Science Centre
North Rhine-Westphalia

Institute of Work
and Technology

Institute for Culture
Studies

Wuppertal Institute for Climate, Environment and Energy

Wuppertal Institute
for Climate Environment and Energy

Annual Report 2004/05

NRW.

Bernd Brouns, Stefan Lechtenböhmer, Jochen Luhmann[1]

“Kyoto plus” — Strategies for Global Climate Policy in the 21st Century

International efforts to combat climate change have entered into a new phase. More than seven years after the adoption of the Kyoto Protocol, its entering into force on 16th February 2005 marked the ending of the first phase of multilateral climate policy, which started in 1992 on the Earth Summit on Environment and Development in Rio. The United Nations Framework Convention on Climate Change (UNFCCC) adopted in Rio established an institutional framework for international climate policy that was complemented by the Kyoto Protocol under which those industrialised nations which are parties to the Kyoto Protocol, for the first time, have taken on legally binding commitments to limit their greenhouse gas emissions. With this, the architecture of international climate policy has undoubtedly obtained an important pillar. However, this pillar needs to be strengthened and the installation of other pillars is required to meet the “greatest challenge of the 21st century” (Tony Blair).

The emerging “Kyoto plus” phase will need to be designed considerably more multidimensional. First, the further development of the Kyoto Protocol will be a core issue in the years to come. In its current form, the Protocol only sets emissions targets for the period 2008 to 2012, but it is designed as a dynamic treaty. It contains a provision that parties to the Kyoto Protocol shall initiate at their first meeting in Montreal (November/December 2005) a negotiation process on targets and measures for the years beyond 2012. In this case, “Kyoto plus” simply means the continuous development of the protocol towards “Kyoto 2”, Kyoto 3”, Kyoto 4” etc.

A precondition for the success of these negotiations is the implementation of existing Kyoto mitigation commitments into concrete measures at the national (and European) level. The implementation of “Kyoto 1” and subsequent agreements is, therefore, another dimension of “Kyoto plus” that will directly affect the international negotiations. As the implementation of Kyoto targets is a rather slow process in many industrialised states, this national dimension will be of utmost significance for the design of future international efforts. In this respect, the start of the European emission trading system in January 2005 is a promising step.

Apart from setting emission targets and establishing new policy instruments as framing conditions mitigation of greenhouse gas emissions depends on the availability and the use of climate and environmentally sound technology options. Therefore, multilateral cooperation is required to promote the development, and even more important, the market entry of these technologies. This is the objective of some of the recent climate policy initiatives such as the “Renewables” process and the “Asia-Pacific Partnership on Clean Development and Climate” by the United States, Australia, Japan, China, India and South Korea. This technology oriented “Kyoto plus” path builds on the international coordination of measures to create markets for climate friendly technologies and is thus an essential complement to the negotiation process under the Climate Convention and the Kyoto Protocol. However, one has to be aware of the fact that in the current

1 This text is based on results of recent research projects of the Wuppertal Institute focussing on international climate and energy efficiency policy. It presents proposals for strategies of future climate (mitigation) policy for further discussion among actors of national and international climate policy as well as the interested public.
We would like to thank Peter Hennicke, Hermann E. Ott, Wolfgang Sterk, Stefan Thomas und Bettina Wittneben for constructive comments on earlier drafts of this texts.

The Kyoto Protocol

The Kyoto Protocol was adopted at the third conference of the parties to the Climate Convention (COP 3) that took place in 1997 in Kyoto/Japan. In this Protocol, industrialised countries that are listed in Annex I of the Convention have agreed on legally binding commitments to reduce their emissions of greenhouse gases such as carbon dioxide (CO_2), methane (CH_4) und Nitrous Oxide (N_2O) in the period from 2008 to 2012 by, at least, 5 percent on average below the level of 1990. Given this overall reduction target, countries have accepted different levels of emissions limitation targets (e.g. EU (15): –8 percent, USA: –7 percent, Japan; –6 percent, Russia: ± 0 percent, Australia: +8 percent). The EU target is further differentiated among those 15 countries that were member states in 1997. Germany aims, for instance, at reducing its emissions by 21 percent, Great Britain by 12,5 percent and France by ± 0 percent whereas a less developed country like Spain is allowed to increase its emissions by 15 percent (UNFCCC 2002). Besides, the Protocol introduces three so called Kyoto mechanisms (emission trading, Joint Implementation, Clean Development Mechanism) that allow for trading of emission allowances among countries aiming at achieving the emission targets in a cost efficient manner. After Russia has ratified the Kyoto Protocol in November 2004 it entered into force on 16 February 2005. Up to now, all industrialised countries apart from the U.S. and Australia as well as many developing countries have ratified the Protocol — in October 2005 the group of Kyoto parties comprised of 155 countries.

Further information on the Kyoto Protocol is available at the website of the UNFCCC secretariat (http//:unfccc.int) and in Oberthür/Ott (1999).

political landscape this path is seen by some actors as an alternative rather than a complement to climate policy under the Convention and Protocol.

All these "Kyoto plus" dimensions have the common goal to reduce emissions, thus paving the way into the "solar age". However, as climate change is already happening it becomes obvious that the climate challenge does not only mean to combat the source of climate change, but that climate policy also needs to include adaptation measures to the impacts of climate change. Starting at the Climate Summit in New Delhi (2002), this reverse side of the medal climate policy and, in particular, the support of the most vulnerable regions und people has gained growing attention in international negotiations. There are, at the same time, interlinkages to the mitigation dimension of climate policy, since many developing countries link the question of their future contribution to global mitigation efforts to the condition that industrialised nations take on responsibility for the victims of climate impacts.[2]

This article sets the focus on the international dimension of an integrated mitigation policy that aims at limiting the impacts of climate change at a tolerable level.

2 For further details on the mutual conditionality of adaptation and mitigation policy for the further development of the climate regime please refer to Ott et al. (2004).

The Challenge in Climate Policy at the End of the First Kyoto Phase

Climate change is just as normal a part of natural history as the rising and setting of Sun and Moon. It reflects the Earth's relationship with the Sun and its sibling planets, which is subject to continuous change as the constellations shift in repetitive patterns. Their rhythmic and stately course seems far removed from humankind, yet humankind has burst in on it like some new constellation. Within little more than a century, the human race has catapulted itself into a position of power on Earth, the basis of its existence, that rivals that of the Sun: today, man-made change in the planet's radiation balance exceeds that caused by changes in the output of the Sun. It is also much more rapid.

Humankind's forceful impact has a name: anthropogenic climate change. This is caused above all by human activities that increase the abundance of greenhouse gases in Earth's atmosphere. At the end of the nineteenth century the concentration of carbon dioxide in the atmosphere was 280 ppmv. That may look like a small amount, and why an increase of such a small amount, or even double that amount, should be so significant is hard to understand. An alternative yardstick for human impact through greenhouse gases (GHG) is the rise in global mean surface temperature caused by the increase in GHG abundance. A rise by 3° Celsius as a result of a 100-percent increase in GHG concentration since the pre-industrial age would be the presumable equivalent — its calculation, however, requires more than just simple measurements and indeed an entire climate model. Yet reactions to this figure will probably be equally unworried: "So Germany will have the same temperatures as Majorca has today — what's the problem?" Positive responses such as this may be expected. This is why we are using a different gauge, namely, the energy or radiative forcing that affects atmospheric processes as a result of humanmade fluctuations in GHG concentration. It is measured in watts of absorbed solar irradiance per square metre (W/m^2) and measures the "force" of human impact. Its advantage is that it compares with the historical forces that shaped the Earth, so it no longer appears insignificant.

We are currently living through a warm period that began twelve thousand years ago. In the previous seven hundred thousand years of Earth's history there was a regular alternation between ice ages and warm periods, depending on the constellation of Earth, Sun and sibling planets. This was reflected in changes in GHG concentration. The maximum range of GHG fluctuation was approx. 1.5 W/m^2. At the end of the pre-industrial age humankind started out from the top end of this range. Today, more than 130 years later, we have generated an additional forcing of 2.5 watts[1] and are approaching 3.5 W/m^2, which equals a 100-percent rise in GHG concentration.[2] There is no indication that this is the upper limit.

The predominant greenhouse gas is carbon dioxide, though other anthropogenic GHGs are not insignificant — they make up around 40 percent of past GHG emissions, and up to 20 percent of future emissions (WRI 2005). Carbon dioxide is the product of an elementary life-sustaining process, i. e. the combustion of organic carbon compounds to exploit their binding energy. However, life could not be sustained without the reverse process, photosynthesis, the formation

1 Considering these figures, one would expect instability (an 'ice age') either to have set in already or to be about to set in. Why the situations are different despite similar or even greater external forcings, and why the present warm period is still more or less stable, is explained in Luhmann (2005a).

2 1.5 W/m^2 reflects an amplitude 200 to 280 ppmv, i. e. a difference of 80 ppmv. 3.5 W/m2 reflects a doubling of GHG concentration as against the pre-industrial age, i. e. a difference of + 280 ppmv. These ratios show that the relationship between GHG concentration and radiative forcing is non-linear, owing to the fact that CO_2-specific absorption bands tend towards saturation. However, to identify the effective radiative change, secondary effects from altered behaviour in Earth's non-physical components need to be taken into account, and these suggest positive feedbacks.

of carbohydrates from carbon dioxide and a source of hydrogen (as water) with the aid of solar energy.

For a long time both these elementary life-sustaining processes coexisted in a natural equilibrium of growth and decay. Human invention began to disturb this equilibrium when the steam engine arrived towards the end of the eighteenth century. In a process we know as "industrial revolution", humankind exploited fossil fuels to get access to the "hoard" of solar energy stored therein, breaching the natural limit that previously restricted humankind to energy flows. The amount of fossil fuels that humankind today burns in a single year took approx. one million years to come into existence with the aid of solar energy. This combustion effects a humanmade forcing on the atmospheric energy balance. The impact of the carbon dioxide released into the atmosphere, however, is approx. one hundred times bigger than the immediate impact we seek to produce when burning energy sources.

Before the event, in the early phases of industrialization, humankind gave astonishingly little thought to where the highly powerful waste products of combustion would go. Yet if there are no sinks to match the increase in sources of carbon dioxide and if human intervention releases more greenhouse gases into the atmosphere than are removed from it in "natural" processes, their concentration in Earth's atmosphere will inevitably rise, quite apart from the impact this or other human activities may have on the absorption capacity of the "natural" system. And this is exactly what happened. A central pillar of the industrialization project is showing cracks. Science realized this in the 1970s; politics in the second half of the 1980s. Yet business is continuing as usual. A more deeply-rooted confidence, a more childlike sense of security than is manifest in this continuance is difficult to imagine. It is based on the hope that the cracks are only on the surface, or that it won't be too bad when the roof comes down. These hopes, however, are groundless.[3]

The structure of the challenge resulting from humanmade climate change is best explained with what we will call the "bathtub simile". Consider the tub as a container with three principal properties: it has a specific maximum capacity limiting the amount it can hold; there is inflow (tap) and outflow (plughole).

