of mini-CHP plants, dated 1 January 2009, are entitled to rating-related support for investments.

► **No support for inflexible, emissions-intensive base load power stations**

The increased availability of energy from renewable sources will significantly reduce the demand for conventional base load power stations. In addition to the rapidly growing proportion of renewables, a highly-flexible, low-emission fossil-fired power park will also be necessary in the future. In the public debate, the arguments for the extension of the operating life of nuclear power stations or the funding of new, base load coal-fired power stations are not only superfluous, but lead in the wrong direction. The Federal Government should therefore neither extend the operating lives of nuclear power stations nor support the construction of new, base load coal-fired power station with cogeneration.

► **Restructuring the German power station park**

If it becomes apparent that the signals provided by emission trading are not sufficient to ensure the sustainable development of Germany's power stations, which will involve a massive reconstruction of coal-fired power stations, the Federal Government must consider further regulatory instruments, such as limit values, in order to reduce the greenhouse gas emissions from fossil-fuel power stations.

¹⁶² Cf. Section 17

¹⁶³ The need for national targets is discussed in Section 16.

¹⁶⁴ Accounting for 30 % of the installed capacity of industrial cogeneration plant

19. Reductions in the heat sector

With a reduced energy demand for the heating of buildings, a more efficient provision of thermal energy, as well as the increased use of renewables for heating purposes, Germany can significantly reduce its greenhouse gas emissions. In order to access this reduction potential of at least 17 million t CO₂, a further development of mitigation instruments is necessary.

The heating market in Germany is based mainly on fossil fuels and is responsible for 40% of energy-related CO₂-emissions. However, the contribution of renewables to the heating market is increasing. In 2007, they provided 7.5 % of total energy consumed. The Federal Government has committed itself to increase this figure to 14% by 2020¹⁶⁵.

If full use is made of the considerable potential for reducing CO₂ emissions from the existing housing stock, then by 2020 the emissions of greenhouse gases could be reduced by some 31 million t CO₂-equivalents. However, this would require considerable efforts, without which there will probably be a shortfall in reduction goals by some 17 million t CO₂-equivalents¹⁶⁶.

The long-term climate protection goals through 2050 require a drastically reduced energy demand for buildings as well as an efficient provision of thermal energy, drawing mainly on renewable sources¹⁶⁷. Extended local heating networks are of key importance for the efficient use of biomass, deep geothermal energy, and solar thermal energy. In order to compensate for seasonal fluctuations, both in the availability of solar energy and heating requirements, it will be necessary to integrate larger external heat storage systems into the heating supply system.

Minimum standards for energy efficiency and the utilisation of energy from renewable sources

► Further tightening the energy conservation ordinance

The 'Passive House' Standard is not only applicable to new buildings, but is also technically feasible for existing ones, and this is indeed desirable in terms of energy consumption in order to achieve climate protection targets. To achieve this, it is necessary to implement further tightening measures proposed under the Energy Saving Ordinance (Energieeinsparverordnung, EnEV) – by 2012 increasing efficiency by an average of 30% and in the medium-term (by 2015) achieving 'passive-house' levels for new buildings. Modernisations should use passive house components by 2018 at the latest¹⁶⁸. It would considerably ease the situation if the requirements for economic efficiency in the Energy Conservation Act (EnEG, Section 4.3) were specified. Amortisation should be over an appropriate period reflecting the realistic lifetime of the construction components.

So far, the requirements of the EnEV only apply to new buildings or complete refurbishments. With a broader formulation of the economic efficiency requirements it would also be possible to include a provision in the EnEV for the retrofitting of all existing buildings

¹⁶⁵ Nitsch (2008); Anteil erneuerbarer Energien: BMU (2008): Erneuerbare Energien in Zahlen. Nationalen und internationalen Entwicklungen. Internet Update. p. 8. Ausbauziel: IEKP, Eckpunkt 14.

¹⁶⁶ Figures from "Projektionsbericht 2009 gemäss Entscheidung 280/2004/EG", http://cdr.eionet.europa.eu/de/eu/ghgpro/envsgwza/Projektionsbericht_DE_2009.doc/manage_document

¹⁶⁷ In the main scenario by Nitsch (2008), renewables supply half of the heating energy still required in 2050.

¹⁶⁸ Municipalities such as Münster and Freiburg already require passive house standards for new buildings on public land.

within the medium-term. For example, a building which does not comply with the Heat Conservation Ordinance 1995, would have to be improved to the EnEV 2012 standard by 31 December 2019.

► Improving enforcement of the Energy Conservation Ordinance

It is estimated that only about 60 % of the required energy savings are actually being achieved¹⁶⁹. This indicates that controls by the responsible federal state authorities are inadequate and that enforcement regulations are sometimes only rudimentary. The Federal Government should therefore specify key provisions for improved enforcement, e.g. random tests of at least 2% of building projects, and scrutiny of the documentation required under the Ordinance¹⁷⁰. The EnEV should include penalties for architects for certain violations.

► Extending the Renewables - Heat Act (EEWärmeG) to include existing buildings

The limitation of the requirement to use biomass, solar energy, ambient and geothermal heat to new buildings considerably limits the effectiveness of the EEWärmeG. The UBA therefore approves of the inclusion of a requirement to use energy from renewable sources when existing buildings are being refurbished.

Financial support for a sustainable heating market

Support programmes can provide a stimulus for energy refurbishment. The Federal Government should continue until 2020 and beyond to provide high levels of support for energy efficiency and energy from renewable sources. By means of regular, detailed evaluations and demanding conditions for the provision of support it should be ensured that refurbishment work is effective. The support programmes are to be continuously harmonised.

► Enhancing the KfW-Programme for energy-efficient refurbishment

The Federal Government should maintain the current levels of support until 2020 and beyond¹⁷¹. The conditions of support should be extended to cover full refurbishment of buildings – when appropriate in a stepwise manner. In the opinion of UBA, individual measures should only be supported if they form part of a “refurbishment timetable” for the energy refurbishment of the entire building. This is the only way to avoid problems such as mould formation in air-tight buildings. Systematic advice and support should be provided for investors so that they are able to achieve the necessary high standards of refurbishment for their buildings.

► Incentives to feed heat from renewable sources into heating networks

Large plants should feed in heat from renewable sources as a priority into district and local heating networks, and this should be rewarded with a bonus, e.g. from the MAP market incentive programme. This would be a useful addition to the support of small energy plants under the MAP programme, the requirements of the EEWärmeG, and the heat bonuses of the Act on Energy from Renewable Sources (EEG). Even with heat bonuses, the co-generation of electricity must remain economically attractive for the plant operators.

¹⁶⁹ Kleeman and Hansen (2005): Evaluierung der CO₂-Minderungsmaßnahmen im Gebäudebereich. Research Centre Jülich - Reihe Umwelt 60, 82 p.

¹⁷⁰ Certificates are usually provided by companies or experts acting for the property owner, who are therefore not impartial. Despite of this their accuracy is so far not checked.

¹⁷¹ For 2009, EUR 1.5 bn. is available for interest reductions and subsidies, and EUR 1.4 bn. from 2010 to 2011

► Promoting the extension of local and district heating networks

The Federal Government should draw up a national plan for the expansion of heating networks – similar to the Federal Transport Infrastructure Plan. This would provide a basis for additional programmes to promote the expansion of local and district heating networks.

► Tax rebates for refurbishing property after purchase

To increase tax deductibility, the costs for refurbishment and modernisation of newly purchased real-estate property should no longer be regarded as part of the cost of the purchase for income tax purposes¹⁷². Investors would then be able to write off the costs either immediately or over two to five years. This would provide a considerable incentive for energy refurbishment.

Rent Law

Rent Law contains important provisions regarding the refurbishment of buildings. These should be extended in order to improve the conditions relating to energy refurbishment.

► Introduction of environmental rent tables and energy-based comparison rents

In the past, the energy efficiency of buildings has not played an important role in local authority rent tables (*Mietspiegel*). Environmental rent tables include the energetic quality as a factor for justifying rent increases, improving market transparency and the economic viability of energy conservation investments¹⁷³. The Federal Government should therefore provide financial incentives for the inclusion of “energetic status” as a parameter in local authority rent tables.

In order to cover all local authorities, a Section 558.2a should be added to the German Civil Code (BGB) to provide the legal basis for the general consideration of energetic characteristics when establishing local rent comparisons.

► Rent surcharge for energetic improvements

The UBA also recommends that instead of the existing rent surcharge of 11% of modernisation costs (Section 559 BGB), landlords should be permitted to levy a “lump-sum surcharge for energetic improvements”. This would considerably improve planning security for the landlord, because it would not be necessary to provide evidence of the level of refurbishment investments to tenants individually. The Civil Code should link the surcharge to proof that the energetic requirements of the EnEV are (over-)fulfilled, and that the rent increase will be balanced within an appropriate period by the lower costs of energy consumption.

20. Reductions in the transport sector

With a combination of behavioural changes, alteration of the infrastructure and technical measures, Germany can reduce greenhouse gas emissions caused by the transport sector. In addition to vehicle-specific reductions, the Federal Government must above all limit the rise in traffic volumes.

¹⁷² This would be achieved by repealing Section 6.1 No.1a Income Tax Act (EStG).

¹⁷³ Positive examples such as the rent table in Darmstadt show that landlords can cite energy refurbishment to justify rent increases. The data for new environmental rent tables can use the energy passes for buildings where these are available. The legislators should require landlords to hold such a pass based on energy requirements, rather than allowing the documentation of past energy consumption.

In contrast to other sectors, traffic-related CO₂-emissions in Germany only fell slightly between 1990 and 2007. As a result the contribution of traffic to total German CO₂-emissions rose in this period from 15.7 to 18.4 %. This is due primarily to an increase in traffic¹⁷⁴. Freight traffic rose by 66 % between 1991 and 2007 and private transport by 26%. This rise almost completely offset the successful vehicle-specific reduction of emissions. Therefore, in addition to instruments to reduce emissions from individual vehicles, the Federal Government will increasingly need to adopt measures to avoid or to shift traffic.

The CO₂-emissions of the transport sector can be reduced significantly by means of a series of instruments. This requires the adaptation of settlement and transport planning, increased promotion of environmentally appropriate means of transport, adaptation of economic instruments, improvement of vehicle efficiency, and influencing of consumer behaviour.

Settlement and transport planning

► Reorientation of settlement and transport planning

The Federal Government, Laender, and local authorities should respond to steadily increasing length of trips by making changes to regional planning strategies in order to reduce induced transport requirements. The changes should include in particular planning for a “city of short routes”, the integration of transport and settlement planning, and the avoidance of traffic-inducing road construction.

► Strengthening regional economic cycles

Within the framework of economic development, the Federal Government and Laender should take into account the consequences of locating manufacturing companies on traffic. A goal of economic development should be to support low-traffic trading ties. The regional and economic development plans and projects should be subjected to examinations of their impact on traffic and transport.

Climate- and environmentally-friendly urban transport

► Efficient public transport

Improvements to infrastructure and services can improve the image of public transport and make it more user-friendly and acceptable. In addition, local authorities should give public transport a higher priority than private traffic on roads. Special bus lanes and priorities at crossings would make public transport faster, especially in inner cities. Traffic guidance systems and restrictive parking management would also encourage a switch to public transport. Funding for public transport from the Federal Government and the Laender should be output-oriented – on the basis of performance indicators such as distances travelled, occupancy rates, passenger numbers, and customer satisfaction. Even in the event of public budget constraints, this makes it possible to achieve considerable improvements to the efficiency of public transport.

► Promoting cycling and walking

The Federal Government, Laender and local authorities should make cycling and walking more attractive by improving bikeways and pathways. In doing so it is important to increase the safety of cyclists and pedestrians in street traffic. Improved services should also be offered for cyclists, such as bike parks at public transport stops and stations, and

¹⁷⁴ In road traffic statistics the term “vehicle flow” is used.

links with public transport services. The advantages of cycling and walking – improved health and fitness, greater flexibility and mobility, etc. – should be highlighted in marketing strategies. Target-group specific educational and promotional work should be carried out – also taking aspects of gender equality into account – in order to improve the image of these forms of mobility and to better integrate cycling and walking into everyday life.

Fiscal instruments

In addition to the further development of cross-sectoral energy taxes (see Section 17) additional transport-related fiscal adaptations should also be implemented.

► Further development of freight vehicle tolls

The Federal Government should extend road tolls to smaller commercial vehicles above 3.5 tonnes (currently above 12 t) and for all roads (currently only motorways). In addition, toll levels should take all environmental, health and accident costs (currently only road costs) into account. Accompanying measures are also required in order to develop the full avoidance and transfer effects of this instrument.

