Network of

European Environment and Sustainable Development Advisory Councils

70/30

Towards European targets for Greenhouse Gas Reduction 2050 and 2020

Statement
of the
EEAC Energy Working Group

The following EEAC Councils support this WG statement:

Austria	Austrian Association for Agricultural Research (OeVAF)
Belgium	Environment and Nature Council of Flanders (MiNa-Raad)
Germany	Advisory Council on the Environment (SRU)
	Advisory Council on Global Chance (WBGU)
	Council for Sustainable Development (RNE) [1]
Portugal	National Council on Environment and Sustainable Development (CNADS)
Slovenia	Council for Environmental Protection (CEPRS)
Sweden	Environment Advisory Council (MVB) - Working Group Ecological Transition
United Kingdom [2]	English Nature (EN)

[1] The RNE endorsed the statement's overall target in previous RNE-recommendations, however could not discuss in detail all arguments of the statement and hence does not endorse the full statement.

[2] The UK Royal Commission on Environmental Pollution (RCEP) supports the idea of long-term targets and has made a recommendation to the UK government to put the UK on a path to reducing its CO_2 emissions by 60% from 1997 levels by 2050. As the Royal Commission has not revisited its recommendation of 2000 it does not support the specific targets of this EEAC WG statement.

EEAC Energy Working Group Statement and Background Analysis

13 December 2004

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Key Message and Statement of the signing EEAC Members

The signing EEAC members support setting *ambitious* long-term emission reduction targets for greenhouse gases within the EU.

1. We see that the political constellation is particularly conducive to long term climate change mitigation measures, both on the global and the European level. There is a political and economic window of opportunity, especially as the pending renewal of the European Power sector needs long term targets in order to optimize investments with long pay back periods.
2. Post Kyoto goals are already part of the political discussion within EU member states: France, Germany, the Netherlands, Sweden, the Czech Republic and the UK already have ambitious long term emissions reduction goals. Greenhouse gas emissions of those countries already exceed 60% of total greenhouse gas emissions within the EU.
3. Scientific evidence on climate change suggests lower greenhouse gas stabilization levels than previously assumed are needed to stay within Europe's threshold of 2 degrees world temperature change. This may imply even more ambitious targets then those foreseen by the group of countries comprising the range of existing long term goals.
4. Trends in global economic cost analysis suggest that climate mitigation may be feasible at acceptable cost, measured as growth years lost over several decades, especially in the view of foreseeable damage from climate change. More research however is needed, for a serious, refined and more specific cost estimate for the EU level.
5. Taking into account the stringency of reductions needed to stabilize greenhouse gases at safe levels, and considering the trend towards sinking estimated costs such ambitious mitigation measures imply, the signing EEAC members recommend that the EU should politically commit to **targets of at least 30% reduction of GHGs below 1990 levels by 2020 and at least 70% by 2050. Those political commitments should be reviewed as they become legally binding in the view of economic assessment.**

Background Analysis

Beyond Kyoto: why long term targets?

Since the beginning of international efforts to curb climate change, Europe has been at the forefront of negotiations, taking a leading role in pushing the world toward binding commitments to reduce emissions of greenhouse gases. These efforts are having an effect, as governments show an increasing willingness to address climate change and businesses (particularly in the energy sector) view climate change mitigation an increasingly important part of their investment decisions. Parties to the Framework Convention on Climate Change (UNFCCC) have taken upon themselves binding targets for reductions of greenhouse gases according to the Kyoto Protocol, the current centerpiece of climate change legislation.

The world

With Russia's ratification of the Kyoto Protocol, the heretofore mainly speculative debate on "post-Kyoto" has officially become urgent. The Protocol's long-awaited entry into force resulting from Russian ratification implies that targets and goals beyond the first commitment period (2008-2012) are no longer merely probable, but relevant and necessary. As yet, however, no such binding goals exist.

Europe

The European Council has recognized this, and has already started gathering information regarding the post-Kyoto period. In anticipation of the international debate on the future of the global climate change regime, it announced in March 2004 that it will consider "medium and longer term emission reduction strategies, including targets" at its meeting in spring 2005. Europe's role as leader in climate policy is recognized by potential participants in a future emissions reduction regime. International dialogues on climate change with developing countries consistently indicate that these look to the EU for leadership in creating strong policy to counteract climate change: "Experience in international governance indicates that in order to achieve progress in regulation, leadership by a strong country or group of countries is required. The European Union has at different stages of the [climate] negotiation process employed leadership qualities, but it lacks a coherent strategy that is persistent over a longer period of time."[1] A leading role on the part of Europe in terms of long term action on climate change can induce participation of other countries in a post-Kyoto regime, as Europe's success in meeting its commitments thus far can be an incentive and model for other parties. Such a regime is our best chance to achieve the global emissions reductions necessary to reduce climate change.

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1 "South-North Dialogue on Equity in the Greenhouse; a proposal for an adequate and equitable global climate agreement" (May, 2004). Sponsored by GTZ, Wuppertal Institut, Energy Research Centre at the University of Cape Town.

EU member states

Post-Kyoto goals have already been created on the national level among member states: five EU countries have already established long term emissions reduction targets. Collectively, these countries comprise over 60% of current EU emissions, indicating that targets for the EU as a whole are not implausible.

European targets: why now?

Political Prospects

The political constellation within the EU has never been better for setting strict reduction targets now: there is a positive momentum within EU leadership circles for strong climate change policy. The EU presidency is currently held by the Netherlands, a country with forward-thinking climate policy and many institutions involved in researching future emission reductions scenarios as well as possible international climate regimes. A recent report commissioned by the Dutch government to inform its current EU presidency term recommended that the EU take on a greater role in both European and global environmental policy making and focus more on *target setting*.[2] After the Dutch term, presidency will be the second half of 2005 rotate to the UK, another country with strong climate change policy and institutions. The British not only have a highly-publicized domestic long term emissions reduction agenda, but also some of the most renowned climate change specialists and institutions. The UK will also take over chairmanship of the G8 industrialized countries' grouping next year, and Prime Minister Tony Blair has already identified climate change as one of Britain's G8 priorities and plans to promote international action on climate change during its chairmanship.[3] In addition, the 10th Conference of the Parties (COP 10) to the UNFCCC meets in Buenos Aires this December. The future of the Kyoto Protocol and prospects beyond 2012 will be the major topic of this global gathering, and an important chance for European negotiators to gather support for Europe's post-Kyoto agenda; however such a European agenda must exist by then.