Let the bathtub stand for Earth's atmosphere, the water it holds for greenhouse gases. In developing their culture of industrial operations, the industrialized nations opened the tap farther than the capacity of the plughole warranted. After World War II they gave it another few turns, opening the tap as far as it would go. As a result, the tub is today filled to approx. 85 percent of its capacity — with the world population still growing and the developing nations just beginning to embark on the industrialization project.

The various greenhouse gases are chemical substances and therefore react quite differently with the environment. For instance, their retention in the atmosphere varies, as do their "side effects" on natural material cycles, in particular the carbon and nitrogen cycles. One common characteristic however is their effect on Earth's energy balance, the radiative forcing that contributes to global warming.

The objective of climate policy must be to curb the increase of GHG concentration in the atmosphere — to keep the water in the tub from rising further, so to speak. Stabilizing emissions at the current level will not achieve this objective; the bathtub would still overflow. The only way to stop the inexorable rise of the "water level" is to reduce emissions drastically and to a precisely defined level, namely, to the capacity of the "plughole", by not emitting more greenhouse gases than can be absorbed. Moreover, "overflow" can only be prevented if this happens soon and consistently.

3 On the history of the discovery of the climate challenge, see Luhmann (2001) and Weart (2003).

Kyoto: Interim Results

The occasion for our present stocktaking is the current state of multilateral climate policy. It has reached something of a turning point, and that is a good point at which to take stock and see what remains to be done.

On 16 February 2005 the Kyoto Protocol was finally ratified. This was a cause for celebration; years of negotiation had come to fruition. In the aftermath, however, it has also become clear where negotiations failed and which results are flawed — all thanks to the global political debate surrounding the Kyoto Protocol.

Once the climate problem had been discovered as a political issue, the leading parties tacitly assumed something like the following timeframe: Starting point is the year 1990. The goal of multilateral climate policy must be to reduce global GHG emissions by approx. 50 percent by 2050. From 1990 to 2050 is three times twenty years. That gives us three phases in which to achieve the success for which we are striving. Given that industrialized nations emit more greenhouse gases than developing countries, they ought to take the lead, so the first phase is theirs. They begin to reduce GHG emissions. In the second phase the developing countries follow suit. And if the joint effort to reduce greenhouse gases shows the desired result, namely, a reduction, the third phase can be devoted to achieving the final objective. That is the (perhaps somewhat tight) schedule. The first phase of twenty years, from 1990 to 2010, turned out to be the Kyoto phase, whose basic results are now clear: the industrialized nations have committed to reducing GHG emissions by 5 percent.

Thanks to legally binding reporting obligations, the emissions level from which humankind set out early in the 1990s can today be determined with some precision. Back then, industrialized and developing nations together each year emitted thirty gigatonnes (Gt/a) of greenhouse gases — at least under the definition of greenhouse gases as reflected in the so-called Kyoto Basket (the Kyoto Protocol does not list all greenhouse gases for whose emission humankind is responsible). This lack of exhaustiveness was a conscious decision; after all, the Kyoto Protocol was conceived as no more than the first step towards a global climate policy, and it primarily targeted industrialized nations.

A more complete statement would be that we started from approx. 39 Gt/a. This takes account of carbon dioxide emissions from deforestation or, as the technical term has it, 'changes in land use'. The Kyoto Basket largely limits carbon dioxide to emissions from "the combustion of fossil energy sources". Our amended statement also takes account of emissions from "international transport", which so far has eluded the grasp of UN logic, based as it is on territorial states and the addition of their discrete figures.

Deforestation is a problem that particularly affects a number of developing countries that are still in the process of 'catching up' with what the industrialized nations 'finished' (in every sense of the word) early in the industrial revolution or before it even began. England, for example, had turned itself into a virtually treeless country. It was precisely this lack that compelled the motherland of industrialization to fall back on and systematically exploit what was erroneously seen as the "subterranean forest", the fossil fuel coal. Although it made a modicum of sense to neglect the emissions category "carbon dioxide from deforestation" during the first Kyoto phase, in which industrialized nations took the lead, this category is quantitatively significant. In future, as developing countries begin to meet their commitments, it will have to be addressed. The same holds true for the international transport segment.

The Foreseeable Point of Departure at the End of the First Kyoto Phase

Now that we have defined the basics, let us turn to the situation, as far as it is foreseeable, at the beginning of the post-2012 phase. The first point to consider is once again a definition, that of "anthropogenic greenhouse gases" according to the Kyoto Basket. We have seen that under this definition the starting point in 1990 was 30 Gt/a, with industrialized nations emitting 60 percent and developing countries 40 percent. The goal was to halve emissions by 2050, which meant a reduction by 15 Gt/a down to exactly that level. To achieve this goal, the industrialized nations were to take the lead — until 2010. Thus far the tacit agreement between South and North on the two phases; thus far the 'basis of transactions' of the UN Framework Convention on Climate Change.

Twenty years later, it has become clear that the North has not met its task. GHG emissions have risen significantly, not only in countries with an industrial backlog, but also in the pioneering i.e. industrialized nations. The rise in GHG emissions in both groups is historically without precedent. The bases for this assessment are the dutiful reports submitted by industrialized nations on the one hand (UNFCCC 2004) and the forecasts of the International Energy Agency (IEA) for developing countries on the other (IEA 2004). According to these sources, we will have to expect a leap in global emissions of 15 Gt/a by 2010, within only two decades.

How is such a grotesque global increase possible? Industrialized nations are responsible for an additional 2 Gt/a (approximately), weighing in with a 10-percent increase. That is primarily due to runaway growth in two non-signatory countries, the United States and Australia. The point here is that the emissions of industrialized nations as a group are not falling but rising. That sets a negative example and delegitimizes demands for appropriate measures from developing countries.

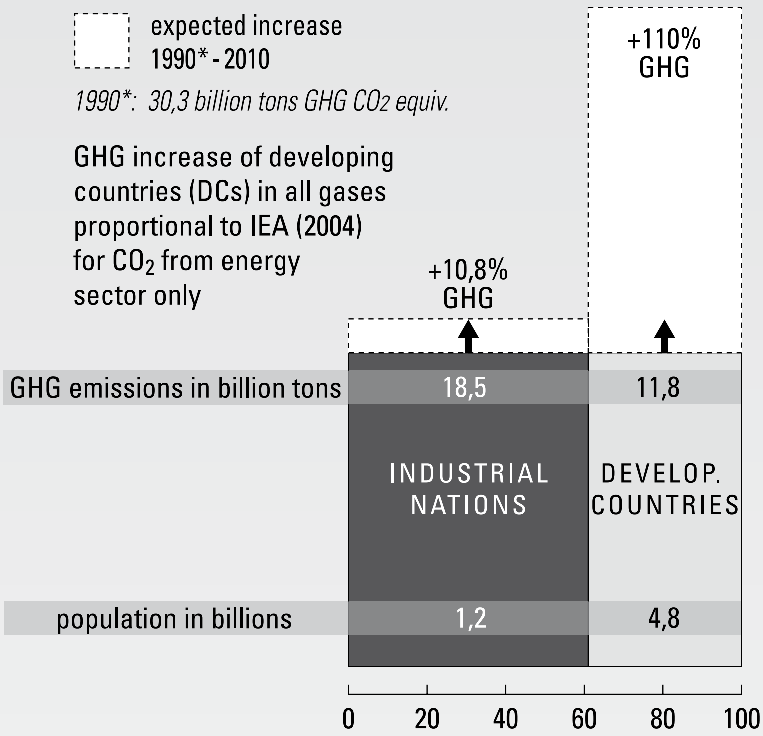
The remaining 13 Gt/a comes from developing countries. Predominant among these is China, followed by India, the Brazil/Indonesia/Iran group, and the group of low-income OECD members Mexico/South Korea/Turkey. The developing countries' share in global GHG emissions in 1990 was nearly 40 percent, and the IEA forecasts an increase of 110 percent for carbon dioxide emissions. This forecast does not account for the "rest" of greenhouse gases, and their growth rate may be expected to be lower than that of gases from combustion, the increase of which the IEA authors seem to see as inevitable in economies that are catching up industrially. However, carbon dioxide from deforestation is still unaccounted for here. In 1990 it made up approx. 8 Gt/a. Developing countries may therefore be expected to emit at least 25 Gt/a of greenhouse gases in 2010, thus overtaking the industrialized economies and their "mere" 20 Gt/a.

The significance of these figures is clear: in 2010, at the end of twenty years and the first of three phases, GHG emissions amounting to 45 Gt/a will be all the international community has to show for its abatement efforts. If the original objective for 2050 is still to be achieved, the challenge now, after a third of the projected timeframe has elapsed, is to reduce emissions by twice as much as was envisaged in 1992, namely, by 30 Gt/a, to a third of the volume expected for 2010. That is a scale that would have been quite inconceivable at the beginning of the 1990s.

The parties to the Framework Convention, and in particular the industrialized nations, are committed to reviewing at regular intervals how the Convention is being applied. That means identifying and comparing the challenge, or objective, and the state of implementation, or policies. The resulting difference determines the task for the future. Such a reassessment was scheduled for 1998, but has been postponed with daunting regularity in the framework of the Convention process. Yet outside the official framework, the Kyoto signatories in particular are preparing to take the Kyoto Protocol further by the end of 2005 at the latest, as was agreed in the pact.

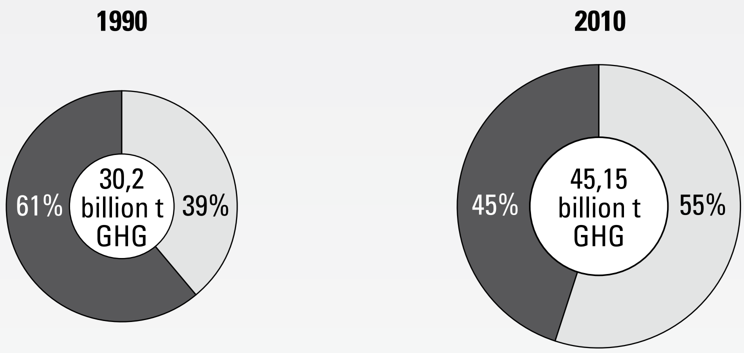
Global outcome of the Kyoto period as to be expected

A making up in greenhouse gas emissions



*Base year of the Kyoto commitment (Source: UNFCCC, Oct. 2004).