► Adapting taxation on company cars

Tax privileges for company cars encourage their use and increase the climate impact of traffic. In future, taxes on the private use of company cars should be linked to the vehicle-specific CO₂-emissions.

Improving vehicle efficiency

► Making more use of the potential for reductions with a CO₂ strategy

In the opinion of the UBA, the EU Regulation on the reduction of CO₂-emissions for new passenger cars is not adequate. According to the regulation, CO₂ limit values for cars will be phased in from 2012 to 2015. The limit value will only apply from 2015 onwards and even then the average CO₂-emissions of new cars in Germany will at best be limited to 140 grams CO₂ per kilometre (g CO₂/km). But the necessary technology to achieve the original target of 120 g CO₂/km is already available. The EU Regulation does not make full use of the potential for energy conservation from the perspective of environmental and economic policies. The Federal Government should demand a binding regulation at EU-level for a long-term target of 95 g CO₂/km for 2020.

► Making low-viscosity oils obligatory

Low-viscosity oils reduce friction losses in vehicle engines and lower fuel consumption. The Federal Government should work within the EU for binding requirements to use low-viscosity oils in all vehicles where this is a technical option.

Influencing consumer behaviour

► Improving CO₂-labelling for cars

In order to increase incentives to purchase cars with low fuel consumption, the Federal Government should introduce consumer-friendly CO₂-emissions labelling for new motor vehicles. This could be similar to the colour-coded efficiency-classes already used for domestic appliances.

► Low rolling resistance tyres should be fully and uniformly labelled

New material mixes and improved technologies make it possible to produce tyres which are quieter and which significantly lower fuel consumption. In order to add impetus to their market penetration, the Federal Government should work towards full, EU-wide la-

belling of low-rolling resistance tyres. This increases consumer awareness and thus supports rapid market penetration. An EU Tyre labelling regulation is currently being negotiated.

► **Speed limit of 120 kilometres per hour (km/h) on motorways**

The Federal Government should introduce a permanent maximum speed limit of 120 km/h (75mph) for all motorways. This would significantly reduce fuel consumption.

21. Reductions in agriculture and with F-gas emissions

Through reductions in reactive nitrogen emissions, the conservation of natural carbon sinks as well as the expansion of organic farming, agriculture can contribute to reducing greenhouse gas emissions and to CO₂ fixation. There are already alternatives to fluorinated compounds which are extremely potent greenhouse gases. In order to ensure the widespread use of alternatives, existing regulation must be rigorously implemented and tightened where necessary.

Agriculture

Under the common reporting format (CRF) agreed under the Kyoto Protocol, agriculture contributed to about 5.4 %¹⁷⁵ of all greenhouse gas emissions in Germany. The greenhouse gases emitted by agriculture include methane from animal husbandry (namely ruminants), and the storage of farm manure, as well as nitrous oxide from the microbial transformation of nitrogen compounds in fertiliser, and the indirect climate effects of ammonia from animal husbandry and farm fertiliser management. In addition, the synthesis of mineral nitrogen fertiliser consumes considerable amounts of energy. However, the climate impact of this is attributed to the chemical industry. Farming activities can also lead to soil carbon being released into the atmosphere as CO₂, as a result of the degradation of humus, in particular from the clearance of moorland for land-use and forestry. Measures to reduce greenhouse gas emissions in agriculture must be oriented on the biological processes which lead to its release.

Forests can act as an effective sink for CO₂ if less wood is extracted each year than the new growth for the year, which was the case in Germany between the two national forest inventories of 1987 and 2002.

► **Implementing measures from the nitrogen emissions reduction strategy**

The Federal Government should implement measures from the nitrogen emissions strategy developed by the UBA¹⁷⁶. In the opinion of the UBA these should include the following measures:

- Optimum fertilisation in terms of the point in time as well as the amounts of fertiliser used. The Fertiliser Ordinance should be made stricter by lowering the permissible balance excess. A short-term objective should be to harmonise the excess under the Fertiliser Ordinance for the area balance (without ammonia emissions) with the target under the sustainability strategy of the Federal Government of 80 kilograms per hectare (kg/ha) for the farm-gate balance (including ammonia emissions);

¹⁷⁵ In 2007, according to the reporting under the Climate Framework Convention (GHG inventory 2009).

¹⁷⁶ Cf. www.umweltbundesamt.de/luft/downloads/emissionen/stickstoffemissionsminderungsstrategie.pdf and www.umweltbundesamt.de/luft/downloads/emissionen/hg-stickstoffemissionsminderungsstrategie.pdf

- Examination of a tax on nitrogen excesses in order to reduce nitrogen losses in animal husbandry;
- Technical improvements in animal husbandry with regard to stalls and storage of liquid manure, which also form a key part of the Federal Government's Ammonia Reduction programme, for example fodder which is adapted to meet the protein requirement and the reduced use of urea fertiliser;
- Increased "cascade use" of manure. This involves first using manure slurry in a biogas plant to generate electricity, and then using the residue as fertiliser. Co-generated heat should also be utilised.

► Increased restrictions on ploughing under Cross Compliance rules

Greater restrictions should be placed on ploughing up sensitive sites and wetlands, for example moors or flood plains, in accordance with the single-payment requirements (cross compliance¹⁷⁷), with the goal of reducing the greenhouse gas emissions which are caused by ploughing permanent pasture and converting it to arable land.

► Extending areas for organic farming

Organic farming contributes to environmental protection and climate change mitigation, because less rapid-acting artificial nitrogen fertiliser is used and the soil is disturbed less. At the national level, the "Federal Organic Farming Programme" should be continued, and within the European Union, it should be considered whether funds are available under Pillar II of the Common Agricultural Policy in order to more efficiently implement the EU Actions Plan for Organic Food and Farming, which has so far not had its own budget.

To stimulate the demand side, suitable educational measures and campaigns should be organised to promote sustainable consumer behaviour, for example nutritional education in schools and child day-care institutions. As a priority, the use of organic products should be increased for example in public canteens, hospitals and schools. Currently the demand for organic products in Germany already considerably exceeds domestic production. The emphasis of the national measures to promote organic farming should therefore be placed at present on promoting the transition of farm operations to make the best possible use of the existing demand to benefit domestic organic agriculture¹⁷⁸.

► Increased role for plant products in nutrition

Increasing the focus of human dietary consumption to include more plants can make a substantial contribution towards achieving climate targets. This makes it possible to reduce nitrous oxide and methane emissions from animal husbandry and reduces the areas needed for fodder cultivation, so that forests can be extended which will fix carbon dioxide. However, animal husbandry should not be displaced to other countries where emissions per production unit are higher than in Germany. The government cannot dictate eating habits, but should provide more information about the implications.

Fluorinated greenhouse gases

In Germany fluorinated greenhouse gases currently contribute only about 1 to 2 % CO₂-equivalents to national greenhouse emissions due to measures adopted to terminate the use of substances which deplete the ozone layer. However, projections suggest that the emission of fluorinated greenhouse gases will increase unless further measures are

¹⁷⁷ Cross compliance is a mechanism that links direct payments to compliance by farmers with basic standards concerning the environment, food safety, animal and plant health and animal welfare, as well as the requirement of maintaining land in good agricultural and environmental conditions.

¹⁷⁸ The gap is currently filled by imports.

adopted¹⁷⁹. For most applications of fluorinated gases there are already environmentally beneficial and economically viable alternatives¹⁸⁰ (e.g. CO₂ as refrigerant).

► Full implementation of existing measures

As a first step, the operators of plant and equipment operating with fluorinated greenhouse gases should be required to fully implement the existing regulations, for example concerning leak testing for refrigeration and air-conditioning equipment. The responsible authorities should monitor compliance regularly.

► Ensuring series production of automobile air conditioning without harmful refrigerants

The automotive industry is tasked with introducing series production of vehicle air conditioning with climate-friendly CO₂ as refrigerant. This is not only a matter of fine words. In addition to climate policy considerations, it is also necessary in order to comply with existing EU law. The Federal Government should therefore continue to support the EU Commission in enforcing the deadlines of the relevant directive.

► Tightening the F-Gas Regulation

The use of fluorinated greenhouse gases is covered by EU Regulation No. 842/2006 (F-Gas Regulation)¹⁸¹. In the course of the review in 2011, the Federal Government should support an extension of the restrictions on the uses of fluorinated greenhouse gases. A practical approach would be a ban on new freezers with fluorinated refrigerant in existing and new supermarkets. In addition to restricted use, levies on fluorinated greenhouse gases, as imposed in Norway and Denmark, are a most suitable way of appreciably reducing emissions.

22. Environmental communication as an instrument for mitigation

Ambitious mitigation is possible – but only as the result of numerous individual decisions. If people in all walks of life attach importance to climate change mitigation, they will be able to achieve the potential for reducing greenhouse gases. It is necessary to establish public awareness about mitigation and adaptation. Environmental communication is particularly important in this respect.

Changing people's behaviour is often an important precondition if climate measures and instruments are to develop their full potential. Political decision makers should therefore also utilise the opportunities of environmental communication in order to influence public awareness about climate issues.

¹⁷⁹ Figures from "Projektionsbericht 2009 gemäss Entscheidung 280/2004/EG", http://cdr.eionet.europa.eu/de/eu/ghgpro/envsgwza/Projektionsbericht_DE_2009.doc/manage_document

¹⁸⁰ Cf. Federal Environment Agency (2004): Fluorierte Treibhausgase in Produkten und Verfahren - Technische Maßnahmen zum Klimaschutz. www.umweltdaten.de/publikationen/fpdf-l/2742.pdf; Federal Environment Agency (2008): Vergleichende Bewertung der Klimarelevanz von Kälteanlagen und -geräten für den Supermarkt. www.umweltbundesamt.de/produkte/fckw/massnahmen.htm

¹⁸¹ Regulation (EC) No. 842/2006 of the European Parliament and of the Council on certain fluorinated greenhouse gases, 17 May 2006.

General climate awareness exists

There is considerable public awareness about the causes and consequences of climate change¹⁸². The public is aware that political measures must be implemented for climate change mitigation. A clear majority (84 %) are in favour of “much stronger” political pressure to enforce climate-friendly means of production, even if this places a burden on individual sectors of the economy. Nearly 90 % approve of a “committed transition to renewable sources of energy”.

A large proportion of people also affirm the need for a fundamental change in everyday actions. 88 % of women and 82 % of men agree to the statement: “In order to conserve energy we must definitely change our daily behaviour”.

The high degree of acceptance of climate measures and the principles of sustainability, but also the high expectations placed on technological innovations open up great opportunities for ambitious measures to protect the climate. Nevertheless, differentiated environmental communication is more important than ever. In the bustle of daily life there are many obstacles in the way of acceptability and action which have to be overcome:

- Inadequate knowledge about the numerous ways of reducing energy consumption,
- Lack of appreciation of the economic advantages of long-term investments in climate mitigation measures, e.g. measures for thermal insulation,
- Lack of knowledge about the complex operations of climate instruments and, consequently, poor acceptance of these instruments¹⁸³,
- Reluctance to make use of alternative mobility strategies such as Car Sharing, which also requires a partial reorganisation of daily routines and a break with old habits.

Education, counselling, and training therefore play a key role in climate protection. The government, as an important initiator of environmental communication, must therefore upgrade environmental communication as an instrument for mitigating climate change.

► Environmental information: Generate acceptance and offer orientation

- Providing appropriate information for target groups creates acceptance even for unpopular measures and offers orientation in the complexity of the climate debate. In order to avoid “not seeing the forest for the trees”, environmental communications must focus on key topics.
- The Federal Government must considerably improve the communicative back-up for climate policies, in particular for controversial topics such as energy taxes and emissions trading, the implementation of the Energy Conservation Ordinance, or the sustainable use of biomass.
- Climate policies should not be lost behind abstract figures about the mitigation of greenhouse gas emissions. This only obscures the real motivating goals and visions. Environmental communications must therefore emphasise the improvements which climate policies can bring for the quality of life.
- Consumers need clear, direct information about the power consumption of products before making a purchase (see Section 27). Aberrations must be redressed in cases like the energy efficiency labels, where the highest Category A is no longer anywhere near the state of the art.
- The public sector must give important signals with climate-friendly procurement¹⁸⁴.

¹⁸² UBA and Federal Ministry for the Environment, Nature Conservation and Reactor Safety (2008): Umweltbewusstsein in Deutschland 2008.

¹⁸³ For example concerning the removal of subsidies with harmful environmental effects, or the introduction of economic incentives such as shifting taxes from the factor labour to the factor energy.