Window of opportunity

The constellation of the energy sector within the EU (the sector most affected by climate policy and potential targets) is also conducive to long term target setting right now, for two reasons. First, the European Emissions Trading System is starting in January 2005. It is hoped that this economic instrument will allow those producing emissions to curtail them in an efficient and cost-effective way. However, this is hardly possible if there is no certainty in the market such that actors can assess what permits will be

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2 "A review of the EU's environmental agenda," (September 2004). Netherlands Environmental Assessment Agency of the Dutch National Institute for Public Health and the Environment (RIVM).

3 Prime Minister Blair's speech on climate change, 14 September 2004, available online at http://www.number-10.gov.uk/output/page6333.asp. See also: "Blair beats the drum on climate change." (September 15, 2004). ENDS Environmental news service, issue 1726.

worth in the future. A recent study by a British consulting firm showed that the coming emissions trading scheme allocate so many allowances that the price of carbon will be relatively low, and that emissions may still increase. It concluded that "clear and unchanging" longer-term emission targets are needed for the trading system to be effective, as these would allow a stable forward market to exist, against which investments in low carbon technologies could be financed.[4]

Second, Europe's power-generating sector is currently undergoing a major overhaul. The existing power production fleet is aging to such an extent that over 200 000 Megawatts worth of power-generating capacity will have to be replaced in Europe by the year 2020.[5] In Germany alone, this figure is estimated at 40-70 thousand MW.[6] The Commission background paper for stakeholder contributions places the amount of capacity to be replaced by 2030 in all of Europe at 700 GW of electricity generation, which is equivalent to the entire currently installed capacity and of which 50 % constitutes the replacement of old plants. The investment costs for this are estimated at € 1.2 trillion. Operators of power plants are thus asking which technologies and which fuels are most cost-effective in the long run, and long term emissions targets determine the answer to these questions, as they affect carbon price, return on investment, and relative technology costs. Operators of facilities that do *not* need replacement will naturally lobby *against* target setting, as their systems were established under previous conditions without targets. The politically optimal time-window to implement targets is therefore when a large part of the energy sector is not directly opposed to them. As the Commission's Background Paper notes, "any change in relative prices generates distributional effects which are more transparent than in the case of technical regulation. In the political process potential losers tend to be more outspoken than the winners, and therefore they often influence the political decision making process more strongly than the potential winners." With such a large portion of Europe's energy production facilities in need of renewal, there are fewer potential "losers" from newly-imposed long term targets than at any other time. Thus, Europe *is in* the politically optimal time-window, with the major overhaul of the energy sector occurring now. Even for member states in which most of the current power production fleet is *not* in need of replacement, the situation in Europe still constitutes a political window of opportunity: power grids are transnationally interconnected more in Western Europe (EU-15) than any other region of the world, and the increased liberalization and deregulation of European energy markets (such as the removal of the tax on power transmission between European countries in January 2004) means that fleet renewal in one European country affects the economies of other European countries as well.

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[4] ENVIROS Consulting (30 September, 2004) "paper highlights emissions could rise under the EU ETS" press release available at http://www.enviros.com/index.cfm?fuseaction=13.1&id=55. See also: Environment Daily (October 4, 2004), "Emission trading 'no good without targets'" ENDS, issue 1739.

[5] From VGB international conference for energy experts "Power Plants 2003" and this year's "Power Plants 2004" at which the theme has been "Ensuring Investments - How can we fill the Generation Gap?" See also *Energiewirtschaftliche Tagesfragen* (Nov. 2003), Volume 53, Issue 11, pp. 771.

[6] Sachverständigenrat für Umweltfragen, Environmental Report 2004: Ensuring Environmental Protection Capacity"; Nomos Verlag, Baden-Baden: http://www.umweltrat.de

Ambitious targets are possible: what this paper shows

The European Council is seeking input on the nature of possible long term emissions reduction targets for the EU. States collectively comprising over 60% of current EU emissions have already set ambitious long term reduction targets domestically. This paper examines in depth the range of reductions these states' targets represent: roughly a span of 50-80% below 1990 levels by 2050. Such a range provides a framework for what is realistically possible on an EU-wide level.

Scientific discussion revolves around what levels of emissions reduction are necessary to achieve the EU's goals for climate change mitigation—staying under 2 degrees Celsius increase of average global temperature. This paper assesses the current status of the debate and results of newest studies, revealing that the science shows ambitious reduction scenarios (strict targets) are necessary to keep climate change within the EU's definition of "safe" levels.

The stringent emissions reductions necessitated by ambitious targets will not be accomplished if they are too expensive. This paper assesses the studies of costs associated with climate change mitigation and the models used to estimate them. As these models become increasingly sophisticated, their estimates for the cost of mitigating climate change consistently *decrease*, with a maximum of recent estimates in the range 2 lost years of GDP growth within the 21st century.[7]

The range of emissions reduction targets within European nations that have them can be a frame for Europe as a whole, but European targets should be at the stringent end of this range, as scientific evidence suggests lower stabilization levels are needed than previously thought. The signing EEAC members recommend a greenhouse gas reduction target below 1990 levels of **at least 30% by 2020 and at least 70% by 2050 for the EU.**

[7] see last section "Interpreting Costs".

What Targets?