B Shift in shares (segments) and increase (circles)



In preparing the G8 meeting in July and the EU Council decision in March 2005, for example, significant efforts were made to determine the scale of the challenge now to be tackled. Carefully researched and precise information was collected, in the EU's case several years in advance.[4] That led to a clearer awareness of the principal issues, which in turn focused numerous individual research results so far scattered across the science landscape, or results that did not meet the IPCC quality standard because they were too "young". It took the call from political quarters to bring about an integrated view on the problem with whose observation science is charged. This integrated view is not going to come about by itself.

A Growing Suspicion: Have We Gone Too Far?

The process of reviewing and focusing a plethora of so far unrelated insights and facts has given rise to a twofold suspicion with regard to the scale of climate change and the impacts we have already set off: have we perhaps gone too far already?

Ice Melt Underestimated

The first suspicion is that the consequences of higher temperatures in the Earth's various spheres may be more significant than has been thought. If scientists investigating the ice sheet, or cryosphere, once called their subject a "sleeping giant" in terms of climate change, they are now talking of a "giant awakened" (Rapley 2005).

Ice-melt models to date suggest that the giant is indeed asleep. Consequently, science "officially" (i. e. in the IPCC's Third Assessment Report) expects a global-average sea level rise of 0.35 metres due solely to thermal expansion of the ocean volume and glacier melts (IPCC 2001, 641).[5]

However, it has since turned out that the ice-melt models used in the IPCC report to portray the Greenland and Antarctic ice sheets as a sleeping giant do not do full justice to the actual ice-melt processes today visible in polar regions both North and South. On the contrary, they are massively underestimated (see Rahmstorf/Jaeger 2004 and Luhmann 2005b). Scientists from the British Antarctic Survey take up the image of the giant, if only to warn of its awakening — a possibility, they say, being careful not to exaggerate the feared threat.

Earth System Analysis Corrects View of "Climate Sensitivity"

The second suspicion may be even more important. Its background is the prevalent view of the link between rising GHG concentrations and the effect on temperatures as "mostly harmless". The realization now, however, is that (a) human intervention in Earth's system is not restricted to greenhouse gases and their impact in the (modelled) climate system and that (b) the increased concentration of "greenhouse gases" not only raises temperatures, as the name implies, but also has complex biochemical effects. Chemically triggered feedbacks from those of the Earth's spheres that have so far been neglected indicate that the link is, in reality, far more dynamic and therefore far more dramatic in its consequences for humankind.

4 In the run-up to the G8 summit, the British government, for example, held a symposium in Exeter on Avoiding Dangerous Climate Change (1–3 February 2005). More information about the conference is to be found at http://www.stabilisation2005.com.

5 On average the melt water contributions from Greenland and Antarctica, together –4 cm, are considered as sinks; global average sea level is projected to rise by maximally 0.88 m over 1990 to 2100 (IPCC 2001, 641).

Let us step back a little and assess the implications of this new perspective. We are talking about changes that affect the assumptions underlying the specific form in which the challenge of climate policy has been formulated, both conventionally and up to this point also in the present essay. Climate models play an important role here. Like all models, they represent a partial system — they stylize a very specific relationship between inside and outside. Inside is the "natural" climate system with properties determined on the basis of past experience; outside is humankind. The channels of possible human impact are defined (political science calls this "framing"), i. e. put in terms of specific GHG emissions; the change in concentrations of other greenhouse gases in turn is identified as internal feedback and its impact is chalked up with the politically focused "anthropogenic greenhouse gases". Everything else is left ceteris paribus.[6] If human behaviour thus defined changes, this changes the values of the related parameters in the climate system modelled (!) to this "fit" — the system itself and its properties remain unchanged. It is only with the help of such assumptions and distinctions that the effects of a changed human impact can be calculated in climate models.

The principal parameter for the description of the properties of the model system is "climate sensitivity". This term has to be taken literally: it refers to the principal property of a "climate" system in the strict sense, more precisely, to the rise in temperature due to the effect following a doubling in the concentration of the greenhouse gas carbon dioxide. Beyond their radiative impact, however, greenhouse gases also react in chemical and biological processes. If such "side" effects trigger changes in the properties of Earth's system that impinge on the principal property of the model climate system, then this is beyond what conventional climate models can represent. The same holds true for human impacts other than GHG emissions.

This new perspective gives rise to questions like the following: What about the sensitivity of the climate system if we think about what will happen to our trusty little friends in the oceans, which have always managed the transformation of carbon dioxide into calcium carbonate for us, and saw to its disposal at the bottom of the sea?[7] For a rise in carbonic acid in the atmosphere will lead to an acidification of the upper levels of the sea — their habitat. Ocean biologists, at all events, are raising the alarm (Turley et al. 2005; Royal Society 2005). What if a rise in surface air temperature over land, combined with copious precipitation, inspires microbes with a great hunger and they begin to decompose the carbon reservoirs of our forests, thus releasing carbon dioxide? For only a third of the carbon reservoir of boreal forests is actually located in the wood of trees; the other two thirds are stored in the unstable humus layer of soils, which is accessible to the warmth-loving microbes. Again, scientists, in this case soil biologists, are raising the alarm (Lewis 2005 and Cox 2005).

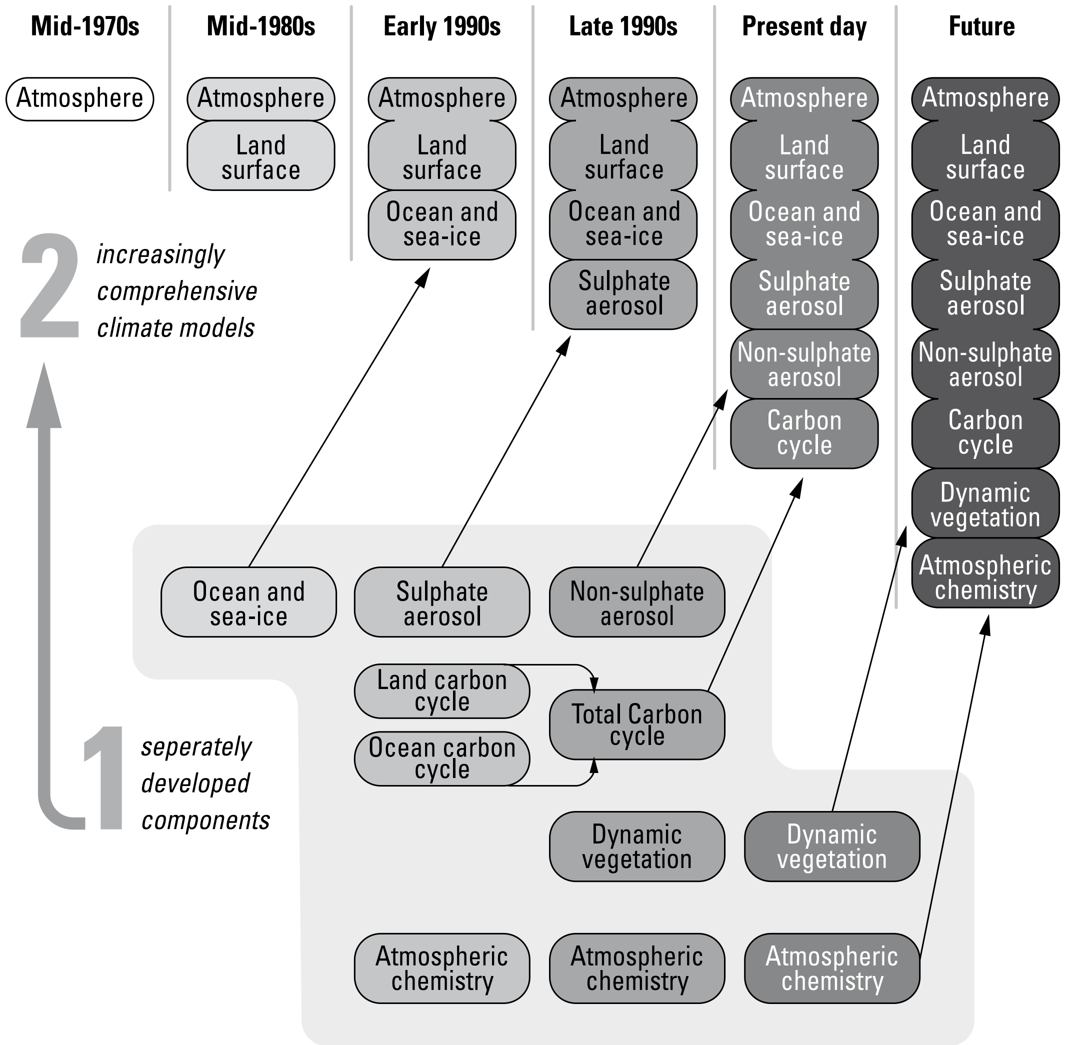
No complete list of concerns that become visible in this perspective can be given here, but let us point to three further implications — resulting from climate change alone — that influence climate sensitivity. The following phenomena are analogous to the two examples given above:

1. Methane from melting permafrost soils;
2. Methane hydrates from oceans; and in a sense also,
3. Termination of one negative radiate forcing as a result of aerosol prevention/phasing out of fossil fuel combustion.

6 This stylization is necessary for calculating the metrics of equivalent CO_2 and/or global warming potential, which in turn is the precondition for the one-dimensional view of greenhouse gases and therefore of any climate policy in the traditional sense.

7 We are referring to planktonic microorganisms — generic name coccolithophorids — that so far have taken over 80 percent of the task of binding carbon in the oceans by transforming it into calcium carbonate which then sinks harmlessly to the seabed.

The gradual evolution of climate models to earth system models



Source: IPCC, Climate Change 2001

The climate science community is very clear that the 'properties' of a climate model need to be considered as a variable. The 'canonized' representation may be found in the IPCC's Third Assessment Report, Technical Summary, Box 3, where the components mentioned above are characterized as components that still need to be "coupled into comprehensive climate models". The result, of course, would no longer be a climate model but a model of the Earth's system. It is no coincidence that in both examples given above it is the biologists who pointed up previously overlooked links. On the contrary, the reason for this is systematic and rooted deep in the science landscape: Climate models stylize climate as a sort of generalized weather and hence a largely physical phenomenon. First approaches to modelling future anthropogenic climate change were conceived accordingly. That gives a skewed view, but a model iz always a simplification. No one will claim that the epistemic ideal of physics is oriented towards vital processes — physics paradigmatically represents the modern ideal of certain knowledge. The greater that human impacts on the Earth's system are conceived to be, obviously the less able physics-based models are to represent the phenomenon of anthropogenic climate. Further spheres, in particular hitherto neglected vital processes, need to be coupled into the model.