¹⁸⁴ Cf. Section 17.

► **Environmental counselling: Combining willingness to act with expertise**

General environmental information can offer an initial orientation. But in order to bridge the gap between willingness to act and actions, it is often necessary to provide counselling which is tailored to meet the specific situation of individuals. This applies in particular for the energetic refurbishment of housing. Energy counselling with a focus on thermal insulation is therefore a field of action which should be expanded by the Federal Government, Laender and local authorities, because sound advice can boost the willingness to make investments.

A further key aspect is the development of empowerment projects, which combine environmental policies with specific social policies by providing socially disadvantaged households with advice about reducing daily power consumption¹⁸⁵. This raises social trust and anchors mitigation of climate change in society.

► **Environmental education: Investing in the future**

The Laender should anchor climate change mitigation in a "National Education Plan Sustainable Development" covering all types of schools and also for other institutions such as environmental centres and job training companies. This would make it possible to extend the success thus far primarily achieved in secondary schools.

New challenges require new expertise, and many more training and qualification measures should be introduced for architects, and workers in skilled trades and other relevant occupations. One step could be the introduction of certification systems for those installing plants to generate power from renewable sources, as required under the EU Directive on the promotion of the use of energy from renewable sources (2009/28 EC, Section 14). Further improvements should be made in the presentation of environmental protection and climate concerns in all branches of vocational training – not least within companies as well.

23. Economic costs and benefits

Germany must implement ambitious climate policies – not least for economic reasons. The large investments required must be weighed against the considerable savings in energy costs. Particularly in the current economic crisis the government stimulus packages must also provide impulses for a climate-friendly restructuring of the economy.

Mitigation costs and benefits

The primary benefits of mitigation involve avoided climate impact costs. As already explained in Section 7, these benefits are so huge that a climate policy based on the two-degree target is also economically advisable. Many individual climate measures are also economically viable in their own right, because the direct economic benefits considerably exceed the costs. Climate impact mitigation is therefore not only urgently necessary in the long term but in many cases already profitable today.

Climate measures often involve considerable investments¹⁸⁶. These are necessary to

¹⁸⁵ For example the Caritas Project (Cf. www.stromspar-check.de). Free "low-power packages" – with low-energy bulbs and switchable extension leads can appreciably reduce home power consumption.

¹⁸⁶ The World Energy Outlook 2008 (IEA 2008) sees a global investment requirement for an ambitious global climate policy, 2010 to 2030, of US \$ 3.6 bn for power stations and US\$ 5.7 bn. for measures to increase energy

achieve significant savings in energy costs subsequently during the life span of buildings, products, plants and equipment. An analysis over the life-cycle in relation to the emission reductions gives the specific avoidance costs of climate impact mitigation measures and instruments, i.e. net costs for each avoided tonne of CO₂¹⁸⁷. Since energy prices can be expected to rise in future, the profitability of climate measures will probably increase further (see Box).

Peak Oil and the development of oil prices

For a long time it seemed that oil shortages were due primarily to the policies of OPEC¹⁸⁸. However, the focus has increasingly shifted to the depletion of fossil fuel supplies – particularly of oil. In recent years there have been fewer oil finds and new fields are becoming more difficult and more expensive to exploit, particularly deep sea and polar oil. It is becoming more and more evident that we cannot continue to increase oil extraction indefinitely, and that in the foreseeable future oil production will in fact decline. There are various predictions about the global peak oil point. Some studies assume that we will never again reach the production levels of 2006¹⁸⁹, other expect that the Peak Oil will be in a few years¹⁹⁰. There are already regions such as the USA or the North Sea where production levels have been falling for years. The result is increasing dependence on OPEC.

The recent volatility of oil prices show how sensitive the market is to imbalances between supply and demand. It is noticeable that the oil price has remained at a relatively high level, even in a period of economic recession. The IEA is expecting considerable price fluctuations in the future¹⁹¹. It has frequently corrected its long-term oil price predictions upwards¹⁹².

Future energy prices, due in part to the uncertainty involved, do not automatically provide a basis for the level of investments in improving energy efficiency and renewable sources of energy which are necessary with respect to climate policies¹⁹³. But the future shortage of supplies and price increases are reasons to reduce dependence on fossil fuels and to make provisions for sustainable energy supplies.

► Germany must make considerable investments in climate impact mitigation, but the net costs of climate measures will be moderate

A 40 percent reduction of greenhouse gas emissions in comparison with 1990 will require considerable additional investments in Germany – some EUR 400bn by 2020.¹⁹⁴ However, since these investments will also lead to considerable reductions in energy costs, the net costs of the climate measures are moderate. More than half of the emission reductions required by 2020 are associated with negative avoidance costs, and therefore lead to net savings (left side of Figure 5). Considerable further reductions

efficiency. Together this represents 0.55 % of gross world product. The figures are taken from the scenario with a stabilisation level of 450 ppm CO₂-equivalent.

¹⁸⁷ There are various approaches to determining specific avoidance costs. Results are therefore mostly not directly comparable. They may use bottom-up or top-down methods, and can cover short periods or life-cycles. Discounting assumptions also influence the results.

¹⁸⁸ Organization of Petroleum Exporting Countries

¹⁸⁹ Schindler and Zittel (2008): Zukunft der weltweiten Erdölversorgung. Energy Watch Group 2008

www.energywatchgroup.org

¹⁹⁰ Bundesanstalt für Geowissenschaften und Rohstoffe (BGR) (2008): Kurzstudie Energierohstoffe 2008

¹⁹¹ International Energy Agency (IEA) (2008): World Energy Outlook 2008

¹⁹² Cf. IEA, World Energy Outlook 2006, 2007 and 2008

¹⁹³ Matthes et al. (2008): Energiepreise und Klimaschutz. Wirkung hoher Energieträgerpreise auf die CO₂-Emissionsminderung bis 2030. Federal Environment Agency, "Climate Change" 09/2008. Cf. also McKinsey (2009): Kosten und Potenziale der Vermeidung von Treibhausgasemissionen in Deutschland. For the BDI.

¹⁹⁴ Jochem et al (2008): Investitionen für ein klimafreundliches Deutschland. For the Federal Ministry for the Environment, Nature Conservation and Reactor Safety.

would only involve moderate costs. Not included are the avoided external environmental costs of energy consumption, i.e. the social consequences of induced air pollution or climate change. Policy-makers therefore can cite economic grounds for adopting the proposed climate protection instruments to exploit this reduction potential.

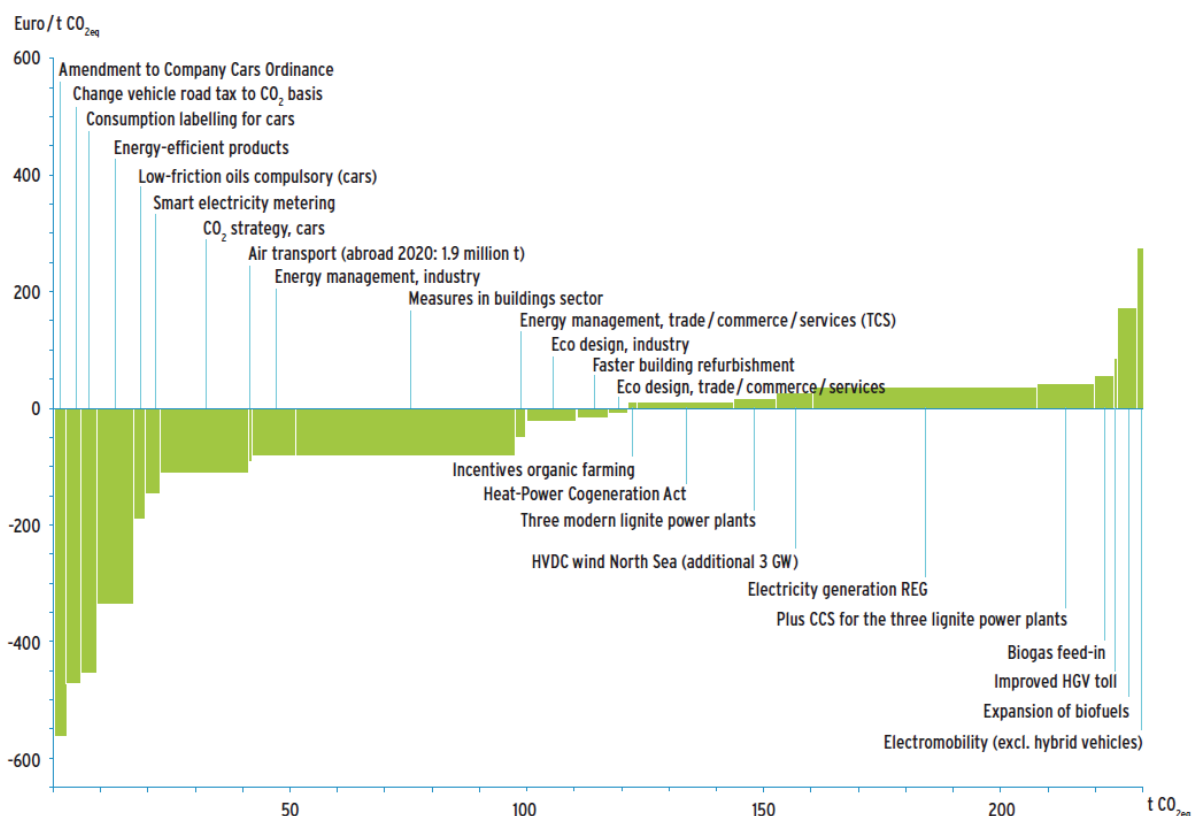


Figure 5: Specific avoidance costs of measures to reduce greenhouse gas emissions¹⁹⁵

Climate change mitigation as a response to the economic crisis

The global economic crisis is a major challenge which calls for decisive action. State intervention and support could cushion the negative consequences of the crisis and provide impulses for new positive developments. However, it would be fatal to neglect climate protection considerations. This could lead to much greater damage than we are currently experiencing in the current economic crisis (see Section 7). Therefore the government should formulate measures to cope with the economic crisis in such a way that they also benefit the climate. This is also appropriate from the point of view of intergenerational equity, because mitigation measures will relieve the burden on future generations – either directly due to lower energy costs or indirectly by lower consequential costs of climate change.

► Building refurbishment: Using economic stimulus programmes

Economic stimulus programmes should support climate policies and environmental protection instead of obstructing them. A good example is the promotion of building refurbishment. By 2020, house-owners in Germany will have to invest almost EUR 170bn for

¹⁹⁵ Federal Environment Agency and Federal Ministry for the Environment, Nature Conservation and Reactor Safety (2009): Umweltwirtschaftsbericht 2009

climate change mitigation. These investments are very effective in reducing greenhouse gas emissions, and they are profitable because the specific CO₂-avoidance costs are negative (see Figure 5). Government programmes can help here to overcome barriers to investment. Additionally, building refurbishment is labour-intensive and thus contributes to stabilising the job market.

The rapid increase in national debt as a result of the economic stimulus packages and other measures to tackle the economic and financial crisis will, in the medium-term, require budget consolidation, in the course of which the government should also eliminate harmful subsidies.

► Restructuring power generation offers an opportunity for climate-friendly structural change

A sustainable power supply requires an increased proportion of power from renewable sources and increased energy efficiency, both of which also offer economic benefits. The transition to renewable sources of energy increases security of supplies and makes the economy more independent from fluctuating oil prices. Even if the specific avoidance costs of renewables are currently comparatively high (see Figure 5), climate policies should continue to include these. Over time, technological innovations can rapidly reduce avoidance costs. The overall energy mix from renewable sources will probably already reach zero avoidance costs soon after 2020 – and after this they will be negative. This is demonstrated by the predicted CO₂-avoidance costs per tonne CO₂ for energy from various renewable sources.