All European nations, as parties to the UNFCCC, have put forward plans to accomplish their respective emissions reductions targets under the Kyoto Protocol for the commitment period 2008-2012.[8] Most have also produced broad sustainability plans (in many cases as part of governmental legislation) in which they indicate several long-range goals for their national environment and corresponding programs or "action plans" to achieve these goals. All such plans address climate change to some extent, and contain at least some reference to long term climate change mitigation. Thus, neither the concept of binding targets nor the idea of long term planning for climate change are entirely new or unexpected for any European member state. A few nations have in fact already adopted long term domestic targets independently: **France, Germany, Sweden, the Netherlands, and the United Kingdom have made well-founded assertions (in some cases of a highly binding nature) of emissions reductions goals for the period *beyond* 2012**. These nations currently produce over 60% of the EU's total greenhouse gas emissions, so collectively; the range their domestic reduction target represents is a good indicator for a feasible EU/wide target.

The domestic targets vary, however, both in respect to the way the goals are stated, and the timeframe in which they are to be achieved. Germany, for instance, attempts to achieve emissions reductions of about 40% from 1990 levels by 2020,[9] whereas the UK sets the 2050 target at 60% from *current* CO_2 levels. Germany's goal is in reduction of all greenhouse gases, whereas Britain's specifies only CO_2. Sweden, on the other hand, has a *per capita* target, which corresponds to a percent reduction target only if estimated population figures relative to 1990 are taken into account. A complete list of national long term targets with the respective conditions, including individual nations' goals for world emissions reduction (which they often use in relation to their own) is depicted below:

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[8] see these countries' 3rd national communication as parties to the UNFCCC, available by country at http://unfccc.int/resource/natcom/nctable.html.

[9] contingent upon the EU achieving at least 30% in that year (see chart), with a correlating long-term goal of 80% in 2050 (Enquete Kommission recommendation).

Overview of Mid- and Long-Term Climate Policy Targets of Countries

Country	Scope & Conditions	Target	Status	Notes
UK	UK CO_2 emissions	**-60% by 2050** from current level (2002) (= approx. -63% from 1990 level)	Royal Commission on Environmental Pollution (RCEP) recommendation adopted by Blair on 24 Feb. 2003 and DEFRA paper in Feb. 2003	consistent with the stabilization of CO2 at no more than 550 ppmv
UK	UK CO_2 emissions	**-20% by 2010** from 1990 level	Domestic government target	Program in place will deliver –19%
Germany	German Emissions of all GHGs, only if EU takes 30% reduction	**-40% by 2020** from 1990 level	Introduced as coalition agreement, now part of German sustainability strategy	Still conditioned and rather weak language: „will aim for a 40% reduction“
Germany	German emissions of all GHGs	**-80% by 2050** from 1990 level	Proposed by parliamentary Enquete Commission in 1990 and 1998	
France	French emissions of all greenhouse gases	**-75% by 2050** from 2000 level	Government adopted Climate Plan 2003, sets the goal of reducing French GHG emissions by factor of 4 by 2050	demands halving of global GHG emissions by 2050 and reducing industrialized country emissions by a factor of 4-5 by 2050
France	globally	50% from current levels (by the end of the century?)		Statement by Prime Minister, contained in “Factor 4” program
Netherlands	Dutch GHG emissions	**-40-60% by 2030** from 1990 levels	Fourth National Environmental Policy Plan (VROM)	
Netherlands	Global GHG emissions	-30% by 2020 from 1990 levels	Speech by NL environment minister Pieter Van Geel, July 2004	Sparked strong conflict with Dutch industry
Czech Republic	Czech per capita CO_2 emissions	**-30% by 2020** from 2000 level (~. –43% from 1990 level)	national climate change plan adopted by Government in March 2004 (intention to reach today’s EU per capita levels by 2020)	includes 40% per capita reductions in 2030, and 20% renewables share in energy supply by 2030
Sweden	Swedish emissions of all GHGs	**-50% by 2050** from current level, decrease per capita emissions from 8t to 4.5t of CO_2-eq. by 2050	Point 15 “reduced climate impact” of Swedish sustainability plan approved/acknowledged by The Swedish Riksdag	
EU-25	GHGs	25-40% below 1990 levels by 2025	Netherlands Environmental Assessment Agency (MNP), part of RIVM (Dutch National Institute for Public Health and the Environment)	Recommendation only

It is meaningful that these countries have such targets, but not very helpful in a larger context if it is not discernable how these goals compare, or how much of an emission reduction they imply *in relation to each other*. To facilitate comparison of the targets, Appendix I shows an across-the-board comparison of all relevant information so that one country's goal can be stated in terms of the criteria for another. Here the relative stringency of the goals becomes clearer, both in terms of absolute and per capita terms.

The chart shows that each country has tailored its goals to domestic circumstances. The main differences in percentage reduction targets are

(1) whether they concern CO_2 or CO_2-*equivalent* values--if the goals for these are the same, the latter is harder to achieve
(2) which base year the reduction percentage is calculated from—if the goals are the same, reduction from 1990 levels is harder to achieve
(3) which stabilization scenario the percentage goals have been estimated to meet—some, like Germany's, aim to achieve stabilization at 450 ppmv CO_2 (about 550 in CO_2-eq) and others, like Britain's, at 550 ppmv CO_2 (about 650 CO_2-eq) the former case requires more stringent reductions so targets based on that scenario are inherently more ambitious.

Taking all these differences into consideration, the range of domestic long term targets in EU countries covers roughly a **span between 50 and 80 percent below 1990 levels of GHGs for 2050, with corresponding goals of at least 30% reductions in 2020**. (see Appendix I for percentage and per capita equivalents).

An EU-wide target set by the Council would therefore probably lie within this range. The study of emissions reduction scenarios commissioned by DG Environment and mentioned in the background paper for this solicitation of stakeholder contributions[10] concludes that EU emission reductions would have to be in the range of 30 – 45 % in 2025 and 70 – 90 % in 2050 compared to expected business-as-usual emissions if the EU was to make a contribution to a 550 ppm CO2 eq. These ranges overlap significantly with those described above that are already "in force" among countries covering most of the current EU emissions.