That is happening, if only tentatively, in reaction to an argument often used in support of prevalent models, that processes for which no precise data are available cannot be taken into account. For there is mounting evidence that these processes do play a significant role, and that conventional models ignore crucial 'feedback' effects. The prospective perception of the full impact of human intervention depends not only on the progressive increase of scientific knowledge, but also on a change in the way the scientific disciplines perceive themselves, their epistemic ideal. It is possible that the crucial impacts cannot be seen by the light of science's traditional epistemic ideal, but lie beyond its limited radius.

State of Science and Security Issues

Humankind is about to enter a situation that is without precedent in the Earth's history. Never before has an external impact of more than 1.5 Watt/m^2 coincided with the existence of two vast inland ice sheets (Antarctica and Greenland). These represent a volume of ice that, if it were to melt, would cause sea levels to rise by more than sixty metres (Rahmstorf/Jäger 2005; Rapley2005).[8]

Describing this situation as "unprecedented", as we have just done, is more than a simple natural-historical proposition. Proposing the term "unprecedented" has epistemological implications in that it signifies the complete lack of experience in respect of such a situation. Experience, however, is the basis of modern science, particularly of physics. It is to physics that we owe climate models and a sense of the threat we face. Hence "unprecedented" refers to a field in which climate science's propositions come at a price, and the price is the reliability of propositions. By paying this price — an additional radiative forcing of approx. 3.5 Watt/m^2 as against the pre-industrial age — we risk losing all orientation. Whether beyond this level the paradisiacal stability of the Holocene can be maintained is a matter of some doubt.[9]

It is up to us, up to what we do. And what we do as a collective is politics. Political efforts towards maintaining that stability have reached a climax: this year and the next will see the setting of the strategic signposts for the continued development of international climate policy.

The objective of climate policy has been outlined in the United Nations Framework Convention on Climate Change: It is to "prevent dangerous anthropogenic interference with the climate system." It is to avoid an anticipated threat, and hence requires a new kind of security policy. Ultimately, the objective is to stay well clear of a certain threshold level ("threat"). However, situations of increased "violence" are likely to become more frequent as we approach this threshold level — dealing with these (implementing adaptive measures) is the second objective of climate policy.

The specific "problem" of climate policy in the sense of security policy is that, due to a lack of experience, it cannot build on deeply-rooted traumata. Other types of security policy are rooted in historical traumata — military security policy has the scourge of war, Hiroshima and Nagasaki;

8 Shares in m SLE (metre per sea level equivalent) are: Antarctica: 57 (eastern Antarctica: 52; western Antarctica: 5); Greenland: 7; mountain glaciers: 0.5. This calculation excludes effects from thermal expansion of oceans and a destabilization or collapse of thermohaline circulation (Rahmstorf/Jäger 2005; Rapley 2005).

9 In a systematic climate policy perspective, this refers to the interpretation of "dangerous" in Article 2: Objective of the Framework Convention. One possible approach is by assessing the consequences in Earth's subsystems of a rise in temperatures beyond a specified limit. The most far-reaching experiment using this approach has been conducted by the Wissenschaftlicher Beirat Globale Umweltveränderungen (German Advisory Council on Global Change, WBGU), see Hare 2003; WBGU 2003). The "epistemological" approach to the interpretation of Article 2 of the Framework Convention outlined in the present essay is discussed more extensively in Luhmann (2005a).

health security policy has Spanish influenza; civil protection has the hitherto hypothetical risk — at least in Western Europe — of nuclear meltdown. To spare humankind the experience of traumata on a similar scale is the purpose of climate policy. That, however, requires an open-minded approach. There is at present a painful lack of efforts to investigate and publicize the scale of the problem and the challenge. But that is what it needs to anticipate and forestall traumata. So far, the course has not been set accordingly. The challenge for climate policy now is to redefine itself for the post-2012 phase, and to do so in several dimensions.

Options for International Climate Mitigation Policy

There are currently lively debates on the design and institutional setting of international climate policy beyond the first commitment period of the Kyoto Protocol. Until two years ago it were mainly discussions among scientists, researchers and non-governmental organisations (Brouns 2003). However, recently the issue of future climate policy also went up on the agendas of various political bodies: it was a priority agenda item at the EU Council meeting in March 2005, one of two key issues discussed at the G8 summit in Gleaneagles (July 2005) and the main focus of an informal "Seminar of Governmental Experts" within the UNFCCC negotiation process (May 2005) — not to mention the various bi- and multilateral initiatives focussing on technological cooperation. The reason for the increasing attention to this topic is three-fold: 1. increasing consensus and new scientific findings on the structure, size and urgency of the challenge; 2. the provision in the Kyoto Protocol to start negotiations on its further development in 2005 and 3. attempts of non-Kyoto parties to build up alternatives to the Protocol.

Depending on the political framing and the interests of actors involved these debates take place under various headings such as "Post-2012", "Kyoto plus", "Post-Kyoto" or "Future action" and are hardly linked to each other. Some proposals refer to the second commitment period of the Kyoto Protocol or focus, at least, on other options within the UNCCC/Kyoto regime, others outline policy options outside this regime, sometimes explicitly jeopardizing its effectiveness.

The Wuppertal Institute has done extensive research on instruments and framing conditions for a succesful climate, energy, and transport policy. Based on this expertise, this chapter outlines two tracks of international climate policy that integrate several components of the various debates and presents proposals for the design of both tracks to stimulate further discussion among actors in German and European climate policy.

An adequate response to the climate challenge ahead needs to rely on, at least, two parallel but integrated tracks of international climate policy that follow different but interweaved rationales:

1. the rationale of an "targets and timetable" approach focusing on emission reduction commitments ("Kyoto Track");
2. the rationale of creating market opportunities and market access for climate friendly technologies through internationally co-ordinated policies and measures by means of global agreements but also leadership coalitions ("Policies and Measures Track").

The first track is closely linked to the Kyoto Protocol ("Kyoto Track") and its core element of legally binding quantitative emission limitation and reduction commitments. In this track, (reduction) target setting is the main policy instrument to set incentives for a re-structuring of the fossil fuel-based economies. The focus is on reducing emissions to minimize climate change impacts in accordance with the objective of the Climate Convention to "avoid dangerous interference with the climate system" (Article 2 UNFCCC). Besides, this "targets & timetables" approach is a decisive prerequisite for the climate policy instrument of emissions trading.

However, as this approach with its focus on “reduction targets” and “burden sharing” has a connotation of severe societal costs and sacrifices for sustainable development it would be supportive to complement it with processes emphasising the short- and mid-term benefits arising from applying new technologies and fostering new business fields in green markets. Focussing on opportunities such as strengthening competitiveness, lowering energy costs and improving living conditions of rural poor in developing countries through the use of renewable energies and efficiency technologies would provide more incentives for politicians and businessmen to act — the long-term benefits of avoided (negative) impacts of climate change alone might not be a decisive driving force. Therefore, it is also important to promote a second track of international climate policy (“Policies and Measures Track”) that focus on the coordination of policies and measures aiming at facilitating market access for climate friendly technologies thereby creating socio-economic and technological conditions to realize emission targets.

Although both tracks should be promoted in separate institutional settings it needs to be emphasised that they do not exclude each other. On the contrary, both tracks are meant to support each other and are a mutual prerequisite.

“Kyoto Track”

As the title of this track already indicates the “Kyoto Track” should build upon the institutional framework of the UNFCCC/Kyoto regime. The process of target setting should be guided by the objective of the Climate Convention (Article 2 UNFCCC) to stabilize atmospheric concentration of greenhouse gases at a level “that would prevent dangerous anthropogenic interference with the climate system” within a timeframe that will allow ecosystems to adapt naturally, not threaten food production, and enable sustainable economic development. Although the Convention does not explicitly mention any concrete figure concerning the required stabilization level, scientific analyses on the impacts of climate change suggest that this should correspond with an increase of global average temperature by not more than 2°C compared to pre-industrial levels (see e.g. Hare 2003, WBGU 2003).[10] This assessment was confirmed by the European Union with the adoption of the “2°C goal” by the European Council in March 2005 (EU 2005a). Apart from the European Union also a number of other European countries and many non-governmental organisations support the “2°C goal” (for an overview see Brouns/Ott 2005a).

Aiming at a maximum temperature increase of 2°C would most probably require atmospheric greenhouse gas concentration to stabilize well below 550 ppmv CO_2 equivalent (EC 2005a; Hare/Meinshausen 2004; WBGU 2003a). The current concentration level is at 350 ppmv CO_2 equivalent whereas preindustrial concentration was about 280 ppmv CO_2 equivalent. Limiting the increase well below 550 ppmv CO_2 equivalent would require global emissions to peak at around 2015–2020 and a reduction of global energy-related CO_2 emissions by about 45–60 percent from 1990 levels by 2050 accompanied by substantial reductions of other greenhouse gases (WBGU 2003a).[11] If some of the feedback effects of the Earth system outlined in the previous chapter occur, even more drastic emission reductions would be required.

10 A temperature rise of 2°C already commits the Earth to significant climate change (IPCC 2001; Hare 2003; Thomas et al. 2004). Therefore, adaptation measures would have to be undertaken, starting in the near-term.

11 Den Elzen/Meinshausen (2005) calculate lower greenhouse gas reduction levels (e.g. 40–45 percent below 1990 levels for stabilization at 400 ppm CO_2 equivalent) as they allow for a certain overshooting for the lower concentration targets, i.e. concentrations may first increase to an “overshooting” concentration level and then decrease before stabilizing. However, based on Hare/Meinshausen (2004) they assume lower concentration levels (400/450 ppm CO_2 equiv.) to be required to limit global mean temperature below 2° Celsius.

Taking this into account it is evident that the mitigation commitments contained in the Kyoto Protocol are only a small step towards achieving the objective of the Climate Convention to avoid “dangerous” anthropogenic climate change. In the long-term, i.e. until mid of century, any definition of adequacy consistent with Article 2 UNFCCC will require increased mitigation efforts from virtually all countries. As greenhouse gas emissions in many developing countries will need to increase in the next decades to fulfil basic development needs (Pan 2004), halving global greenhouse gas emissions by mid-century implies much deeper emission cuts for industrialised countries. However, also emissions of the most advanced developing countries will need to deviate from their “business-as-usual” trends substantially in the fairly near future (den Elzen 2005; Höhne et al. 2005). What is required in thinking beyond 2012 is, therefore, further and more systematic differentiation among developing countries to identify those that are able and required to go ahead. In any case, emission limitation commitments will form a central element of any future architecture of the climate regime.