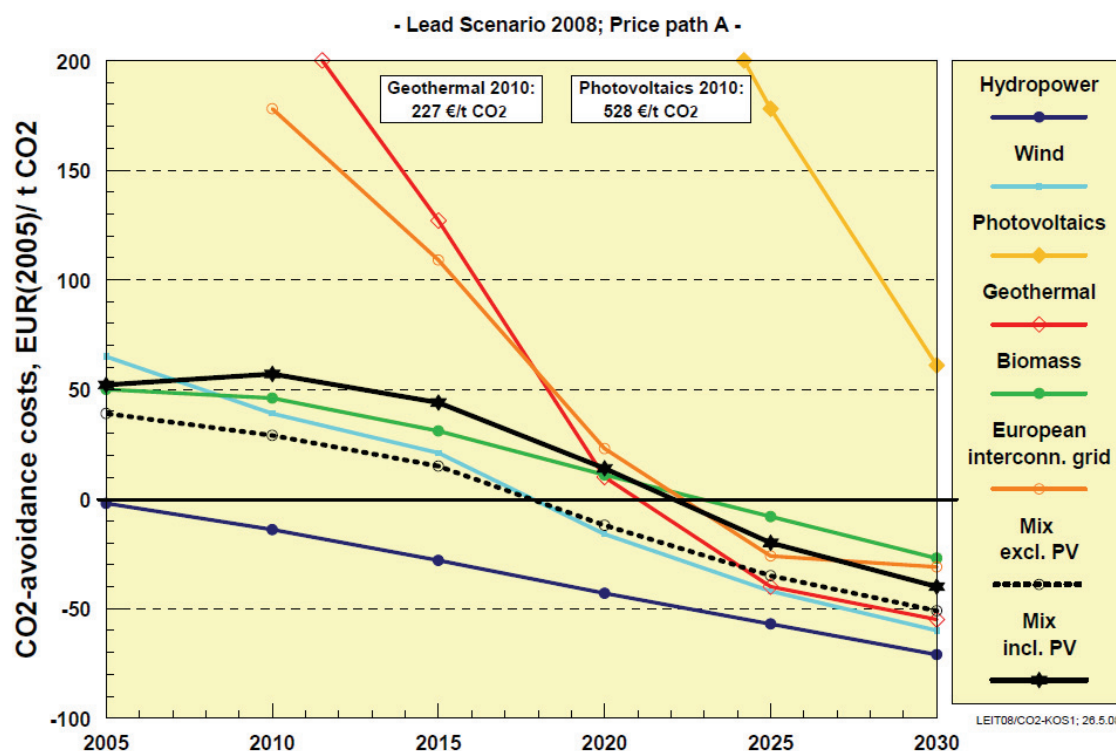


Figure 6: CO₂-avoidance costs of energy from renewable sources¹⁹⁶

¹⁹⁶ Nitsch (2008), p. 123; also www.erneuerbare-energien.de/files/pdfs/allgemein/application/pdf/leitstudie2008_key_findings_en.pdf

► **Efficient use of energy creates economic opportunities.**

Improved energy efficiency reduces energy costs in the short-term and in many cases is therefore already economically viable. In addition, energy-efficient companies are better equipped in the long-term to cope with price increases and fluctuations. Figure 6 shows that measures to improve energy efficiency are very effective when viewed macro-economically, because they have negative avoidance costs. Sustainable development in the energy sector not only supports mitigation measures but also restricts current and future economic risks.

Sustainability-focused companies are more successful.

The promotion of so-called green investments is already profitable. The index of the world's 90 leading companies in the "clean energy" sector shows an average yield of 10 % - significantly above the average of other share indices. Green investments not only prevent future crises, they are also successful today. The importance of green economic policies, especially in times of financial and economic crisis, is highlighted by the study "Green Winners: The Performance of Sustainability-focused Companies in the Financial Crisis" by the management consultancy A.T. Kearney, March 2009. The study finds that sustainability-focused companies can cope with the financial crisis considerably better than their competitors and in almost all industrial sectors are performing much better on the financial markets. The authors conclude that: "The most sustainability-focused companies may well emerge from the current crisis stronger than ever – recognised by investors who appreciate the true long-term value of sustainability."

► **Environmental innovation – climate-friendly transport**

The Federal Government has various ways of supporting companies in their research efforts in the climate field. It should do more to promote specific climate innovations and to help with market penetration. Basically, the automotive industry must concentrate more on improving the efficiency of vehicles rather than on increased acceleration and more powerful engines. Economic stimulus measures such as the scrapping scheme for old cars – as necessary as they seem to be in times of economic crisis – should promote this trend and not obstruct it.

24. Consequences for growth and employment

A comprehensive and ambitious mitigation strategy strengthens growth of the economy and creates jobs. Employment can be generated by measures for improving the energy-efficiency of buildings, companies and the transport sector. Reducing greenhouse gas emissions by 40% before 2020 will create some 630,000 jobs and ensure that the German economy has a strong position on the world market for mitigation goods. Adaptation measures can also generate positive effects on the labour market.

Macroeconomic effects of climate policies

As explained in Section 7 with reference to the Stern Review, the long-term global costs of ambitious mitigation measures are moderate. Nevertheless, climate change represents a considerable challenge for the business sector because it requires fundamental restructuring over a period of several decades, which makes it necessary to begin at

once. New studies for Germany show that climate change presents challenges and opportunities, because an ambitious climate programme involving a reduction of greenhouse gases by 40 % over the next decade will increase economic growth and create a considerable number of new jobs.

► Climate change mitigation has a positive effect on growth and employment

A climate policy which reduces greenhouse gas emissions by 40% compared with 1990 levels would lead to some 630,000 additional jobs in Germany in 2020 and would increase GDP by more than EUR 80bn (see Scenario MesebergPlus¹⁹⁷). This would above all be the effect of a positive investment impulse generated by the climate-friendly conversion of the capital stock of companies. Germany will then over decades benefit from reduced energy imports in combination with growing domestic purchasing power – which will benefit the economy as a whole. Figure 7 illustrates the employment dynamics of various climate policy scenarios. The Meseberg scenario takes into account the measures decided upon in Meseberg. The MesebergPlus scenario includes measures aimed at achieving the 40% target by 2020. The figure also shows the employment effects of measures to increase efficiency in companies, buildings, and in traffic.

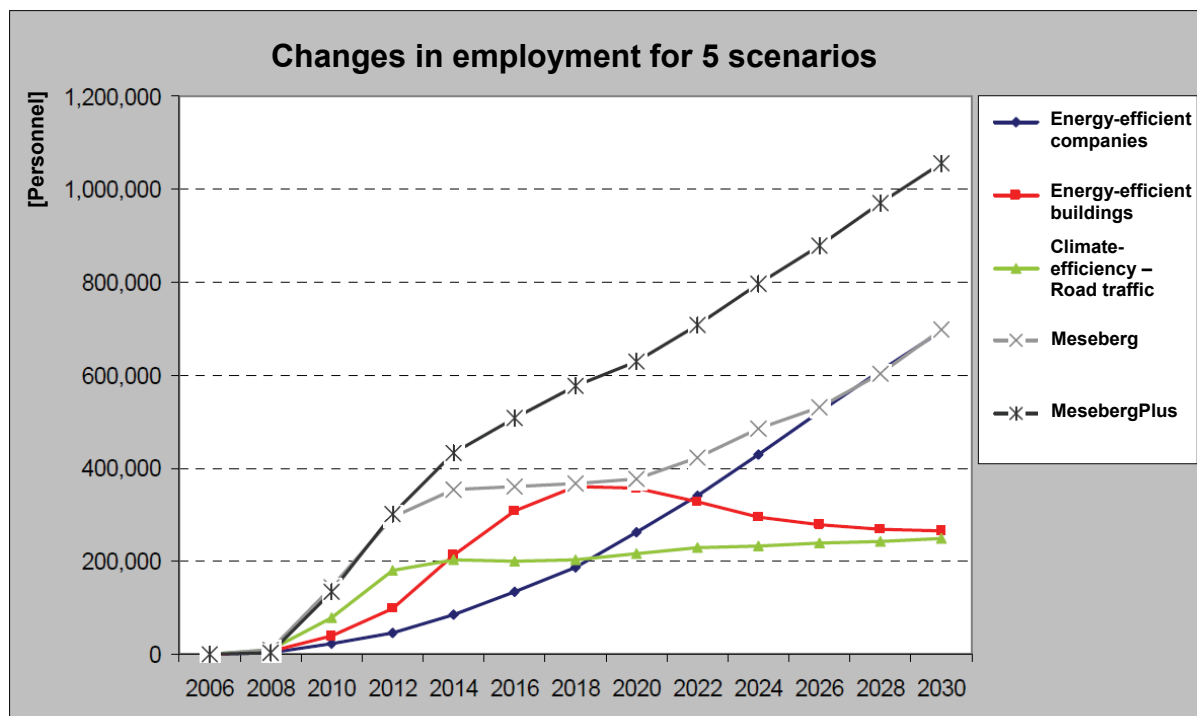


Figure 7: Positive employment effects of climate policies¹⁹⁸

► Differences in sector effects

Schade et al. (2009) show in sector analyses that mitigation of climate change will involve a transfer to providing more services, which as a rule are less energy-intensive and

¹⁹⁷ Schade et al. (2009): *Gesamtwirtschaftliche Wirkungen von Energieeffizienzmaßnahmen in den Bereichen Gebäude, Unternehmen und Verkehr*. Federal Environment Agency. Climate Change 8/2009. Jochem et al (2008, see above) arrive at only 500,000 jobs in 2020 with a similar scenario, but they include fewer measures in the building sector.

¹⁹⁸ Schade et al. (2009)

at the same time more labour-intensive than goods production. There will be an increase of more than 425,000 jobs in services. Positive effects will also be felt in construction and civil engineering with almost 150,000 new jobs, and industrial goods with more than 65,000 new jobs, as well as traffic and transport with nearly 40,000 jobs. Slightly positive effects will also be registered in 2020 in the field of energy, mining and chemical engineering (6,000 jobs). New jobs created with relationship to energy from renewable sources will offset job losses in the fossil energy system.

Export opportunities created by mitigation measures

Environmental protection and climate change mitigation have become increasingly important for the industrial sector in recent years. From 2005 to 2007, the production of environmental protection and climate-related goods rose by 27 percent. This means that 5.3 percent of industrial production in Germany is accounted for by goods for environmental protection and climate change mitigation. A considerable contribution to this development was made by the successful export business. Figure 8 shows the development of the shares of major international trading countries of potential environmental protection goods. Germany is the only one of these countries whose share has increased in recent years. Since 2004, Germany has been the largest exporter of environmental protection and climate change mitigation goods. Export developments were particularly positive for the Energy/Environment sector (Table 1).

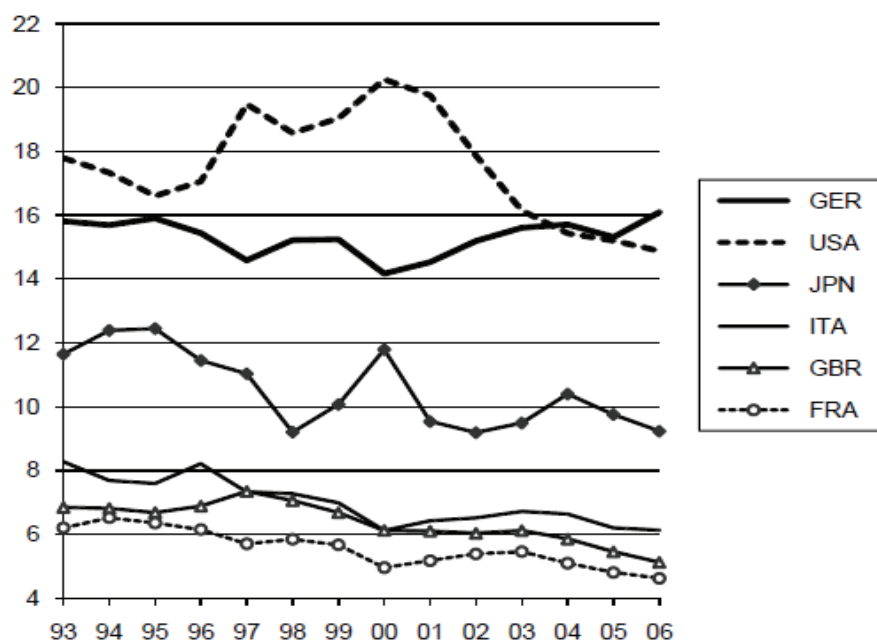


Figure 8: Shares of international trade in potential environmental protection goods 1993 - 2006¹⁹⁹

¹⁹⁹ Legler and Schasse (2009): Produktionsstruktur und internationale Wettbewerbsposition der deutschen Umweltschutzwirtschaft (based on OECD, ITCS - International Trade By Commodity Statistics, Rev. 3 (compiled). - COMTRADE-Database.