Though it may seem more politically feasible to institute an EU-wide target at the *lower* (less ambitious) end of this span because such a target will receive less opposition from business and industry, scientific evidence increasingly indicates that only targets at the *higher* end of the range will keep climate change within the EU's limit of 2° Celsius climate change goal. Fortunately, costs analyses that are also changing, with highly sophisticated models showing that the needed more ambitious targets may in fact be economically feasible.

[10] Criqui, Kitous, Berk, den Elzen, Eickhout, van Vuuren, Kouvaritakis and Vanregemorter (2003) *Greenhouse Gas Reduction Pathways in the UNFCCC Process up to 2025,* Study Contract: B4-3040/2001/325703/MAR/E.1 for the DG Environment.

Why such stringent targets?

On a political level, regardless of the scientific evidence on GHG reduction and how much is needed, Europe has committed itself to reducing its share of annual greenhouse gas emissions *relative to those of the rest of the world*. In Marrakech, Parties agreed that Annex I countries should reduce emissions 'in a manner conducive to narrowing per capita differences between developed and developing country Parties' (UNFCCC 2001a)—this means that any long term plan for global emissions reductions will inherently imply some convergence of *per capita* emissions among countries. Current average annual per capita emissions in Europe are about 9 tons, and the per capita levels that correspond to the span of existing emissions reductions shown above range from 2.39 to about 4.5 tons of CO_2-equivalent per annum in 2050 (see Appendix I). Most developing countries currently have per capita emissions rates of under 2 tons, so even if those rise in the coming decades, reducing emissions to targets at the ambitious end of the range above (achieving the lower per capita figure) better fulfills Europe's obligation to narrow per capita emissions.

Recent scientific evidence regarding stabilization levels provides another reason why it is necessary to apply stricter targets for long term emissions. The discussion within the scientific community revolves around what it takes to keep atmospheric GHG contents from hitting the "dangerous levels" referred to in the Framework Convention. Though the definition of "dangerous" is the subject of much discussion and debate, the EU has defined its goal of staying within dangerous levels as *keeping global average temperature increase from exceeding 2°C above pre-industrial levels*.[11] This is the threshold advocated by the IPCC and other climate research institutions. Previously, it was assumed that staying under this threshold corresponded to stabilizing global atmospheric CO_2 concentrations at or below 550 ppmv. Both Great Britain's emission reduction target[12] and previous statements of the European Council regarding climate goals are based on that stabilization scenario.[13] Many cost estimates are also based on the amount of emissions reduction it would take to achieve that scenario. More recently it has become evident, however, that stabilization levels will likely have to be *much lower* to stay within the given temperature target.[14] The factor affecting the connection between atmospheric GHG content and average temperature change is *climate sensitivity*: how much the climate system reacts to increased GHG levels. The DG

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[11] "the Council [...] ACKNOWLEDGES that to meet the ultimate objective of the UNFCCC to prevent dangerous anthropogenic interference with the climate system, overall global temperature increase should not exceed 2ºC above pre-industrial levels; [...]" (Spring European Council 2004, 25-26 March 2004) (Doc 7631/04 (ANNEX), page 29).

[12] Royal Commission on Environmental Pollution, Energy – The changing climate, 22nd report, June 2000.

[13] "[...] the Council believes that global average temperatures should not exceed 2 degrees above preindustrial level and that **therefore concentration levels lower than 550 ppm CO2 should guide global limitation and reduction efforts**. [...]" (1939th Council meeting, Luxembourg, 25 June 1996).

[14] Azar and Rodhe (1997), and Andronova and Schlesinger (2001). For a summary of this issue, see Baer and Athanasiou, *Honesty About Dangerous Climate Change,* available at http://www.ecoequity.org/ceo/ceo_8_2.htm.

Environment study shows, for instance, that with a *median* climate sensitivity, the global temperature will eventually stabilize at 2.3°C (exceeding the 2° goal) even under a *450* ppm CO_2 scenario.[15] The estimates keep getting lower: according to a more recent compilation of the latest projections, the probability of achieving the 2°C target is only "likely" for a stabilization level *well below 400* ppm CO_2. The chance of the 550 ppm scenario staying within 2° is "unlikely" to "very unlikely" (see Appendix II).

This shift in scientific consensus is prompting more institutions and government to adopt lower stabilization scenarios for their climate impact and costs projections: Sweden's Climate Plan proposes that the EU's stabilization objective be changed to 550 ppm CO_2 *equivalent* rather than from 550 ppm CO_2,[16] and a recent EEA workshop on climate change targets[17] made all recommendations "consistent with a concentration target of a maximum of 450 ppm CO_2 (550 ppm CO_2-eq), assuming a low to average climate sensitivity." In September 2004, the British Department for Environment, Food and Rural Affairs,[18] published a new report saying "earlier EU work linked a 2 degree temperature rise to atmospheric carbon dioxide levels of 550 ppm, and this was the assumption made for our Energy White Paper. But the more recent IPCC conclusions suggest that a concentration limit of about 450 ppm would be more appropriate."[19]

Differences in stabilization profile are relevant because they have a significant effect on the amount by which we must reduce emissions: stabilization at 550 ppm CO_2-equivalent (~450 ppm CO_2) requires global greenhouse gases to be reduced by 30% in 2025 compared to baseline, while the stabilization at 650 ppm CO_2-equivalent (~550 ppm CO_2) requires a reduction of only 15%.[20] The *amount* of emissions reduction necessary is in turn directly linked to the *cost* of climate change mitigation. The recent higher estimates for the amount of reductions necessary therefore imply that achieving them will also come at higher cost. However, cost projections are becoming increasingly complex and sophisticated. Newer models incorporating components of economic and technological cycles, and new ways of putting cost in perspective, are showing that even stringent emissions reduction is economically feasible.

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[15] Criqui, et al (2003).

[16] Swedish National Climate Strategy, 2001.

[17] June 2004, summary report available at http://air-climate.eionet.edu.int/docs/meetings/040629_En_GHGEm_CC.

[18] which had used a 550 ppm CO_2 stabilization scenario to compute its long term reductions goals and costs thereof in February 2002.