The Role of Industrialised Countries

From a political-strategical point of view, the first level of differentiation contained in the Convention, that between industrialised countries (Annex I) and developing countries (non-Annex I), remains valid.[12] It is difficult to imagine any action by developing countries if industrialised countries do not reduce emissions — and this includes the United States. There is little chance of meaningful mitigation action by developing countries without the U.S. taking on a quantified reduction commitment.[13]

There are at least three major reasons why industrialised countries need to continue to lead in reducing emissions. Firstly, from the point of responsibility, they are responsible for the majority of greenhouse gas emissions in the past, which has caused current climate change. The difference in emissions per capita is even more marked. It would be patently inequitable if those countries, by virtue of being wealthier and consuming more fossils fuels both historically and currently, were to deplete the atmosphere’s rapidly diminishing capacity to serve as a safe sink for greenhouse gas emissions. Secondly, they are wealthier and therefore have greater financial and technological resources to mitigate. Thirdly, from the point of mitigation potential, the share of “luxury” emissions compared to emissions from activities related to basic human needs is larger in industrialised countries. Reducing these “luxury” emissions will not jeopardize basic human needs.

Considering these reasons, it is obvious that emissions reductions in Annex I countries must be strengthened considerably in the period after 2012. To comply with the “2 °C goal” industrialised countries would need to reduce its greenhouse gas emissions by at least 20 percent by 2020 and further up to 80 percent until 2050, taking 1990 as base year (WBGU 2003a; 2003b).

However, the level of country specific reduction targets would have to be adjusted to the respective national circumstances that are differing considerably among Annex I countries. Comparable to the “Triptych approach” that was used by the European Union as a basis for its internal burden-sharing agreement of its Kyoto target, a thorough analytical base could provide a reference for the

12 Annex I to the Climate Convention includes the “Western” industrialised countries as well as the former communist countries of Eastern Europe and Russia.

13 This was one of the core messages of a dialogue project involving researchers from 13 countries, most of them from developing countries. For more information on the project see http://www.north-south-dialogue.net. The project report outlines a strategy to re-engage the U.S. in the “Kyoto Track” by cc-operating with and supporting actors on the federal, state and community as well as private level (Ott et al. 2004). One element is an intensified co-operation in initiatives under the “PAMs track” to remove some reservations on multilateral climate co-operation.

direction where negotiations should be heading. Countries could, for example, be differentiated according to their potential to mitigate and their responsibility due to high past emissions to ensure fairness but also economic efficiency. This would direct mitigation efforts towards those countries with the highest potential for mitigation (Brouns/Ott 2005a).

Some industrialised countries have recognised the urgency of action and have already adopted mid- and long-term reduction targets. Those targets are within the range most probably required to reach the "2 °C goal", e.g. the French government aims at a 75–80 percent reduction of emissions until 2050 (France 2004).[14] Also the Environment Council of the European Union concluded at its meeting in March 2005 that "reduction pathways by the group of developed countries in the order of 15–30 percent by 2020 and 60–80 percent by 2050 compared to the baseline envisaged in the Kyoto Protocol should be considered" (EU 2005b).

Turning into such a "sustainable" emission path would require profound structural changes. However, the report of the German study commission on sustainable energy supply has demonstrated for Germany that an 80 percent reduction of CO_2 emissions by 2050 is technically and economically feasible (Hennicke/Müller 2005; Hennicke 2004; Enquete-Kommission 2002; Fischedick et al. 2002). This assessment was confirmed by a study of the UK government on the economic impacts of its 60 percent reduction targets (UK 2003). It suggests that reaching the same level of GDP as in the business as usual projection for 2050 would only be delayed by a couple of months summing up to less than one year and concludes "that the cost impact of effectively tackling climate change would be very small". However, the complexity and cost of a transition to a non-carbon economy will grow with each passing year of business-as-usual development, as society continues to invest in capital that embodies a commitment to years or even decades of continued greenhouse gas emissions. Therefore, setting longer-term reduction targets in the near future is required to give investors, business and consumers the right incentives to contribute with their activities to the decarbonisation of the economy.

Differentiation among developing countries

Based on the principle of "common but differentiated responsibilities and respective capabilities" contained in the Climate Convention, emissions from developing countries have not been subject to quantitative emission commitments up to now. However, any definition of adequacy consistent with Article 2 of the Convention will require increased mitigation efforts from almost all countries. Emissions from at least some developing countries will need to start to decrease in the fairly near future to complement the dramatic reductions being undertaken in the North. This is particularly true for newly industrialised and rapidly industrialising developing countries.

In order to take forward the negotiation process, there is a need for further differentiation among developing countries.[15] To be both fair and reflective of national circumstances, differentiation should be based on the three criteria of responsibility, capability and potential to mitigate. In view of these criteria, the developing countries obviously differ greatly. They include, for example, all countries with the lowest emissions per capita. However, so are several countries with the highest emissions per capita worldwide — Qatar, for example. All least developed countries

14 Brouns/Ott (2005a) provide an overview of mid- and long-term reduction targets adopted in industrialised countries.

15 This chapter is based on results of the project "South-North Dialogue — Equity in the Greenhouse" that was co-ordinated by the Wuppertal Institute and the Energy Research Centre (South Africa), with financial support from the German Federal Ministry for Economic Cooperation and Development (BMZ) through the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ). For more information please refer to Ott et al. (2004), Winkler et al. (2005), Brouns/Ott (2005) or the project website http://www.south-north-dialogue.net.

(LDC) fall into this category, but so do countries such as Singapore, with a per capita income well above the average of the industrialised countries.

Given this diversity of national circumstances, there is little reason to think that all developing countries would contribute in the same way to global mitigation efforts. If developing countries are differentiated according to the three criteria mentioned above, four groups can be identified:

- “Newly industrialised countries” (NIC) such as Saudi Arabia, Singapore, South Korea;
- “Rapidly industrialising developing countries” (RIDC) such as Brazil, China, Iran, Mexico, South Africa;
- “Other developing countries” (ODC) such as Egypt, India, Indonesia, Pakistan, Venezuela;
- “Least developed countries” (LDC) such as Afghanistan, Bangladesh, Ethiopia, Sudan.

These groupings could build the basis for the assigning of mitigation (and financial transfer) commitments. To determine the different type(s) of commitments for each group of countries a set of decision rules that is (again) based on the criteria of responsibility, capability and potential to mitigate could give guidance:

First, the potential to reduce emissions should determine the level of the reduction targets. In a first approximation, this potential arises from the emission intensity of a country (CO_2 emitted per unit of the gross domestic product) and from the emissions per capita. This line of action would guarantee a cost efficient climate regime, since emissions would be reduced wherever the potential for doing so was highest.

Second, obligations to finance the climate protection measures required would have to derive from the respective capability of a country. This capacity could be measured against the average income and the Human Development Index[16]. Depending on the level of capability in developing countries, industrialised countries would need to co-finance mitigation activities in developing countries.

Third, to what extent obligations become binding should ultimately depend on a country’s contribution to climate change. The accumulated emissions since 1990 could serve as a suitable indicator. At that time, the United Nations had already identified the greenhouse effect as a human-made problem and since then, countries have been aware of the problems related to their emissions of greenhouse gases.

Applying these rules also to the four country groups of developing countries reveals the following. Countries belonging to the group of “newly industrialised countries” (NIC) and the “rapidly industrialising developing countries” (RIDC) would have to take on quantitative mitigation commitments. However, both country groups could rely on industrialised nations co-financing some of their measures. Without such transfer payments, emission targets for NIC/RIDC would not become binding. On the other hand, the remaining two groups (ODC, LDC) would “only” have to take on qualitative instead of quantitative commitments, e.g. to gradually adopt policies and measures for a more climate-friendly direction of their development.

This differentiation does not imply to split the negotiating group of the “G 77[17] and China” politically as the solidary co-operation within this bloc will still be of utmost significance for the role of developing countries in negotiations. However, solidarity among these countries requires also that those, which are better off, make a contribution to global climate protection on a different scale than, for example, least developed countries. Only in this way can the group retain its

16 The Human Development Index (HDI) measures the level of development in a country in three basic dimensions: life expectancy, literacy and income (UNDP 2003).

17 The group of “77” (developing countries) which currently comprises 132 countries was founded in 1964 to help developing countries to pursue common goals and develop leverage in United Nations deliberations (vgl. http://www.g77.org).

important unity in negotiations with the traditional industrialised countries and, at the same time, tackle the climate problem.

During a transition period, the Clean Development Mechanism (CDM) of the Kyoto Protocol could offer, in the short-term, a point of departure to further develop the existing legal framework towards mitigation commitments for developing countries. This mechanism allows industrialised countries to acquire emission certificates from mitigation projects undertaken in developing countries and count them towards their Kyoto targets. In its current design, the CDM allows only for single projects but there are growing discussions to expand the scope to sectoral projects (Sterk/Wittneben 2005). Designing the CDM in such a way would enable governments of developing countries to generate emission certificates by implementing mitigation measures. These certificates could be sold to industrialised countries and would thereby provide an additional incentive for mitigation measures. Besides, such a mechanism could stimulate the establishment of technical infrastructure (e.g. emission inventories) that are required for taking on emissions targets at a later stage. Depending on the political willingness and openness for innovation of countries a sectoral CDM could be introduced without modifying the current structure of the Kyoto Protocol.

The "Policies and Measures (PAMs) Track"

The "Kyoto Track" is a necessary but not sufficient way to address the climate challenge. On the contrary: targets and timetables have to be supported by underlying policies and measures for greenhouse gas emission reductions by improving energy efficiency and fostering the market penetration of renewable energies. Those strategies create the material basis for the agreed targets. Due to the required rate of restructuring of the energy system these policy and measures will only be successful if not only promoted at to the national level but also through harmonized proceeding of key countries and the support of small nations.

This was already recognized during the negotiations of the Protocol in the run-up to the Kyoto conference (COP 3). At that time, a key agenda item of negotiations was the international co-ordination of policies and measures that lead to emission reductions (Oberthür/Ott 1999). However, these negotiations resulted only in a very general provision in the Kyoto Protocol that has not (yet) yielded any impacts.

In recent years, however, the conditions for multilateral policy initiatives focussing on the co-ordination and implementation of policies and measures seem to have improved. In June 2004, it was the international "Renewables 2004" conference in Bonn that kick-started a process of promoting and implementing renewable energies. In the International Action Programme adopted at the conference, governments, international organisations and stakeholders have committed themselves to a broad range of activities aiming at the increased use of renewable energies. These activities sum up to about 200 proposed voluntary actions and commitments from all over the globe. Initiated by the German government, the "Renewables" process continues with the "Beijing International Renewable Energy Conference 2005" in November 2005 hosted by the Chinese government.

Besides this, several other initiatives emerged that focus on the promotion of specific technologies such as the "Carbon Sequestration Leadership Forum", the "International Partnership for the Hydrogen Economy" and the "Methane to Markets Partnership". However, some argue that these initiatives are promoted to undermine the Kyoto process. These doubts were partly confirmed when officials of the Australian government welcomed the "Asia-Pacific Partnership on Clean Development and Climate" between China, India, South Korea, Japan, the U.S. and Australia, as an alternative to the Kyoto Protocol — although four of its members are parties to the Protocol.