Table 1: Annual change of world exports of potential environmental protection goods 1993 to 2006 (in %)²⁰⁰

<i>Environmental protection purpose</i>	Mean annual change			
	1993-2006*	1993-1998	1998-2003	2003-2006
Waste	9.1	9.1	2.6	20.8
Water	8.7	8.7	4.5	16.3
Air	9.7	9.6	6.0	16.2
Measurement and control technology	9.5	9.3	6.1	15.5
Noise	9.9	10.6	5.5	16.5
Energy/environment	10.1	9.0	6.5	18.3
Rational energy use	8.9	9.3	4.2	16.4
Rational energy transformation	8.4	7.2	7.0	12.9
Renewable sources of energy	15.3	10.8	12.7	28.3
Total	9.5	9.0	5.7	17.1
Manufacturing industry goods	9.0	8.6	5.9	14.9

Note: * estimated

With a 28.3 % increase in exports in the period of 2003 to 2006, energy from renewable sources is far above the average for the period of 17.1 %. It is predicted that in the coming years, the worldwide demand for energy-efficient products and technologies will grow rapidly.

► Climate policies should create reliable framework conditions in order to secure a competitive advantage.

The global market for climate change mitigation goods will continue to grow at above average rates. In addition to renewable energy technologies, it is also expected that there will be an increase in energy-efficient products. The economic opportunities for German companies lie above all in the export business, in particular to countries with growing populations and demands. Ambitious domestic climate policies can encourage companies to specialise in the development of climate-friendly technologies and strengthen their competitive position on international markets. Effective national climate policies which create reliable framework conditions for companies, such as the Renewable Energy Sources Act (EEG), smoothes the way for strengthening the leading economic role in climate change mitigation.

²⁰⁰ OECD, ITCS - International Trade by Commodity Statistics, Rev. 3 (compiled.). - COMTRADE-Database

Synergies and conflicts between climate policies and other environmental objectives

Policies relating to international development, energy, construction, transport, finance, industry and commerce, farming and forestry, and also regional policies can have grave implications for climate policies. Conversely, measures for emissions reduction and adaptation to climate change have effects on the targets of environmental policies, such as clean-air measures, soil conservation, water protection, and nature conservation.

The UBA plays an active part in the discussions of synergies and conflicts between climate policies and other environmental objectives, pursuing the overall goal of making climate policies and environmental protection economically, environmentally and socially sustainable.

25. Climate change mitigation, human health and ecosystems

Climate change mitigation measures often have co-benefits for other protected assets. The use of efficient power stations with low sulphur and nitrogen oxide emissions reduces the acidification and eutrophication of ecosystems. However, mitigation measures can also have a negative impact on other protected assets. The increased use of biofuels can lead to increased emissions of pollutants such as nitrogen oxides or particulate matter.

Climate policies also make an important contribution to reducing air pollution. Lower concentrations and depositions of acidifying and eutrophying air pollutants such as sulphur dioxide (SO₂) and nitrogen oxides (NO_x) lead to benefits for the protection of ecosystems' functions and services as well as for biodiversity. At the same time, it helps to meet quality targets for the protection of human health²⁰¹.

National emissions of greenhouse gases and air pollutants clearly show these synergies. According to investigations of UBA, suitable policies will lead to a reduction of greenhouse gas emissions by 41 % in 2020 compared with 1990²⁰². The measures can also reduce the emissions of key air pollutants (Table 2).

²⁰¹ This does not always apply for biomass use, for e.g. the use of biogas in cogeneration plants can lead to increased nitrogen oxide emissions and formaldehyde emissions. This demonstrates the need for environmentally-compatible regulation of the use of bioenergy.

²⁰² Comparing the "With measures" scenario from PSz IV with an ambitious climate policy "With additional measures" aimed at reducing greenhouse gas emissions by 41%. Federal Environment Agency (2008): Politiksszenarien für den Klimaschutz IV - Szenarien bis 2030, Climate Change 1/08.

Table 2: National reduction of emissions of greenhouse gases and air pollutants by mitigation measures: differences between scenarios “With measures” and “With additional measures”²⁰³

		Differences in emissions between the scenarios “With measures” and “With additional measures”	
Year		2015	2020
GHGs	CO ₂ -equivalents	10 %	17 %
Air pollutants	SO ₂	7 %	15 %
	NO _x	11 %	18 %
	NM VOC	0 %	1 %
	particulate matter PM ₁₀	1 %	3 %
	particulate matter PM _{2.5}	1 %	3 %

Significant emission reductions are achieved above all for sulphur dioxide from power generation and for nitrogen oxides by a range of technical and non-technical climate measures relating to transport.

► **Reducing greenhouse gas emissions helps to promote human health.**

The appreciable reduction in emissions of nitrogen oxides in the transport sector would make a significant contribution to cleaner air. This would be important firstly for the long-term compliance with an important air quality target, the NO₂ limit values from 2010 under the European Union Air quality directive intended to protect human health²⁰⁴. Secondly, the measures to reduce emissions help to meet air quality objectives. An ambitious climate policy covering transport makes it possible to comply with the EU limit values for particulate matter and nitrogen dioxide pollution in the air, which are currently exceeded in most German towns and cities. The transport policy should not only cover the reduction of emissions, but should also aim at reducing road traffic and shifting it to other modes of transport, because only in this way will it be possible to limit the emissions from tyre and brake wear.

► **Reducing greenhouse gas emissions promotes the protection of ecosystems**

Climate change mitigation measures contribute significantly to compliance with national ceilings for the emission of nitrogen oxides which will be specified by the amendment to the European Union NEC Directive²⁰⁵ through until 2020. Among other things, they have been determined to protect ecosystems against excessive inputs of nitrogen. This should reduce the still persisting harmful effects nitrogen deposition into ecosystems has on sensitive types of vegetation and on soil and water quality.

The measures already implemented by the Federal Government, Laender and local authorities to reduce emissions of greenhouse gases should be continued and extended taking into consideration synergies for reducing air pollution.

²⁰³ Federal Environment Agency (2008): Politikszenerarien für den Klimaschutz IV - Szenarien bis 2030, Climate Change 1/08, Federal Environment Agency (2008): PAREST - Strategien zur Verminderung der Feinstaubbelastung, unpublished interim project report.

²⁰⁴ The limit value for nitrogen dioxide will probably be exceeded in 2010 at many measuring stations close to traffic orientated measuring stations all over Germany

²⁰⁵ Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2001:309:0022:0030:en:PDF>

Climate policies can conflict with other objectives of environmental protection

In order to achieve the necessary reductions of greenhouse gas emissions in Germany, numerous instruments have been developed in recent years and measures have been adopted. This has led to some conflicts with other objectives of environmental policies. An example is the conflict between the increased use of bioenergy and protecting human health against air pollution by particulate matter. The Federal Government is already developing solutions to reconcile this conflict of interests.

► Tighter emission limits for small combustion installations

A goal of German climate and energy policies is to increase the proportion of energy consumed from renewable sources, from currently 7.5 % to 14 % of final energy consumption by 2020. The Renewables-Heat Act (2009) and the market stimulus programme to promote the use of energy from renewable sources have an important contribution to make. The largest proportion of renewable sources of thermal energy is currently the burning of wood in small private wood-fired boilers and stoves. However these are significant emitters of particular harmful air pollutants, such as particulate matter, polycyclic aromatic hydrocarbons and nitrogen oxides. Particulate matter threatens human health because the fine particles can enter the airways, lungs and the cardiovascular system. The EU-wide limit values for particulate matter (daily mean PM₁₀ limit value for outdoor air) are already exceeded in more than 100 German towns and cities, in some cases considerably, so that measures to reduce particulate concentrations are urgently needed²⁰⁶. The spread of small wood-fired boilers and stoves will lead to an increased health threat if climate change mitigation measures are not augmented by measures to reduce other types of emissions as well.

The UBA has been involved since 2006 in work on amendments to the ordinance on small- and medium-sized combustion installations with the goal of achieving a significant reduction in the polluting emissions from small wood-fired stoves. According to the calculations of UBA for 2020 the amendment would reduce the annual mean PM₁₀ by more than 2 micrograms per cubic metre (µg/m³)²⁰⁷. Despite the importance of the amendments for air quality and human health, the Federal Environment Ministry and the UBA have met with considerable resistance. Measures to reduce air pollution are often regarded as an obstacle to climate protection rather than as a way of making it possible to use biomass without harmful impacts on the environment and on human health.

► Promoting larger biomass-fuelled installations

Heat from biomass is usually generated in small, widely distributed installations. However, typical biomass, such as straw, chaff, or rape seed cake can be expected to create high levels of air pollutants and should therefore be used preferentially in larger furnaces with a thermal rating of several hundred kilowatt (kW). It is simpler and more cost-effective to implement technology for emissions reductions at this scale. In order to conserve energy, it is particularly appropriate to install co-generation systems, in which heat energy which cannot be used on site can be fed into district heating networks. These can operate using Organic Rankine Cycle (ORC) plants²⁰⁸ or Stirling engines. The Federal Government should increasingly include such strategies in its support programmes.

²⁰⁶ The cities had to implement action plans to maintain air quality.

²⁰⁷ This value applies for average German residential areas, and there for heavily polluted areas. For some regions of southern Germany the difference could be as much as 4 µg m⁻³ which is nearly as large as the difference between mean urban and mean rural PM10 concentrations.

²⁰⁸ ORC: Organic Rankine Cycle plants; turbine with an organic mass fluid with liquid-vapour phase change at a much lower temperature than water. The organic liquid should contribute as little as possible to the greenhouse gas effect, and the risk of leaks should be low. Current ORC plants do not always meet these conditions.

26. Biomass utilisation and sustainable agriculture

The increased use of biomass as a fuel can have an impact on ecosystems if the cultivation and use of the energy crops is not sustainable and is carried out to the detriment of intact ecosystems. The cultivation of biomass for energetic use, foodstuff or fodder, or as industrial raw material competes for the available land. But worldwide, more than 1 billion people are malnourished. In June 2008, Germany committed itself to an ambitious package of measures to tackle the causes of poverty and hunger worldwide. Key causes are the enormous consumption of resources in the industrialised and emerging countries and the associated destruction of the environment and nature, as well as the global growth and unequal distribution in population. In the future, biomass production must be more efficient and sustainable if it is to meet the needs of a growing world population.

Sustainable bioenergy generation and environmentally-sound agriculture

Agricultural production in Germany has negative impacts on the environment and is therefore not sustainable. Such environmental impacts include nitrogen inputs in nutrient-poor areas, surface waters, and forests, leaching into soils and surface waters, and also the impairment of habitats for wild animals and plants.

The cultivation of energy crops in Germany currently involves certain specific environmental impacts. The cultivation system in some regions includes tight crop rotation, and increasingly large areas used for the cultivation of maize and rape-seed²⁰⁹. This development can impair the soil ecology²¹⁰, cause groundwater pollution due to the leaching of nutrients, washing away of top soil, and the permeation of pesticides, and can also lead to the spread of harmful organisms, e.g. the Western corn rootworm²¹¹.

Despite the efforts of the Federal Ministry of Food, Agriculture and Consumer Protection (BMELV) as outlined in its National Action Plan for the Sustainable Use of Plant Protection Products to reduce the use of pesticides²¹² the intensity of treatment with plant protection products will probably increase. This will be due to the increasing areas used to grow energy crops and comparatively high treatment indices²¹³ for these crops, for example due to the use of insecticides on rape-seed crops.

In the past, marginal land and fallow areas were available to compensate for the impairment of biodiversity due to intensive farming²¹⁴. If these areas are in the future used for growing energy crops without compensatory measures, then this will further increase the pressure on biodiversity exerted by climate change, land use and pollution. This will also apply if farmers in certain regions increasingly convert grassland and permanent pasture to arable land²¹⁵. Ploughing moorland, in particular, releases much of the fixed carbon

²⁰⁹ The increased cultivation of energy crops with undesirable aspects such as tight crop rotation is a result of the "Nawaro" bonus offered for organic raw materials in the amended EEG Act 2004. This problem can be reduced with the implementation of the Sustainability Ordinance for biofuels in the coming years.

²¹⁰ www.umweltdaten.de

²¹¹ Tackling *Diabrotica virgifera* requires in turn the increased use of insecticides.

²¹² BMELV (2008): National Action Plan on the Sustainable Use of Plant Protection Products. <http://nap.jki.bund.de/> (-> NAP 2008 (English))

²¹³ The treatment index, developed by the Julius Kühn Institute (JKI) lists the number of times a plant protection product is used, taking account of any reductions in the amounts used and whether only partial areas of land are treated. Cf. www.pestizidreduktion.de

²¹⁴ The intensive use of pesticides improves yields, but reduces the food supply for birds and mammals

²¹⁵ Under the CAP, EU member states are required to maintain permanent pastures (cross compliance). But in

and nitrogen in the soil, and runs counter to the desired reduction of greenhouse gases.