[19] "Scientific and technical aspects of climate change, including impacts and adaptation and associated costs," DEFRA, Sept. 14, 2004. Available online at http://www.defra.gov.uk/environment/climatechange/pdf/cc-science-0904.pdf.

[20] Criqui, et al (2003).

The cost of stringent targets

This following section intend to give a broad overview of current information on costs of mitigating climate change and the trends in cost assessment, as fiscal feasibility is the main criterion target setting. Governments of countries which have established long term targets have collected information on cost predictions to determine how high they can realistically afford to set their domestic goals. The European Commission intends to do this for long term targets on the European level, so a range of the latest results of cost-estimates for long term climate change mitigation among its member states is a useful tool. Sophisticated modeling of long term costs, however, has as yet not been done for many member states. Few studies exist that predict climate change mitigation costs for *individual* member states, so it is not possible to compile a range of individual country cost estimates indicating the overlap among countries, as was done here for the reduction targets.[21]

A vast array of models exists, however, for *global* cost estimates, and of national climate action plans that indicate they have based their long-term reduction goals on cost estimates at all, then usually on the results of these global projections interpolated for their country or region.[22] These usually predict costs in terms of losses in GWP (gross world product) for a given timeframe.[23] Because few Europe-specific cost prognoses in these terms exist beyond the first Kyoto commitment period, the long term cost estimates of mitigation presented here are also projections of *macro* effects of climate mitigation on future *world* GDP, on which many peer-reviewed studies have been published. The original model for such world projections hails from the IPCC, whose SRES scenarios include wide ranges of cost projections according to various possible global emissions scenarios.[24] While world trends used for estimates are not identical to predicted trends for Europe (particularly income growth rates), a range of predicted costs on the global level can serve as a rough indicator of possible financial implications for Europe, as IPCC studies have for member states. It will be shown that global models project cheaper mitigation costs when incorporating certain components and methods, a trend that applies regardless of the region or level a model analyses. Thus, even if predicted costs for climate mitigation globally are only an indirect indicator for costs in the EU, the fact that predicted costs of mitigation are getting cheaper is true for the world and for Europe specifically.

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[21] Some countries have done studies predicting mitigation costs specific to their nation, however, and more are expected to be published in the coming months.

[22] An example is Britain's Energy White Paper, which relies on the IPCC estimate that "action aimed at stabilizing carbon dioxide […] would lead to an average GDP loss for developed countries of around 1% in 2050" and concludes that the "outcome of our UK analysis is consistent with that review […]equivalent in 2050 to just a small fraction (0.5-2%) of the nation's wealth".

[23] Sometimes costs are projected in absolute numbers, such as trillions $ US, which makes them seem prohibitive. Using % GWP makes costs relative to the year in question and therefore implicitly accounts for inflation or currency devaluation.

[24] IPCC Special Report on Emissions Scenarios for the Third Assessment Report (2001) are available online at http://www.grida.no/climate/ipcc/emission/htm.

Baselines, assumptions and scenarios:

As stated in the Post Kyoto Background Paper, model-based analysis relies on both assumptions and scenarios. Assumptions are quantifiable projections usually based on historic trends, such as population growth, economic development, or energy price changes. Scenarios are alternative potential states or political situations, such as the situation that all countries participate in emissions trading or that developing countries take on binding emissions reductions. There are hundreds of such factors implicit in estimates of cost of climate change mitigation. The foundational component of all studies is the *reference scenario* cost estimates are measured against, usually referred to as "business as usual" (BAU). Based on a package of *assumptions*, BAU projects a *scenario* under which no particular mitigation action is taken, which is then compared to other scenarios that *do* include instruments to mitigate climate change but have the same assumptions. This baseline is already hard to define, as factors not intentionally directed at climate change mitigation can promote emissions reduction, like the collapse of eastern European economies did. It is also the reason studies cannot be compared easily: differing BAU scenarios mean there is no "common denominator" by which to equalize the cost outcomes of the different scenarios tested. More pessimistic BAU scenarios make for cheaper estimates of mitigation costs in the long run and vice versa, such that for instance an inefficient emissions reduction scheme can be portrayed as cost-effective simply through the scenario it is compared against, or vice versa. Updating or converting to more efficient energy production facilities, for example, may be counted as a mitigation cost since it aims to reduce greenhouse gas emissions. However, as the aforementioned power plant overhaul in Europe is necessary anyway, much of this cost actually falls under "business as usual," thereby greatly *reducing* the relative costs of a mitigation scenario for Europe.

Assumptions and scenarios are often one and the same because including a certain factor in a model can have inherent implications for the projected outcome in terms of mitigation costs. A typical factor like this is inclusion of damage costs. If a model includes **costs of potential climate change related impacts** (such as storms and flooding) in the BAU projection, the relative costs of a scenario with climate mitigation may be lower, as mitigation would presumably reduce the amount of climate related damage in the long run. The same goes for **adaptation**: if a model accounts for long term expenditure on adaptation to changed climatic conditions (higher dykes or flood plain management) overall costs of mitigation scenarios may also be lower, as relatively less adaptation may be necessary in the long run. **Co-benefits of mitigation** represent a similar cost factor: subtracting averted costs of regional air pollution (such as reductions in sulphur dioxide, NOx, and aerosols) from the total costs of mitigation produces a definitively cheaper scenario. For Europe, accounting for **emissions trading** also reduces costs of mitigation scenarios in relation to a baseline, especially if the model includes potential savings from mechanisms such as **Joint Implementation** and the **Clean Development Mechanism.** As stated in the Commission's background paper, "studies usually look only at the direct costs of reducing GHG emissions and neglect direct and other potential ancillary benefits, such as avoided costs in terms of climate impacts and adaptation to climate change." Although some studies do account for one or more of these factors, in general most do not and therefore the range of predicted global costs compiled here can be assumed to be overly conservative, i.e. expensive.