In this respect, the key role the U.S. plays in these initiatives together with its bilateral climate partnerships is ambiguous.

It remains to be seen, which impacts those initiatives will have on the promotion of climate friendly technologies. However, these examples show that the discussion about the introduction of common and coordinated policies and measures that was already initiated before Kyoto could be revitalized — possibly in a more voluntary approach as demonstrated by the "Renewables" process. Further discussions can build on the number of proposals and lists of policies and measures that were discussed in the mid nineties and left aside with the agreement of the Kyoto Protocol. Here we want to stress two key policy areas that should be the priority subjects to strong international efforts by international coordinated processes:

- The first process should comprise international coordinated action in the field of energy/eco taxation. A number of encouraging examples e.g. UK, Germany, Denmark show the potential importance of an ecological finance reform (ETR), that imposes higher taxes on resource use — namely energy — and removes subsidies for energy. International coordination of important industrialised countries — possibly supported by border tax adjustments — and multilateral action e.g. towards kerosene taxation for aviation would thus reduce the risk of adverse effects on international competition thereby facilitating further substantial steps towards an ETR.[18]
- The second process — described below in more detail — has to focus on energy end-use efficiency. This is — as e.g. the EC puts it in its recent Green Paper on Energy Efficiency — "without doubt the quickest, most effective and most cost-effective manner for reducing greenhouse gas emissions" (EC 2005b). But in spite of many similar statements made in the last decades, it is still not sufficiently present on the political agenda in many countries.

How the latter global initiative[19] for a strategic and target oriented increase in energy efficiency could be structured will be outlined as follows. It should have four main components:

- First: The identification of strategic technologies and solutions for an energy-efficient economy — a step that can be based on scenario analyses of the technologies, solutions, and improvements in energy efficiency necessary to achieve stringent greenhouse gas (GHG) emission reduction targets, as well as on numerous efficient technologies already available on the market or currently under development.
- Second: The negotiation and setting of indicative targets for market creation for energy-efficient products and solutions as well as for average energy efficiency improvements of sectors or national economies, and the development of specific technology options.
- Third: Promotion of the implementation of potentials and targets for energy efficiency by an international co-ordinated development and implementation of best practice in policies and measures for energy efficiency.
- Fourth: International development and promotion of other instruments, e.g., the creation of supportive market structures, energy market frameworks and institutions for energy (end-use) efficiency.

---

18 ETR implies potential international distribution problems as the resource rents are shifted from producer to consumer countries. This aspect has to be kept in mind in order to prevent strong opposition from energy-producing countries.

19 Such an initiative could draw on the US-German bilateral cooperation in the field of energy conservation, efficiency and new technologies proposed by President Bush and Chancellor Schröder on February the 23rd 2005. The necessity of such an initiative is also highlighted by the EC (2005b) in the Green paper on energy efficiency which also highlights similar results of the US National Commission on Energy Policy.

These four steps are essential for an international initiative for energy efficiency as a crucial element of the PAMs Track. They are outlined below in more detail focussing on energy end-use efficiency.

Identifying strategic climate mitigation "technology modules"

Looking into the technological intersections of long-run "back casting" energy scenarios one important message is obvious: First and foremost fostering energy end-use efficiency, but also cleaner and more efficient power production (e.g. combined heat and power/CHP) as well as renewable energies are necessary prerequisites of any ambitious climate mitigation strategy. This is good news for both the North and the South, because it implies a certain tendency for technological and structural convergence between developing and industrialised countries. Efficient end-use technologies combined with decentralised and diversified power supply and grid structures could serve the needs of both developing and industrialised countries in terms of cost efficiency, competitiveness, democratic control and emissions reductions, if well adapted to the specific national conditions (Hennicke 2004; Hennicke et al. 2004). However, there appears to be a growing worldwide consensus that energy end-use efficiency — in particular for transportation, buildings, electric appliances and processes — should be given highest priority in most regions of the world, and that energy efficiency improvement should be integrated with and linked to the market introduction of renewable energies.

Therefore, as many states as possible from all around the world should co-operate to identify the strategic technology modules for energy end-use efficiency, CHP and renewable energy that are, in combination, able to mitigate climate change, to minimise risks, and to support sustainable development.

Indicative target setting for market creation and specific technology options derived from scenario analysis

There is a striking discrepancy between the apparent consensus about the strategic importance of energy end-use efficiency and the reluctance of politics and the private sector to overcome barriers and foster the market introduction of efficiency technologies. Therefore, a key element to tackle climate change and to promote risk-minimising energy policy is a global initiative for a strategic and target oriented increase in energy (end-use) efficiency. For this reason, it would be a worldwide signal and an important step towards a more targeted efficiency policy, if — after many years of bargaining — the EU Directive on Energy End-use Efficiency and Energy Services were adopted in the coming months. This Directive would set a mandatory target to the EU Member States for achieving additional energy savings in sectors not covered by the European Emissions Trading Directive of at least 1 percent per year compared to the baseline.[20]

The "Renewables" process demonstrate: the failure to agree on global targets for renewable energies and energy efficiency, e.g. at the World Summit on Sustainable Development in Johannesburg 2002, is not prohibitive for a successful climate mitigation process in the "PAMs Track", as long as "coalitions of the willing" take the lead and conduct ambitious implementation programs. As such programs cause technological and policy oriented learning curve effects, cost degression as well as positive effects on income and employment, they are the most convincing arguments for

20 The historic level of energy efficiency improvement in the EU has been about 1.6 percent per year (EC 2005b). Current BAU projections expect baseline rates of about 1.4 percent per year for the next two decades (Mantzos et al. 2003).

replication and worldwide dissemination. The commitments contained in the International Action Programme of the "Renewables 2004" to establish 163 GWel of additional renewable electricity capacity by 2015, i.e. avoiding 1.2 gigatons of CO_2 per year in 2015 — or about 3 percent of the greenhouse gas emissions expected for 2010 — have shown that a technology-oriented climate mitigation process could be fostered even without the formal and binding targets as has been demanded at the Johannesburg Summit. Even the signal of indicative targets, the monitoring and the reporting system are of paramount importance to build up a world market for renewable energies. There is, however, a "missing link" in the success story of the market introduction of renewable energies: it is still only supply driven and is not systematically linked with the much more cost-effective increase of energy efficiency to keep the national energy bills as low as possible and thus making the still more costly renewable energies affordable even for poor countries. A recent scenario analysis for the EU shows that the increase in energy efficiency has to be more than doubled to about 3 percent per year vs. past trends for the next decades (Lechtenböhmer et al. 2005, Lechtenböhmer/Thomas 2005) in order to achieve GHG reductions consistent with the share the EU has to contribute to global climate stabilisation. Similar results can be derived from global energy and emission scenarios: An increase of energy efficiency improvement rates by 60 to 100 percent compared to past trends is a minimum target in all scenarios that try to show paths to achieve sustainable emission levels (Hennicke et al. 2004).[21]

It is thus essential to start a parallel process with innovative OECD countries and key developing countries such as China and India directly on targets for energy efficiency (particularly energy end-use efficiency) increase supported by the promotion of strategic efficiency technologies, as well as targeted shares of CHP and renewable energies. To achieve these target is in their national interest and does not only contribute to national income and sustainable development but at the same time will reduce the growth rate of greenhouse gas emissions. The same holds true for sector-specific targets, e.g. for the transportation or building sectors, which are in the macroeconomic and ecological interest of industrialised and developing countries.

Within the "PAMs Track" therefore, a portfolio of feasible and robust options for "positive target setting" could be developed, e.g., efficiency standards for automobile fleet consumption or for new/existing buildings, growth rates of domestic energy end-use productivity, the share of renewable energies in power/heat production, or the share of CHP in power systems.

Identifying best practices and lessons learned on laws, regulations, programs and projects for the promotion of energy efficiency and renewable energy

Energy efficiency potentials are extremely distributed to a multitude of technologies, purposes and actors — that is why simplistic 'one fits all' policies fail to activate these enormous potentials. What is needed instead is a comprehensive policy package consisting of the basic portfolio of general information, targeted advice, financial incentives, other DSM measures and market transformation programmes, voluntary agreements with manufacturers, legislation/administration (e.g. setting of minimum energy performance standards — MEPSs), and the creation of a strong institutional framework, e.g., of Energy Agencies and Energy Efficiency Trusts.[22]

Within the PAMs Track, states should therefore agree to implement vigorous and comprehensive policies for assisting all market actors in improving energy end-use efficiency in combination

21 Among others, Blok (2005) shows that improvements by even 5 percent or more seem to be achievable in industrialised countries.

22 For more details on this list see e.g. Lechtenböhmer/Thomas (2004). A detailed concept for an energy efficiency fund for Germany as well as a couple of programmatic proposals can be found in Thomas/Irrek (2005) and at http://www.wupperinst.org/Projekte/fg2/3216.html.

with renewable energy whenever and whereever feasible. International co-ordination and dissemination of best practice in policy are essential elements of the PAMs Track and the international initiative for energy efficiency.

Within OECD countries, the International Energy Agency (IEA) is already active in disseminating best practice in energy (end use) and renewable energy policy, but more could certainly be done. International donor institutions such as the Global Environmental Facility (GEF), the International Finance Corporation (IFC), the World Bank or the Environment and Development Programme of the United Nations (UNDP/UNEP) as well as national (e.g. GTZ) or EU project supporting institutions should also work much closer together and disseminate best practices and lessons learned in a more systematic and target group specific way. By international and authorized cooperation it would be easier to standardize and disseminate a portfolio of successful laws, regulations, programs etc., which could foster social learning processes.[23]

Establishing supportive frameworks and institutions

Two highly effective measures are the introduction of energy saving funds following, e.g., Danish, Norwegian, and British examples (see Thomas/Irrek 2005) and the definition of individual savings targets for energy suppliers for electricity and gas suppliers or network companies as already introduced in the UK, Denmark, Italy, or Flanders (Belgium) (OFGEM 2004).

An international and national supportive framework should be established to replicate these and other success stories to finance energy efficiency investment and foster market aggregation. New institutions like a “Network of International Energy Efficiency and Renewable Energy Agencies” should be established and international as well as national public benefits trust funds should be founded to create incentive schemes and pre-finance supportive measures. National funds could as well be backed up by international funding organisations as e.g. currently ongoing under the UNECE Energy Efficiency 21 Project[24]. These institutions should build up “Knowledge Management Systems” to foster target group specific information, standards and technological know how.