► Extensive cultivation of energy crops

Growing energy crops should not result in additional environmental impacts. Various research projects of the *Fachagentur Nachwachsende Rohstoffe*²¹⁶ show that extensive cultivation is possible without a loss in profits. Ways of reducing environmental impacts should be promoted and used for all farming methods, e.g. with reduced fertilisation and pesticide application. Diffuse inputs of nutrients and pollutants resulting from farming have consequences for groundwater and surface waters, as well as for sensitive terrestrial ecosystems, and they must be reduced for the entire agricultural sector.

► Harmonising agricultural support with the objectives of energy- and development policies

The growth of energy crops should be integrated in sustainable land use, so that there are positive overall effects. These include an increase in crop diversity (with positive consequences for biodiversity) and combined land use systems such as agroforestry. The Federal Government should adapt agricultural support from the “Second Pillar” (Rural Development Policy) to the “new challenges” identified in the CAP Health Check²¹⁷. This applies both to adaptation to climate change as well as to the increased use of energy from renewable sources. This policy shift can and should also help to end market distortions caused by the exports of subsidised agricultural surpluses. In the importing countries these hinder the development of domestic food production and thus counteract the objectives of international development policies.

► Increased controls on compliance with environmental law in energy crop cultivation

Sustainable energy crop cultivation should comply with environmental legislation in a transparent manner. This applies both for the principles and provisions for the application of fertilisers (DüV²¹⁸) and the obligation for appropriate cultivation of a location including sustainable crop rotation which serves to reduce erosion and maintain typical local levels of organic matter in the soil. Energy crop cultivation must comply with the requirements of the EU Single Payment Scheme for (e.g. maintenance of permanent pasture: cross compliance²¹⁹). The rules for good farming practice (Section 17 BBodschG) should be examined, and if necessary augmented. Adequate controls should be ensured, and failure to comply should be met with sanctions, e.g. reduction of payments.

north and south Germany appreciable areas of grassland are being ploughed up (NABU 2006). This is because existing regulations only prevent a very high net loss of grassland, but offer no protection against a regional shift.

²¹⁶ Above all EVA I and II : “*Entwicklung und Vergleich von optimierten Anbausystemen für die landwirtschaftliche Produktion von Energiepflanzen unter den verschiedenen Standortbedingungen Deutschlands*”. In six typical regions of Germany, energy crops are grown in rotation. The first cycle was completed in 2008, and a project extension means that a second cycle of rotation is possible through to 2012. See

www.nachwachsenderohstoffe.de

²¹⁷ Common Agricultural Policy, November 2008.

²¹⁸ Düngeverordnung (Fertiliser Ordinance), Bundesgesetzblatt 2006, Part I No. 2

²¹⁹ Cross Compliance links single payments with statutory agricultural management requirements. Council Regulation (EC) No. 73/2009 from 19.01.2009 refers to 18 statutory requirements from the fields Environment, Public, animal and plant health, as well as Animal welfare. In addition, all agricultural areas, in particular those no longer used for production, should be maintained in good agricultural and environmental conditions.

Criteria for sustainable bioenergy cultivation

The ambitious targets for the use of biomass to generate energy adopted by the Federal Government, the EU, and also other countries can only be met by increasing imports of biogenic fuels. Expanding the energetic use of biomass can lead to the impairment of ecosystems if the cultivation and use of the energy crops is not sustainable, and risks destroying intact ecosystems. The extension of agricultural energy crop production involves land use changes which may be direct (new use of previously unused areas) or indirect (displacement of an existing use).

Lower production costs make the cultivation of energy crops in tropical regions an interesting proposition. However, especially in lower latitudes there is a risk that extending agricultural production could be to the detriment of areas of global importance for biodiversity, e.g. tropical rainforests or savannahs. Changes in land use lead to a rise in greenhouse gas emissions, for example when rain-forests, peatland/moors²²⁰, and savannah are replaced by plantations²²¹.

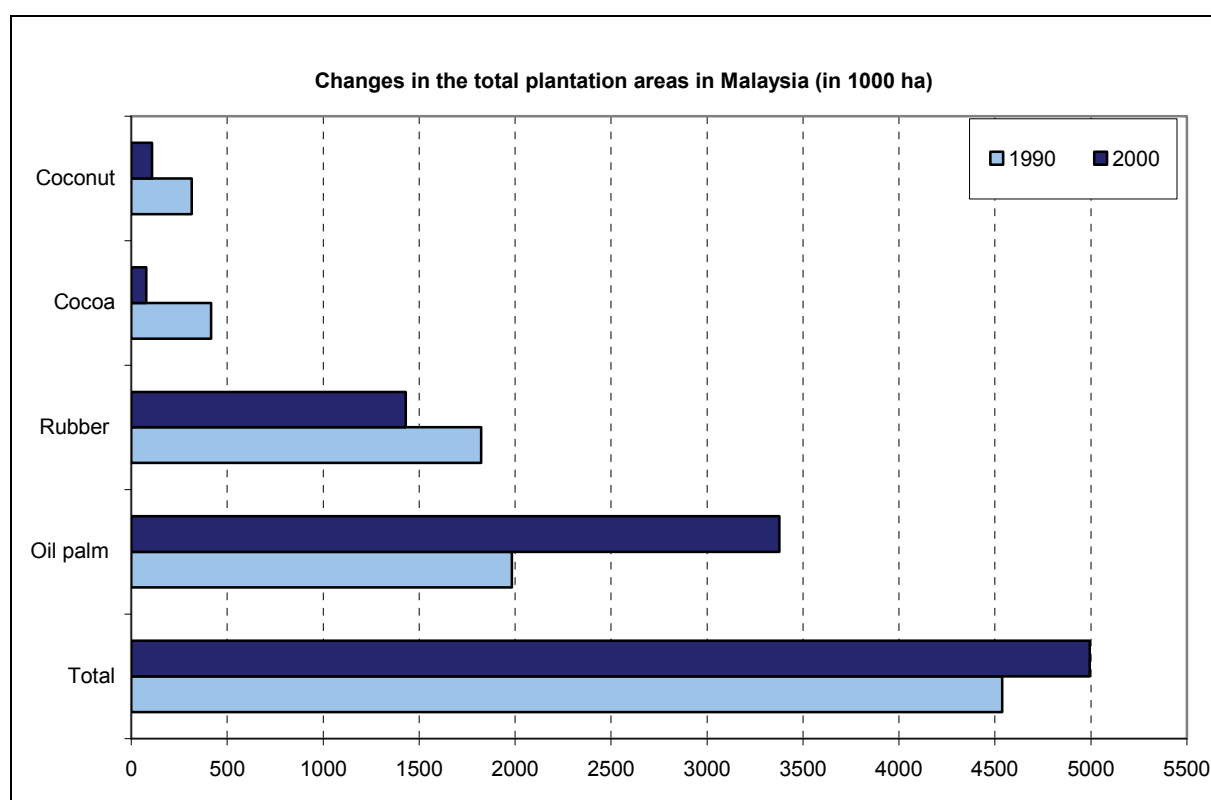


Figure 9: Changes in plantation areas in Malaysia from 1990 to 2000²²².

²²⁰ In moorland the problem is particularly severe. According to Hooijer et al (2006) some 50 - 100 t CO₂ per ha are released annually by logging and drying out moor forests. It is estimated that about 25 % of Malaysian and Indonesian palm plantations are on moorland. If GHG emissions from the transformation of moorland were included in the greenhouse gas inventory under the Kyoto Protocol, Indonesia would be the world's third largest emitter of greenhouse gases after China and the USA.

²²¹ According to IPPC (2007d) then along with the use of fossil fuels, changes in land use and agriculture are the main drivers of climate change.

²²² In Brazil, soy-bean and sugar-cane plantations and cattle rearing make both a direct and indirect contribution to the on-going destruction of the rain forests, in Malaysia und Indonesia above all oil palm plantations.

Currently, representatives of the 192 signatory countries to the UN Framework Convention on Climate Change are discussing how to integrate measures for the reduction of deforestation in developing countries. The successful conclusion of negotiations at the 16th Conference of the Parties at the end of 2010 would provide incentives for maintaining forests, rather than converting these to arable land for the cultivation of energy crops. Already before the conclusion of the negotiations, Germany could voluntarily agree not to use biomass from newly deforested areas. The EU Directive on the promotion of the use of energy from renewable sources²²³ specifies sustainability criteria for biofuels and bioliquids. These sustainability criteria include the conservation of wetlands and areas with high biodiversity value²²⁴ as well as areas with high carbon stock. A further criterion is presented by the requirements for greenhouse gas emissions savings. Liquid biomass and biofuels must achieve a GHG emissions saving of 35 %, and 50 % from 2017 (or 60 % if the installation goes into operation in 2017 or later). Since the transposition of the Directive, biofuels and other bioliquids produced from raw materials obtained from specified natural areas²²⁵ which were converted for this use after January 2008 shall no longer be included as part of the required national contingent of energy from renewable sources. Since all support policies require this inclusion, the demand for non-compliant biofuels can be expected to be low, at the latest after the end of the transposition phase for the Directive on 5 December 2010. The Federal Government has already transposed these requirements into German law. The Biomass Electricity Sustainability Ordinance and the Biofuel Sustainability Ordinance came into force in September 2009.

► Sustainability criteria for gaseous and solid biomass

Not only biofuels and bioliquids have to be certified, but also gaseous and solid biomass. The European Commission has announced its intention to propose sustainability criteria which the Federal Environmental Ministry (BMU) plans to transpose directly into German law. Particular attention is to be paid to the efficiency of the various uses of biomass.

► Including indirect and direct changes to land use in certification

The method for evaluating the sustainability of biofuels and bioliquids in the EU Directive has not included the greenhouse gas emissions which are attributable to direct and indirect changes of land use. Their integration, particularly regarding the indirect impacts, is demanding. Solutions have to be developed globally, rather than for a single nation. The Federal Government should fully support the efforts to reach solutions both through policy expertise as well as financially.

► Extending certification of biomass to include all uses

In addition to the certification of global traded biomass for use as a fuel, sustainability certificates should also be required in future for globally traded biomass which is utilised as animal fodder, as a foodstuff, or as an industrial raw material. Realistically, this long-term goal can only be achieved step by step through bilateral agreements and the acceptance of suitable certification systems. A medium-term goal should be a global convention on sustainable production, which would allow signatory countries market access without having to provide evidence for individual cases.

²²³ Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (1)

²²⁴ These areas include primary forests, designated protected areas, highly biodiverse grassland, and conservation areas recognised by international agreements or included in lists drawn up by intergovernmental organisations or the International Union for the Conservation of Nature.

²²⁵ Forests and wooded land, designated areas, natural or biodiverse grassland, wetlands, continuously forested areas with more than 30% canopy cover, peatland and others.

► Resolving controversies about the energetic use of biomass

Biomass for various uses is in direct competition for limited global resources such as land, water, energy or investments. There is considerable controversy about the use of biomass as a fuel among both scientists and politicians. On the one hand is the possible contribution of biofuels to climate protection, but on the other hand are the questions of securing global food supplies, because worldwide more than 1 billion people are starving. However, climate change mitigation and secure nutrition do not exclude each other, rather the goal must be to find solutions and use synergies in order to harmonise the various uses of biomass. Biomass production will in the future have to become more efficient and sustainable in order to satisfy the needs of a growing world population.

The Federal Government announced an ambitious package of measures in June 2008 aimed at combating the causes of global poverty and hunger. These causes are the gigantic consumption of resources in the industrialised countries and the associated destruction of the environment and nature, as well as population growth. The International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) agreed on a global report at its plenary session in April 2008 which calls for a radical rethinking of global agriculture and offers a perspective for feeding everybody. In its recent report on bioenergy and sustainable land use, the German Advisory Council on Global Change (WBGU) refers to global land management as the challenge of the future.

The Federal Government should work in European and international bodies for sustainability certification which covers all uses of biomass, including as fodder, foodstuffs and as an industrial raw material. The Federal Government should also continue to play an active role in combating poverty and hunger, and should contribute nationally to food security by programmes for resource conservation and sustainable lifestyle as well as promoting international partnerships for the development of a global sustainable land management system.

27. Climate change mitigation and resource conservation

Resource conservation in technical processes is often associated with an improvement in energy efficiency and greenhouse gas balances, and vice versa. There are considerable synergy potentials in relevant sectors of the economy, including the pulp and paper industry, construction industry and the waste management sector. Approaches to product labelling must provide effective help in avoiding negative global effects on resources.