Variables:

Against the diverse reference scenarios, the goal of models (particularly non-IPCC projections testing for the cost-effectiveness of one particular variable) is to test for the cost of implementing certain mitigation instruments, and thus to find out what type of scenario is cheapest in the long run. Variables often tested for are the structures of climate regimes, such as "contraction and convergence" or "multi-stage" approaches, and the existence of an emissions trading scheme and how many countries participate in it. Which of the long term global regime strategies costs less for whom is complex and varies according to study, but a factor contributing to the cost outcome for all of these scenarios is stabilization level. Mitigation measures prove to be cheaper or costlier depending on their stringency, which in turn is determined by the stabilization level attempted. This difference in affordability is so significant that attempted stabilization level appears to have even greater overall influence on cost estimates for developed countries until 2020 than does the distribution scheme or regime design chosen.[25] Because as mentioned earlier the consensus on what stabilization levels are needed is changing, the applicability of cost results is, too. Studies often determine a range of costs corresponding to a range of scenarios based on achieving a range of stabilization levels, for instance 450 to 650 ppmv CO_2. Now that we know the higher end of the stabilization levels range is probably unlikely to fulfill the 2° target, the cost estimates those levels produced are less valid. Those are, however, generally the cheaper estimates. Is there evidence for affordable costs at stricter stabilization levels? Our compilation of analyses indicates there is: **the range of cost estimates for the world based on a stringent stabilization scenario (450 ppm CO_2 or lower) clusters around 0.5-2% decrease in present value GWP in 2050 for models incorporating endogenous change, and does not exceed 5% GWP decrease for other models. T**hat is, estimates of percentage loss to GWP (or regional GDP in some models) range around 0.5-2 and never higher than 5 percent of a baseline scenario, even for stabilization rates under 450 ppm CO_2. Some studies even result in *positive* GDP change relative to business as usual, as they account strongly for co-benefits of mitigation or profit from rapid advancement in energy efficiency.[26]

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[25] From conclusions of Workshop "Future International Action on Climate Change," Berlin, June 2004. Accessible online at http://regserver.unfccc.int/SEORS/sb20events/FileStorage/FS_120363453.

[26] A comprehensive model of possible paths for Europe's energy future shows that it is technically feasible for Europe to reduce CO_2 emissions to 50% below 1990 levels by 2020, and gives estimates of costs of achieving various percentages of that potential. These turn out to be positive, i.e. *gains* in yearly GDP from the economic advantages of increased energy efficiency and positive feedback on technology prices. Reducing 17% below 1990 levels by 2020, for instance (about 65% of technological potential) could achieve a net *profit* for Europe of 167 billion Euros in 2020, which 2% of the predicted GDP for the EU-15 in that year. Achieving 75% of the reduction potential would bring reductions below 30% of 1990 levels; exact profits were not calculated for that scenario. (Krause, Koomey, Olivier, 2000. "Cutting Carbon Emissions While Making Money, Climate Saving Energy Strategies for the European Union." IPSEP: *Energy Policy in the Greenhouse*. Vol.2, part 2).

Endogenous technological change:

The factor producing more optimistic cost estimates even at lower stabilization levels is the degree to which *endogenous technological change* is accounted for. This is a measurement of the response of technological development to economic incentives also known as policy-induced feedback effects and includes aspects such as autonomous energy efficiency improvements, backstop technologies, and so-called "learning-by-doing" which relate to the inherent increase in knowledge capital connected to a technology's market proliferation. Older or simpler models (particularly those based directly on IPCC SRES projections) do not account for many of these factors, but models that incorporate them produce cheaper estimates for mitigation because they project inherently reduced costs of technologies such as renewables or policy feedback effects on fossil energy prices. Other positive aspects of endogenous change include that investment in R&D and technological innovation can give a comparative advantage, and that technological "spillover effects" can lead to improved trade.

The specific effects these cost criteria have on price estimates can be seen from compared results of various studies. One meta-analysis from 2002 was conducted on seven cost models based on the IPCC Special Report on Emissions Scenarios, run on various stabilization levels. The study compared the hundreds of different possible cost outcomes for a wide range of stabilization targets and concluded that the corresponding cost results are "strongly clustered, with only a few results outside the range -4% to 0% GWP."[27] This range comprises models which incorporate relatively little endogenous change: "technological progress is assumed to be invariant to the mitigation policies being considered. If in fact the policies lead to improvements in technology, then the costs may be lower than the models suggest."

Studies that take endogenous learning into predictions for mitigation costs come up with cheaper mitigation costs: Kypreos and Bahn (2003) conclude that for the year 2050, GWP losses are only 1% with learning incorporated as opposed to 1.3% without.[28] Gerlagh and van der Zwaan conclude that without the endogenization of technological change, "studies typically arrive at costs […] at the percentage level. We find costs that are one to two orders of magnitude lower, depending on the extent to which energy demand and technological change are accounted for endogenously."[29] The MIND model of the Potsdam Institute for Climate Impact Research weights heavily the ability of enterprises to react to scarcity through more efficient energy use, potential of renewables to lower energy prices, and possibility of carbon removal technologies such as carbon capture. Its cost predictions are around 0.5% less GWP than their