Cooperation, integration and maximizing positive inter-linkages with other conventions and environmental agendas would create large synergies and reduce costs. This holds true e.g. for national plans of implementing more sustainable production and consumption patterns or programs to reduce local air pollution from transportation and other sources, to increase air quality or for afforestation and protecting biodiversity.

The same is true for policies and measures that are not focussed especially on climate issues, but apparently have some positive side effects on climate mitigation, e.g. for policies like “Reducing import dependencies from oil and gas“ or “Raising security of supply and reducing risks through substituting oil products by more efficient cars and alternative fuels“ (e.g. biofuels, solar energy use, hydrogen produced from natural gas saved through energy efficiency).

23 One example is the E-Parliament project that developed a web site for members of parliament on options and potentials for energy efficiency and best practise legislation (see http://www.e-parl.net/energy).

24 The UNECE energy efficiency investment fund was established to reduce carbon dioxide emissions under the Kyoto Protocol (see http://www.unece.org/press/pr2005/05ireedd).

"Kyoto plus": Synergizing Targets and Measures

The entry into force of the Kyoto Protocol is a milestone for international climate policy and a step forward on the way to combat climate change. Complementing the institutional framework of the Climate Convention, the Protocol establishes concrete commitments for industrialized countries to reduce emissions and provides new instruments for climate policy by introducing its flexible mechanisms. In addition to the implementation of the commitments defined in the Protocol, the development of an international "Kyoto plus" strategy will become the main focus of climate policy. The cornerstones of such a strategy will be set in the next few years. One of those will remain the Kyoto Protocol that has to be developed further but also needs to be complemented by additional tracks.

However, as climate change is already underway any climate policy focussing on mitigation activities will not be able to avoid any human induced climate change but can only limit its extent. The well documented changes in the Arctic regions that could be observed in the last few years could serve as an indicator for the changes to be expected in other regions in the near future. The changing climatic conditions in the Arctic have already severe impacts on the (cultural) survival of the Inuit people as well as on the Arctic wildlife (Arctic Council 2004). Therefore, apart from mitigation policies any "Kyoto plus" strategy also needs to include an adaptation pillar. This means to prepare, at an early stage, adaptation of livelihoods and lifestyles to those climate change impacts that will not be avoidable. The portfolio of adaptation activities is quite diverse including measures such as raising dykes, avoiding settlements in regions exposed to flooding or landslides, but also improving primary health care as well as the knowledge of people and decision makers on expected climate change impacts. At the international level, the support of those regions that are most vulnerable to climate change is of utmost importance. The adaptation funds agreed upon at the climate summit in Marrakesh (2001) and the "Buenos Aires programme of work on adaptation and response measures" adopted in Buenos Aires three years later provide a basis for this adaptation pillar that is, however, quite instable so far (Ott et al. 2005; Huq 2003).

However, as some climate change impacts will have irreversible consequences any strategy to adapt is only of limited effectiveness and can only be the response to the inevitable. To prevent the avoidable is the objective of those "Kyoto plus" paths focussing on mitigation to be designed in the coming years. If the occurrence of an unprecedented global warming in earth history is to be avoided, current efforts under the UNFCCC/Kyoto regime have to be strengthened and, at the same time, complemented by intensified international coordination of policies and measures.

Apart from ambitious reduction targets for the "North" the further development of the Kyoto treaty also need to comprise the enhanced involvement of developing countries. It will be crucial to agree on an approach that defines the contribution of (groups of) countries to global mitigation efforts in a transparent manner and according to the respective national circumstances. The continuation of the equal treatment of countries such as South Korea and Singapore, on the one hand, and Burkina Faso and Bangladesh, on the other hand, will not lead to adequate results from an environmental perspective. As fairness and economic effectiveness will be required to ensure the acceptance of international agreements, the differentiation among countries should be based on the criteria of "potential to mitigate", "responsibility for climate change" and "capability to finance mitigation activities" (see Ott et al. 2004).

This regulatory approach of setting emissions targets needs completion by the international co-ordination of policies and measures. This will promote, on the hand, the implementation of "on the ground" measures as well as market access for climate sound technologies thereby facilitating compliance with the emission targets. On the other hand, this path could serve as a means to re-integrate non-Kyoto countries "step by step" in the "Kyoto-Path". A "policies and measures" approach was already on the agenda of international climate negotiations before Kyoto (1997) but

The Wuppertal Institute's team had to give a lot of interviews at the 10th annual conference on Framework Conventions on Climate Change (6–17 December 2004, in Buenos Aires). From left to right: Wolfgang Sterk, Bernd Brouns, Dr. Bettina Wittneben, and Dr. Hermann E. Ott talking to a journalist from the Deutsche Welle.

Photo: Dennis Tänzler

was neglected afterwards in favour of the "targets and timetables" approach of the Protocol. Just in recent years, e.g. at the "World Summit on Sustainable Development" in Johannesburg (2002), there were attempts to create markets for climate technologies by means of international co-operation and to agreeon promotion measures. This kind of efforts do not necessarily require the participation of all countries. Co-ordinated initiatives among a limited number of countries could rather offer opportunities for "like minded" countries to position themselves strategically on emerging markets. Model character has the process initiated by the "Renewables 2004" conference that was a response to the failure to agree on an initiative with universal participation at the Johannesburg Summit. This process has the potential to serve as a catalyst for the formation of leadership alliances.[25]

What lacks despite the diversity of current initiatives is a process to effectively promote efficiency measures, although, in the mid-term, these have the largest potentials for reducing emissions — in North and South. Most analyses on renewable energy sources emphasise that these can only build the basis for a future energy system if they are combined with the efficient use of energy. Therefore, an initiative focussing on energy efficiency as part of a "Kyoto plus" strategy is of decisive importance. An efficiency initiative could also provide starting points for the re-engagement of the USA as the bilateral agreement "U.S.-German Joint Actions on Cleaner and More Efficient Energy, Development and Climate Change" indicates that was signed by President Bush and Chancellor Schröder on 23 February 2005.

In particular the European Union which promoted the co-ordination policies and measures before the adoption of the Kyoto Protocol could initiate in co-operation with other industrialised and developing countries an international process aiming at improved market access of energy efficiency technologies and the setting of targets and voluntary agreements for energy efficiency. The adoption of ambitious voluntary commitments of EU member states as part of the currently discussed energy efficiency directive would be a good basis for the EU to start from.

Both, the further development of the Kyoto targets as well as the co-ordination of policies and measures in various areas and constellations should go "hand in hand". The current strategy of some actors to play one political approach off against the other needs to be transformed to mutual supportive strategies. The approaches of internationally agreed emissions targets and national/regional policies and measures complement each other — doing one without the other is hardly imaginable. Only both approaches together can generate the synergies and the power required to pave the way towards the "solar age".

25 Jänicke (2005) outlines the significance of pioneer countries for the (horizontal/international) diffusion of innovations, in particular in the case of new regulations and approaches in environmental policy.

From May 19th to 27th of 2005, the meeting of the subsidiary bodies UN Framework Conventions on Climate Change took place in Bonn. The Wuppertal Institute presented current research results concerning international climate policy items at two events and an information stand. Photo: Bettina Wittneben

Franz-Josef Schafhausen, Senior Legal Secretary, reported at the workshop "Projects for climate protection and EU-emission trading — Prospects after the starting period", organised by the Wuppertal Institute at TerraTec fair in Leipzig. Photo: Bettina Wittneben

References

Arctic Council (2004): Impacts of a Warming Arctic — Arctic Climate Impact Assessment. Cambridge: Cambridge University Press.

Blair, Tony (2004): Speech by the Prime Minister at the launch of the Climate Group. 27 April 2004. London: 10 Downing Street. http://www.number-10.gov.uk/output/page5716.asp (21.10.2005).

Blok, K. (2005): Improving Energy Efficiency by Five Percent and More per Year? In: Journal of Industrial Ecology, Vol. 8, No. 4, 87–99.

Bodansky, Daniel (2004): International Climate Efforts Beyond 2012: A Survey of Approaches. Arlington: Pew Center on Global Climate Change. http://www.pewclimate.org/docUploads/2012%20new%2Epdf (10.03.2005).

Brouns, Bernd (2003): Overview of ongoing activities on the future design of the climate regime. Project Report. Wuppertal: Wuppertal Institute. http://www.wupperinst.org/download/1085_overview.pdf (23.08.2005).

Brouns, Bernd and Hermann E. Ott (2005a): Taking the Lead: Post-2012 Climate Targets for the North. Wuppertal Paper. Wuppertal: Wuppertal Institute. (forthcoming).

Brouns, Bernd and Hermann E. Ott (2005b): Solidarity understood correctly. In: D+C Development and Cooperation, Vol. 32, No. 5, May 2005, 207–209.

Cox, Peter, Chris Jones and Chris Huntingfor (2005): Conditions for Positive Feedbacks from the Land Carbon Cycle. Presentation at the conference “Avoiding Dangerous Climate Change“ (1–3 February 2005). http://www.stabilisation2005.com/day1/COX.pdf (24.08.2005).

Crutzen, Paul J. (2002): Geology of mankind — The Anthropocene. In: Nature, Vol. 415, 23.

Den Elzen, M. G. J. (2005): Differentiation of countries’ post-2012 mitigation commitments under the “South-North Dialogue” Proposal using the FAIR 2.1 world model. MNP report 728001032/2005. Bilthoven: Netherlands Environmental Assessment Agency (forthcoming).

Den Elzen, M. G. J. and M. Meinshausen (2005): Meeting the EU 2 °C climate target: global and regional emission implications. Report No. 728001031/2005. Bilthoven: Netherlands Environmental Assessment Agency. http://www.rivm.nl/bibliotheek/rapporten/728001031.pdf (21.06.2005).

Enquete-Kommission (2002): Final report of the Enquete-Kommission “Nachhaltige Energieversorgung unter den Bedingungen der Globalisierung und der Liberalisierung”. BT-Drucksache 14/9400 vom 07.07.2002. Berlin: Deutscher Bundestag.

EC — Commission of the European Communities (2005a): Commission Staff Working Paper. Winning the Battle Against Global Climate Change. Background Paper. 9.2.2005. Brussels: European Commission. http://europa.eu.int/comm/environment/climat/pdf/staff_work_paper_sec_2005_180_3.pdf (02.08.2005)

EC — Commission of the European Community (2005b): Green Paper on Energy Efficiency or Doing More With Less, COM (2005) 265 final, 10.6.2005. Brussels: European Commission.

EU — Council of the European Union (2005a): European Council Brussels, 22 and 23 March 2005, Presidency Conclusions, 7619/05. Brussels: European Union. http://ue.eu.int/ueDocs/cms_Data/docs/pressData/en/ec/84335.pdf (26.04.2005).