► Promoting energy- and material-efficient manufacturing technology in order to promote climate change mitigation and resource conservation

Technologies to increase energy efficiency and reduce greenhouse gas emissions as a rule also improve material efficiency and thus help to conserve natural resources. The IPPC Directive²²⁶, with its cross-media approach, is a good example of how interactions between various environmental protection objectives can be systematically integrated and optimised.

A specific application to increase the heat and water recovery from process- and waste-water flows, which was tested for the further development of the BAT reference docu-

²²⁶ Integrated pollution prevention and control Directive (2008/1/EC). This promotes the use of the best available techniques.

ment²²⁷, for the pulp and paper industry, demonstrates how improved energy efficiency can also lead to reduction in resource consumption (Figure 10).

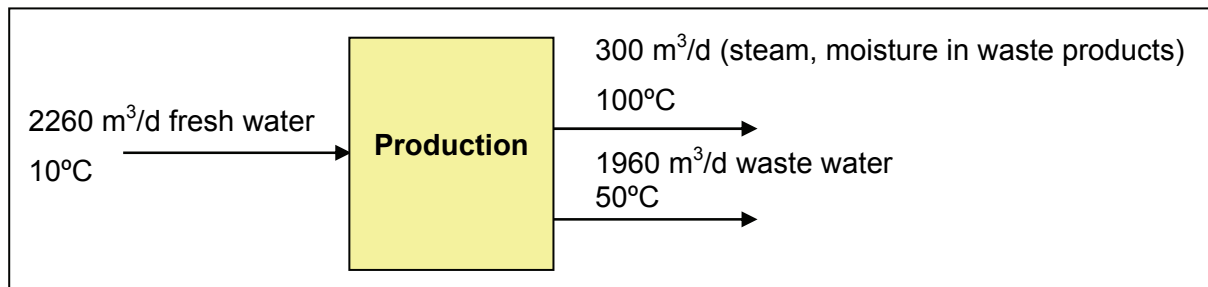


Figure 10: Simplified water balance of a paper factory

The good quality of the treated wastewater makes it possible to reuse the treated, warm outflow in the production. The closed cycle and the use of recovered heat as substitute for primary energy eliminate some 2,000 t CO₂ annually and saves some 600,000 m³ of fresh water.

► Using the potential for resource conservation in construction and waste management for climate protection

Synergy effects between emissions reduction and resource conservation are also initiated from the resource side, because high resource productivity is generally associated with lower greenhouse gas emissions.

Modern resource management uses a life-cycle approach and also takes into consideration the greenhouse gas emissions released in the production processes. These depend among other things on the material inputs in the preceding energy- and material-intensive processes. In the construction industry the use of lightweight construction methods can lead to a considerable increase in resource productivity and at the same time can contribute to climate change mitigation. The recycling of materials also contributes to the reduction of greenhouse gas emissions and increased resource productivity. In the course of the waste framework legislation at the EU level and the implementation of the Recycling and Waste Management Act in Germany since 1994, considerable progress has been made in the development of techniques and processes which conserve resources. Reductions in CO₂-emissions by recycling are shown in Figure 11 for glass, paper, recycling-plastic and wood²²⁸.

²²⁷ Innovation promotion programme of the Federal Environmental Ministry for the large-scale implementation of new techniques.

²²⁸ Fraunhofer UMSICHT/Interseroh (2008): CO₂-Einsparungen durch werkstoffliches Recycling.
www.umsicht.fraunhofer.de

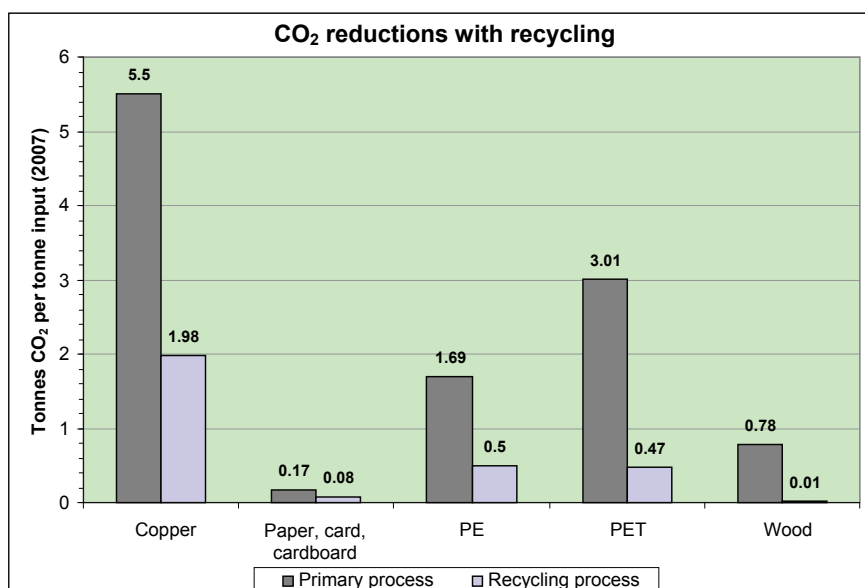


Figure 11: CO₂-reductions by material recycling

► **Purchase incentives for low-CO₂ products should not impair resource conservation**

Information about environmental protection, for example voluntary product labelling, can stimulate the purchase of low-CO₂ products and thus help to effectively reduce greenhouse gas emissions. But if this is not integrated in an overall view of environmental impacts, as is the case with the best-known German environmental label (Blue Angel), then the objectives of resource conservation are endangered.

The current evaluation of paper production demonstrates the possible distortions which can result. Some product labels ignore the overall environmental advantages of recycled paper in comparison with fresh paper, such as lower use of wood, water, energy and transport, as well as less waste. Although 20 % of the fresh-fibre paper used for copying on the German market causes lower CO₂-emissions than recycled paper, this does not necessarily imply an overall environmental advantage²²⁹. Already, 42% of industrially logged timber worldwide is used for pulp and paper manufacture, and this proportion is increasing²³⁰. If consumers were to respond to the labels by purchasing more fresh paper, then this would only reinforce the negative global environmental impacts of the current consumption of fresh-fibre paper. Even though the wood is farmed sustainably, the land is no longer available for other uses. In addition, the depletion of natural forest leads to an irreversible loss of biodiversity and as a result of increased CO₂-emissions further reinforces the greenhouse effect.

In the opinion of the UBA, concentrating solely on individual environmental aspects does not lead to the desired goals. Product labelling must address special protection targets on the basis of a comprehensive approach, like the 'Blue Angel'. The UBA therefore favours retaining the existing standards for the evaluation of the environmental impacts of products and developing these further.

²²⁹ IFEU et al: Aktuelle Marktstudie in Datengrundlagen zur Klima- und Ressourceneffizienz von Kopierpapier auf dem deutschen Markt, UBA project: Z 6 - 20 739/87 (FKZ 363 01 167) unpublished.

²³⁰ Abramovitz and Mattoon (1999): Paper Cuts. World Watch Institute, p. 19 ff ; www.worldwatch.org

► Advancing sustainable ecodesign requirements for energy-using products

The EuP Directive²³¹ aims at taking into account both climate considerations and the conservation of natural resources. Although resource efficiency has so far not received sufficient attention, the Directive is in principle a successful example of how to approach conflicts between climate policies and other product and environmental policies²³². The Directive is a cornerstone of the EU's energy and climate policy, and of the policy for sustainability in production and consumption. The goal is to minimise the environmental impacts caused by energy-using products by means of specifying environmental requirements for the design of products. Preliminary studies show that the energy consumption and the resultant greenhouse gas emissions during use represent one of the largest environmental impacts of most energy-using products.

Over the next two years, the UBA will develop proposals for a methodology to integrate further environmental aspects, in particular material efficiency, in the preliminary studies for energy-using products. Taking selected product groups as example, UBA will investigate the potential for resource conservation offered by appropriate environmental design requirements.

► International regulation of resource conservation

The Federal Government should work within the EU to promote an international convention on sustainable resource management. The objective is a sustainable reorientation of technological and social advances with the objective of achieving national and international resource conservation in harmony with the requirements of climate protection and other core tasks of environmental policy. A proposal for this has been formulated²³³.

► Promoting sectoral agreements on resource conservation

System solutions such as sectoral agreements, for example relating to Metals – Motor vehicles – Recycling, could provide the impulse for targeted structural change. A new feature is the integrated approach to sectoral and material flows in motor vehicle production, starting from the metal production. Metal recycling, which is currently regulated through the EU End-of-Life Vehicles Directive, is also included. The sectoral approach makes it possible to account for material flows involving amounts which were previously too small to be included (e.g. rare metals), as well as other materials, and also to consider energy aspects and emissions reductions in the same context.

²³¹ Directive 2008/28/EC of the European Parliament and of the Council 11 March 2008 amending Directive 2005/32/EC establishing a framework for the setting of ecodesign requirements for energy-using products, as well as Council Directive 92/42/EEC and Directives 96/57/EC and 2000/55/EC.

²³² Energy using products require energy in the form of electricity, or solid, liquid or gas fuel. Energy related products may also affect energy consumption, e.g. windows, insulation, or bathroom fittings.

²³³ Bleischwitz & Bringezu (2007): Globales Ressourcenmanagement, Konfliktpotenziale und Grundzüge eines Global Governance-Systems. Stiftung Entwicklung und Frieden.

28. Climate change mitigation and adaptation policies within the context of other environmental policies

At all political levels, climate policies should be shaped in a way that conflicts between climate change mitigation and adaptation and between that area and other protected environmental assets can be resolved in a transparent manner while at the same time optimising synergies. In the opinion of the UBA it is important that potential conflicts are identified as early as possible. Therefore, decision-makers in law-making institutions, planning bodies and permitting authorities at the national, Laender, regional and local level should make full use of the available assessment instruments. The Federal Government should also encourage their further development. The integration of aspects of climate change mitigation and adaptation in other political fields is also essential. The goal of sustainable development must guide the activities.

It will become increasingly important to form transparent, goal-oriented climate policies at all levels of decision making. Sustainable development must be the guiding principle for actions²³⁴. Only a comprehensive view of the effects of planned instruments and measures in all policy fields will make it possible to identify synergy effects and conflicts at an early stage, and to take these into consideration. This opens up possible alternatives to the proposed instruments and measures. Law-makers and planning and permitting authorities at the Federal level, and in the Laender, regions and local authorities should make increased use of existing, well-developed instruments in order to identify synergies and conflicts at an early stage and to take the necessary steps for action.

► Assessing all impacts of legislation at an early stage

Many instruments for mitigation of and adaptation to climate change take the form of legislation. Before this is passed, the Federal Government is required to determine and describe all intended and unintended impacts of the proposed provisions on environmental, economic and social concerns. This procedure, known as regulatory impact assessment (RIA), is obligatory for all legislative proposals at Federal level under the Joint Rules of Procedure of the Federal Ministries (GGO)²³⁵. The ministry responsible for formulating the draft proposal must (at an early stage) involve all other ministries which may also be affected. This procedure ensures that the differing interests are thoroughly examined, and that they receive due representation. Synergies and conflicts of the new regulations soon become apparent for all policy fields. The RIA has only been implemented this broadly since the year 2000, and in 2009 an explicit requirement was added to examine long-term consequences and compatibility with sustainability objectives. Prior to this, insufficient attention had been given to environmental protection concerns in the RIA. The UBA is in favour of attaching greater importance to environmental matters in the formulation of legislation, so that this will lead to more balanced regulatory decisions.

► Making full use of environmental assessment instruments to identify solutions during planning and implementation

When drawing up new plans and programmes – for example for dealing with flood risks – it is necessary to weigh up the consequences for all interests involved. The interests must be weighed up against one another in order to reach a fair outcome. Strategic Envi-

²³⁴ Federal Government (2008): Für ein nachhaltiges Deutschland. Fortschrittsbericht zur Nationalen Nachhaltigkeitsstrategie

²³⁵ Section 44 of the GGO

Environmental Assessment (SEA) is used for plans and programmes at all levels from Federal Government, through Länder and regions to local authorities, in order to determine and evaluate the impacts of a plan or programme on protected environmental assets, including the climate, and to take them appropriately into account in the planning process. Planners can use the SEA in order to contribute to reducing greenhouse gas emissions and/or to provide effective support to climate change adaptation as well as help to determine and evaluate the impacts of mitigation and adaptation measures on other environmental assets. Since the impacts on all environmental assets have to be included in the SEA, and not just the positive consequences for the climate, the conflicts and synergies with other environmental goals become clear at an early stage. This makes it possible for planning authorities to make targeted changes while the plans or programmes are still being formulated in order to achieve improvements through synergy effects or eliminate identified conflicts.