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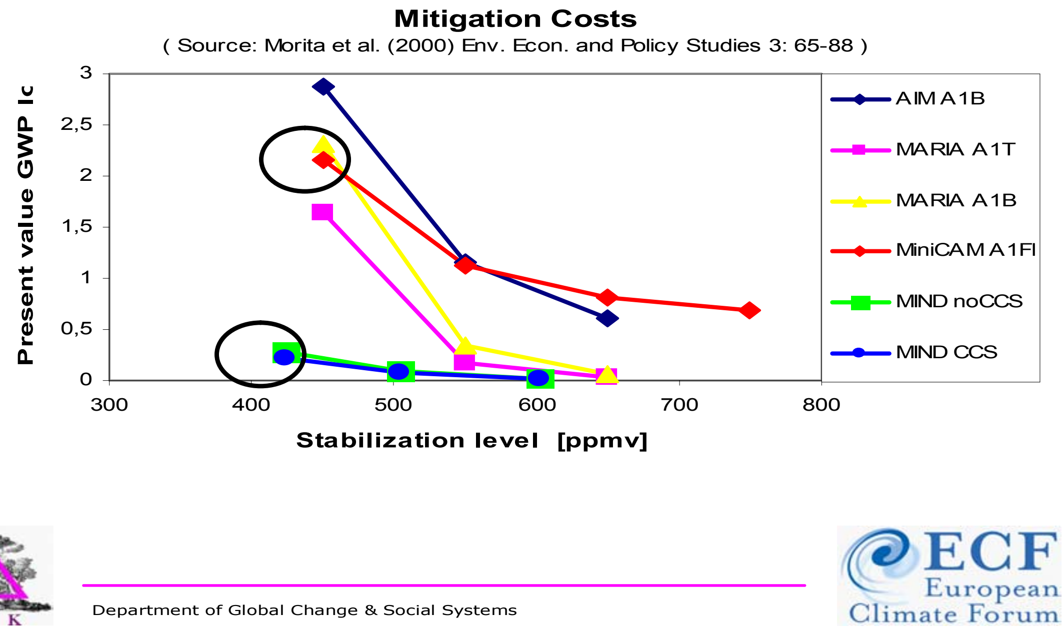
[27] Barker, Koehler and Villena, 'The costs of greenhouse gas abatement: a meta-analysis of post- SRES mitigation scenarios', *Environmental Economics and Policy Studies,* Vol.5, 2002, pp. 135-166.

[28] Kypreos, S. & Bahn, O. (2003). "A MERGE model with endogenous technological progress", *Environmental Modeling and Assessment*, Kluwer Academic Publishers. 8: 249-259.

[29] Gerlagh and Zwaan (2002): "Gross World Product and Consumption in a global warming model with endogenous technological change" Resource and Energy Economics, 25 (2003) 35-57.

reference scenario, which is also significantly lower than a host of other cost prognoses, especially for a 450 ppmv stabilization level:



The proliferation of models showing this factor projects lower costs of mitigation is not proof in itself that incorporating endogenous change more accurately predict future world developments. Policymakers must decide whether a scenario assuming high rates of technological change and endogenous learning is plausible and viable compared to scenarios that do not weight these factors. A recent forum on climate cost-modeling sponsored by the European Commission[30] has made this decision less arbitrary: it concluded that "the cost of policies can be substantially reduced by designing them to incorporate technological flexibility," and that "models tend to indicate lower costs when they include more mechanisms--a more complete description of dynamic reactions to policy signals."[31] **Thus it would seem that in general, policymakers can more confidently believe models projecting lower costs of emission reduction in the long term, which in turn means that lower stabilization scenarios and more stringent and ambitious reductions goals may be considered achievable.**

[30] "Climate Change Forum," a high-level meeting on climate modeling at the European Parliament on 26 November 2002, sponsored by the European Commission for Community Research.

[31] Other conclusions from the forum include that "Models fitted with endogenous learning mechanisms generally show significant cost reductions particularly when they incorporate agents' reactions to Climate Policy signals," that "in recent years there has been emerging a consensus from a wide variety of models that an effective Climate Change Policy is feasible at a non-trivial but bearable cost, and that this may mean a "possible shift of debate towards perceived benefits of avoidance".

Reduction timeframe: why intermediate targets?

Another important factor influencing cost is the *time path* models assume mitigation efforts will take—whether stringent emissions reductions will be undertaken right away, or if emitters will have more time to achieve them. There are two conflicting theories on the cost effects of timing. Long term targets with no intermediate goals sets a time frame for business and industry, such that they are not forced to invest in new technology right away (when it is still more expensive) thereby saving in the short run to get greater cost-effectiveness out of (potential) investment in mitigation measures later. On the other hand, "starting strong" by instituting medium-term targets (such as 30% reductions by the year 2020) spurring greater initial investment in new technologies can cause the cost-reducing effects of endogenous technological change to kick in sooner.[32] The current status of the European energy market indicates that for Europe, the latter theory applies because so many installations are being renewed anyway--the costs of installing the latest technology *now* are thus not an *additional* mitigation measure, but part of "normal" investment cycles.[33] The stability of Europe's immanent emissions trading system also depends on medium term targets for investment security of potential traders of allowances. Thus for Europe, the strategy of starting soon with medium-term targets promises reduced mitigation costs in the long term. Also, because greenhouse gases have a cumulative warming effect in the atmosphere, an earlier start to reductions decreases the required reduction rates *later*: a ten-year delay of global action that could have started now *doubles* the required reduction rates in 2025.[34]

Interpreting Costs

The percentages of GDP lost in even some cheaper cost prognoses amount to billions of dollars in absolute terms. This allows opponents of climate change mitigation to emphasize the expense of such measures. Cost figures look very different, however, in the long term context of expected annual growth. IPCC scenarios project world income growth rates ranging from 0.8 to 2.8% per year over the period 1990–2100,[35] so the difference in annual growth rates between a future *without* climate change mitigation measures and a case *with* strong mitigation would likely be less than a tenth of a percent a year over this century. Depending on how much GWP grows, the percentage loss that mitigation measures comprise can be tiny in the long run. At average or even conservatively projected GWP growth rates, the world can expect to be ten times richer in 2100. The percent GWP loss attributed to climate change mitigation (even

32 According to Gerlagh and van der Zwaan (2002), "If we include endogenous technological change, investments in the carbon-free technology are brought forward in time. Initially, investments go at the cost of consumption. After about 2060, consumers and society can profit from the experience and cost reduction phenomenon brought about by the early investments in the initially relatively expensive carbon-free technology. Consumption levels then exceed the BAU reference levels."

33 Sachverständigenrat für Umweltfragen, Environmental Report 2002: Towards a new leading role, and Environmental Report 2004; Ensuring Environmental Protection Capacity; at: http://www.umweltrat.de.