EU — Council of the European Union (2005b): 2647th Council meeting, Environment, Brussels, 10 March 2005, 6693/05. Brussels: European Union. http://ue.eu.int/ueDocs/cms_Data/docs/pressData/en/envir/84322.pdf (26.04.2005).

Fischedick et al. (2002): Langfristszenarien für eine nachhaltige Energienutzung in Deutschland, Forschungsvorhaben für das Umweltbundesamt, UFOPLAN FKZ 200 97 104, Wuppertal Institut, DLR, Wuppertal, Stuttgart.

France (2004): Plan Climat 2004. Face au changement climatique. Agissons ensemble. Paris: Ministère de l’Écologie et du Développement Durable.

Graßl, Hartmut (2005): Das Klima der Erde und seine Änderungen. In: Münchener Rückversicherungs-Gesellschaft (Ed.): Wetterkatastrophen und Klimawandel. Sind wir noch zu retten? München: Edition Wissen, 18–23.

Hare, William (2003): Assessment of Knowledge on Impacts of Climate Change — Contribution to the Specification of Art. 2 of the UNFCCC: Impacts on Ecosystems, Food Production, Water and Socio-economic System. Expertise for the WBGU Special Report Climate Protection Strategies for the 21st Century: Kyoto and Beyond´. Berlin: WBGU. http://www.wbgu.de/wbgu_sn2003_ex01.pdf (14.03.2005).

Hare, Bill; Meinshausen, Malte (2004): How much warming are we committed to and how much can be avoided? PIK Report No. 93. Potsdam: Potsdam Institute for Climate Impact Research. http://www.pik-potsdam.de/pik_web/publications/pik_reports/reports/pr.93/pr93.pdf (10.03.2005)

Hays, J.D.; Imbrie, John; Shackleton, N.J. (1976): Variations in the Earth's Orbit: Pacemaker of the Ice Ages. In: Science, Vol. 194, No. 4270, 1121–1132.

Hennicke, Peter; Müller, Michael (2005): Weltmacht Energie. Herausforderung für Demokratie und Wohlstand. Stuttgart: Hirzel.

Hennicke, Peter (2004): Scenarios for a robust policy mix: the final report of the German study commission on sustainable energy supply. In: Energy Policy, Vol. 32, 1673–1678.

Hennicke, Peter; Thomas, Stefan; Irrek, Wolfgang; Zymla, Bernhard (2004): Towards Sustainable Energy Systems: Integrating Renewable Energy and Energy Efficiency is the Key. Discussion Paper for the International Conference 'Renewables 2004'. Wuppertal/Eschborn; Wuppertal Institute/GTZ. http://www.wupperinst.org/download/renewables/sustainable-energy-systems.pdf (24.10.2005).

Höhne, Niklas; Phylipsen, Dian; Ullrich, Simone; Blok, Kornelis (2005): Options for the second commitment period of the Kyoto Protocol. Climate Change 02/05. Berlin: Umweltbundesamt.

Huq, Saleemul (2002): The Bonn-Marrakech agreements on funding. In: Climate Policy, Vol. 2, Issues 2-3, 243–246.

IEA — International Energy Agency (2004): World Energy Outlook. Paris: OECD.

IPCC (2001): Climate Change 2001: The Impacts, Adaptation, and Vulnerability. Cambridge: Cambridge University Press.

Jänicke, M. (2005): Trend-Setters in Environmental Policy: The Character and Role of Pioneer Countries. In: European Environment, Special Issue, Vol. 15, No. 2, 129–142.

Lechtenböhmer, S.; Grimm, V.; Mitze, D.; Wissner, M. (2005): Energy Efficiency as a key element of the EU's Post-Kyoto Strategy — Results of an Integrated Scenario Analysis, in: European Council for an energy efficient economy, Proceedings 2005 Summer study: Energy savings, What works and who delivers?, 203–212, www.eceee.org.

Lechtenböhmer, S.; Thomas, S. (2005): The mid-term potential for demand side energy efficiency in the EU, Information in brief, Wuppertal Institute for Climate, Environment, Energy.

Lechtenböhmer, S.; Thomas, S. (2004): Efficient appliances as keystone strategy in long-term energy policies — a policy-oriented scenario approach, In: 3rd International Conference on Energy Efficiency in Domestic Appliances and Lighting — EEDAL 2003, Torino, Italy, 1–3 October 2003. Torino, 2003, 1–13.

Lewis, Simon L. et al. (2005): Tropical Forests and Atmospheric Carbon Dioxide: Current Knowledge and Potential Future Scenarios. Presentation at the conference "Avoiding Dangerous Climate Change" (1-3 February 2005). http://www.stabilisation2005.com/day1/lewis.pdf (24.08.2005).

Luhmann, Hans-Jochen (2005a): Wie Desaster ihren "Master" finden. In: Gaia, Jg. 14, H. 3, 213–218.

Luhmann, Hans-Jochen (2005b): Klimawandel und Küstenschutz. In: Berliner Republik, H. 2/2005, 66–70.

Luhmann, Hans-Jochen (2001): Das Klimasystem: Experiment mit der Lebensgrundlage — Ich bin klein, mein Herz ist rein oder Auf der Suche nach der verlorenen Erinnerung an das Erschrecken über sich selbst. In: Ders.: Die Blindheit der Gesellschaft. Filter der Risikowahrnehmung. München: Gerling Akademie Verlag, 155–182.

Mantzos, L. et al. (2003): European energy and transport trends to 2030, published by DG TREN, Brussels.

Oberthür, Sebastian, Hermann E. Ott (1999): The Kyoto Protocol. International Climate Policy for the 21st Century. Berlin: Springer.

OFGEM (2004): Energy Efficiency Commitment 2005-2008, Administration procedures, December 2004.

Ott, Hermann E.; Brouns, Bernd; Sterk, Wolfgang; Wittneben, Bettina (2005): It Takes Two to Tango — Climate Policy at COP 10 in Buenos Aires and Beyond. In: Journal for European Environmental Planning Law, Vol. 2, No. 2, March 2005, 84–91.

Ott, Hermann E.; Winkler, H.; Brouns, B.; Kartha, S.; Mace, M.J.; Huq, S.; Kameyama, Y.; Sari, A.P.; Pan, J.; Sokona, Y.; Bhandari, P.M.; Kassenberg, A.; La Rovere, E.L.; Rahman, A. (2004): South-North Dialogue on Equity in the Greenhouse. A proposal for an adequate and equitable global climate agreement. Eschborn: GTZ. http://www.wupperinst.org/download/1085_proposal.pdf (14.09.2004).

Pan, Jiahua (2004): Meeting human development goals with low emissions. In: IDS Bulletin "Climate change and development", Vol. 35 No. 3, July 2004, 90–97.

Rahmstorf, Stefan; Jaeger, Carlo C. (2004): Sea level rise as a defining feature of dangerous interference with the climate system. Submission to the EU stakehoder consultation on action on climate change post 2012. http://forum.europa.eu.int/irc/DownLoad/kqefAgJ2moG-ylTEH5P6-d_xTp00uSrDfc5F-pHFVXmUpoo2u/Rahmstorf_Jaeger_2004_SeaLevelRise.pdf (24.08.2005).

Rapley, Chris (2005): Antarctic Ice Shield and Sea Level Rise. Presentation at the conference "Avoiding Dangerous Climate Change" (1–3 February 2005). http://www.stabilisation2005.com/day1/Chris_Rapley.pdf (24.08.2005).

Royal Society (2005): Ocean acidification due to increasing atmospheric carbon dioxide. London, Juni 2005. http://www.royalsoc.ac.uk/displaypagedoc.asp?id=13314 (24.08.2005).

Sterk, W.; Wittneben, B. (2005): Addressing Opportunities and Challenges of a Sectoral Approach to the Clean Development Mechanism. JIKO Policy Paper. Wuppertal: Wuppertal Institut. http://www.wupperinst.org/download/JIKO-PP_2005-1.pdf (24.09.2005).

Thomas, C.; Cameron, A.; Green, R.E.; Bakkenes, M.; Beaumont, L.J.; Collingham, Y.C.; Erasmus, B.F.N.; de Siqueira, M.F.; Grainger, A.; Hannah, L.; Hughes, L.; Huntley, B.; van Jaarsveld, A.S.; Midgley, G.F.; Miles, L.; Ortega-Huerta, M.A.; Townsend Peterson, A.; Phillips, O.L.; Williams, S.E.; (2004): Extinction risk from climate change. Nature, Vol. 427, 8 January 2004, 145–148.

Thomas, S.; Irrek, W. (2005): Will there be an Energy Efficiency Fund in Germany? Proceedings 2005 Summer study: Energy savings, What works and who delivers?, 213–222, www.eceee.org.

Turley, Carol (2005): Reviewing the impact of increased atmospheric CO_2 on oceanic PH and the marine ecosystem. Presentation at the conference "Avoiding Dangerous Climate Change" (1–3 February 2005). http://www.stabilisation2005.com/day1/Turley.pdf (24.08.2005).

UK — United Kingdom (2003): Energy White Paper. Our Energy Future — Creating a Low Carbon Economy. London: Department for Transport, Department for Environment, Food and Rural Affairs. http://www.dti.gov.uk/energy/whitepaper/ourenergyfuture.pdf (15.03.2004).

UNDP — United Nations Development Programme (2003): Human Development Report 2003: Millennium Development Goals: A compact among nations to end human poverty. New York: UNDP. http://hdr.undp.org/reports/global/2003 (24.10.2005).

UNFCCC (2004): Information on national greenhouse gas inventory data from Parties included in Annex I to the Convention for the period 1990–2002, including the status of reporting. Executive summary. Note by the secretariat. FCCC/CP/2004/5, 14. October 2004. Bonn: UNFCCC Secretariat.

UNFCCC (2002): Agreement between the European Community and its member states under Article 4 of the Kyoto Protocol. Note by the secretariat. FCCC/CP/2002/2. Bonn: UNFCCC Secretariat.

WBGU — German Advisory Council on Global Change (2003a): Climate Protection Strategies for the 21st Century. Kyoto and Beyond. Berlin: WBGU. http://www.wbgu.de/wbgu_sn2003.pdf (15.03.2004).

WBGU — German Advisory Council on Global Change (2003b): World in Transition: Turning Energy Systems Towards Sustainability. Berlin: WBGU. http://www.wbgu.de/wbgu_jg2003.pdf (15.03.2004).

Weart, Spencer R. (2003): The Discovery of Global Warming. Cambridge (Mass)/London (UK): Harvard University Press.

Winkler, Harald; Brouns, Bernd; Kartha, Sivan (2004/5): Future mitigation commitments. Differentiating among non-Annex I countries. (Submitted to Climate Policy).

WRI (World Resources Institute) (2003): Climate indicators analysis tool (CAIT). Version 1.5. Washington DC: WRI. http://cait.wri.org (14.09.2004).