Environmental impact assessment (EIA) is another instrument which can contribute to climate change mitigation and adaptation. The EIA is comparable with the SEA, but is only carried out as part of the permitting procedures for specific projects, such as a new industrial plant. From the point of view of climate change mitigation, the EIA can be beneficial for projects involving high greenhouse gas emissions, such as a new coal-fired power station, or projects offering considerable adaptation potential, such as large-scale forestation projects. In such cases, the authorities can use EIA to present the conflicts and synergies and press for alternatives which do not impact negatively on the climate and other environmental assets.

► **Reviewing and adapting existing sectoral policies with regard to potential synergies**

The example of agricultural policy shows the potential which exists for the implementation of other environmental policy goals if the instruments of individual government departments are systematically examined for synergy effects relating to climate policies.

Existing agro-environmental instruments should be reviewed for potential reductions of greenhouse gas emissions and adapted accordingly. This can lead to additional synergies with regard to water protection and air pollution control objectives. Reductions of nitrous oxide emissions can be achieved by careful and reduced use of nitrogenous fodder and fertiliser. This would also lead to a marked reduction in nitrate levels in surface waters and ammonia emissions, and therefore to reductions of the risks for health and for biological diversity.

Further potential for synergies between climate change mitigation and adaptation and other protected environmental assets is possible in the fields of development, energy, construction, transport, finance, economic, industrial and regional policy. The UBA will actively encourage the exploitation of these multiple benefits for all aspects of environmental policy.

29. Developing sustainable energy supplies

Germany can establish itself as a leading global player by converting solely to renewable sources of energy, setting an example for the development of a sustainable development of the energy system. Such an approach would equally take into account factors such as climate change mitigation, environmental conservation and public health as well as the secure provision of energy. In the long term there is no alternative to such a reorganisation of the energy system. The German Federal Environment Agency (UBA) assumes all decision makers obliged to promote these ongoing developments and to treat them as a priority in all economic, legislative and administrative decisions.

Climate change mitigation represents a key criterion for sustainable development and as the previous Sections have shown it requires the consideration of further sustainability criteria beyond the direct demands. Energy supplies are particularly important for the lives and welfare of mankind. The discussion of the principles of a sustainable development of energy supplies has been going on for at least a decade²³⁶.

The guiding criterion is "Protecting the climate, environment and public health". But other criteria are also of fundamental importance (see box). The development of the energy supply system should in the first place be organised so that this remains within the boundaries set by the capacity of the balance of nature. Other sustainability requirements such as security of supply and profitability can only be optimised within these limits. In contrast, fossil-nuclear energy supplies do not fulfil all the sustainability criteria at all or in only to a limited extent, despite considerable efforts over recent decades with regard to reducing air pollution, and controlling the risks of nuclear energy or regarding coal mining.

²³⁶ Federal Environment Agency (2002): Nachhaltige Entwicklung in Deutschland. Die Zukunft dauerhaft umweltgerecht gestalten. Berlin; Wuppertal Institute and DLR (2002): Langfristszenarien für eine nachhaltige Energienutzung in Deutschland. UFOPLAN project FKZ 200 97 104, Wuppertal, Stuttgart; Wuppertal Institute et al. (2004): Ökologisch optimierter Ausbau der Nutzung erneuerbarer Energien in Deutschland. Forschungsvorhaben, for the Federal Ministry for the Environment, Nature Conservation and Reactor Safety, FKZ 901 41 803, Stuttgart, Heidelberg, Wuppertal.

Criteria for the sustainable development of energy supply

- **environmental, climate and public health compatibility**
Sustainable environment, climate and public health compatibility must take into consideration all the effects of the energy supplies throughout the whole life cycle. The currently discussed retrofitting of coal-fired power stations with carbon capture and storage (CCS) systems ignore the massive environmental and health impacts and external costs of coal mining.
- **Comprehensive economic feasibility**
Acceptable macroeconomic costs for energy services are important for sustainable energy supply systems. This must also include external costs, which so far have been met by the community. A prominent example is climate impacts, which are not covered by the consumer costs of fossil fuels.
- **Social compatibility**
Energy use must be offered at socially acceptable prices. If the energy prices are too high, the scope for action of both the public and private sector is reduced. This effect has a considerably greater impact in poorer countries than in industrialised countries, but here too it can considerably restrict people's choice.
- **Long-term security of supply**
The access opportunities for energy use are of key importance for the development of a macroeconomy. Insufficient access to energy resources signifies a considerable limitation of development options for a large proportion of people. Currently some 20 countries control 70 to 80 % of globally available fossil fuels and nuclear resources.
- **Low risks and fault tolerance**
A sustainable energy policy limits risks of energy supply over time and space. Phasing out nuclear energy is a step towards sustainability; the frequent accidents in nuclear power stations highlight the existing risks²³⁷
- **Effective resource conservation**
We must conserve limited resources in order to keep options for coming generations. The efficient use of resources generally also leads to lower environmental impacts and offers economic benefits.
- **Trans-regional and international cooperation**
According to the motto "Act locally, think globally", the sustainable development of energy supply systems also includes trans-regional and global considerations. International cooperation serves to balance out the availability of resources in regions, and helps to avoid destabilisation tendencies and potential of conflicts.

Taking into account these sustainability criteria, the best course for sustainable energy supply is offered by a complete transition to a most efficient use of energy from renewable sources. The worldwide potential for renewables, considering conservative technological, structural and environmental constraints, is about six times the current end consumption of energy worldwide. Even if, as expected, global energy demand rises considerably, it could still be met completely and reliably with renewable energy sources²³⁸. However, sustainable development requires that efficiency of use is also taken into consideration. With such a strategy, it would be possible to achieve the necessary reduc-

²³⁷ Cf. Klaus et al (2009).

²³⁸ Bundesumweltministerium (2009): Erneuerbare Energien - Innovationen für eine nachhaltige Energiezukunft. Berlin 2009.

tions of global CO₂-emissions required for climate change mitigation by 2050, and also in the long term to replace the fossil-nuclear energy supply system to a large extent²³⁹.

For Germany, the Lead Study 2008²⁴⁰ investigates a long-term reconstruction of the energy supply systems while taking account of the restrictions of environmental protection. Figure 12 shows the principle of this development for Scenario E3, which by 2090 envisages the complete phasing out the use of fossil and nuclear fuels through comprehensive measures to increase energy efficiency and to make greater use of power from renewable sources.

With the measures described above in Section 17 to 22 we can continue the on-going development towards sustainable energy supplies. In addition, further measures need to be adopted in order to achieve the goal of supplying all power needs from renewable sources. This would put Germany in the position of a pioneer, and provide an example of the feasibility of a necessary development which would ensure the long-term future of life on the planet – not only due to preventing dangerous climate change.

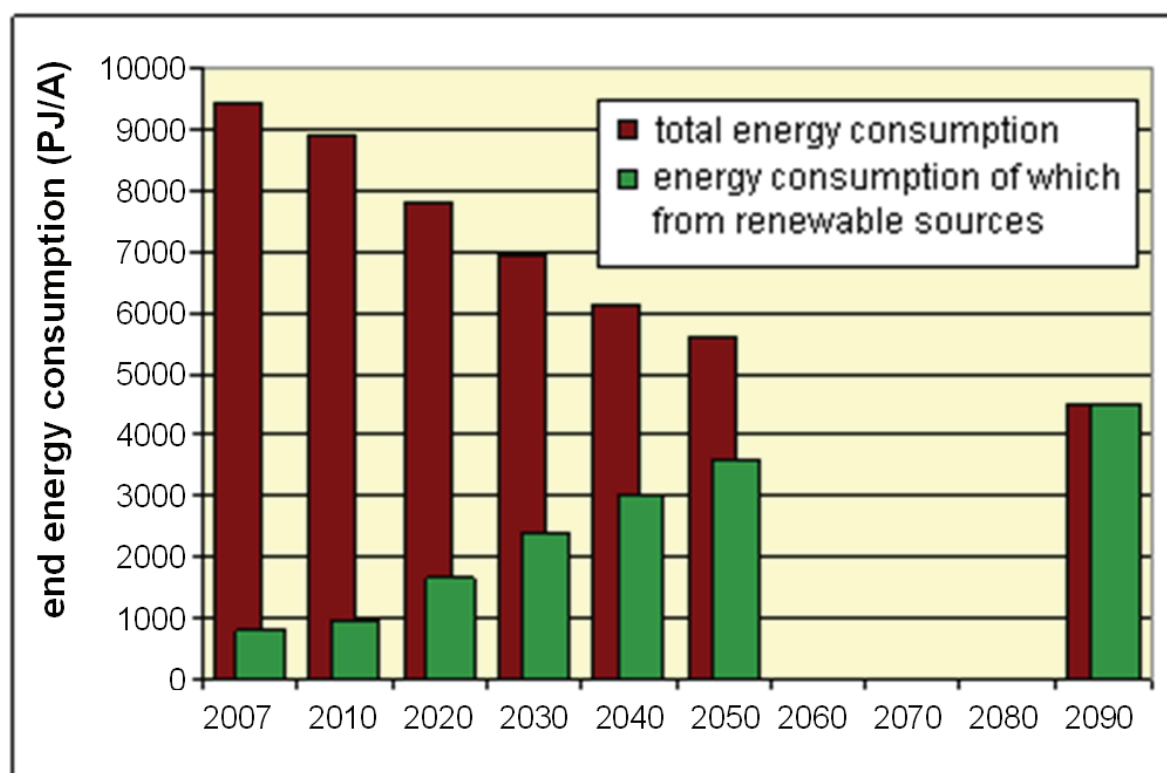


Figure 12: Necessary developments of end energy consumption and the proportion of renewables through to 2090²⁴¹

The following three strategy elements have been discussed in various forms in other publications. If fully adopted, they would establish the direction for the sustainable development of energy supplies. By reducing energy demand at various levels we would be able to fully cover remaining energy requirements from renewable sources.

²³⁹ Cf. Greenpeace/EREC (2008). The scenario of a global energy supply uses efficiency measures to achieve a nearly unchanged energy consumption with 56 % share of renewables in primary energy consumption in 2050. Global CO₂-emissions are reduced by 50 % compared with 1990 levels by 2050 without nuclear power and CCS.

²⁴⁰ Nitsch (2008).

²⁴¹ Nitsch (2008)

1. Higher living standards with less energy

Our standard of living should be uncoupled from the energy intensity. Planning and development processes take into account the implications for energy demands, e.g. when planning settlements. We must use less end energy (power, heating and mobility) to provide the necessary energy services, such as warm and well-lit living spaces, to manufacture products, or to transport goods and people.

2. Resource conservation by efficient transformation and final use of energy

The energy for the essential services must be transformed, transported and used as efficiently as possible.

3. Meet the remaining demand with energy from renewable sources

The energy requirements, which have been considerably reduced by the first two optimisation stages, will be met entirely from renewable sources. The optimum use will be made of the potential of all sectors in Germany, Europe and worldwide in terms of energy, macroeconomics, and environmental considerations, in combination with storage and demand-side management.

These strategic elements form a logical sequence, so that each takes into account the previous developments. We can achieve sustainable development of energy supplies by optimising them both in terms of their interactions as well as the effects over space and time.

► Energy master plan for a sustainable energy supply system

The UBA recommends that the Federal Government, on the basis of the existing measures²⁴², should develop an Energy Master Plan for the development of a sustainable energy system. This should be based on the consideration of all criteria necessary for the development of a sustainable energy system. Ambitious long-term objectives should signal the direction in accordance with the strategic elements outlined above.

► Establishing social consensus

In the course of developing the Energy Master Plan, the Federal Government should initiate a public discussion process, regarding a sustainable energy system. Federal Laender, associations and various groups of actors should also contribute by setting their own objectives towards establishing a clear orientation for Germany and creating a global example. The UBA assumes all state and private decision-makers obliged to support the Federal Government in these efforts. The Federal Government should treat this consensus as a priority in all legislative and administrative decisions.

► Formulating necessary framework conditions

The Federal Government has already given clear signals for the development of a sustainable energy system by introducing a variety of measures²⁴³. In sections 17 to 22 above, numerous measures are cited for the continuation of this approach. In order to ensure a development in accordance with its Energy Master Plan, the Federal Government will in the future have to create legal, administrative and economic framework conditions, and support important sectors of research.

²⁴² Integrated Energy and Climate Programme of the Federal Government (IEKP), EU directives on energy from renewable sources and energy efficiency, and the measures mentioned above

²⁴³ Cf. IEKP, Unterstützung einer europäischen Klimaschutzkonzeption, and the EU directives on energy from renewable sources and energy efficiency.