34 Specifically, from -14% per 5 year commitment period to -31% per commitment period. (Meinshausen, 2004).

35 IPCC Special Report on Emissions Scenarios, 3.3.3 Scenarios of Economic Development, available online at http://www.grida.no/climate/ipcc/emission/059.htm. Range quoting Alcamo et al. (1995) and Grübler (1994).

the high estimate of 5% under strict reduction scenarios) would delay this growth by about two years, such that the world is ten times richer in 2102 AD rather than in 2100.[36] This illustrates the highly relative nature of cost estimates when they are put into the context of long term growth rates.

The interpretation raises the issue that costs and the future conditions they will accrue under are so uncertain that they can be projected in almost any light. Therefore, an educational and informative component is increasingly important to successful climate policy. A recent study on cost by the Pew Center on Global Climate Change also notes:

"*Widely divergent estimates of the potential costs and benefits leave those with a stake in the debate freer to characterize costs as best suits their interests. These characterizations, more than the underlying economics, may determine the ultimate policy outcome. A cost-conscious climate strategy, then, may need to concern itself as much with the perception of cost as the reality."*[37]

Indeed, public awareness campaigns spreading information about climate change, its implications, and the relative nature of its costs may be the most important part of a long term emissions reduction scheme. Reduction targets are easier to accomplish both politically and economically if they are perceived as necessary and feasible by the public on whom costs will fall.

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[36] See: Azar, C. and Schneider, SH: 2002, 'Are the Economic Costs of Stabilizing the Atmosphere Prohibitive?' *Ecological Economics* 42, 73–80.

[37] Aldy, Baron, and Tubiana (2003) "Addressing cost: the Political Economy of Climate Change" in Pew Center: *Beyond Kyoto: Advancing the International Effort Against Climate Change,* emphases added.

Appendix I

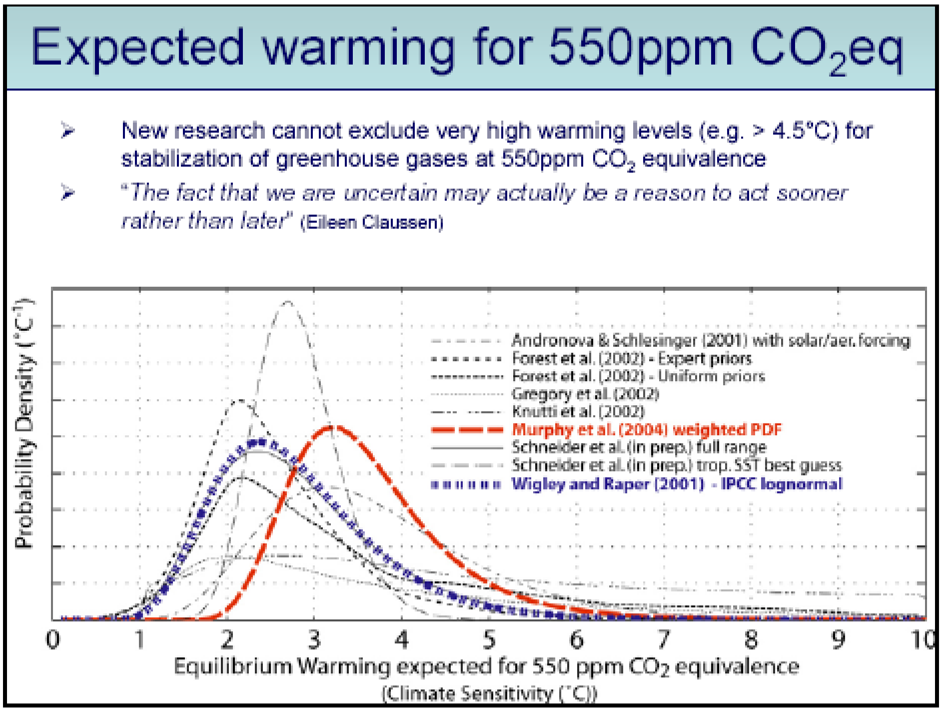
Cross-national comparison of domestic long-term emissions reduction targets

country	1990 absolute amount (from EEA 2004). All figures in MtCO2**eq**. second figure=base year calculation (UNFCCC)	tons/ cap of CO2-eq 1990	2002 absolute amount (from EEA 2004) in MtCO2-eq	2002 % rel. to base year	t/cap. CO2-eq 2002	Kyoto Goal in % below 1990	Kyoto Goal absolute (in MtCO2-eq)	Intermediate absolute goal	Intermediate % goal	2050 absolute in MtCO2-eq	2050 percent	2050 tons per capita/ annum
UK	743 / 746	13	634.8	-14.9	10.6	12.5	652.75	421 MtCO2 by 2020*	20% CO2 from current levels by 2010	253.92 (=240 CO2)	60% CO2 from current levels	4.36 t CO2-eq*
France	565 / 564.7	10	553.9 (eigene Angabe: 384.3 MtCO2)	-1.9	9.24	0	564.7			141.18	75% GHG from current levels	1.83 t CO2/ 2.39 t CO2-eq
Germany	1,249 / 1253.3	15.79	1016	-18.9	12.34	21	990.0			250.6 (=202.9 CO2)	80% CO2 from 1990	3.14 t CO2-eq*
Netherlands	211/ 212.5	14.21	213.8	.6	13.31	6	199.75		40-60% CO2 reductions from 1990 by 2030			
Sweden	70.4 / 72.3	8.45	69.6	-3.7	7.84	4	69.41			about 40.5	about 50% GHG from 1990 levels	4.5 t CO2-eq
Czech	187.5 (UNFCCC, not EEA)	18.19	137.7 (in 1999, UNFCCC)	-26.8 (1999)	13.42			41.31 MtCO2-eq, about 9 tCO2/person /yr by 2020	-43% from 1990 levels by 2020			
EU	4,231/ 4,245.2	11.2	4,123	-2.9	9	8	3905.58					

* Population projection used to calculate future per capita emissions are from domestic sources if given, otherwise US census data

Appendix II

From: Malte Meinshausen, presentation "EU's 2°C target and implications for global emission reductions." Brussels: Sept.1 2004



Probability of staying within 2 degree global temperature target: