Climate OptiOns for the Long term - Final Report

Volume A

COOL – Synthesis Report

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Abstract

The aim of the COOL project was to develop strategic notions as to how drastic reductions of greenhouse gas emissions in The Netherlands could be achieved in the long term, both in a European and in a global context, using a method of participatory integrated assessment. The project brought together in a dialogue setting scientists, policy makers and stakeholders representing different groups and different interests in society. Experiences and insights from different groups were thus available for the process. In the dialogue, which was set up as a series of workshops, long-term policy options for significant greenhouse gas emission reductions and their feasibility were analysed. As Dutch climate change policy is dependent on international policy developments, the COOL project incorporated a dialogue at a European and at a global (world wide) level as well as at a national (Dutch) level.

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1. INTRODUCTION

1.1 About this report

This report, which is Volume A in a series of reports, contains a synthesis of the results of the Climate OptiOns for the Long term (COOL) project, an NRP project that ran from December 1998 till June 2001. Three other separate reports present the outcomes of the three sub-projects that were running under COOL: the National Dialogue project (Volume B) the European Dialogue project (Volume C) and the Global Dialogue project (Volume D, published as an RIVM report). A fifth report contains information on the methodological evaluation and experiences in the project (Volume E). Furthermore Strategic Visions of all dialogue groups as well as an overall summary of the project have been published for a wider audience.[1]

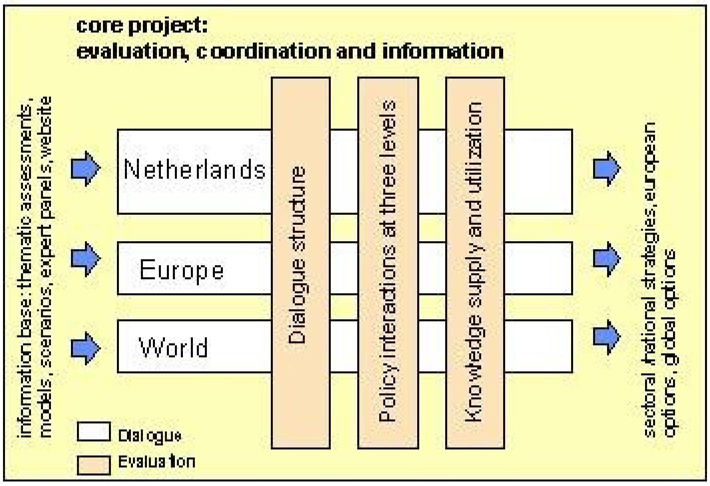
1.2 The COOL-project

The COOL project was a participatory integrated assessment project, which had as its objective the development of insights and recommendations for long-term climate change policy in The Netherlands, within an international context by identifying (elements of) viable strategies for drastic GHG emission reductions (50-80% by 2050, based on 1990 levels). A second objective was to contribute to the development of methods for participatory integrated assessment. The project attracted participants from the business community, the environmental movement, societal groups and scientific research, working together for a year in a dialogue to look at how, over the long term, one might be able to de-couple economic growth from the emission of greenhouse gases. In this way, a range of experiences and insights was included in the process. The considerations embraced both national and international levels. In a small country like The Netherlands, national climate change policy is strongly dependent on international developments in the context of the Framework Convention on Climate Change (FCCC) and the European Union. Therefore, to be able to devise and evaluate policy options for The Netherlands it is

[1] See for COOL-publications www.wau.nl/cool and for information on journal publications and follow-up projects related to COOL, http://www.vu.nl/ivm.

essential to have insight into international economic and political conditions and policy developments. For this reason three sub-projects on three different geographical levels were run parallel to each other. One at the national, Dutch level, one at a European level and one at global level. Nationally, the groups explored possibilities for emission reduction by Industry & Energy, Transport & Traffic, Housing & Construction, and Agriculture & Nutrition. At the European level, participants from a number of European countries looked at the possibilities for emission reduction in both the Transport & Traffic and the Energy sectors in Europe. At global level, the exploration principally concerned how north and south could work jointly towards a long-term solution to the climate problem. Interdisciplinary scientific teams supported the groups with state of the art scientific information derived from different NRP projects and other research.

Figure 1.1 - Structure of the COOL project -COOL's two main objectives have been translated into the project structure depicted below. The substance of the project is represented here by its three dialogue tracks/pathways (the rows), which are traversed by three main types of methodological issues for evaluation (the columns). The COOL project was divided into three sub-projects: the National Dialogue (co-ordinated by the Institute for Environmental Studies: IVM), the European Dialogue (co-ordinated by Wageningen Agricultural University: WAU) and the Global Dialogue (co-ordinated by the National Institute for Public Health and Environment: RIVM). An umbrella Core project organised the exchange of experiences in the three dialogues, the development of methods, the evaluation and the scientific information base. Scientific support was mainly provided by Utrecht University, the National Institute for Health and the Environment (RIVM), the National Energy Research Center (ECN) and Ecofys.



1.3 Why far-reaching emission reductions?

The United Nations Framework Convention on Climate Change, in effect since 1994, specifies as its objective; “to stabilise GHG concentrations in the atmosphere at such a level and within such a timeframe that no dangerous interference with the climate system occurs, threatening food supply, natural ecosystems and sustainable development”(UNFCCC, 1992). According to IPCC (2001), to fully stabilise CO_2 concentrations, net global emissions ultimately have to decline to the level of persistent uptake by the biosphere and oceans, which is expected to be very small, requiring reductions in the very long term by more than 95 % compared to 1990 levels. The time frame in which this is accomplished will determine the level of stabilisation. Thus the challenge of controlling the risks of climate change in accordance with international agreements means that drastic emission reductions are inevitable and that they may have to be realised over a relatively limited period of time. For the purposes of the COOL project it made sense to look for relatively strict limits. The challenges of the emissions reductions become clearer, providing useful insights even if the international decision-making process would chose to opt for less stringent levels later on. A stabilisation level of 450 ppm CO_2 (or roughly 550 ppm of CO_2 equivalent, including the effect of other greenhouse gases) would require a 15-25% global emission reduction by around the year 2050 compared to current values. Additionally, it would require a much higher (50-80%) cut in greenhouse gas emissions in industrialised countries (including Europe), given the much higher emissions in per capita terms of industrialised countries and the need to allow for developing countries to improve their welfare significantly. Is this achievable? What resources would it require? What does it mean for developing countries trying to combat poverty and improve the living conditions of their people? And what does it mean for industrialised countries that have built their current prosperity on fossil fuels and energy intensive development patterns? These are the key questions when looking at ways to control climate change in the long term and which formed parts of the discussions in the COOL Dialogues. The deliberations within the groups at the three different levels culminated towards the end in so-called "Strategic Visions". In the case of the National and European Dialogues, each sector group has sketched options and strategic considerations with regard to the climate change issue for its own sector. The Global Dialogue summarised its conclusions in a synthesis document.

1.4 Methods

In developing pathways for a future with low greenhouse gas emissions and assessing the various options that can contribute to such a path, the COOL project deviated from more conventional studies on two major methodological points. Firstly, in assessing the various pathways and options it used a participatory approach, often labelled participatory integrated assessment (PIA) or participatory policy assessment (PPA) (see van Asselt et al. 2001 for an overview). Secondly, in designing and constructing the pathways and various options for achieving radical reductions in greenhouse gas emission, the COOL project followed a backcasting rather than a scenario or forecasting methodology. We will shortly introduce both methods.

1.5 Participatory Integrated Assessment

Participatory Integrated Assessment starts from the assumption that designing policies and strategies and assessing their contribution in reaching final goals improve when these activities and processes are not restricted to a small inner-circle of scientists and policy-makers, but also involve interest groups and civil society. Particularly regarding complex, unstructured environmental problems where scientific investigations have their limitations, a broader involvement of different actors would add meaningful information, new insights and a less narrow and less technocratic view on causes and solutions. More specifically, the arguments in favour of a more participatory approach can be summarised as follows (cf. Funtowicz and Ravetz, 1993; Dunn, 1994; Fisher, 1990; Hisschemöller and Hoppe, 1996; Wynne, 1996; Irwin, 1995; Dryzek, 1987; Mayer, 1997):

- It helps to bridge the gap between a scientifically defined environmental problem and the experiences, values and practices of actors who are at the root of both cause and solution of such problems;
- Participation helps in clarifying different, often opposite, views and interests on a problem, making problem definitions more adequate and broadly supported;

- Participation has an important learning component for the participants
- Participation in the scientific assessment may improve the quality of decision-making, not by taking over the role of scientific expertise but by adding and complementing it with other dimensions. As such it increases feasibility, prevents implementation problems, reinforces the commitment of stakeholders, increases the democratic content, etc.

With the need for a participatory approach when dealing with the climate change issue, some important observations can be made. Firstly, climate change constitutes a so-called unstructured problem for public policy. Unstructured problems involve major uncertainties about what knowledge is relevant for understanding and addressing the issue, and uncertainties and conflicts about the values at stake. Secondly, many stakeholders perceive the issue as remote in time, space and personal experience, and hence not really as an issue of direct concern. The third observation relates to differences in scale and levels of abstractness. The conceptualisations of the climate change problem and solutions from a global perspective do not easily tally with the priority given to problems and solutions at the local level. Taken together, it can be said that the combination of the lack of structure, remoteness and the differences in scale levels of abstractness has far-reaching implications for choices in the project methodology. The dialogue should be designed in such a way that participants have sufficient freedom to address their own policy questions and information needs, but at the same time should produce the strategic visions that concentrate on reducing CO_2 emissions.

1.6 Backcasting

The second main methodological characteristic of the COOL project is a backcasting approach. According to one of the founders of backcasting, Robinson (1990), " …the major distinguishing characteristic of backcasting analysis is a concern, not with what is likely to happen in the future, but with how a desirable future can be attained. It is thus explicitly normative, involving working backwards from a particular desirable future end-point to the present in order to determine the physical feasibility of that future and what policy measures would be required to reach that point…" Backcasting is claimed to be especially suited for long-term problems due to its problem solving characteristics.

Initially it has been developed especially in energy studies, to be broadened later to other sectors such as transport and infrastructures (Dreborg, 1996). Rather than analysing possible scenarios for the long term and in this way forecasting the possible and likely development paths of a social system, backcasting takes a desirable long-term future. It then analyses in reverse what different actions; steps and conditions are crucial at various points in time, up until the most recent point in time, in order to reach the final normative objective. Backcasting should thus be seen in line with Constructive Technology Assessment (Schot, 1992), Transition Management (Rotmans, et al., 2000), and more normative branches of Ecological Modernisation (see Mol and Spaargaren, 2000). In practice, however, the contrast between backcasting and forecasting methods and techniques is not that sharp, as a backcasting methodology often uses forecasting exercises for_looking at partial sub-problems on a limited time frame.

Within the COOL project the methodology of backcasting has been operationalised in five main steps (cf. Figure 1.2). The first step is the definition of the problem and setting the criteria for a solution (climate change by greenhouse gas emissions and 80% CO_2 emission reduction between 1990 and 2050 for the OECD countries, respectively). The second step is the development of a so-called "image of the future", an image of the social system or sector in 2050 that meets the requirements set by the criteria. The third step is the path analysis. For this, an analysis is made of

1. the pathway from the image of 2050 to the present day in order to identify the transformations that are necessary,
2. the lead-time for different options that can contribute to such transformations (e.g. rate of development and diffusion of fuel cell technology),
3. the crucial actors and conditions that make such options work, and
4. the starting time, to ensure that these options contribute to the final image.

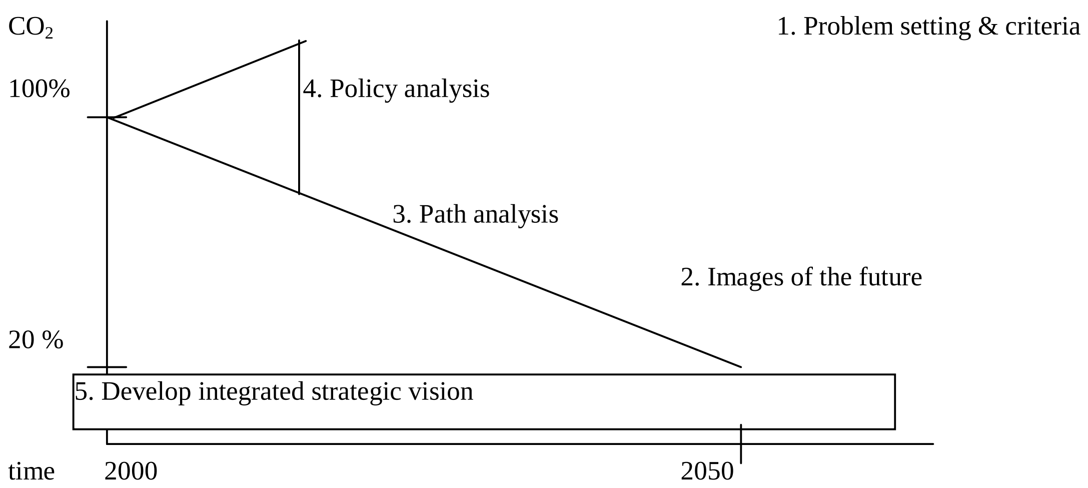
Step 4 is a comparison of current trends - not only in terms of greenhouse gas emissions, but also in relation to energy production and use, transport demand and supply, agricultural production and consumption - and the desirable trends according to the path analysis. This gap analysis provides us with ideas on the necessary policies for the coming years to close this gap and set in motion the required social transformations. The last step entails the formulation of an integrated strategic vision, in which the outcomes of the former four steps are integrated into one document.

This document brings together the possible options and necessary measures to be taken, the timing required for these options and measures, the conditions that support these options and measures, and the coalition of actors that are crucial for implementing these options and measures.

The crucial aspect of backcasting studies is not so much constructing the long-term future or designing a recipe for a pathway to a desirable future, an impossible goal in the current times of reflexive modernity. Backcasting is a tool that informs us about the possibilities for radical changes. It highlights the pros and cons, in terms of the conditions for and consequences of different strategies, options and solutions that contribute to these radical changes.

Each of the sub-projects in COOL made use of the backcasting method in an adapted form relevant to the geographical level and the specific setting of each Dialogue. Thus, the three sub-projects dealt with the various steps in the backcasting process in different ways.

Figure 1.2: Main steps of backcasting



1.7 Methodological evaluation

The methodological objective of COOL was to contribute to the development of methods for participatory integrated assessment, so as to improve the effectiveness of such assessments for decision-making processes. In order to meet this objective the project has evaluated three different, although closely related, methodological issues:

- The contribution of stakeholder participation to integrated assessment: examining the added value of participatory approaches as part of Integrated Assessment and evaluating the approaches followed in the various dialogues.
- The aspect of knowledge utilisation in integrated assessment: focussing both on how knowledge is brought into the dialogues' (supply side) and how it is requested and used by the participants (demand side)
- The interactions between science and policy at the three levels of policy making, i.e. national, European and international level have also been evaluated, although to a lesser extent. The initial idea was that in the case of global climate change, stakeholders at each level are constantly assessing the situation at other levels, because of the strong interactions. The unique combination of three levels in one project made it possible to study this issue at the three levels simultaneously and offered opportunities for methods to be exchanged between levels. However, this particular methodological issue was addressed in less detail than the other two.

1.8 Outcomes of the three COOL Dialogues.

The remainder of this document presents the outcomes of the three dialogues. Chapter two provides a summary and synthesis of the four Strategic Visions in the National Dialogue. Chapter three summarises and analyses the two Strategic Visions of the European Dialogue. Chapter four reports on the outcomes of the Global Dialogue. Chapter five summarises the main methodological conclusions.

More detailed information on the sub-projects and findings concerning methodology can be found in separate reports.

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2. SUMMARY AND CONCLUSIONS of the National Dialogue

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Box 1 The National Dialogue as a process

The National Dialogue project was carried out by a project team and a scientific support team. The project team's main responsibility was to organise and facilitate the dialogue and to report its results. The scientific support team provided the dialogue groups with 'state of the art' scientific information on options to reduce greenhouse gases in The Netherlands. The members of the scientific support team were also included in the project team.

The project has been carried out in three phases: a design phase, the actual dialogue phase and a reporting phase.

During the DESIGN PHASE the project team interviewed about 100 people from the four sectors involved on the dialogue's/discussion's scope and focus and the possible composition of the dialogue/discussion groups. These interviews have contributed a great deal to the design of the actual dialogue/discussion. Chairpersons were contacted for each dialogue group. About sixty people accepted the invitation to participate in the dialogue/discussion on an individual basis. In the meantime, the scientific support team developed Future Images (see Box 2). The dialogue/discussion participants received two notes for approval, the first addressing the dialogue's Scope and Rules of the Game, the second dealing with the dialogue's Process and Schedule.

The actual DIALOGUE PHASE was divided into three steps:

1) Firstly, the dialogue groups discussed the Future Images presented by the scientific support team. Inspired by these images, they developed two images for their sector, which both took –80% GHG emissions as a starting point. These images together constituted the starting point for the analysis of options in the second stage of the dialogue.
2) The groups then selected options for emission reduction for further analysis. They analysed the options using the backcasting technique. This meant that the dialogue group took as a starting point the final situation where the option had been implemented. For a period of fifty years from now, the chances and barriers for the option were identified and the major problems solved. Lastly, the results of the backcasting exercise were visually presented on a time sheet.
3) Lastly, the groups compared the outcomes of the separate backcastings in order to identify criteria for long-term climate change policy. Then, they identified clusters of options which, from their point of view, met their criteria, and identified participants and policy instruments that they considered vital for implementation.

Each dialogue group met six times between November 1999 and March 2001. Representatives of each group also met at two joint workshops, where they exchanged interim results and discussed their conclusions.

In the REPORTING PHASE, the findings for each sector were laid down in so-called strategic vision reports, sectoral policy briefs, and this synthesis report, all of which were reviewed by the participants.

For more information about the COOL project, see: http://www.nop.nl/cool.

2.1 The National Dialogue in the COOL project

The National Dialogue in the COOL project (Climate OptiOns for the Long term) aimed at developing insights and recommendations for Dutch long-term climate change policy, in terms of both content and process. The dialogue was carried out in four dialogue/discussion groups, which addressed four sectors of the Dutch economy, namely Housing, Industry & Energy, Agriculture and Transport. For each of these sectors, the dialogue addressed the following question: What measures are required in order to realise reductions up to 80% by 2050 (as compared to 1990 levels) for greenhouse gas (GHG) emissions in The Netherlands? Dialogue participants did *not* address the issue as to whether such an emission reduction would be desirable as a climate change policy target. Whereas the realisation of -80% for The Netherlands by 2050 was taken as a point of departure, the dialogue explored implementation trajectories for reduction options using a method known as backcasting. It is also important to note that the dialogue groups were asked *not* to fake consensus in their strategic recommendations. Hence, the dialogue outcomes articulate differences in view with respect to the preferred trajectories for de-linking GHG emissions and economic growth.

This chapter presents and synthesises the findings and conclusions from the National Dialogue, taking into account the divergent views among and within the dialogue/discussion groups. The authors are the only people responsible for this report’s contents - particularly concerning its recommendations.[2]

Findings and conclusions from the National Dialogue mainly address climate policies for the period 2012 – 2050, that is the period after Kyoto. Section 2 focuses on the analysis of options for major emission reductions as carried out by the four dialogue groups. Section 3 presents the trajectories toward –80% GHG emissions by 2050 for the sectors Housing, Industry & Energy, Agriculture and Transport. Together, these trajectories indeed account for about an 80% reduction potential for The Netherlands by 2050. Section 4 then highlights the criteria that, according to the dialogue, should underlie long-term climate change policy. This section also elaborates on the doubts and conflicting views from the dialogue on long-term climate change policy. Lastly, Section 5 presents recommendations. These are meant for the coming 5 – 10 year period, when The Netherlands should prepare for the long term and particularly take into account the uncertainties and conflicting views that have been put forward in the dialogue.

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[2] Participants and the members of the COOL external review committee have reviewed a former version of this report. It was also discussed at the national COOL conference held in Amersfoort on May 11, 2001. The reactions were mainly positive. Some participants were critical about the recommendations concerning CO_2 removal and storage.

Box 2 Two future images/visions for The Netherlands in 2050

In order to stimulate the dialogue, the scientific support team developed two future images of The Netherlands in 2050, both of which sketch a society that has been able to realise –80% GHG emissions. The images/visions are based on two scenarios used by IPCC, which have been quantified with respect to the Dutch situation.

According to the images A and B, for the 1990 - 2050 period, production grows to 4-6 times its 1990 level. The images differ more with respect to the increase in per capita income, as the population size in A is assumed to be smaller than in B. Without major technological innovations, the Dutch economy would double its energy consumption, compared to 1990 levels. However, it is assumed that because of major achievements in material and energy efficiency the final energy demand is about 30% below the 1990 level. A set of plausible choices as regards fuel supply and CO2-removal and storage bring down the total Dutch CO_2-emissions to 40 Mton/year (= -80% /1990).

	Image A	Image B
World-orientation	Cosmopolitan, Global Village	Regions, trade blocks
Economy	High growth and dynamic market	Moderate growth, strong regulatory gov.
Social	Individual	Community, family
Physical Environment	Suburbanisation, fragmentation	Careful planning
Transport	Road transport Private transport	By train and ship Public transport
Environmental attitude	Economic values	Environmental values
Population (million)	16	19
GDP (1990 = 100)	570	440
Private car, km (1990 = 100)	170	170
Agriculture, km (1990 = 100)	65	78
Energy demand (PJ)	2000	1800
Fossil (PJ)	950	400
Biomass (PJ)	800	1200
Solar / wind	135	170
Nuclear (PJ)	80	0
CO2-storage (Mton)	50	5

The dialogue groups elaborated these images for their respective sectors. The groups have done this in quite different ways. For Industry and Energy, two technological trajectories were defined toward –80% (Clean Fossil and Sustainable). For Transport, a distinction was made between a sector that is allowed free expansion, and a sector that is bound by governmental restrictions (Free Way and Moderate Transport). For the Housing sector, it is assumed that the dominant factor with respect to emission reduction is the speed at which buildings are replaced (The renewed Netherlands vs. The familiar Netherlands). For agriculture, the distinction was found in different scenarios for the sector under environmental restrictions (Low emission Bulk vs. Mixed Landscape). The fact that the groups used two contradictory images in exploring the viability of reduction options explains the range in the emission reduction figures for the sectors, since these figures have been calculated for two images per sector.

2.2 Analysis of options for emission reduction

In order to learn about possibilities for considerable emission reductions in the long term, the dialogue groups investigated opportunities and barriers for the implementation of 22, mostly technical, reduction options. For each analysis, the groups took either one of two conflicting images for the sector as a point of reference. Both images unfold a future in which The Netherlands has been able to reduce its GHG emissions by 80%, but in most other aspects the images contradict each other (see Box 2). Some options, i.e. biomass, solar PV and wind were evaluated by several groups. Box 3 gives an overview of the 22 options that were analysed by the four dialogue groups.

Box 3 indicates that the dialogue groups limited their scope. Obviously, it was impossible to analyse every option given the limited time available for the dialogue. In some cases, assumptions were formulated as regards the options that were not taken into consideration. The absence of the nuclear option may need some clarification. Several dialogue groups have discussed as to whether the nuclear option should be considered in the backcasting. Arguments for not doing this in the Dutch context include the most controversial nature of this option in The Netherlands, the persistence of the nuclear waste issue and the limited uranium stocks for the long term.

All options that were analysed may, potentially, contribute considerably to the significant reduction of greenhouse gases in The Netherlands. However, the implementation of each option will face considerable obstacles, even if the trajectory for implementation is assumed to be 50 years. In some cases, there is considerable doubt as to whether implementation will be possible at all, such as the option to draw back the demand for transport through a change of individual behaviour. At the same time, opportunities were identified for national government, the EU and private actors. Box 4 presents an overview of the major barriers and opportunities as identified in the backcasting exercises.

In general, the main barriers/obstacles relate to problems at government level (especially for options that ask for a joint European approach) and a lack of public acceptance. The general trend of government retreat in an era of liberalising energy markets appears in conflict with the needs for implementing a variety of climate change options. After all, this requires a major role for public institutions in many areas.

Major opportunities are identified with respect to technology development as well as in terms of gaining public acceptance. Climate change policies in The Netherlands can contribute in a positive way to domestic comfort, a reduction of traffic disturbance and a more pleasant landscape, without negatively affecting matters that people care about, such as income and mobility.

Box 3 Options analysed in the four dialogue groups

• Biomass (Industry, Agriculture, Transport)	• Measures to reduce emissions from manure and fermentation (Agriculture)
• Chain optimisation of wood (consumption) (Agriculture)	• Micro-combined heat and power (Housing)
• Combined heat and power (Industry)	• Modal shift from private to public transport (Transport)
• CO_2 neutral greenhouse (Agriculture)	• Modal shift from air to train (Transport)
• CO_2 removal and storage (Industry)	• Modal shift from road to water (Transport)
• Draw back demand for transportation through behaviour change (Transport)	• Passive solar (Housing)
• Energy-efficiency in industry (Industry)	• Replacement speed of buildings (Housing)
• Fuel cell (Transport); see also under Hydrogen)	• Sinks (Agriculture)
• Heat Pump (Housing)	• Solar PV (Housing, Industry)
• Hydrogen economy (Industry, Transport)	• Underground transport (Transport)
• Measures to reduce emissions by land management (Agriculture)	• Wind (Housing, Industry)

Box 4 Main barriers and opportunities

• Barriers	• Opportunities
• Technology development	• Technology development
• Vested interests in sector	• Public acceptance / Image
• Costs (compared to other options)	• Fit in with trends in sector
• Public acceptance (a variety of image and acceptance issues)	• Efficient use of limited space
• National government (internal co-ordination and enforcement)	• National government
• European Union (especially co-ordination)	
• Infrastructure	
• Limited space	

2.3 Long -term trajectories toward –80%

For each sector, specific trajectories (packages of options) were identified in order to realise a reduction of emissions of 80% by 2050. These trajectories are mostly complementary, but in some instances they contradict each other.

Housing

For the Housing sector two complementary options are proposed - one for existing buildings and another for the construction of new buildings.

The package for **Existing Buildings** looks as follows (in this preferential order):

- Dwelling insulation (roof, crawling space and housing front),
- Sustainable energy applications (solar powered heating, solar PV, wind)
- Low-calorific heating: heat pump combined with micro combined heat and power (CHP), as a successor of the high efficiency boiler.

The package for **New Buildings** consists of (in this preferential order):

- Integrated design with optimal orientation to the sun and use of daylight,
- Optimal thermal insulation,
- Balanced ventilation with recovery of heat,
- Sustainable energy applications (solar powered heating, solar PV, wind)
- Low-calorific heating: heat pump combined with micro CHP, as successor of the high efficiency boiler.

It is assumed that the reduction potential for houses applies at least to the same degree to utility buildings.

The dialogue group has a strong preference for sustainable energy options that can be applied at the level of buildings. It also sees a potential for wind energy utilisation. It is expected that consumers will prefer renewable energy sources and are even willing to pay more for this, if needed. Only if renewables prove insufficient to realise -80% by 2050 should CO_2-removal and storage be applied. Hence, the fossil part of the energy supply will also become CO_2 neutral.

Dependent on assumptions related to the replacement speed of houses and utility buildings, an emission reduction of between 80 – 90% comes into sight. As the replacement speed accelerates, it will then be possible to realise further reductions (emissions related to removal and reconstruction of buildings included).

The question remains as to whether electricity from the grid can be produced in a sustainable way or whether clean fossil fuels also need to be applied.

Box 5 Emission reductions for two trajectories in the Housing sector

A calculation for houses shows the following results for 2050:

- Under ***autonomous developments*** (i.e. without addition options), CO_2 reduction through improving efficiency in buildings and power stations will exceed the increase of CO_2-emissions as a consequence of the increase in total building stock. CO_2-emissions will go down by 10 – 25% in 2050 as compared to 1990 levels.
- If ***additional reduction options*** *inside* the dwelling are used to its maximum potential, CO2 emissions will be further reduced to -60 – -70% as compared to 1990 levels.
- If ***the grid can also supply 'clean' electricity***, a further reduction will be possible of up to 80 – 90% as compared to 1990 levels.

Hence, a realisation of –80% appears within reach.

Box 6 Emission reductions of CO_2 for three conflicting trajectories in the Industry & Energy sector

	Clean Fossil		Sustainable Energy system		Hybrid	
Scenario & supply mix	Emission Megaton CO_2	Reduction	Emission Megaton CO_2	Re-duction	Emission Megaton CO_2	Reduction
Low growth	16	75%	15	76%	18	72%
High growth	26	60%	26	60%	29	55%
High growth, no materials eff.	30	54%	31	52%	34	48%

As a comparison: The 1990 CO_2-emissions for Dutch industry were about 64 Megatons

Industry & energy

The first observation to be made with respect to the industrial sector is that a major improvement in efficiency is essential for the realisation of –80% by 2050. A great deal is expected from combined heat and power options, particularly in the short and medium term. The second observation is that all supply options that really matter, such as biomass, CO_2 removal and storage, and renewables (wind, solar) are, for different reasons, controversial. However, if an 80% reduction is to be realised by 2050, it is most likely that all available options should be applied, thus efficiency renewables as well as CO_2-removal and storage. Thirdly - to a large extent conflicting trajectories have been calculated for this sector.

- In the trajectory **Clean Fossil,** 80% of the energy carriers come from fossil sources, in particular from natural gas. Here, the focus is on developing a Hydrogen infrastructure, CO_2-storage, biomass and CHP (combined heat and power). A moderate efficiency improvement is assumed (35% or 0,75% per annum).
- In the trajectory **Sustainable Energy system,** abou**t** 70% of the energy carriers come from renewable sources, in particular from imported biomass. There is also a focus on solar and wind energy. A high level of efficiency improvement is assumed (50% or 1% per annum). In this trajectory, there is no effort to develop the clean fossil package CO_2-storage, hydrogen and CHP.
- The third trajectory is a **Hybrid**, which combines the other two - except for biomass. It includes solar and wind energy sources but also CO_2-removal and storage, Hydrogen and CHP. For this trajectory, a low rate of efficiency improvement is assumed (20% or 0,4% per annum).

The reduction of CO_2 emissions for the three trajectories is presented in Box 6. Dependent on assumptions on sector growth, efficiency improvement and the contribution from CO_2 neutral supply options; the sector industry and energy may realise an overall reduction of up to about 50 – 75% by 2050 compared to 1990 levels. Additional reductions could be realised by the utilisation of CO_2-neutral feed stocks (biomass in particular) in among others the fertiliser and chemical industries. If all these options were utilised, it would be possible to realise a (theoretical) reduction of almost 100% for the industry & energy sector.

Box 7 Contribution to emission reductions by the "Agriculture" sector

	Reduction potential*) (Megaton CO_2-eq.)
Reduction - primary production	
• CO_2 neutral greenhouse	9-14
• Closed stables	2-3
• Emissions per cow	0.5-1.5
• Organic fertilisers	Uncertain
• High efficient use of fertilisers	1
Total primary production	*12-18*
Sustainable energy and materials NL	
• Utilisation of agri residuals	0.5-1
• Manure fermentation	0.5-1
• Combustion of (dry) manure	1
• Bio-energy production NL	1
• Wind farms on shore	1-1.5
Total sustainable energy and materials NL	*4-6*
Sustainable energy sources and materials from abroad	
• Chain optimisation of wood consumption	2
• Bio-energy production imported (400-500 PJ)	38
Total sustainable energy sources from abroad	*40*
Sinks	
• Increase groundwater level in peat pastures (450 kha)	?5-7**
• New forest (350 kha)	?1
• Forest and land management	?1
Total sinks	*?7-9*

*) The reduction potential of the options cannot simply be added because of overlap.
**)? means that the net effect is uncertain

Box 8 Energy use figures for transport, converted into CO_2 figures

CO_2 emissions in Megatons	
1990 level	28
Trend 2050	60-75
Total Effect trajectories 1-3 compared to trend	-25
Technical solutions	-15
Draw back demand	-5
Modal shifts	-5
Results for 2050 without CO_2 neutral fuels	35-45 (+20-50%)

Agriculture

For the agricultural sector it is assumed that policies are developed and implemented in a European context. Three complementary trajectories are suggested,

- **Measures as regards the primary production:** CO_2 neutral greenhouses, closed stables where animals have sufficient space, organic instead of artificial fertiliser and a huge improvement in the efficiency of fertiliser use.
- **Energy production and chain optimisation of wood consumption.** Energy production relates to the available biomass and on shore windmills. Optimisation of wood consumption presumes that wood is used primarily for high-level applications, especially for construction, and only used as fuel as a last resort.
- It is presumed that **interventions in the food chain** will, also, significantly reduce emissions, but these have not been analysed in the backcasting.

As well as these trajectories, there are opportunities for using sinks as a means of contributing to CO_2 reductions. Possibilities in this respect include changing cropland into pastures, new forests, shallower ploughing, and in particular increasing the groundwater level in peat pastures (this prevents peat oxidation and stimulates the formation of new peat). These measures should, however, be counted with great uncertainties in the net results.

Box 7 summarises the opportunities for Dutch agriculture to reduce CO_2 and non-CO_2 greenhouse gases considerably, both within and outside the sector itself. The range of figures results from different expectations as regards the volume of primary production by 2050.

- Implementing measures related to primary production renders an emission reduction of 12-18Mt CO_2 eq. This yields a 60-80% reduction in the remained emissions (5-10 Mt CO_2/eq) compared to 1990 levels.
- Energy production and optimisation of wood consumption renders an additional reduction in the order of 6-8,5 Megatons CO_2-eq. (this is 25-35% of the overall emissions from the sector in 1990).
- Sinks could render another 7-9 Megatons CO_2 (also 25-35% of the sector's emissions in 1990).

This means that, in total, the sector is able to reduce 100-150% of its own emissions by 2050. Interventions in the food chain are not yet included in this figure.

What is most remarkable is this sector's contribution to reductions in other sectors. The shift from artificial to organic fertiliser for instance, in combination with increased efficiency in use, will probably render a reduction in the order of 8-11 Megaton CO_2 equivalents (N_2O en CO_2) provided that these measures are also applied outside of The Netherlands. This branch of industry will be likely to shift its core business in The Netherlands. Cement production for example will be affected by a chain optimisation of wood consumption, as the use of concrete in construction will be reduced. In total, agriculture may result in a reduction of 14-19 Megaton CO_2-eq. in other sectors.

Transport

For this sector, a general observation is that economic developments leading to an increased demand for transport cannot be influenced by this sector.

Four trajectories were formulated in order to achieve –80% by 2050:

- The trajectory **CO_2 neutral transport fuels** includes the development and use of bio fuels and / or clean fossil transport fuels combined with CO_2-removal and storage.
- The trajectory **Technological solutions to draw back energy demand for vehicles** includes the development and use of efficient vehicles. Hence, it will cost less energy to meet total demand for transport.
- The trajectory **Draw back of demand for transport** includes behaviour change by individuals as well as more efficient commodity transport thanks to ICT, which leads to driving less ‘empty’ kilometres.
- The fourth trajectory is **Modal shifts**. This includes shifts from road to water transportation, from air to rail and from private to public.

Major breakthroughs for addressing the climate change issue are expected from the first and the second trajectories in particular. However, modal shifts toward low energy / CO_2-efficient modes of transportation and drawing back the overall demand for transportation are also claimed to be necessary. This claim is warranted by two observations: Firstly, the considerable growth of the sector, expected for decades to come, is likely to put a large strain on the availability of CO_2 neutral transport fuels. It is thus assumed that there may be limits with respect to the availability of CO_2 neutral fuels (e.g. from biomass and renewable energy sources). Secondly, modal shifts appear relevant in the context of issues other than climate change, especially those that relate to the lack of available land and to congestion.

Calculations have been made with respect to the possible developments in terms of energy use in the trajectories, excepting one that focuses on clean transport fuels. The results were translated into figures for CO_2, as presented in Box 8. It appears that energy use by the sector will increase by 20 - 50% in 2050, despite a package of powerful measures. This figure clearly shows that the use of CO_2 neutral fuels, in combination with other technological solutions such as the fuel cell, will be essential in terms of realising far-reaching emission reductions. Without this option, the realisation of any reductions will become highly uncertain, as the growth of the sector exceeds the impact of efficiency improvements. Eventually, therefore, the market penetration of CO_2 neutral fuels will to a large degree determine whether greenhouse gas reductions become realised in this sector. Theoretically, reductions up to 100% then become a possibility.

Box 9 Findings for the four sectors in 2050

Sector	Housing	Industry & Energy	Agriculture	Transport
Trajectories	Existing buildings: sustainable New buildings: sustainable	Clean Fossil: CO_2 storage, H_2, efficiency Sustainable Energy System: Biomass, wind, solar, high efficiency Hybrid: CO_2, H_2, sustainable	Primary sector Energy and materials Sinks	Draw back of demand for transportation Efficiency – Modal shifts Clean fuels
Emission reduction	80–90%	50-100%	100-150%	?? -100%

The outcomes of the dialogue in the sectors Housing, Industry & Energy, Agriculture and Transport suggest that reductions are possible for The Netherlands of up to 80% by 2050. It may be however that trajectories identified for different sectors come into conflict with one another. It may also be questionable as to whether Clean Fossil (Industry & Energy) will be capable of providing sufficient electricity from renewables to houses and buildings (Housing). It is also doubtful as to whether there will be sufficient biomass to meet the various claims. After all, both the Transport and Industry & Energy sectors put a claim on imported biomass in order to meet the energy demand of households and businesses as well as to meet the need for clean transport fuels. An important point that should also be mentioned is that trajectories may have different implications in terms of costly infrastructures. A trajectory sustainable energy system supposes high investments that are very different from the investments required by a clean fossil scenario. The dialogue has noted the existence of such inconsistencies but has not addressed them further.

2.4 Choices for the long term

Box 9 summarises the findings related to the four sectors. From these findings a considerable number of dialogue participants conclude that, under certain conditions that The Netherlands are unable to completely establish or guarantee, such drastic emission figures as –80% by 2050 become imaginable. However, in the dialogue several doubts have been raised as to whether –80% may be practically feasible. It will not be possible to implement all options at the same time, for instance. Even within a schedule of about fifty years from now, choices may have to be made.

This becomes clear if the criteria that the four dialogue groups have identified as relevant for long-term climate change policy, are taken into consideration. These are explained in Box 10. The dialogue unanimously concludes that climate change policy in The Netherlands should foster options that meet the criteria *climate effectiveness*, *sustainability*, *cost effectiveness* and *social support*. These criteria are not always compatible, however, and may even be in conflict. Opinions diverge at this point.

First of all, there are different views and expectations with respect to both what is feasible and what is socially acceptable, given the current state of technology. There is a shared assumption that huge technological progress will be seen over the coming years in many areas relevant to climate change policy. According to some sources, however, an emission reduction up to 80% by 2050 will be imaginable even without huge innovations. In their line of argument, it may be concluded that major barriers relate to problems in government (political will, initiative, consistency etc.), particularly at the level of the European Union. Other important barriers/obstacles relate to private sector or consumers' inertia (mainly due to lack of acceptance). This line of argument shows a degree of similarity with the argument put forward in the IPCC Third Assessment Report, i.e.: Significant greenhouse gas reductions are technologically feasible at acceptable costs, but the social and institutional barriers are enormous.

Others however, question the social acceptability of measures necessary for achieving/realising –80% in the present technological context. Here the tension becomes evident between on the one hand the criterion climate effectiveness and on the other the criteria sustainability and social support. Serious doubts and differing viewpoints relate to the options that are considered crucial for realising significant emission reductions.

Box 10 Criteria for long-term climate policy as developed in the dialogue

- *Climate effectiveness:* agreement exists that climate effectiveness should be the most important criterion in the stimulation of options to reduce emissions. The other criteria that emerged from the dialogue may on occasion restrict the criterion of climate effectiveness.
- *Sustainability* means social, ecological and economic sustainability (people, planet, profit). Not everybody considers the favourable options for emission reduction equally sustainable. This applies to CO_2 storage, biomass and hydrogen in particular. At the same time, it is recognised that the impacts of climate change may be such that these controversial options can no longer be neglected. This may be the case even if a worldwide reduction in the order of 80% for The Netherlands is realised.
- Long-term climate policy and *social support* have to reinforce each other. According to some, this assumes that the climate policy should follow the current developments in the sector (Agriculture) and that the consumer should be actively involved in this policy (Housing). A fairly general impression is that important options such as CO_2 storage, biomass and wind energy do not have a high score on the criterion of social support. In turn the options that seem to have high social support have a low score on the criterion of cost effectiveness.
- *Cost effectiveness*: if there is a choice between options, the alternative that realises the highest reductions against the lowest costs will be given preference. It should be noted that this criterion is mainly suitable for comparing options that are already completely developed. The question is however to what extent this can be assumed in the assessment of long-term developments, since the uncertainties are huge in terms of development costs.
- The social support for climate policy will be enhanced if options are offered that do justice to the co*nsumers' freedom of choice*. It is assumed that there is a general trend toward more consumer sovereignty that will continue over the next few decades. This criterion can conflict with cost effectiveness since some options will be cost effective only if applied on a very large scale. A hydrogen infrastructure requires large infrastructure investments, but it restricts the consumers' freedom of choice.
- *Governmental / administrative fit* points to the preference for options which can either be implemented with the current set of instruments/tools in The Netherlands or fit in properly with European rules.
- The criterion *consistency of governmental policy* especially points to the tension between climate change policy and the liberalisation of the energy market in particular, which has been spotted in different dialogue groups.
- *Technical reliability* refers to the strength of options available. Some link this criterion with a preference for simple, low-tech options of long durability that are easily repairable should anything go wrong. The dominant culture has a bias in favour of high-tech, yet relatively vulnerable options.
- *Potential for innovation* means that options will be assessed in relation to their capability to generate more sustainable technological innovations. The assumption that underlies this criterion is that large-scale innovations will be necessary since the degree of sustainability of options such as CO_2 storage and biomass is doubtful.

CO_2 removal and storage

There is concern that carbon -once stored underground - could leak out at a certain point in time with potentially serious consequences for local plant and animal life. Another question relates to the possibilities for government and society to manage and monitor underground CO_2 for an infinite period of time. In addition to this resistance, there have been concerns raised that a choice for large-scale CO_2 removal and storage could lead to a neglect of sustainable options, especially the implementation and further development of solar and wind energy. In contrast to this line of argument, it has been suggested that climate change, even if drastic emission reductions are realised by 2050, may have an irreversible impact on highly valued ecosystems. In this case, CO_2 removal and storage can probably not be avoided. After all, *if the sustainability criterion warrants objections against* CO_2 *underground, then this same criterion can certainly not lead to accept an ongoing increase of* CO_2 *in the atmosphere.* An additional advantage of this option is perhaps that once it has proven to be cost-effective, The Netherlands is less dependent on other countries and Europe in making the transition toward a CO_2 neutral energy system.

It can be concluded from the dialogue that under stringent conditions, future CO_2 removal and storage may meet with sufficient social support. However, the first of these conditions to be fulfilled will be the strong support and encouragement of those options that are, in the long term, expected to make CO_2 storage unnecessary.

Biomass

Biomass, too, is not generally considered a sustainable option. There is scepticism with respect to the availability of biomass, given the amount and diversity of claims in various sectors. Concerns have been raised that once more it is the industrialised countries, which show a rapid growth of energy use and transport that will solve their problems at the expense of less wealthy regions such as South America, Africa and Eastern Europe. Will food security in these regions not be endangered by a shift to large-scale biomass production? What negative social impacts can be expected from this? It is, however, largely recognised that at least theoretically sufficient land is available for biomass. Starting biomass production on degraded lands will bring considerable benefits to the exporting countries. Therefore, the problems faced resulting from future large-scale biomass production and use will not necessarily lead to a rejection of this option. However, the concerns relating to its social and ecological impact renders a plea for sustainable production and use (chain optimisation) of biomass. One of the barriers identified in this respect is the global climate regime itself, as it provides incentives for dumping biomass from the forest right into the oven.

Renewables - renewable energy sources

Whereas on the one hand, the dialogue anticipates a variety of problems relating to the sustainability of clean fossil and biomass, on the other hand it observes that The Netherlands, given the current state of technology, faces limitations with respect to the potential of renewable energy sources or renewables (particularly solar and wind energy). These limitations are partly physical in nature (too little space for wind turbines and solar panels) and partly due to the costs of back-up systems, which are expected to be huge. Nevertheless, there are no limits in an absolute sense –there is always the possibility of import and, as systems become more effectively linked in the future, the necessity of back-ups is likely to decrease. In order to understand the divergent views on the potential for sustainable options more fully, it is necessary to establish the positions of the various sectors. For the Housing sector, renewables can already make a difference today. For this sector, the limits for renewables have not yet been reached. Major breakthroughs seem unnecessary in order to realise –80%. It is also expected that these options will meet with a positive attitude among consumers. Despite this, for those sectors that are most responsible for current Dutch greenhouse gas emissions, namely Transport and Industry, solar and wind energy do not constitute serious alternatives either now or in the years to come. Moreover, the public acceptance of renewables may also be questionable. It is not unlikely that a hypothetical offshore windmill park with a 20.000 Mwe potential along the coastline of Northern Holland (from Den Helder to Zandvoort) will meet with public resistance. Is it sustainable to externalise problems from land to the sea?

Energy efficiency

Demand-side management is a crucial option for all sectors in order to bring down emissions. Opinions diverge regarding the possibilities for further efficiency improvements. Some are worried that the pace of efficiency improvement (since the seventies about 1 - 2% per annum) cannot be maintained. Existing processes come very close to the thermodynamic minimum. Hence, a plea is made for the strong encouragement of process innovations through extensive co-operation between companies.

Breakthroughs in sustainable and demand-side management are also considered necessary in order to avoid (too large) claims on CO_2 removal and storage and biomass in the future. A variety of views have been articulated with respect to the role of government in future climate policy in a socially acceptable way alongside and articulated with the issue of technological feasibility of –80%. Are market instruments and institutions adequate, in particular an emissions trading regime, given the necessity of major technological breakthroughs and the implications of many options for infrastructure? Can the Dutch government and the European government make a difference in an era of liberalising energy

Box 11 Conflicting views relating to the transition towards a -80% energy system

Emission trading regime / other market related instruments? Technology available?	In the mid/long term,	As soon as possible
Not yet	R&D through non-competitive, cross-sectoral co-operation. Major role of government in financing and R&D infrastructure. D	Long-term standard setting for specific sectors or technologies / combine with ecotax to avoid externalities B
Yes	C To mobilise support for the adoption of innovations by non-market instruments (create lead customers).	A Acceptance and implementation of options by companies and consumers.
Based on Matthijs Hisschemöller, Magnus Andersson, Marleen van de Kerkhof and Willemijn Tuinstra: 'What we do not know yet about the institutions needed for the transition toward a decarbonised economy; A report from the COOL dialogue.' *Paper presented at the METRO Conference on Institutions and Instruments to Control Global Environmental Change*, 21-22 June 2001, Maastricht, The Netherlands: page 16.		

markets? The dialogue observes that as an impact of liberalisation, governments as well as big companies take less interest in (fundamental) research. Some however expect that the shift from regulatory measures toward market instruments, particularly the introduction of a system of tradable emission permits; will in time generate the technological innovations needed. If such a system includes a cap, which is regularly revised in a downward direction, options that are initially too expensive will become cost-effective. Others raise doubts here. They argue that government and not the market is the institution capable of safeguarding long-term perspectives.

Government is needed in particular to stimulate and support the research & development of a (limited) number of technologies as well as to perform the role of 'lead customer'. Moreover, government also has a traditional role to play in realising major infrastructure projects.

Box 11 summarises different views from the dialogue which link insights and perceptions as regards the available knowledge and technologies, with opinions on the time needed in order to implement market instruments and institutions. As an ideal-typical representation, Box 11 fails to do justice to the dialogue since many issues, opinions and nuances are not addressed. What should be mentioned here in particular is the observation made by various dialogue groups that climate policies may benefit from a more active involvement of those consumers willing to make a contribution.

In fact Box 11 distinguishes and solves four problems. In cell A, an innovation is available at a reasonable cost. The problem, however, is how to promote its adoption through the market. The solution can be found by giving CO_2 a price. There are a great number of options that this problem frame can be applied to. One of these may be CO_2 removal and storage, provided that safety is no longer an issue. In cell B, no product is available as yet, but it is reasonably expected to become available after some period of time. It is also clear as to which specific companies will have to deal with this. Long term standard setting, as proposed for the development and implementation of CO_2 neutral transport fuels, is considered a market conform instrument that can easily evolve into a system of tradable permits. The problems identified in the right-hand column of the table can both be very well addressed with market instruments. This is different for the left-hand column of the table. The main difference is that, instead of competition provoked by market (type) instruments, co-operation between parties is considered pivotal in solving their problems. In cell C, a product is available but for some reason (there may be a variety of reasons here, including the costs of the product or the absence of a market) it cannot be made available through market competition. In order to stimulate its adoption, government must use non-market

instruments. The plea for a fixed share of renewables in the energy supply is an illustration of this kind of solution strategy. In cell D, the theoretical knowledge is available but a lot of R&D seems needed in order to put a product in the market. In this case – and differing from the starting position in cell B- there may even not be a clear idea about the kind of product that is to be developed, the participants to involve or the knowledge needed in order to achieve a breakthrough. Options that may fit in with this problem framework are breakthroughs in industrial process efficiency, or, in the long term, solar power.

So far, the problems and accompanying solution trajectories have been presented as distinct and complementary. Together, they could be considered as sketching a trajectory for transition over time, beginning with R&D and ending with measures to endorse fair market competition. In everyday practice, however, the distinction between these kinds of problems may be far from obvious. It has already emerged that the question as to whether or not state of the art technology may help in realising major reductions is answered differently by the Housing and Industry sectors. The issue of efficiency is taken as an example in order to explore the meaning of this point in more detail.

Divergent views on efficiency improvement were articulated in the dialogue. This may be explained on the one hand by the fact that efficiency is a package including a diversity of options. Some are already available and can be implemented at short notice, whilst others still require fundamental research and technology development. From this observation it might be concluded that, as such, the policy instrumentation needed for realisation should also be very diverse. However, other participants in the dialogue have put forward opposing views, which may justify the inference that the dialogue has articulated *conflicting* views on one and the same issue. The view that technological barriers constitute the main obstacle at this moment can be addressed by a strategy as proposed in cell D, namely non-competitive co-operation and strong government support for R&D. In contrast, there is the observation that in the past efficiency has shown a rapid improvement in response to external pressures, such as an energy crisis or a price increase. From this, one may conclude that incentives for further improvement of efficiency will be provided by a regime of tradable emission rights (cell A in Box 11).

This example raises several important questions: Who decides in the years to come what kind of problem is at stake and which solution strategy is the most suitable? Then, when it turns out that one does not face one single problem but different ones (in which case the views put forward are not really *conflicting*): How 'tailor-made' must a policy be in order to implement the best technology? How 'tailor-made' can a policy possibly be in order not to be caught up in detail? When do policy instruments come into conflict with each other such that the policy loses both its transparency and its consistency? Up to what level does liberalisation allow for far-reaching government support, if this could lead to the promotion of certain technological developments at the expense of others? The major challenge in the development of long-term climate policy probably lies in addressing these types of questions at the crossroads of technology, economy and governance.

It is mainstream to assert that an environmental policy must always use a mix of policy instruments. As to whether or not this is always possible or that choices have to be made is a somewhat neglected issue. A close examination of National Dialogue indicates that it is very important indeed to explore and investigate when and how different policy instruments may come into conflict.

Box 12 A selection of specific recommendations for the four sectors

Housing

- Integrated design, including the use of passive solar energy in building codes;
- Support solar PV by encouraging agreements between solar PV producers and energy suppliers about liability and incentives (government);
- Stimulate the use of wood in house building;
- Address the issue of groundwater contamination by antifreeze in heat pumps, generic subsidies (government).

Industry and Energy

- Introduce measures for stimulating the use of heat power generators in industry, trajectory for linking heat power generators with clean fossil options (government, companies);
- Develop plans to implement a hydrogen infrastructure (step by step introduction or radical change), (all parties involved);
- Develop industrial parks in accordance with ecological principles and create agreements between companies in order to co-ordinate the demand and supply of heating and cooling (sector).

Agriculture

- Gradually diminish production and use of artificial fertiliser (Netherlands, sector, EU);
- Co-ordinate policies regarding nature and landscape with those regarding the climate issue (sinks) (Netherlands, managers of nature reserves);
- Create good housekeeping on the farm (sector);
- Make an inventory of sustainable food options (all parties involved).

Transport

- Develop long-term standard setting for the transition to a CO_2 neutral fuel market (at a European level);
- Internalise the costs of CO_2 into the fuel price (at a European level);
- Introduce a test for the climatic impacts of new infrastructure (Netherlands);
- Include transport as a part of environmental management systems and certification schemes (sector).

2.5 Preparing for the long term: recommendations

This section presents recommendations on how to prepare for the long term. These recommendations relate to proposed actions to be taken in the period between now and 2012. They are aimed at government, business and the environmental and consumers movements. The starting point is the general view that comes from the dialogue:

> *From the National Dialogue it is concluded that emission reductions of up to –80% are imaginable by 2050. Not all dialogue participants are, however, (equally) optimistic about the feasibility of such reductions. In particular, there is considerable doubt as to whether or not these reductions will be possible without causing or aggravating problems other than climate change either here or elsewhere. This leads to the conclusion that –80% may be attainable for The Netherlands in a socially acceptable manner provided that as well as overcoming many social, institutional and psychological barriers, major technological breakthroughs will be realised in specific areas. European and Dutch governments are supposed to take leading roles in this respect, but it is doubtful as to whether this is possible.*

This conclusion points on the one hand to a mild optimism and on the other hand to persistent doubts and concerns relating to the desirability of certain options as well as to the capabilities of government. An effective long-term government strategy needs to find a way of dealing with these contradictory impressions, with the observed doubts and divergent opinions. They all point to real issues that have to be coherently addressed after all. The recommendations given in points 4 – 10 below deal with these issues. The dialogue has also generated some shared views as regards general factors that will make a long-term climate policy successful. These are dealt with in recommendations 1 - 3. In addition, Box 12 provides information on specific recommendations for the sectors as developed by the dialogue groups.

General

1. *Use the next 10 years effectively!* It is already possible to begin implementing various options for the four sectors. Although the climate problem is urgent, however, and its urgency is likely to increase over the coming period, it is particularly important to spend adequate time developing a coherent long-term strategy and to take action accordingly. In this respect it is critical to fine-tune substance and process, as well as to co-ordinate actions at global, European and national levels. Additionally the timing of decisions (not taking decisions too late - but not taking them too hastily either) is of critical importance.

Box 13 Lessons learned from the National Dialogue process

- A dialogue group with stakeholders from different expert fields, with different opinions and views, will increase the possibility of generating new insights for policy.
- The success of the group depends heavily on the quality of process support. It is critical that the different steps in the process are transparent to the participants.
- In a demand-driven dialogue, it is crucial that the wishes, concerns and expectations of all participants are used as a starting point for discussion.
- A certain degree of autonomy from the dialogue groups will increase the participants' involvement in the work of the group and in the end product.
- The role of scientific support in a dialogue deserves special attention. The information that is offered should be accessible, compact and tailor-made. Furthermore, a proper communication of information is of vital importance.
- The backcasting method results in insights related to chances and obstacles in the implementation of options for climate policy. However, it alone does not stimulate the participants to articulate and discuss conflicting views.
- Using future images and backcasting stimulates a long-term scope in the dialogue. These methods do not cut the participants off from their own experiences, opinions and interests. This should not be the project's intention.
- An extended preparation phase and a good budget are essential to ensure the satisfactory progression of the dialogue.
- To work in an interdisciplinary team requires careful communication and a good workplan. This takes time!

2. *Ensure a sustained involvement with the issue!* It is essential to create the conditions necessary to enable the transition towards a CO_2 neutral energy system. The following conditions are important:
   - a sense of urgency among stakeholders and the public at large over a long period of time, in order to deal with this issue,
   - A sustained political will to make sincere efforts (high on the political agenda for many years),
   - Consistency of government policy in order to provide private actors with the empowerment necessary in order for them to make their own contributions.

   Long-term policy must allow for critical evaluation alongside (but not in isolation from) existing short-term policy. The approach taken in the COOL project - a discussion between scientists and stakeholders from society - may serve well in terms of elaborating on long-term strategies. Therefore, it is important to use the process lessons from COOL (Box 13 highlights some salient lessons from the COOL process).

3. *Is there social support for –80% as a long-term target?*

   The National Dialogue addressed the feasibility of emission reductions of up to 80% and not its desirability. The outcomes from the dialogue and the involvement of its participants justify raising the question of establishing a long-term reduction target in the order of –80% in a national as well as a European context. Sufficient time is needed in order to explore the implications and impacts of such a decision fully. Answering such a question presumes that the specific themes below are addressed coherently.

Themes for long- term climate change policy

4. *Make an integrated assessment of the effectiveness of instruments and institution over time!*

   The COOL dialogue signifies a relationship between the technological, economic and political / institutional aspects of long-term climate change policy. It is critical to become informed about the effectiveness of instruments and institutions needed in order to realise reductions in the various sectors. At this moment, an integrated approach to this issue, which involves different disciplines, is lacking. Such an approach at the crossroads of technology, economics and governance, must shed a new light on the interactions between the choice of instruments and (unwanted) policy effects over time.

5. *Knowledge, knowledge infrastructure*: The dialogue suggests that it is critical to invest heavily in fundamental and applied research in order to force major breakthroughs in a European context. It is proposed that an international Institute of Excellence be established in co-operation with governments, business and science, which will work on optimising solar PV. Initiatives may be taken in a similar vein with respect to hydrogen and biomass. These proposals from the dialogue are in contrast to the movements of retreat from Dutch government and business with respect to research at this moment in time. Stimulation of R&D must be accompanied with a critical reflection on current knowledge infrastructure, especially on its transparency and its accessibility for demanding parties.
6. *Market development and the adoption of innovations:* In addition to proposals for a strong impetus for R&D, the dialogue has indicated barriers for innovations needed in order to penetrate the market. Traditionally, government takes on the role of lead customer; that is it takes the risks linked to novel products. As well as government, environmental and consumer NGOs – National Governmental Organisations - may also be of significance here, e.g. by mobilising lead customers who may then become shareholders in the new product.
7. *Implications for space and infrastructure*: In close relation to the recommendations under 4 and 5, it is critical to obtain a clear picture of the implications of climate change policy options for the use of limited space and infrastructure. Such an assessment would need to focus on a variety of issues, such as expansion of the grid, underground or surface grid and pipelines, requirements for petrol stations, and all kinds of other implications with respect to waterways, bridges, landscape architecture, design and management of industrial areas, opportunities for (re) locating businesses etc. As yet, there is much to learn about costs and sustainability, as well as about the division of labour between government and private actors in adjusting infrastructure in order to accommodate climate policies.
8. *Empowering consumers*: The potential of consumers as participants in the climate issue has so far been underestimated in Dutch climate policy. Attention largely focuses on providing incentives for behaviour change at the level of the individual as far as consumers are concerned. Despite this, an (organised) intervention by consumers may constitute a stimulus for accelerating change on the supply side. The opportunities that currently exist in order to increase consumers' involvement should be explored. A strengthening of individual responsibility and consumer sovereignty must be pivotal objectives in such an assessment.

Box 14 Publications in the context of the National Dialogue

Arentsen, M. and E. Luiten (2001). Shaping future technology. Position paper for the COOL-dialogue on climate change options. CTSM, Twente en U&U, Utrecht.

Bennett, G. (2001). Long-term institutional change and climate control measures in Europe. Syzygy, Nijmegen.

De Boer, J. (2001). Consumptiecultuur en Klimaatverandering. Essay opgesteld in het kader van de COOL-dialoog. IVM, Amsterdam.

Faaij, A., S. Bos, J. Spakman, D.J. Treffers, C. Battjes, R. Folkert, E. Drissen, C. Hendriks and J. Oude Lohuis (1999). Beelden van de toekomst. Twee visies op de Nederlandse energievoorziening ten behoeve van de Nationale Dialoog.

Faaij, A., M. van de Kerkhof, M. Hisschemöller, R. Folkert, H. Jeeninga, M. Kok, O.J. Kuik, P. Kroon, A. Seebregts, J. Spakman, D.J. treffers and D. de Jager (2001). Kernthema's van de strategische visie voor het lange termijn klimaatbeleid in Nederland. Hoofdpunten uit de strategische visie van de groepen Gebouwde Omgeving, Industrie, Landbouw & Voeding, Verkeer & Vervoer van de Nationale Dialoog van het COOL project.

Folkert, R.J.M. (2001). CO_2-opslag: potentieel en milieu/veiligheidsaspecten. Notitie ten behoeve van de Integratie Workshop COOL. RIVM, Bilthoven.

Hisschemöller, M., M. van de Kerkhof and O.J. Kuik (2000). Climate OptiOns for the Long term. De Nationale Dialoog – Tussenrapport. W-00/02 IVM, Amsterdam.

Hisschemöller, M. , M. van de Kerkhof, O.J. Kuik, M.T.J. Kok, J. Spakman, D.J. Treffers, M. Spanjersberg, A. Faaij, J. Oude Lohuis, A. Seebregts, P. Kroon, J.A. Annema, H. Jeeninga and W. Tuinstra (2001). Backcasting exercities in COOL – De Nationale Dialoog. W-01/03. IVM, Amsterdam.

Hisschemöller, M. (2001). De bestuurlijke aspecten van lange termijn klimaatbeleid. Notitie ten behoeve van de Integratie Workshop COOL. IVM, Amsterdam.

Spakman, J., R. Folkert and G.J. van den Born (2001). Biomassa: potentieel en implicaties.

Spakman, J., G.J.v.d.Born, G.J.Elzenga, K.W.van der Hoek and R.J.M. Folkert (2001). Relaties tussen Landbouw, Klimaat en Beleid.

Thema III Assessment Team (1999). Informatiepakket fact sheets ten behoeve van de Nationale Dialoog.

Treffers, D.J. (2000). Energiebesparing in de Industrie. Paper voor de Nationale Dialoog van het COOL project. NW&S, Utrecht.

Van Lieshout, M. and A.F.L. Slob (2001). ICT en klimaatverandering. Essay opgesteld in het kader van de COOL-dialoog. TNO, Delft.

Van Luttervelt, P. (2001). De kracht en invloed van de consument. Een ondergewaardeerde factor. Den Haag.

Van Soest, J.P. (2000). Klimaatbeleid voor de Industrie. Essay in het kader van de COOL-dialoog. LE, Delft.

Van Zeijts, H., W.J. van der Weijden, and M.C. Hanegraaf. Landbouw en broeikaseffect: systeemgrenzen, toekomstbeelden en mogelijke maatregelen. Utrecht, Centrum voor Landbouw en Milieu.

One instrument to be investigated more fully is the option of providing individual consumers with emission rights.

9. *Trajectory Biomass*. In this trajectory, all barriers for a large-scale adoption of biomass are looked at/examined in an integrated way. At an international level, initiatives are required in order to develop a system for certifying sustainably produced biomass. One of the major issues for the future should be to determine whether or not chain optimisation is a workable national and international objective (at this stage the climate regime provides incentives for burning biomass). This question also implicates the opportunities available for developing an international monitoring system. Nationally and at the European level, barriers to biofuels, (such as taxes for alcohol), should be inventoried and addressed. Research into various biomass potentials must be intensified.
10. *Trajectory CO_2 removal and storage*. This trajectory delivers all relevant information to enable political decisions on CO_2 removal and storage. Special attention needs to be given to safety issues relating to transport and underground storage, as well as to possible reactions underground. Demonstration projects may be commenced. The assessment and the decision making should specify under what strict conditions (e.g. safety, continuation in investments in renewables), when and at what kinds of locations CO_2 storage will be permitted. Given the nature of the resistance against this option - and at the same time the opportunities this option may provide in order to bring down emissions significantly and at a reasonable cost - an open discussion is even more highly recommended for this trajectory in order to facilitate the determination of effective alternatives in the decision-making process.

Box 15 Dialogue participants (part 1)

Group Housing

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Group Industry and Energy

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G.N. van Ingen	Akzo Nobel Energy B.V.
P.W. Kwant	Shell International
W.J. Lenstra	Ministerie van VROM
N.A. Manders	Essent Energie
P.E. Metz	European Business Council for a Sustainable Energy Future, e^5
J. van der Sar	Kerk en Wereld
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Box 15 Dialogue participants (part 2).

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Group Transport

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A.B.M. van der Plas	Nederland Distributieland
P.H.P. Sierat	Verachtert B.V.
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3. SUMMARY AND CONCLUSIONS of the European Dialogue

Magnus Andersson, Willemijn Tuinstra, Tuur Mol

3.1 Introduction

The European dialogue focused on two sectors: energy and transport. Distinct features of the COOL Europe project are its focus on the long term and its focus on radical carbon dioxide emission reductions. Most other research activities on climate policy so far have focused on the short term and on incremental changes. Moreover, the dialogue has relied on a broad set of European stakeholders to develop these insights. Participants in the COOL Europe project have been (1) policy-makers at local, national and international levels; (2) representatives of the private sector, (3) representatives of environmental NGOs, and (4) representatives of the scientific community.

Four workshops formed the core of the COOL European Dialogue. Long-term sector strategies (2000-2050) have been connected with climate policy in a participatory process. The workshops followed a sequence focussing on elaborating the following points;(1) Future Images of 2050, (2) a Path Analysis connecting these Images to the present, (3) Short-term actions needed in order to reach long-term goals, and (4) Strategic Visions which integrate the previous three points. Backcasting has been used in the COOL Europe workshops. Backcasting or anticipatory scenarios are retrospective, i.e.; they start from some normative final state, and explore the preconditions and strategies that could lead to this state.

The structure of this chapter is as follows. Section 2 summarises the main findings from the transport and energy groups with respect to images of the future and path analysis. Section 3 contains an analysis of the main findings. Section 4 gives some final reflections on how the COOL Europe approach could be taken further.

3.2 Summary of the two dialogues

3.2.1 Introduction

According to both sector groups it is technologically possible to redesign the European energy and transport systems while reducing carbon dioxide emissions by 80 per cent. Calculations carried out in the energy group show that it also seems economically feasible to achieve the 80 per cent reduction target, although further economic calculations are needed. Both sector groups argue that European governments should stimulate the move to more sustainable consumption and behaviour patterns in a more active way than previously. Central and Eastern European countries are establishing new industries, economic structures and consumer cultures. It is critically important to channel these dynamic changes towards low-carbon (emission) options rather than the business-as-usual options. EU enlargement is therefore a window of opportunity for EU climate policy.

3.2.2 The energy sector

Two future images have been the starting points for the backcasting exercises in the energy group. Both these images of the European energy system in 2050 meet the criteria of 80 per cent reduction of carbon dioxide emissions compared to 1990 levels. In the ***biomass-intensive image*** biomass has the largest share of the fuel mix. Besides biomass wastes, energy crops will be grown, which are expected to require 80 Mha, or 17 per cent of total land area in Europe (cropland currently covers 140 Mha, or 30 per cent of total land, with forests and woodlands covering 33 per cent). About 80 per cent of land demand for energy crops can be met using excess croplands, starting with currently set-aside land. This land is presumably being used for dedicated energy crops with significant net energy yields. The second image relies much less upon biomass. This image is referred to as the ***solar hydrogen image.*** In this image, solar PV generated electricity is used to produce hydrogen. The hydrogen may be used not only for electricity and heat production, but also as a transport fuel.

It appears that biomass and wind power will be the most important renewable energy sources in the next few decades. Beyond 2030 solar PV will have the greatest potential. Land availability and biodiversity considerations are potentially important constraints for the development of the biomass option.

Hydrogen will be an important energy carrier in the long term, but immediate action would be required in order to have a hydrogen system established within half a century. Modernisation of the energy and industry sectors in Europe and related sectors such as transport will have to include further efficiency improvements in both supply and demand. It is important to establish new institutions that will be responsible for energy efficiency in liberalising markets for energy in Europe. Increased competition and decentralisation in combination with the internalisation of external costs can promote the ecological modernisation of the energy system.

Electricity prices will fall dramatically as competition is introduced into the European electricity markets. Lower prices can lead to higher demand for and consumption of electricity. It also provides, however, a potential window of opportunity in order to internalise external effects by introducing environmental taxes and removing counterproductive subsidies at the same time. On balance the consumer prices would not have to be increased while the most unsustainable plants and other components would have to be closed down.

The issue of decentralisation

There were strong preferences among some members of the energy group for decentralised production of electricity, fuel and heat. In such a system electricity would be generated by systems such as solar, wind (on-shore and offshore) and combined generation of heat and power (CHP). Besides CHP, heat could also be supplied by heat pumps.

Recent technological developments in conventional technology have supported decentralisation. With conventional technologies the economy of scale is decreasing with technological developments over the last decade. Computer control reduces the cost of monitoring and control, so that reducing the number of plants is not as important as it was twenty years ago. The costs of component failures in the large plants are greater than the costs in the small ones. Construction times for large plants have proven much longer than for smaller plants.

In the electricity system the cost of transmission has become obvious as re-regulation introducing competition has revealed the relation between the cost of electricity production on the one hand and electricity distribution on the other. If distribution costs as much per unit of electricity, on site production may be economical even if production at the site costs twice as much as central generation. Thus, the competitive market creates private incentives for local solutions that may be beyond what is economically rational from the systems perspective. The co-generation of electricity and heat is economical if the electricity production is situated close to the heat demand, thereby avoiding long heat transmission pipelines. This has made small electricity production units popular. To many owners of commercial buildings and to industry, the extra supply security of on site electricity generation capacity may also appear as an important value. The new renewable sources of energy such as solar radiation and wind energy are naturally decentralised and require decentralised transformation. The technology required to utilise these resources is becoming commercially viable. To utilise these resources, electricity regulations have to be adapted to decentralised generation, thereby also paving the way for decentralised solutions using conventional resources and technologies. In the energy dialogue group there have been some important discussions involving the use of terminology to describe these systems. Decentralised heat and energy production may be interpreted as meaning that the small-distributed units operate independently only to serve local demand. However, economic optimisation of the operation of many distributed units may be very rewarding whilst relying on relatively inexpensive computer control systems.

Some people in the energy group preferred not to take a stance regarding their viewpoint on decentralisation versus centralisation. They would rather judge all technologies on their own merits regarding emission reduction and resource conservation. In their view, the desirable outcome would probably be a mixture of both small and large-scale technologies.

3.2.3 The transport sector

Future Image

Unlike the energy group of COOL Europe, the transport group opted for the development of only one future image of 2050, as the basis for further analysis and discussion. In the brainstorm that preceded the construction of the future image, the participants had been rather reluctant to construct two possible distinct and contrasting futures (e.g. a “technical change" one and a "behavioural change" one), arguing that the future would always be a combination of the two. The final future image consisted of four dimensions: 1) improved efficiency; 2) fuel substitution; 3) changes in societal structures and patterns; and 4) changes in awareness, values and lifestyles. Improved energy efficiency and new fuels directly affect emissions (emissions per unit of transport), while new patterns of human activities, values and lifestyles have an impact mainly on transport volume. The assumptions regarding energy supply and emission levels correspond with those for the energy sector.

In the future image for 2050 the transport system is characterised by a large variety of niche vehicles (for example, small electric city vehicles), all-purpose cars and new systems such as personal electric vehicles that can link up with each other and form trains that move via special tracks. There is no single system that dominates the transport network to the same extent as the private all-round car did at the beginning of the twenty-first century. Another prominent feature is the spread of inter-modal transport with smooth and short transitions between modes. IT is being widely used in intelligent traffic control and information systems, as well as for flexible road pricing. The energy efficiency in the transport sector is high.

The future image served its purpose very well: it was a starting point for discussion, to give an idea of the 'agenda' for transport in 2050. However, the group was very much aware that this image was only one of many possible futures. There was widespread agreement on the view that the image as such remained 'conservative' and contained a rather 'industrial society' perspective.

Path Analysis

Subsequently, in the path analysis a range of options was developed for each of the four building blocks, providing a path from the future image to the present. Each of the options in the four categories contained an indicative time-path, advocacy coalitions and supportive conditions.

Many options intended to *improve efficiency* may be taken in the short term. They are relatively easy to develop and implement and do not involve many uncertainties. The appropriate participants can also be readily identified.

Fuel substitution involves more difficult choices, greater uncertainties and more complex coalitions of participants. It is of greater significance in the medium term. However, it also offers more scope for radical change.

Changes in structures and patterns require a long period to take effect and involve substantial uncertainties. The changes are also dependent to a large extent on appropriate actions by a wide range of actors in other sectors and need supportive conditions from the external environment.

Changes in awareness, values and lifestyles are on the one hand difficult to influence since they are dependent on a wide range of factors and complex interactions within society. On the other hand lifestyles and value-patterns change constantly, albeit not always in a favourable direction from an environmental point of view. Such changes entail a huge potential for contributing - directly and indirectly - to radical changes in CO2 emissions from the transport sector.

The path analysis explored the options that could enable society to achieve the objective set in the future image. In doing so, the focus was more on the variables themselves than on the outcome (in terms of emission reductions and actual transformations in the transport system). It was felt that only by identifying the key variables and understanding how they could be (re)-formed that targets could be achieved.

Table 3.1 Overview of the main options and actions advocated by the COOL Europe sector groups.

Energy	**Transport**
Biomass - Co-ordination between CAP/waste policies and biomass policy - Set-aside subsidies for energy crops - Biofuel production requires concerted action by fuel and vehicle producers Hydrogen - Scale up production of solar PV - Precombustion decarbonisation to involve the fossil fuel industry - Development of hydrogen vehicles with fuel cells - Address the "Hindenburg syndrome" - Start preparation for a standardised European infrastructure for hydrogen distribution Energy efficiency - Energy performance standards for new building (European guidelines) - Mandatory energy performance certificates for houses upon sale - Minimum efficiency standards for all appliances, updated every five years	New fuels: biofuels and hydrogen Efficiency of vehicles: reduced driving resistance Improved management systems for transport companies Decentralised concentration: - Land-use and city planning - Park-and-ride schemes - Road pricing - Restricted parking in centres - Flexible public transport - Bike networks - Upgraded service level of existing sub-centres ICT: - Optimised use of infrastructure - Optimised logistics chain - Intelligent vehicles - Tele-working, Tele-learning, Tele-shopping Awareness/lifestyle changes: - Local experiments - Highlight best practises - Information campaigns - ICT - Build partnerships - Increase awareness of politicians

Disagreement: Degree of decentralisation of the energy supply system	

3.2.4 Bridging the gap

A look into Europe's emission inventories is not encouraging. We see an upward trend of emissions, particularly for carbon dioxide, from 1994 onwards. According to the most optimistic estimation, existing policies and measures will overall reduce the EU GHG emissions in 2010 by 1.4 per cent from the 1990 level. This would result in an expected gap of –6.6 per cent between the effects of existing policies and measures and the EU's Kyoto target (ECCP 2000). In order to reverse this negative trend, urgent action is required with respect to emissions from the transport sector and the negative effects of the liberalisation of energy markets - together with the process of EU enlargement.

Transport

The fastest increase in emissions is expected in the transport sector. A thorough gap analysis is required regarding the negative trends with respect to the modal split. A case in point is that the EU is closing 600 km of railways per year and at the same time building 1,200 km of motorways. Furthermore, the Trans European Networks (TEN) are arguably giving too little attention to waterways and railways. There is a lack of policies in the field of aviation: lack of internalisation of external costs, lack of a level playing field, and prices which sometimes undercut railway prices.

Energy

In the energy sector, the gap analysis should be focused on the ongoing liberalisation of the European energy markets. It is a process that is currently going against Europe's climate policy goals. The introduction of competition in the electricity markets has led to lower electricity prices in Germany and elsewhere. Demand has increased because incentives to improve energy efficiency have been reduced. Another effect is that spending on R&D has fallen due to lower profits from electricity production and that co-generation is suffering. The greening of the liberalisation of the energy markets cannot be solved at the national level but instead requires a European approach.

3.2.5 Emission reduction potentials

In order to attain the desirable situation in 2050, the growth rates for several energy sources need to be high. In the energy sector, natural gas electricity production needs to grow by almost 4 per cent. Wind energy needs to experience an annual growth rate of almost 10 per cent. Solar PV has to grow by 17-22 per cent per year. For biomass production the annual growth rate needs to be between 2.8% and 3.8 per cent. A high absolute growth is occurring in wind energy use and in particular electricity production, but the largest relative growth by far is occurring in the use of solar electricity (see Table 3.2).

Table 3.2 Required growth rates for various energy sources to meet the amount of energy reflected in the energy images (Source: annex to energy Strategic Vision).

Energy source	**Growth factor (1990-2050)**	**Required annual averaged growth rate**
Wind energy	173	9.9%
Solar PV	5,556 [a] 51,307 [b]	17.0% [a] 21,8% [b]
Biomass	7.5 [a] 4.6 [b]	3.8% [a] 2.8% [b]
Natural Gas	8	3.9%
a = biomass-intensive image b = solar hydrogen image		

For both the energy and the transport sectors it is assumed that energy consumption in 2050 will stabilise at current levels. This is the result of a 2 per cent per year growth in economic activity, a 1.5 per cent per year energy efficiency improvement and a 0.5 per cent per year structural change. Structural change will be realised by shifts towards less energy-intensive products and a higher contribution of energy-extensive sectors such as information technology, services, etc. to GDP. Table 3.3 below brings together the most important elements that can contribute towards target fulfilment, that is, achievement of an 80 per cent emission reduction.

In conclusion, the -80 per cent target is possible and feasible in both sector groups. It is critically important however that all available options are employed within the categories of (1) fuel substitution, (2) energy efficiency, (3) changes in structures and patterns and (4) green lifestyles (see Table 3.3).

Despite this optimistic conclusion, many uncertainties remain. It is particularly important to address knowledge gaps and uncertainties regarding (1) the rebound effects of ICT, (2) the appropriate relationship between market support vs. large-scale R&D efforts for the development of sustainable energy technologies and (3) the future land availability for biomass. Addressing these and other challenges for the long term will require an ongoing learning process. Stakeholder dialogues, such as COOL, are useful tools for confronting the challenges, defining problems, elaborating on new strategies and increasing the stakeholders commitment to be involved in the process.

Table 3.3 Most important contributions to target fulfilment (-80 per cent).

Energy	**Transport**
Fuel substitution Natural gas Biomass Solar (in the solar hydrogen image)	Fuel substitution Biofuels Hydrogen (55 % of the market share for passenger transport in 2050)
Energy efficiency Demand side improvements Co-generation	Energy efficiency Modal shift Improved driver training and reduced

	driving resistance
<u>Structures and patterns</u> Energy-extensive industry and buildings	<u>Structures and patterns</u> Decentralised concentration Structure of industry
<u>Green lifestyles</u> Very important as a precondition for the other elements	<u>Green lifestyles</u> Very important as a precondition for the other elements

3.2.6 From promising options to feasible actions: critical factors for the transition

Transforming promising options into feasible actions is the most challenging task of any long-term policy strategy. The realisation of a goal – and particularly such an ambitious goal as the COOL target in such a complex environment as the energy and transport sector – requires a wide range of factors to be understood and formed. There are uncertainties to be clarified, preconditions to be met, boundaries to be created, perceptions to be changed and countervailing reactions to be anticipated. The most important - but not the only –factors to be considered are given below.

Carbon pricing. Both the energy and the transport groups are strongly convinced that pricing of externalities is vital in order to create the sustainable development of a market economy. Without carbon dioxide pricing it will be difficult to reach the necessary long-term climate policy objectives. In the energy dialogue it was assumed that different instruments (taxes, emissions trading and project-based instruments such as Joint Implementation) can work together in a strategy in order to achieve carbon dioxide pricing. The transport group has highlighted options such as road pricing and a tax shift from labour to natural resources.

Addressing the institutional deficit in supranational environmental management. Globalisation is the process through which both the markets for products, services and investments and the operational sphere of companies become increasingly international in character. We are seeing that the capability of transnational companies and investors to take actions that have an impact on the environment is outpacing the capacity of governmental institutions to manage the processes that cause those impacts. An “institutional deficit” is evolving through the combination of the declining capacity of governments to impose national environmental controls on companies and the failure to realise a proportionate increase in the environmental control capacity of international institutions. This development, however, is likely to feed two countervailing needs. Firstly, more explicit and more elaborate international rules on the scope for local, national or regional differentiation with respect to trade regulations and instruments where necessary in the interests of environmental protection; and secondly, more effective international enforcement regimes. Business will certainly be reluctant to accept a significant degree of regulatory differentiation. In a parallel development, however, companies themselves will appreciate the advantages of launching initiatives that demonstrate high levels of social and environmental responsibility, thereby strengthening consumer trust in particular brand names as well as - in the words of an executive from a major company - securing a “societal residents permit”.

The COOL Europe project has identified a number of institutional innovations that could facilitate the transformation towards a de-carbonisation of the European energy and transport sectors. These suggestions are presented in Table 3.4 below.

<u>Table 3.4</u> Possible institutional innovations.

Processes and driving forces	Possible institutional innovations
Globalisation	• More elaborate rules on environmental protection. • More effective international enforcement regimes. • A new role for the WTO regarding climate protection. • Consistent and transparent policy framework to help voluntary climate protection measures by private companies.
EU enlargement	• Shift in EU policy-making towards a greater need to develop policy frameworks, mechanisms and

	instruments that are effective in establishing and securing long-term goals and objectives. • Establishment of Centres for Sustainable Energy Transitions in CEE countries.
The climate agenda: climate science, public awareness, UNFCCC, Kyoto Protocol etc.	• Strengthen the ‘long-term capacity’ of the European Commission. Cross-DG unit on long-term climate change policy. • Develop a European long-term vision of the UNFCCC regime.
Liberalisation of European energy markets	• Establish new institutions to deal with energy efficiency and renewable energy.

EU enlargement.

The economic transformation in Central and Eastern Europe can be channelled towards low-carbon options. Biomass and energy efficiency are especially important options in this respect.

EU enlargement will have three important consequences for EU institutions. Firstly, it will increase the already substantial degree of diversity within the EU still further, with a concomitant decline in Community cohesion. Secondly, the greater number of participants will complicate still further Community decision-making procedures and the allocation of competencies. Thirdly, the Union will face even greater challenges in ensuring that Community measures are appropriately, consistently and promptly implemented across a greater number and a more diverse family of member states. The greater diversity, institutional complexity and implementation challenges that are the inevitable consequences of enlargement will steer EU policy-making towards an emphasis on framework measures. Such measures will lay down the targets for a particular policy object while allowing the member states a greater degree of discretion both in terms of how the objectives are achieved and which instruments are applied for that purpose. This infers a shift towards longer-term policy-making as well as a greater need to develop policy frameworks, mechanisms and instruments that are effective in establishing and securing long-term goals and objectives – an essential requirement for effective climate control measures. Groups of member states may also establish forms of flexible co-operation, for example with regard to the use of economic instruments for climate change policy.

Liberalisation of the European energy markets. The European energy sector is in a period of major liberalisation with the intention of increasing competition and removing national trade barriers. In particular the markets for electricity and gas are changing. This is fundamentally altering the context for climate and energy policies. Increased competition and decentralisation in combination with internalisation of external costs can promote the ecological modernisation of the energy system. As already mentioned, liberalisation of electricity markets in Europe is a window-of-opportunity for introducing carbon taxes *without* increasing consumer prices. It is important to establish new institutions that will be responsible for energy efficiency in the liberalising of energy markets in Europe.

Social aspects and reactions by vested interests. The measures that will be required in order to realise an 80 per cent reduction in CO_2 emissions in Europe by 2050 will have far-reaching consequences, not only for energy and transport but also for virtually all economic participants. The extent to which other participants can be persuaded to become fully party to such a process, however, is open to question. Many participants, particularly whose economic interests are most at risk from climate control measures, can be expected to oppose and obstruct such moves. Furthermore, government and the climate-change coalition can shape many crucial socio-economic variables – such as international trade, consumer demand and cultural perceptions. The way in which other participants may respond to climate control proposals and measures is therefore a crucial factor to consider when designing long-term climate change strategies.

The role of the private sector. The dialogue has shown that an increasing share of companies in the private sector is aware that constraints on carbon dioxide emissions are likely in the future. These companies are now prepared to take a proactive approach to the challenge of climate change and call on the European governments to create fair and more stimulating business conditions for (existing and new) carbon-efficient products and services. Whether these industrial efforts will continue or whether companies will retreat into defending established supply structures will depend on whether or not these development efforts are supported by authorities and rewarded by the customers. Clear signals for the long term are required in building confidence among these major investors in order to convince them that the radical transformation will last.

3.3 Analysis and evaluation

The objective of this section is to analyse the strategic visions of the two sector groups, energy and transport, and to bring some of the most remarkable characteristics to the fore. Firstly the COOL Europe dialogue is put into a broader perspective. Three short sections then follow, looking at the key outcomes of these Dialogues.

3.3.1 The COOL Europe dialogue in perspective

The COOL Europe project has addressed long-term climate policy challenges in Europe by involving stakeholders in dialogue about/concerning feasible options. COOL Europe is not the only stakeholder process addressing European climate change policy. Within the recently established European Climate Policy Programme (ECCP), managed by the European Commission, various policy-makers, scientists and stakeholders meet to identify policies and measures which will help the EU to implement the GHG reduction target set by the Kyoto Protocol (ECCP 2000).[3] This similarity to COOL is matched by significant differences. In contrast to COOL the focus of ECCP is on the short term. Moreover, the ECCP is a policy-making exercise, while COOL Europe is primarily a scientific exercise, potentially with policy consequences.

If we compare the COOL Europe exercises with other scientific projects, interesting conclusions can be drawn. A comparison between the energy images developed in the COOL Europe energy group and other international sustainable energy scenarios - two IPCC scenarios from the recent IPCC "Special Report on Emission Scenarios" (2000) and a scenario from "Renewable Energy; Sources for Fuels and Electricity" from Johansson et al. (1993) - reveals that the COOL Europe images have a substantially larger share of 'other renewables'. This is especially the case in the solar hydrogen image. The share of biomass in the COOL images lies between the shares envisioned in the IPCC scenarios and the Johansson intervention scenario. This is consistent with the non-intervention character of the IPCC scenarios with regard to climate change, which leads to a lower level of fuel switch towards renewables/biomass. The gas consumption in the images is also in line with the other scenarios. The lower share of oil in the COOL images is explained by the biomass and/or solar hydrogen used for transport in these images. The COOL images foresee no usage of nuclear energy (non-fossil electric), which is similar to the Johansson intervention scenario, or of solid fuels. In the other scenarios some solids still remain, but in one of the IPCC non-intervention scenarios this is limited to only 3 per cent.

Recently, the OECD has developed guidelines for sustainable transport under the environmentally sustainable transport (EST) project. The basic techniques used in the EST project are scenario construction and backcasting. The project examines what kind of policy framework will be necessary to ensure that transport systems are environmentally sustainable in the year 2030 and beyond. By developing a set of essential criteria to be met, and then by using alternative projections to explore different ways forward, this work is helping to show the policies that will be required in the years to come. This approach is both long-sighted and comprehensive, taking local, regional and global effects into account (OECD 2001), and in that sense has parallels with the COOL Europe project. COOL Europe differs in the emphasis on stakeholder dialogues and on climate change issues (rather than overall sustainable development).

In comparison with the studies quoted above and with other long-term analyses, the path analyses conducted within the framework of the COOL Europe project have been less focused on technical aspects and placed more emphasis on institutional aspects. Furthermore, they were more focused on the identification of necessary boundaries for various participants on which to take action and on barriers for these actions. This is even truer for the European transport Dialogue than for the energy Dialogue. In this respect the VISIONS project (Rotmans et al., 2001) is probably one of the most closest to COOL Europe, as the former also focused on Europe and on the social and institutional changes,

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[3] Furthermore, following the Cardiff Process initiated in 1998, a strategy to integrate environmental concerns into transport and energy policies, and other sectors, has been developed by European Union.

rather than the technical ones. The VISIONS project forecasted scenarios with a focus on sustainable development in general. One of the scenarios examined the impact of globalisation on European integration: the nation state would fade away as a protective force for its inhabitants and European politics might consist predominantly of corporate strategies. Another scenario involved fundamental social change caused by dramatic technological developments in information and communication technology and biotechnology. A second project that needs mentioning is the ULYSSES project (Urban Lifestyles, Sustainability and Integrated Environmental Assessment; De Marchi et al., 1998). It shares its dialogue characteristics with COOL Europe - a pre-occupation with social and institutional issues and a focus on climate change issues (in a sustainability context) in Europe. It differs from COOL Europe, however, in its more local orientation, taking lay-people in major European cities as the main participants in the dialogue process in order to develop local GHG reduction strategies and options.

3.3.2 Between European Union and local level action

Creating a European platform for long-term climate policy

It is clear that the EU has leadership ambitions in relation to the process towards implementation of the Kyoto Protocol. Thus far, however, relatively little is known about its strategy for the second and third commitment periods and beyond. The question then arises: how could the EU develop a fruitful climate policy platform for discussion and for developing medium and longer-term policies?

COOL Europe took the desirability to develop a long-term climate policy vision for Europe as a starting point. In order for such a vision to have value and to mobilise stakeholders and policy-makers, it has to convert long-term ideas via pathways leading to immediate actions by stakeholders. If the outcomes of COOL Europe are analysed then the truly European dimension is not all dominating. Although European integration, European institutions and European actors are mentioned, their position is not as prominent as one would have expected in a European Dialogue. Private actors, local and national governmental authorities and social movements and organisations seem to have at least an equally important position in contributing to the development and implementation of radical GHG reduction strategies. It is, however, hard to envision the emergence of a hydrogen economy in Europe without a joint European vision and co-ordinated European investment strategies. Some of the central questions 'behind' the COOL Europe long-term climate strategy documents are the following: which policies and measures need to be dealt with at Community level? What options at national level are most dependent on EU policies? Who should take the lead on these issues? What is the specific role for European institutions?

In developing radical European climate mitigation strategies; the COOL-Europe Dialogue groups have identified ancillary benefits of climate change policies by linking climate change with other policy domains. Obviously, a move to hydrogen or biomass economies would lead to improved urban air quality, improved human health, lower congestion problems, fewer traffic accidents and respiratory diseases in the cities. There would also be regional environment benefits such as less soil pollution, improved agricultural output, and better forest systems. The work of the OECD indicates huge benefits, potentially 30-100 per cent offset from the cost of direct mitigation. Local communities are in a particularly good position to value ancillary environmental benefits (OECD, 1999: 47), linking a European strategy with bottom-up interests.

Somewhat surprisingly perhaps, the COOL Europe dialogue did not bring up the European Energy Charter for discussion. For the longer term, this initiative could be highly relevant for European climate policy. It should be mentioned that Ruud Lubbers, the former Prime Minister of The Netherlands, has already proposed the expansion of the Energy Charter Treaty to include carbon dioxide policy (Lubbers et al., 1999).

EU enlargement

According to the European Commission (1999) the enlargement of the EU represents an opportunity to enhance the institutional and technical capacities within the candidate countries as well as to raise the profile of climate change with stakeholders and the public in general in Central and Eastern European countries. In addition, this enlargement provides an opportunity to ensure sustainable growth by controlling greenhouse gas emissions.

Enlargement of the EU has also played a significant role in the European Dialogue of COOL, as it affects not only the possibilities and challenges of the accession countries, but it also reflects the opportunities and challenges of the EU, within and beyond the domain of climate and energy policies.

First of all there is an economic dimension. If all the candidate countries from Central and Eastern became members of the EU, the EU's population would increase by 29 per cent, but its GDP by only 5 per cent (Economist, 2001a). Secondly, as has been pointed out in the European COOL dialogue, enlargement will necessitate a process towards more effective decision-making rules in the Council of Ministers. The Council of Ministers would need to reform its voting procedure. The need to move away from unanimous voting would become increasingly apparent. It is already almost impossible today within the 15 Member States; it will be even more difficult with 25 or 27 members.

The EU financial instruments to develop environment protection and transport infrastructure among accession countries in Central and Eastern Europe (for example, ISPA – Instrument for Structural Policies for Pre-Accession – and the European Investment Bank) are important tools for promoting the development towards climate-friendly options in both the energy and transport sectors. The COOL Europe process, however, has revealed that ISPA, EIB and other key players in the enlargement process sometimes tend to promote investments that are not fully compatible with the requirements of sustainable development. This problem is linked to the policy preferences of *both* sides involved in the enlargement process. As one representative of the European Commission put it during a COOL Europe workshop:

> "If there is not a sufficiently strong political will and demand from the various players in Central and Eastern Europe then it will be very difficult for our side to come forward with the sustainability criteria. The accession countries need to make a much bigger claim what they really want in their policies, in their political statements, in their own countries. They have to tell the Commission what they want and what they feel is necessary. Only then will there be pressure for the Commission to reconsider and rethink some of the concepts which are currently being transferred to the transition economies."

Action at local level

Although being a Dialogue at a European level, the COOL Europe project has strongly emphasised the importance and relevance of actions at local level - decentralisation of the energy supply system and the role of local consumers being the most outspoken examples.

Decentralisation. Owing to technological developments in the past ten years, decentralised options on the supply side are becoming increasingly important in the European energy sector. In that sense, the call for decentralisation in the European Dialogue reflects the state-of-the-art position. There is also currently an economic drive for decentralisation: "It is micropower, not megapower, that the market favours, thanks to the far smaller financial risk involved" (Economist, 2001b: 31). Hence, decentralisation is clearly an autonomous trend, and as such emphasised by the COOL Dialogue (be it stronger in the energy than in the transport group). If this trend is to be encouraged it is important to address the following questions: what instruments and approaches are needed in order to achieve a far-reaching decentralisation of the European energy system? What institutional framework will be required? Can the EU achieve a far-reaching decentralisation without an energy chapter within the Treaty on the European Union? Where, how and to what extent do decentralised options link to centralised energy infrastructures?

Citizens and consumers. The COOL Europe process has also emphasised the crucial role of public awareness, citizen-consumers and lifestyle changes. By voting green with their wallets consumers can support the introduction of climate friendly options; by political involvement the public can influence both formal and informal political decisions. However, there is a risk involved in relying too much on voluntary behavioural change as a consequence of the 'green' attitudes of individuals. Nevertheless, it is clear – and stressed by the COOL Europe Dialogue – that policies for *radical* emission reductions may only be possible if they have the political support of a large number of the public. Additionally, technological innovations may also be only possible if market demand of consumer and customers is available.

These European and local level actions come together in a new role for the EU at local level. The EU could become active in facilitating and supporting various initiatives, mediating and building coalitions within and between cities. The fact that DG Transport and Energy has recently become involved in promoting clean urban transport is a good example of this. The question is to what extent will this new role of the EU be compatible or in conflict with the subsidiary principle that is endorsed by the EU?

3.3.3 The role of the private sector

Globalisation is a robust trend that the EU has to learn to work with when looking for long-term strategies in order to address global climate change. Both sector groups in COOL Europe have recognised the fact that cross-border climate policy is a necessity in a globalising world. It is extremely encouraging that representatives of multinational companies have participated actively in the European dialogue, in both sectors groups, in order to discuss far-reaching emission reductions.

Under precisely what conditions, however, would these companies commit themselves to undertake radical emission reductions? This is likely to depend upon - among other factors - the structure of future investment regimes, especially in the supra-national perspective. This issue is a point that until now has been largely overlooked in the climate change policy debate. In an input paper to the COOL Europe process, von Moltke (2000) argues that the climate regime is essentially an investment regime. In his view, virtually all strategies for emission reduction, whether undertaken by individuals, households, corporations or public agencies have the character of investments. To promote a consistent transition from more greenhouse gas emitting technologies to less greenhouse gas emitting technologies requires that the risk/return ratio for the latter must be notably better than for the former. A central issue for any international investment regime is its ability to balance the interests of private actors against public goods in a manner that is both equitable and non-discriminatory. This is a goal that is currently beyond the reach of most international regimes, with the possible exception of the EU. This unique characteristic of the EU makes this institution so interesting as an experiment in creating a supra-national investment regime. The international community can perhaps learn from this experiment in creating institutions capable of achieving a balance between the interest of private actors and public goods.

A second point the European Dialogue draws our attention to, are those ideas that have become known in the scientific literature as “sub-political arrangements” (Beck, 1994): the increasing role of non-state actors in radical environmental reforms. The COOL

Europe Dialogue sees enterprises, along with non-governmental environmental organisations, utility sectors, and consumers, as having an important role. COOL Europe has moved beyond a state-centred strategy towards GHG emission reduction. The potential in the ongoing co-operation between many European and US companies in terms of climate change emission mitigation is a current process that reflects these COOL Europe ideas. The feasibility of and conditions for voluntary agreements involving US and European companies and sectors could and should be investigated.[4]

3.3.4 Technologies and markets

Creating a market for solutions

In evaluating the strategic visions of both European Dialogue groups, a major technological optimism can be identified. Both sector groups in COOL Europe have been quite optimistic regarding the future availability of sustainable energy and transport technologies.[5] In their view the key challenge lies less in designing the options for the long term than in putting them into practice. Governments have a role to play in creating favourable conditions – that is, a market – for climate-friendly options within the energy and transport sectors. Both sector groups identify major difficulties and barriers in developing markets for desirable technologies, making them competitive, fitting them into the social and institutional characteristics of a European society, and infiltrating these innovations into the everyday lives of consumers, the public, enterprises and farmers. In the case of renewable energy technologies, this implies that governments could:

(1) Provide a guaranteed market with favourable prices and/or premium prices for renewable electricity;

[4] In the past two decades large segments of the international business community has moved from an initial position of denying the climate change problem to take an open and sometimes proactive approach. In the past few years companies such as BP, Shell, Ford and Daimler Chrysler have all left the US based Global Climate Coalition, a stronghold for the opponents of Kyoto Protocol.

[5] This thinking is in line with the message coming from a recent study commissioned by the Department of Energy, Transport and the Regions in the UK on the role of technology in emissions abatement for the medium to long term. It concludes that reductions in world fossil carbon emissions of 50-60 per cent by 2050 and 70-90 per cent by 2100 are technically attainable. The study argues that it is important to focus on the economic, social, political, and institutional barriers (AEA Technology 2001).

(2) Provide a guaranteed market share for renewable electricity with competition among all suppliers;
(3) Mandate electricity purchase for a certain time period at fixed cost levels;
(4) Provide capital subsidies for renewable energy systems (OECD 1999).

The COOL Europe dialogue has emphasised that policy initiatives of this type are of crucial importance for embarking on sustainable emission trajectories. Carbon pricing has been identified as an outstanding issue in the COOL Europe process in terms of assisting market creation. Without carbon taxes, it has been argued, it would be very difficult to reach the necessary long-term climate policy objectives. So far, however, it has been very difficult for the EU to move on this issue and one wonders if the European Dialogue is not too optimistic about this. Efforts to introduce a common hybrid carbon/energy tax have failed due to strong opposition from some member states, mainly Spain and the UK. Four countries in the EU (Denmark, Finland, The Netherlands and Sweden) have introduced carbon and/or energy taxes specifically to address climate change. The environmental effectiveness of the specific carbon-related taxes has been limited because tax rates have been set relatively low and exemptions are often provided to energy-intensive firms (OECD, 1999: 51). More far-reaching and European wide carbon taxes will indeed be an issue for a *long*-term strategy.

Carbon pricing will certainly help renewable energy sources to penetrate but may have its limitations as an incentive for the radical changes that are needed for the long term. It is unlikely that the hydrogen economy will emerge as a result of carbon pricing only. In such situations carbon pricing can be combined with other policies, such as standard setting and information campaigns.

In carbon pricing the pre-conditions to be met are of course essential, as identified by the COOL Europe Dialogue. The competitiveness of European industry may decrease if it is to face far-reaching carbon pricing that is absent in countries such as the United States and Japan. Clearly, such options and agreements with potentially substantial economic consequences will have to be co-ordinated at an international level. Perhaps it would be useful to explore the idea as to whether the WTO could play a role in promoting a global regime on carbon pricing.

European technology policy

The European dialogue has given relatively little attention to the role of European programmes involved in research and technological development. Despite this, once the easiest and cheapest measures have been taken in order to address climate change, the EU will need new solutions to back up the traditional policies and measures. New technologies will be necessary in virtually all sectors. In designing a long-term R&D strategy for the EU, the following aspects should be taken into consideration. Firstly, it is essential that the EU gives enough financial resources to research and technological development. In relation to the GDP, the EU currently spends less on R&D than either the USA or Japan. The EU is far behind the USA in the development of the fuel cell that is considered to be one of the most promising technological options for the long term for both the energy and transport sectors.[6] Secondly, the priorities of existing R&D programmes should be revised. Historically, energy R&D in the EU has been heavily biased towards looking at fission and fusion[7]. None of these options are in line with the preferences of the energy group of COOL Europe. Thirdly, the future role of the existing R&D centres in the accession countries in Central and Eastern Europe should be defined precisely and the possibility of establishing new centres of this kind should be explored. (The energy group in COOL Europe has proposed the establishment of Centres for Sustainable Energy Transitions in this region.) Lastly, the desirability and feasibility of a "Manhattan project" or an "Apollo Project", to force breakthroughs in some crucial technology areas should be assessed.

3.4 Concluding remarks: moving on

The major contribution that the COOL Europe Dialogue has made to climate change policy and mitigation strategies is to be found not so much in innovative and new ideas which open the eyes of the reader in terms of strategic visions on energy and transport. It is more the fact that two broad and diverse groups of stakeholders have worked together

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[6] The distinction between the electricity and transport sectors will be reduced following the large-scale introduction of fuel cells.

[7] For example, in the 5th RTD Framework Programme covering the period 1998-2002 ("Energy, Environment and Sustainable Development Programme"), more than 1 billion Euro was dedicated to non nuclear energy (renewables and energy efficiency) and in the Euratom Framework Programme about 1 billion Euro is expected for nuclear energy (fusion and fission).

upon and indeed agreed upon strategic visions for the achievement of radical GHG emission reduction over a period of 50 years.

The preparations of the long-term strategies in Europe can only be done in extensive consultation with stakeholders. Such a process is particularly useful in order to identify barriers as well as to define and re-define solution strategies. As Senge et al. (1999: 567) states: “The real work of strategy is less about setting ‘the strategy’ than creating forums, both formal and informal, for addressing deep strategic issues that otherwise would become impossible to discuss, and for cultivating the collective capacity to rethink and recreate.”

The real proof of the value of these kind of participatory policy analyses and designs are of course not to be found within somewhat ‘protected’ experiments such as the COOL project. The proof will be visible when moving from such a scientific experiment in participatory policy analysis to designing actual policy strategies for the long term. Particularly if these strategies involve a radical departure from the existing trend as a common frame of reference, then a common vision of the future among the most relevant stakeholders is required. In this way, COOL Europe forms a starting point.

Annex 1: List of Participants in the COOL European Dialogue Project

Transport Group

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R. Kemp, MERIT, the Netherlands;
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B. Quenault MIES, France;
R. Sartorius, German Federal Environmental Agency, Germany;
B. Schell, F. Goodwin, European Federation for Transport and Environment, Brussels;
H. Somerville, British Airways, UK;
B. Tegethoff, Coalition of German Consumer Unions, Germany;
B. Thorborg, Dutch Ministry of Transport and Waterways, the Netherlands;
R. Torode, International Union for Public Transport (UITP), Brussels;
J. Trouvé, Schenker BTL, Sweden; A. Wijkman, European Parliament, Brussels.

Energy Group

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T. Kram, ECN, Netherlands,
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S. Minett, Cogen Europe,
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B-O Svanholm, Birka Energi, Sweden,
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4. SUMMARY AND CONCLUSIONS of the Global Dialogue

Marcel Berk, Jelle van Minnen, Bert Metz, William Moomaw

4.1. Introduction

In line with the general objectives of COOL, the aims of the COOL Global Dialogue project were to:

- explore the most promising options for long-term international climate policy and their implications for the medium term;
- enhance the understanding between parties with different positions and interests in the climate change debate;
- broaden the understanding of scientific aspects of the climate issue, and, if possible,
- develop common frameworks for analysing and evaluating policy options.

The COOL global dialogue project was designed as a series of four workshops, which took place in the period July 1999 to February 2001. Participants in the workshops were a group of about 25 policy makers from both developed and developing countries and stakeholders from the NGO and business community involved in international climate change policy negotiations, together with climate change scientists, mainly from Dutch research institutes.

This chapter includes the main results of the COOL global dialogue project. It was written by the RIVM research team, but reflects important shared insights as well as differences of opinion within the group of participants (see Annex 1)

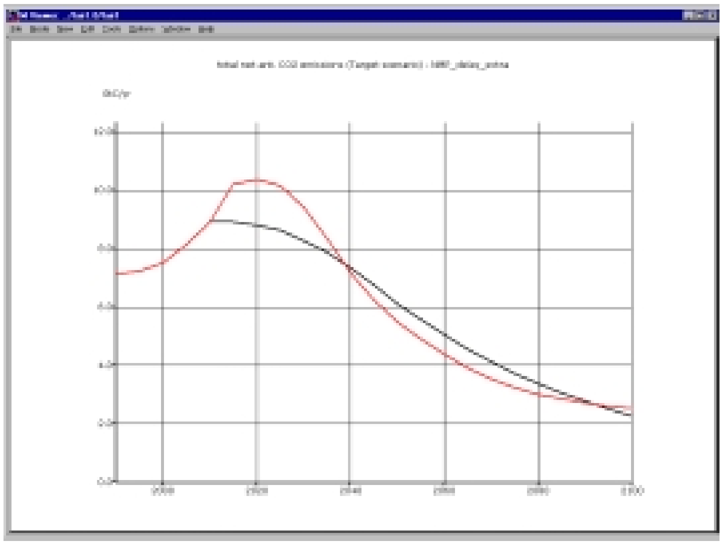
The Starting Point: exploring the implications of keeping the option of stabilising CO_2 concentrations at 450 ppmv open

The starting point for the global analysis was to achieve a stabilisation of greenhouse gas (GHG) concentrations at a level of no more than 450ppmv of CO_2 plus 100ppm equivalent of other GHGs by around 2100. The participants accepted this level as a starting point for an evaluation of its technical, economic and political implications, after an evaluation of the global and regional climate change impacts. It is more or less in line with the starting point of an 80% reduction by 2050 in the national and European dialogues (see below). It should be stressed, though, that it was neither considered to be ‘safe’ nor ‘desirable’. In fact, some participants considered it not ‘safe’ enough, while others considered it to be unachievable.

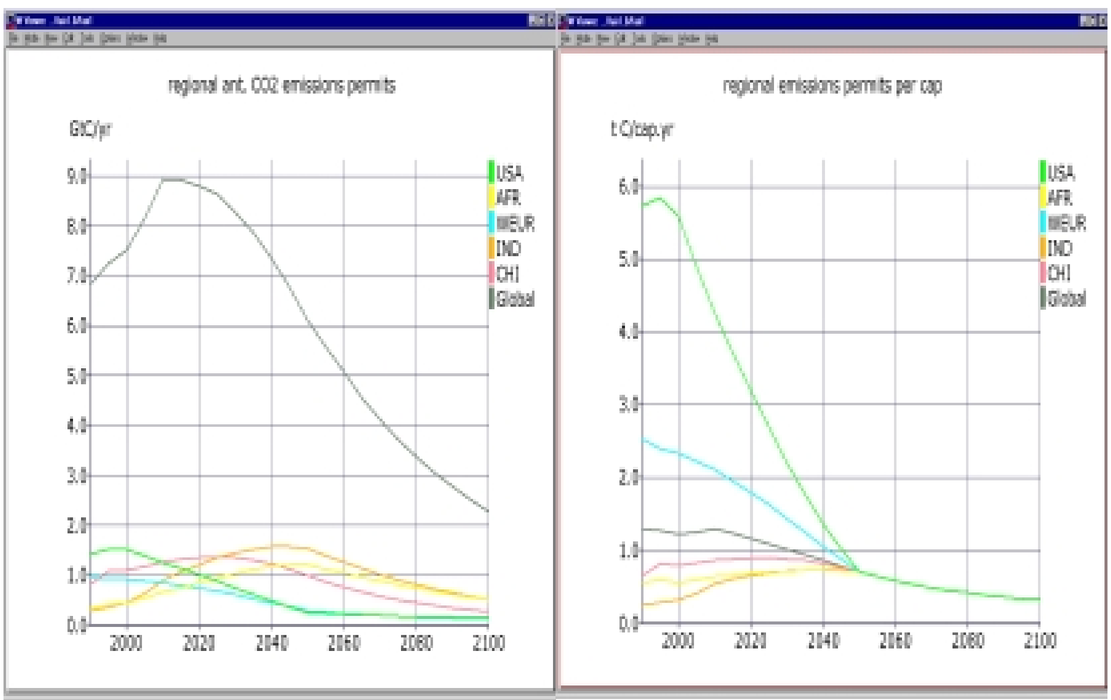
Like the COOL National and European Dialogue projects, options for long-term climate policy and short-term implications were explored using a so-called “back casting” methodology. This consists of a (backward) exploration of pathways from possible images of the future to the present with the aim of formulating important conditions, strategies and short-term actions in order to make these futures attainable.

For the purpose of exploring possible images of the future, the long-term (2100) stabilisation target was translated by the COOL project team into a reduction of global CO_2 emissions of about 15-25% by 2050 compared to 1990 levels. The range relates to the options for the timing of emissions reductions in order to stabilise atmospheric CO_2 concentrations at 450 ppmv by 2100. In 1990 global anthropogenic CO_2 emissions amounted to about 7.2 GtC (including land use emissions e.g. resulting from deforestation). If with early action global emissions were to be limited to less than 9 GtC by 2010-2020, global emissions could then gradually be reduced to about 6 GtC by 2050 before decreasing further to about 2.5-3.0GtC by 2100. However, if emission reductions were to be delayed and global CO_2 emissions increase to more than 10GtC by 2020-2030, emissions would then have to decline more steeply to about 5,4 GtC CO_2 by 2050 and 2.0-2.5 GtC by 2100 (see Figure 4.1.)

As shown in Figure 2 this choice is comparable to the 80% reduction selected by the National and European dialogue in case of a convergence of future per capita emission levels between rich and poor regions.



<u>Figure 4.1</u>: Alternative anthropogenic CO_2 emission profiles for stabilising atmospheric CO_2 concentrations at 450 ppmv by 2100 (source: FAIR model, den Elzen et al, 2000; Berk and den Elzen, 2001)



<u>Figure 4.2</u>: Regional emission space (absolute and per capita) with a linear convergence of per capita CO_2 emissions by 2050 under an emission profile for stabilising CO_2 concentrations at 450 ppmv (Source: FAIR model, den Elzen et al, 2000; Berk and den Elzen, 2001)

4.2. The Challenge of De-carbonising the Global Economy

What is the challenge?

For most people climate change is not the most important concern for their future. In particular for those 1.3 billion living in poverty with an income of less than $1 per day, obtaining adequate food, clean water, access to energy resources, a safe place to shelter and healthy living conditions are of greater concern. However, climate change is interlinked with many of these issues. It may impact on the availability of food and water and affect the safety of settlements as well as health status.

Climate Change is particularly related to the global energy system, which by 1995 was responsible for about 80% of global CO_2 emissions and 65% of all greenhouse gases, released primarily by the wealthiest 1 billion people. At the same time, world wide about 2 billion people lack access to modern fuels and electricity, which are important for improving their opportunities for economic development (UNDP, 2001). The present energy system however is at the heart of the climate problem owing to the extensive use of fossil fuels. The heavy reliance on fossil fuels for our energy supply results not only in the release of greenhouse gases, but also in many local and regional environmental and health problems. The future of our energy system is crucial not only for our climate, but also for providing opportunities for development and for abating many other environmental problems. These will need to be dealt with simultaneously. From a sustainability perspective the challenge is therefore to provide billions more people with adequate energy services, while at the same time reducing the carbon-intensity of the world economy: i.e. de-linking economic development and carbon emissions.

Present trends lead us in the wrong direction

In its most recent World Energy Outlook 2000 (IEA, 2000) the International Energy Agency explored the future of the world's energy over the next twenty years. The study indicates that world energy use and CO_2 emissions are expected to grow steadily in the next two decades, with 2/3 of the growth taking place within developing countries. Energy intensity (E/GDP) is predicted to decrease at about the same rate as in the 1971-1997 period (about 1%), but world carbon intensity (C/E) is expected to increase, thus reversing the long-term trend for de-carbonisation. Other assessments (e.g. World Energy Assessment of UNDP (2001), IPCC-Third Assessment Report (2001)) indicate that additionally, on a longer time scale, scarcity of fossil fuels is not expected to be a major motivator of change in energy systems. The fossil resource base is at least 600 times the current annual fossil fuel use (UNDP, 2001).

What emission reduction efforts are needed for stabilising at 450 ppmv?

The emission reduction effort[8] required depends on the way the world develops in the future. Recently, the Intergovernmental Panel on Climate Change (IPCC) developed a new set of non-intervention or baseline scenarios - as part of its Special Report on Emissions Scenarios (SRES). These provide alternative emissions trajectories for the main direct and indirect greenhouse gases up to 2100 on the basis of explicit story-lines about how the world could develop demographically, socio-economically, and technically (IPCC, 2000). The IPCC identified four different groupings of possible futures by way of combining two dimensions: the level of globalisation and a materialistic versus sustainability value orientation (Figure 4.3).

[8] That is the difference between baseline projections and required emissions trajectory to achieve stabilisation at 450ppm. This is different from reduction levels compared to 1990 levels.

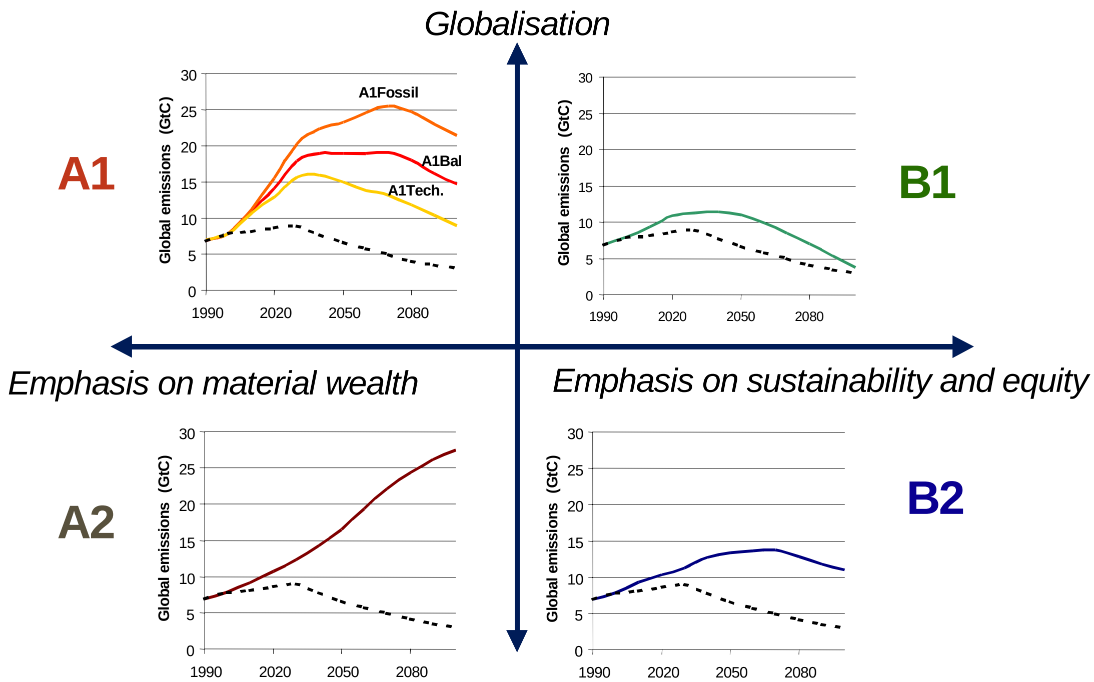


Figure 4.3: Global CO_2 emission trajectories for the different IPCC-SRES marker scenarios compared to a 450 stabilisation emission profile (dotted line)

From the set of SRES emission scenarios we can learn a number of things for strategies required in order to limit future CO_2 concentrations to 450 ppmv:

- The level of emission reduction effort needed by 2050 can range between 40% for a B1 world to over 60% for an A2 world and even 75% in an A1-fossil fuel oriented world (permitted global emissions compared with baselines).
- The economic, social and political conditions in the various worlds have important consequences for both the willingness and capacities for mitigating global CO_2 emissions: thus a less affluent and/or divided world is less likely to be able to drastically reduce CO_2 emissions than a rich and globalised world.
- The types of worlds concerned have consequences for the acceptability of possible mitigation strategies and preferred policy instruments. In the B-type of worlds the concerns for environmental and social consequences of climate policy options are likely to be strong, while the A-type worlds will have a preference for lowest cost, market-oriented solutions. The B-type worlds may be willing to pay more for renewables in order to avoid the need for nuclear, large-scale biomass or CO_2 removal.

- Finally, both the A1 and B1 type of worlds offer better perspectives for the development of effective global climate regimes than an A2 type of world. In a B2 world greenhouse gas mitigation may be less dependent on global arrangements and could also result from either regional efforts and/or other policies supporting sustainable development.

From this analysis we can conclude that striving for a world oriented towards sustainable development will also make it much easier to meet stringent climate change goals.

Is a 15-25% reduction of global CO_2 emissions by 2050 feasible?

In the COOL project we focused our assessment on the feasibility of such an emission reduction in two different worlds: A1 and B1. For this assessment, the participants performed a backcasting exercise, supplemented with insights from the IMAGE TIMER energy model, and other information, such as the IPCC-Third Assessment Report (IPCC, 2001).

The assessment indicates that a 15-25% CO_2 reduction may be considered technically feasible in both types of worlds. It will, however, be more difficult to realise in A1 than B1 worlds due to both higher baseline emissions and the drive for a least cost energy supply in a market-orientated world. To reduce global CO_2 emissions it will be necessary to make use of almost all options (energy saving, efficiency improvement, fuel switching, use of biofuels, renewables, etc) since no single option will be able to generate sufficient emission reductions.

In an A1 world with high emissions it is expected that there will be both more need for and more acceptance of large-scale contributions from both biological and physical carbon sequestration and/or nuclear energy. By contrast, in a B1 world with relatively low baseline emissions, the need for and acceptance of such options are likely to be low. Energy saving and supply shifts are expected to be easier to implement in a B1 world due to environmental concerns.

Whilst improvement in energy intensity (i.e. energy saving, energy efficiency) will remain important particularly during the first few decades, reductions in the carbon-intensity of the energy system (i.e. by the use of alternative energy sources) will eventually become a more important factor.

What are the strongest options for stabilisation at 450ppmv in different worlds?

The COOL global dialogue project identified a number of rather robust energy technology strategies that are likely to be successful independent of the way the world may eventually develop:

- efficiency improvement (both in energy supply and demand; including CHP)
- a fossil fuel shift to natural gas use (power sector)
- fuel cell use (in all sectors)
- biomass energy (in particular biofuels in the transport sector)
- renewables, notably wind and solar energy (power and residential sectors)

Most of these options seem to be strong even in the case of less stringent stabilisation levels, such as 550 ppmv (Riahi and Roehrl, 2000).

In the *power generation sector*, in the short to medium term, in particular gas combined cycle technology will be very attractive (where natural gas infrastructure is available) to replace coal-based power stations. Decentralised combined heat and power (CHP) systems of all types will also make an important contribution to lowering net CO_2 emissions. Gas combined cycle technology may also bridge the transition to a hydrogen based energy infrastructure when combined with more advanced fossil options (like coal gasification combined with CO_2 removal), biomass and other renewables (wind /solar) and electricity production based on fuel cells. Fuel cell technology seems to be a strong energy technology due to its high efficiency and its flexibility in scale and input (natural gas, hydrogen from renewables, synfuels from biomass). Biofuel use may play a substantial role in power generation regionally, but this seems less substantial than its role in the transport sector. An increased access to natural gas and the development of gasification and fuel cell technology will also result in improved opportunities for the highly efficient distribution and co-generation of heat and electricity.

In the *transport sector*, fuel cell powered vehicles are likely to become ultimately dominant in the transport sector combined with energy carriers such as synthetic liquids from biomass (ethanol) or from fossil fuels (methanol) and eventually hydrogen. This transition could be facilitated by the introduction of the internal combustion-electric hybrid car, because this will enhance the development of electric traction technologies and reduce the need for a rapid adjustment of energy infrastructure.

In addition, there are also more socially or organisationally strong options that reduce the need for mobility and promote a shift from car use to public transport as well as non-motorised means of transportation. These relate to issues such as urban planning, improvement of logistics, the use of information and communication technologies and measures to discourage car use.

What are the economic impacts of reducing global CO_2 emissions for stabilising CO_2 at 450 ppmv?

The economic impacts of the mitigation of CO_2 are an important concern for policy makers. The mitigation costs are, however, only part of the overall economic picture. Ideally, to judge the economic soundness of GHG mitigation one must also consider the avoided damages and co-benefits of GHG mitigation as well as their timing. During the COOL global project their relevance was acknowledged but avoided damages were not quantified.

The main determinants of the overall economic impacts (in terms of loss of welfare) of stabilising GHG concentrations are the stringency of the stabilisation target, the reference scenario, discount rates used, the timing of emission reductions and policies and measures implemented. IPCC indicates that the welfare effects of stabilising CO_2 concentrations at 450ppmv are generally two to three times as high as stabilising at 550ppmv, depending on the baselines used. Despite this, except for very high baselines (like the IPCC A2 scenario), global welfare effects of stabilisation at 450 ppmv seem to be limited, particularly given the huge increases in welfare projected in most baseline scenarios.

According to analyses with the WorldScan model, the global loss of GDP by 2050 for the A1 and B1 scenario (assuming full emission trading) would be in the order of 1.4 and 0.6 percent, respectively (Table 4.1). These figures involve substantial uncertainties stemming from model assumptions. Nonetheless, there is an upward bias to CO_2 mitigation cost estimates, since the model does not account for the option of carbon sequestration, nor for technological learning, which particularly affect implementation costs in the long term.

On the other hand, most models used for assessing the costs and economic impacts of GHG mitigation including IMAGE/TIMER and WorldScan, assume too easily a major fuel shift away from coal in response to climate policies for coal dependent countries such as China and India. Whilst economically sound, it would have major social implications that may pose great political obstacles, as we still witness in many developed countries. If this fuel-shift option cannot be implemented (fully), the economic impacts of GHG mitigation for such countries will be much larger than projected.

In any case, it is clear that full emission trading and / or early participation of developing countries is important in order to keep the overall implementation costs low. According to Worldscan analysis of stabilisation at 450 ppmv on the basis of the A2 baseline large welfare impacts will be much larger (up to 4% by 2050). This confirms that stabilisation at 450 ppmv will be very hard to attain in an A2 world for economic as well as political reasons (even with full emission trading).

What will be the regional distribution of economic impacts?

The regional economic impacts will depend on the burden differentiation, the level of emission trading and the position of regions as an energy importer or exporter. They can be much larger than world average levels and result in (relative) losers and winners, which could even change over time. This is illustrated by the Worldscan analyses of stabilising CO_2 concentrations at 450ppmv under a regime of a convergence of per capita emission allowances by 2030 with full trade (Table 4.1). Even in such a case, the economic impacts in the long run for some developing countries may be larger than for most developed countries.

<u>*Table 4.1:*</u> *Economic impacts of per capita convergence by 2030 for stabilising CO2 concentrations at 450ppmv for two baseline scenarios (IPCC-SRES A1 and B1)*

Percentage change in Gross National Product for 12 world regions (a)

	A1		B1	
	2030	2050	2030	2050
OESO	**-0.7**	**-1.5**	**-0.3**	**-0.4**
Japan	-0.2	-0.7	-0.1	-0.2
Pacific OESO	-1.1	-2.4	-0.6	-0.9
United States	-1.1	-2.2	-0.5	-0.6
European Union	-0.4	-0.9	-0.2	-0.3
FSU and Eastern Europe	**-1.2**	**-2.3**	**-0.6**	**-1.3**
Eastern Europe	-0.8	-1.1	-0.3	-0.6
Former Soviet Union	-1.3	-2.9	-0.7	-1.
Asia	**0.3**	**-0.9**	**0.5**	**-0.5**
China	0.0	-2.1	0.2	-1.3
Dynamic Asian Economies	-0.7	-2.3	-0.6	-1.1
India	1.9	1.3	2.2	0.7
Rest of the World	**-0.2**	**-1.5**	**0.1**	**-0.7**
Latin America	-0.6	-1.3	-0.3	-0.7
Middle-East en North Africa	-1.1	-4.3	-0.4	-1.5
Sub Sahara Africa	2.6	1.9	2.0	0.4
Annex B	**-0.7**	**-1.7**	**-0.3**	**-0.5**
Non Annex B	**0.1**	**-1.2**	**0.3**	**-0.6**
Global	**-0.3**	**-1.4**	**-0.1**	**-0.6**

[a] **Percentage difference to baseline scenario**

Source:WorldScan model, Bollen, CPB/RIVM, 2001

How should we deal with fossil fuel dependent countries?

Global CO_2 mitigation is likely to affect coal and oil exporting countries particularly negatively. During the COOL project it was debated if this would imply the need for compensation measures as demanded by OPEC. This proved to be a contentious issue. While it was acknowledged that in particular low-income oil exporting developing countries could be significantly affected, compensation was not considered to be the proper strategy. Firstly, the level of economic impacts will differ greatly between individual countries, depending on the relative importance of fossil fuel exports in the economy and options for exporting gas instead. Moreover, the losses projected in the short term are often within the range of historical price fluctuations. During the 21^{st} century, the depletion of conventional oil will make a shift towards other energy resources and/or economic activities inevitable for most oil exporting countries even without climate policies. Climate policies are likely to delay the depletion of conventional oil and extend revenues over a longer time period. Most participants therefore considered the matter as an issue of economic adaptation to a new market reality. Some transitional support for low-income developing countries for adaptation policies was not excluded.

Use of the Kyoto Mechanisms, taxation on carbon rather than energy, the removal of coal subsidies, and use of bio-sinks will all help to reduce the impact on oil producers as well as lowering the overall costs of GHG reductions. For coal dependent countries, physical carbon sequestration could be an important option in order to limit the social and economic costs of GHG mitigation. Most participants considered further exploration of this option relevant in collaboration with fossil fuel dependent countries.

What is the importance of the timing of emission reductions?

It is often argued that the least-cost pathway for stabilising GHG concentrations would be a gradual departure from baseline emission trends with more rapid reductions later on

(IPCC, 2001). This is explained by the fact that a gradual short-term transition from the world's present energy system both minimises the premature retirement of existing capital stock and provides time for technology development. While this seems generally true for stabilisation levels of CO_2 at 550 ppmv or higher, it does not seem to hold true in the case of stabilisation at 450 ppmv.

A delayed response pathway for meeting 450 ppmv results in much higher levels of carbon intensity reduction than does early action. According to IPCC (2001) in the case of high emissions baseline scenarios, (such as A1 and A2) as well as for stabilising at 450 ppmv, early GHG mitigation is essential. This will avoid serious pressure on both social development and technological progress in the second half of the 21st century.

Calculated differences in costs between early action and delayed response are mainly dependent on the baseline and the applied discounting rates. In the case of stabilising at 450 ppmv using low discount rates (such as 3%) early action seems economically attractive even in the case of low baseline scenarios, such as B1, due to the advantages of technological learning (van Vuuren and de Vries, 2000). Currently, the advantages of technological learning are not usually taken into account in analyses with macro-economic models (like Worldscan).

Early action will also result in a quicker reduction in the rate of climate change, which is presently much higher than ecosystems have been exposed to for the last 100,000 years and generally considered too high to allow many ecosystems to adapt (IPCC, 2001).

What are the co-benefits of GHG mitigation?

Policies and measures that reduce CO_2 emissions result in substantial co-benefits related to simultaneous reductions of other pollutants, such as particles, sulphur and nitrogen oxides, which are major contributors to transboundary air pollution and acidification. Non-climate benefits are often excluded when evaluating optimal economic mitigation policies. Not all benefits can easily be monetised, for example non-tangible assets such as biodiversity. Assessments by IPCC and UNDP (2000), however, indicate that they are substantial, particularly by reducing costs related to health effects from local and regional air pollution. The magnitude and scope of these co-benefits will vary with local geographical and baseline conditions, but under some circumstances they form a significant fraction of private (direct) mitigation costs or are even comparable to the mitigation costs (IPCC, 2001).

What are the main barriers to and opportunities for a transition to a low carbon future?
Many obstacles hinder the implementation of options for the reduction of CO2 emissions. Some of these are related to the costs of mitigation measures, but many are not. The back casting exercise carried out during the COOL project revealed that the type of barriers also depend on the kind of world we will live in. In a market-oriented A1 world, the price of new technologies, the costs of their development, a lack of willingness by the public to adjust lifestyles and governments to intervene could be important barriers. In a B1 sustainable development-oriented world, however, the social and environmental implications of some mitigation options - such as large-scale biomass, CO_2 removal and storage - could be major barriers.

At the same time, there are barriers that are more general in nature or that result from present trends. Important barriers are:

- A lack of problem awareness / “sense of urgency” among the general public;
- Uncertainty about climate policies (for the private sector in particular);
- Vested interests of fossil fuel producing sectors (in both developed and developing countries);
- Social implications of reduced coal use (in both developed and developing countries);
- Fear of many industrialised countries of becoming too dependent on energy imports;
- Privatisation / liberalisation of energy markets (in particular for the development of renewables / energy research investments).

The participants of the COOL Global Dialogue project also identified important opportunities:

- The existing energy capital stock will be fully replaced by 2050, while even more capital stock will be newly installed, particularly in developing countries;

- The growth of emissions can be reduced by pursuing sustainable development policies (developing countries);
- Highlighting the co-benefits of GHG mitigation measures will help their implementation; for example the removal of fossil fuel subsidies (as part of the liberalisation of energy markets);
- The reduction of the dependence on energy imports from a limited number of countries (developed countries) / the burden of oil imports (developing countries) by the development of biofuel use;
- Growing societal forces related to new “green” industries and the introduction of the Kyoto mechanisms.

What are important conditions for a transition to a low carbon future?

During the project, participants identified a number of important conditions for achieving a 15-25% reduction in global CO_2 emission by 2050, largely irrespective of the type of world we will live in:

1. *A broad public awareness of the climate change problem and a belief that there are feasible, acceptable and affordable solutions.*
   For the acceptance and implementation of climate policies, public awareness of the seriousness of the problem and its potentially wide-ranging negative implications is essential. It will also be useful for convincing and supporting both industries and governments to take action.

2. *The development of clear and effective global and national climate policies, that provide incentives to companies and consumers to change their behaviour and put a price on carbon emissions.*
   Clear policies are important for industries for making (alternative) investment decisions and for giving carbon emissions a price. They should include the use of the Kyoto Mechanisms to enhance the cost effectiveness of mitigation strategies. In addition, it is essential that the monitoring and policy assessment capacity of these

countries be enhanced in order to enable developing countries to take on quantitative commitments in the future and make use of the Kyoto Mechanisms.

3. *Developed countries will have to lead the way, by developing and implementing new technologies (e.g. fuel cell car, PV) and adjustment of lifestyles.*

   This requires reversing the downward trend in energy research investments as well as a redirection towards renewables and low or carbon free fossil energy options. It will also require discussions and policies on sustainable development for achieving lifestyle changes.

4. *Broad scale and effective transfer / diffusion of modern technological knowledge to developing countries and integration of climate policies into sustainable development.*

   The transition to a low carbon future will require a dramatic change of technologies and related knowledge along with the service infrastructures supporting them. This poses a challenge to developing countries. It is likely to succeed only if there is a major transfer of technologies, as well as the development of the capacity in developing countries to absorb and develop efficient and sustainable technologies. International climate policy regimes are likely to face major implementation problems if there are insufficient local incentives in developing countries. The support of sustainable development policies in developing countries, such as in the area of energy, urban planning, waste management, forestry and agriculture, may help when developing effective strategies in order to limit GHG emissions.

5. *Some support to fossil fuel dependent developing countries to restructure their economies, develop new energy resources and technologies and to soften the regional consequences of reduced fossil fuel production.*

   While the overall economic costs of a transition to low carbon futures seem limited, some sectors and countries will be substantially affected and may effectively delay mitigation policies if simply ignored. This relates in particular to the coal and oil industries as well as countries heavily dependent on coal and oil use and export revenues.

To overcome this problem, attention should be given the development of strategies that stimulate and support these sectors and countries in adapting to climate change policies. Such strategies may include developing alternative sources of income (economic diversification, other energy resources like natural gas or renewables), exploring fossil fuel pricing mechanisms and exploring CO_2 sequestration options.

4.3. How should we organise global co-operation?

What is the challenge?

Global climate change poses one of the most difficult organisational challenges humanity has ever faced. Such a challenge is likely to be more difficult to deal with than finding affordable technological solutions for the mitigation of greenhouse gas emissions.

At the same time, the institutional structures for dealing with the problem are far from ideal. In essence, effective global climate governance relies on the voluntary co-operation of nation states with no option for avoiding free-riding by any enforcing mechanism. International efforts have resulted in the United Nations Framework Convention on Climate Change (UNFCCC, 1992). The Convention shares a common goal – that is the stabilisation of the GHG concentrations in the atmosphere at a level that prevents dangerous anthropogenic interference with the climate system - however this objective has not yet been quantified. In addition, the UNFCCC does not include legally binding emission limitations. Developed countries were asked to bring their GHG emissions back down to their 1990 levels by the year 2000. Very few have been able to meet this goal.

In 1997, the UNFCCC was followed by a supplemental agreement, the Kyoto Protocol (UNFCCC, 1997). This agreement defined binding quantified commitments for the developed countries for the 2008-2012 period. Although the targets were set, the rules for implementation were left unsettled. Currently, therefore it is far from clear as to whether or not the KP will ever be ratified by enough states to come into force, particularly in the light of the lack of US support for ratification.

The challenges of engaging developing countries in global GHG emission reduction

One of the most crucial issues for the development of an effective international climate change regime is the issue of the future differentiation of commitments for developed and developing countries. While developing country CO_2 emissions presently constitute about 40% of anthropogenic CO_2 emissions, per capita emissions are on average about 5 times below those in the industrialised countries. It is expected that within a few decades these emissions will outgrow those of the industrialised countries (although per capita emissions would still be far below those in industrialised countries).

The future differentiation of commitments was one of the issues that was explored and discussed during the global COOL dialogue project. It proved to be a contentious issue since it relates strongly to diverse views of equity or fairness. At the same time, the limitations and risks of the present ad hoc approach as adopted by the Kyoto Protocol were recognised. Dealing with the question of an equitable differentiation of commitments may become an urgent issue, particularly if we are to see global CO_2 emissions brought back to below present levels before the middle of this century.

What are the limitations of the Kyoto Protocol approach?

In terms of differentiation of commitments, the Kyoto Protocol does not set a very good precedent for future negotiations.

- There is no clear principle or logic as to how Annex I countries agreed their targets. Without accepted principles and rules for determining a fair differentiation of commitments, negotiations resulted in a watering down of the overall emission reduction target.
- The KP is based on a simple division between developed and developing countries that will be problematic in future climate change negotiations.
- The negotiations on the KP resulted in an agreement on targets at CoP-3 (Kyoto), but left the “rules of the game” unsettled. As a consequence, the post-Kyoto negotiations

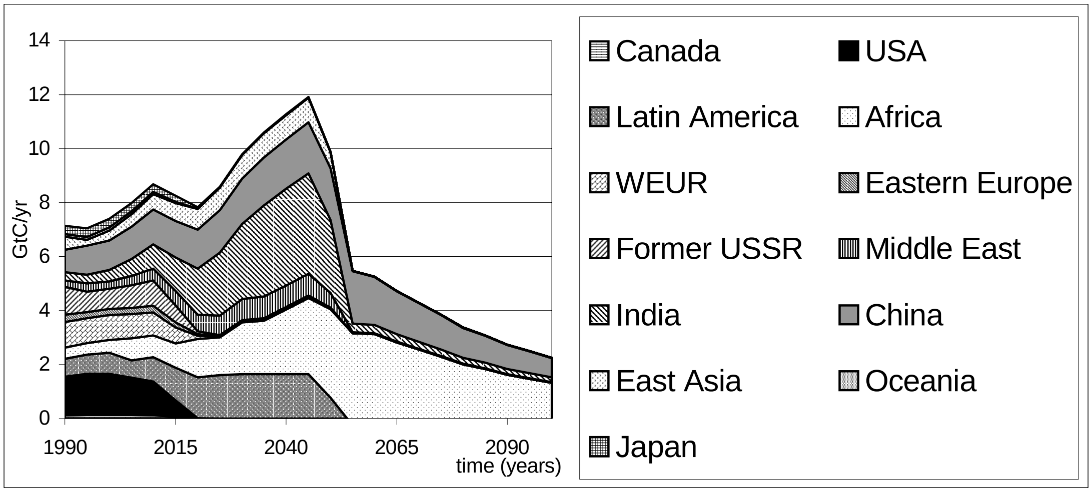
on these more technical issues have become the subject of a re-negotiation of the commitments involved. For future arrangements it seems wiser to reach agreement on the rules of the game first before determining the commitments.

- The way the KP was negotiated has limited the access of developing countries to the negotiation process. Future negotiations should be more open and transparent allowing for a more equal participation of developing countries and to overcome present block divisions.
- Lastly, the Kyoto Protocol takes a short-term approach to commitments without a long-term perspective. This encourages short-term actions in order to meet the numerical Kyoto target that may be incompatible with requirements for stabilising GHG concentrations in the long-term.

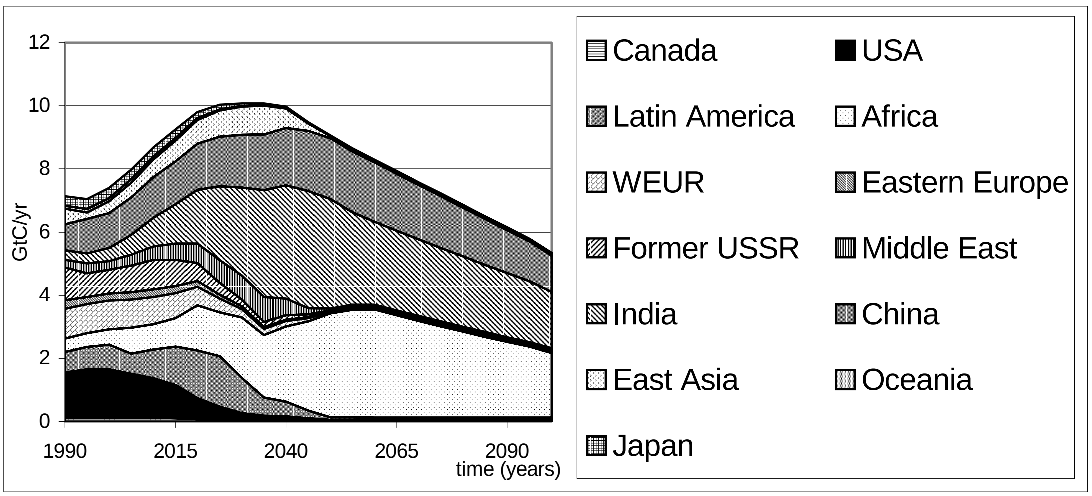
What type of climate regime approach do we need?

The lack of any systematic approach or architecture for the Kyoto targets poses a potential threat to the development of an effective and acceptable future climate regime. An incremental evolution of the climate regime in the form of a gradual ad hoc extension of the Annex I group is unlikely to bring about the level of global emission control needed to keep open the option of stabilising CO_2 concentrations at 450 (550 ppmv equivalent).

In order to keep open the option of stabilising CO_2 concentrations at 450 ppmv, major developing countries (like China and India) will need to start participating in global greenhouse gas emission control at much lower levels of income than did the developed countries at the time of signing the UNFCCC. CO_2 stabilisation levels of 550 ppmv or less may be unattainable (see Figure 4.4). This may be the case if the group of countries adopting quantified commitments - following the first commitment period - is limited to middle income developing countries -and if these countries initially take on only efficiency improvement targets. This in turn could set a precedent for relatively poor, but major developing countries such as India and China.



(a)



(b)

Figure 4: Global and regional CO_2 emissions permits for an increasing participation regime aimed at stabilising CO_2 concentrations at 450 ppmv (a) and 550 ppmv (b). There is a participation threshold of 75% of 1990 Annex I per capita income, and burden sharing is based on per capita CO_2 emissions. In the case of the IMAGE-SRES A1 scenario, India and China only participate after 2040. Under this assumption it is not possible to meet the goal of stabilisation at 450 ppmv and there is scarcely any emission space for developed countries if the goal is to reach 550 ppmv.

A Comprehensive Approach

Based on these insights, most participants of the COOL Global Dialogue hold the view that there is a need to develop a *comprehensive approach:* that is a regime that defines principles, criteria and rules for differentiating future commitments for all countries in a consistent and transparent way. This will make the adoption of future commitments predictable and legitimate as well as providing more guaranties for the effective control of global GHG emissions in order to meet the goals of the Climate Convention.

All COOL participants realise that it will be very difficult to agree on any such approach and that it may take a long time to reach an agreement. For this reason some participants were sceptical about the chances of making much progress if negotiations were focused on reaching agreement on such an approach. They expect more results from an incremental approach that begins with involving developing countries on the basis of voluntary commitments with relative targets or technology agreements. This should allow developing countries to participate early and make use of the Kyoto Mechanisms without posing any risk to their economic development (see Baumert et al, 1999, Philibert, 2000). It was generally acknowledged, however, that – unless it is part of a comprehensive approach - such a strategy might not be sufficiently effective in keeping open the option of stabilising CO_2 concentrations at 450 ppmv. Ratification of the Kyoto Protocol would provide time to explore and develop a more comprehensive future regime without delaying action.

How should equity/equality be dealt with in differentiating future commitments?

Equity will be an essential element of any future international climate regime that will be acceptable to all and thus be effective. The issue of equity in future climate regimes embraces a broader package than principles and rules for the differentiation of mitigation commitments. It also concerns the distribution of costs for the adaptation to and impacts of climate change. IPCC (2001) has indicated that it will be developing countries in particular that will be damaged by climate change because they are more vulnerable. While the distribution of costs for the adaptation to and impacts of climate change will probably be dealt with via other policy instruments (such as an adaptation fund), it is also likely to play a role in discussions on a fair differentiation of mitigation efforts. Moreover, climate impacts and adaptation costs will certainly play a major role in discussions on the "adequacy of commitments" and thus on the (overall) stringency of reduction targets.

The COOL dialogue project demonstrated that perceptions concerning an equitable differentiation of future commitments differ widely and that no common position could be found. Some view agreement on equity principles between developed and developing countries as a precondition for effective international collaboration in order to combat climate change. Others consider such an approach too idealistic and fear it may burden the climate debate so much that no real progress will be made. They generally believe in a more pragmatic step-by-step approach rather than in elaborate solutions.

It was concluded that equity aspects would be an important element of future differentiation of commitments, but that it should not become an overriding issue. In the search for acceptable climate change regimes it seems wise not to focus on any single equity principle, but to look for approaches embracing different equity principles instead. Principles, like differentiation rules, can only be guiding, and cannot determine the differentiation of commitments. They may help by providing defaults for starting negotiations and against which countries must argue for exceptions.

Moreover, focusing too much on principles of equity would also overlook the relevance of other aspects of future climate change regimes, such as environmental effectiveness, efficiency, operational requirements, institutional building and the role of both technology transfer and capacity building.

Whatever the principles and rules for differentiation adopted, there are however a number of *outcomes* that were generally considered as being unacceptable:

- Pollution is rewarded;
- Countries with the highest ability to pay have the smallest commitments;
- Climate change or climate change policies worsen the present global inequality ;
- Developing countries have to decrease their emissions immediately, and
- A group of countries, in particular developing countries, bears a disproportionate or abnormal burden.

4.4. Short-term implications and actions

What are the short-term implications of leaving open the option of stabilising CO_2 concentrations at 450 ppmv?

From the assessment during the COOL global project we can conclude that within a timeframe of 50 years a 15-25% reduction in global CO_2 emissions is technically feasible at acceptable economic costs. Starting from a long-term perspective is essential for making short-term choices that keep the options open for emissions trajectories compatible with stabilisation at 450ppmv.

It will, however, require a major transition in the energy system towards high end-use efficiency and a low carbon-intensive energy supply that will not come about easily. Many technologies are currently available at a moderate or competitive cost (IPCC, 2001) but there are few policy instruments in place to ensure their implementation. In addition, technologies predicted to become available still need further development and to be made available at competitive costs in order to be widely implemented. Moreover, the assessment has identified major economic, social and institutional barriers that will have to be overcome as well as conditions that need to be met.

Timing will be a crucially important issue due to inertia in both the natural and human systems. The inertia in the human system is clear if we look at the long turnover period to rates of capital stock. Many areas have turnover rates in the order of 20-40 years, such as power plants, industrial complexes and means of transportation, while most infrastructures such as highways may even have a considerably longer life span.

The long turnover rates of the energy infrastructure imply that a full energy transition will take many years. It also means that in 50-100 years time there will be one or more full replacements of all capital stock, offering unique opportunities for change. If, however, we wish to avoid costly adjustments owing to a premature retirement of capital stock, we have to start anticipating the need for future emission reductions as soon as possible. Every day a number of decisions are being made around the world that impact upon the level of GHG emission for many years, such as the construction of a new energy infrastructure or urban planning. Therefore, opportunities for preparing for a low GHG emission future are present today - provided that decisions are being made on the basis of a long-term climate strategy.

This brings us to another major system delay: policy development and implementation. Law and decision making at a national level often takes several years, maybe five or more before measurable results can be witnessed. In the case of climate change, however, national policy development and implementation is strongly dependent on international policy making and here law and decision making usually takes a number of years.

In the absence of clear (international) climate change policies, there is the risk that in the meantime many short-term decisions by both private actors and governments commit us further to the use of fossil fuels. This may be through the installation of new fossil- based energy infrastructure, by the exploration for new fossil fuel reserves or by investing in the improvements of fossil combustion technologies. These actions will make it more difficult and costly to move away from fossil fuel use in the future. Therefore, preparing for the future as of now is very important.

At the same time, there is also the risk of locking in to the wrong solutions, such as technologies that turn out to be more costly or less suitable or acceptable than expected. It could also mean a premature exclusion of options, such as CO_2 removal and storage. The assessment points to some strong technological strategies, but section 3 also indicates that we will probably need to keep the option of stabilising CO_2 concentrations at 450 ppmv open, particularly if the world develops according to higher emission baselines.

Do we need quantified long-term climate targets?

One of the issues discussed during the COOL global dialogue project was the question of the need for quantified long-term climate targets. Based on the precautionary approach, some feel that it would be useful to elaborate the objective of the FCCC into some provisional quantified (range of) long-term stabilisation targets and timeframes, taking into account scientific uncertainties and intermediate impacts. This would provide a clear reference for evaluating the adequacy of short-term climate policies. A clear example is provided by the EU: in 1996 the EU Council adopted as a long-term climate target a global average temperature change of less than 2 degrees Celsius compared to pre-industrial levels and a stabilisation level for CO_2 concentrations well below 550 ppmv[9]. Others, however, believe it is still too early to set any (provisional) climate targets, due to scientific uncertainty.

In any case, it will be very difficult to reach international consensus on quantified long-term targets. This is due to the fact that both their adequacy and implications are hard to access. Views about a "safe" level of climate change and tolerable impacts will differ widely and be influenced by the regional distribution of impacts, differences in the ability to adapt and the timeframe agreed. It is therefore more likely that the evaluation of the adequacy of commitments will be an evolutionary process, with policy adjustments made over time on the basis of a regular review of scientific insights and changes in societal concerns.

Given the system inertia discussed above, however, this does entail the risk of preparing too late for any major technological and societal changes needed should the level of climate change and/or its consequences prove to be more severe than presently known. Therefore, a key element of climate policy making should be to constantly reflect as to whether or not certain policy options that cannot yet be excluded are still within reach at acceptable costs. As suggested by one participant, this could be termed a "mirror-approach": reflecting on short-term policy decisions to ensure they keep the range of long-term policy options open that may be required in order to meet the objectives of the Climate Convention.

What are the short-term policy priorities?

In general, a number of things seem particularly crucial over the next ten years:

[9] Note that these two quantitative targets are not necessarily compatible: this may be the case only if the climate sensitivity is at the lower end of the IPCC range (1.5- 4.5) and the future contribution of non-CO_2 gases is assumed to be small.

- Begin limiting greenhouse gas emissions, for example by implementing the Kyoto Protocol and its mechanisms;
- Develop a more comprehensive regime for a future differentiation of commitments and define rules for a broader and more transparent future participation of countries in global greenhouse gas emission control;
- Invest heavily in the development, demonstration and adoption of new technologies required by developed and developing countries in order to take on substantial emission reduction targets in future commitment periods;
- Establish stronger public awareness of the seriousness of the climate change problem to secure public support for more substantial future emission reduction efforts, and
- Develop further methodologies for evaluating the adequacy of commitments and possible next steps under the Climate Convention
- Incorporate climate protection goals into sector-oriented sustainable development strategies in both developed and developing countries

What short-term actions are important in order to keep open the option of stabilising CO_2 concentrations at 450 ppmv?

During the COOL project a number of short-term actions were identified as important in order to keep open the option of stabilising CO_2 concentrations at 450 ppmv. These are related on the one hand to a transition to a low-carbon intensive economy (de-carbonisation) and on the other hand to the development of the regime for international climate change policy.

Short term actions to enhance de-carbonisation:

- *efficiency*: the introduction of policies in order to increase energy efficiency, such as the development of international (minimum) standards for both products and production processes, energy subsidy reforms and the greening of taxes.

- *renewable energy*: the introduction of (increasing) national targets / regulation for minimum market or production shares of renewables and the promotion of green electricity (e.g. by certificates, energy tax exemptions).

- *Natural gas*: support for closing leakages in natural gas systems and enhancement of the development of international gas-infrastructure. This is essential for increasing the access to natural gas for substituting coal use, particularly in developing countries.

- *Coal:* In the case of coal there are two options: (1) substitution of coal power plants by gas-fired plants or renewable energy (wind power, biomass), enhanced by the removal of coal subsidies, the introduction of a carbon tax, and tax exemptions for green energy; (2) enhancement of R&D with the option of CO_2 removal and storage in combination with the development of hydrogen based energy systems.

- *Transportation*: support for the development of public transport (to reduce congestion, pollution and air travel) and the use of biofuels (e.g. carbon tax exemptions for biofuels / biofuel content, removal of import levies on ethanol) and an acceleration of the introduction of fuel cells in cars, buses, trucks and ships.

Short term actions to enhance international climate change regime development:

- Ratification of the Kyoto Protocol - preferably with USA participation, but if need be without - to keep the momentum for action alive, to show that developed countries are taking the lead, and - by giving carbon a price - to send the right signals to the private sector.

- An early commencement of discussions concerning more comprehensive regimes for the differentiation of future commitments. These could start informally and be formalised at a later stage within the context of the FCCC. The EU could begin a discussion internally as well as with its new member states.

- Commence discussions with international sectors about (voluntary) global technology standards. Discussions could also begin looking at the option of special international sector agreements with international industries concerning the limitation of greenhouse gas emissions or technological standards - such as the aviation and maritime sectors (not yet covered under the Kyoto Protocol) - or the steel, chemical, power generation and car industries.

- The development of a climate impacts assessment for bilateral and multi-lateral investment portfolios of development banks and foreign investments. This should promote the integration of climate change policy considerations into various sectors.

- The organisation of national and international campaigns for enhancing the public understanding of the climate change problem and the need for measures - combined with international networking - to allow the exchange of ideas and experiences in a positive way.

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Annex 1: List of participants in the COOL Global Dialogue Project (1999-2001)

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5. CONCLUSIONS AND LESSONS FOR PARTICIPATORY INTEGRATED ASSESSMENT

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5.1 Introduction

This chapter contains the conclusions and recommendations from the methodological evaluation of the three COOL Dialogues. More details on evaluation and methodology as well as on the evaluation framework and the evaluation reports of the three separate dialogues can be found in Volume E " Evaluating the COOL Dialogues" of the COOL Final Report.

The comparative evaluation of the three dialogues in the COOL project was conducted along three different - although closely related - methodological pathways: 1) dialogue structure, 2) knowledge supply and utilisation and 3) policy interactions at and between the three levels. For each pathway, some important issues will be discussed and comparisons between the three dialogues will be made (see appendix 5.1. of the Evaluation Report for an overview of the strong and weak points of each Dialogue). Section 5.2 discusses the dialogue structure in Integrated Assessment: what lessons were learned about the project team, the backcasting technique, the input of scientific knowledge, the role of the chair, creativity, divergence/convergence and learning in a stakeholder dialogue? Section 5.3 deals with the aspect of knowledge utilisation in Integrated Assessment: in what way was knowledge brought into the dialogues and in what way was knowledge requested? How was this knowledge utilised by the participants? Section 5.4 addresses the science-policy interactions at and between the three levels: what experiences with the three levels did the COOL dialogues generate? How can this be used to further improve our understanding of the role of science-policy interactions in (multi-level) political processes? What contribution can Integrated Assessment make to these processes? The chapter ends with some general conclusions (Section 5.5).

5.2 Dialogue structure

COOL was a stakeholder-driven dialogue. The National, European and Global Dialogues consisted respectively of four (Housing, Industry & Energy, Traffic & Transport, Agriculture & Nutrition), two (Transport, Energy) and one group, with stakeholders from among others business, environmental and consumer NGOs, government and unions. In the preparation of the dialogue, special attention was given to the composition of the dialogue groups. Efforts were made to involve people from outside the existing climate change network. Although some participants stated that additional expertise in the group would have been desirable, in general, all the groups were considered sufficiently heterogeneous to address different existing views, opinions and interests with respect to the climate change problem.

As regards dialogue structure, the following lessons can be derived from the COOL dialogues.

The project team

The COOL dialogues have shown that interdisciplinary working can be enriching and at the same time very difficult. Although the members of the project team often speak different ‘languages’, it is crucial that they discuss, listen to each other and learn from each other. In initiating the actual dialogue, it is vitally important to try and anticipate possible problems and to schedule the project in such a way that one is – of course to a certain extent – able to cope with the unexpected. The National Dialogue in particular has claimed a first phase period in the project that might, at first glance, look rather long. This nine-month period was used for the purpose of fine-tuning the project design and to invite the sixty participants for the dialogue groups. In retrospect it can be concluded that this length of time was not unrealistic and that the actual dialogue has benefited from this period of preparation. Of the three projects, the National Dialogue has most consistently followed its schedule and has addressed a wide variety of issues at a fairly concrete level as well as making some specific recommendations for policymakers. However, one serious point for improvement must still be related to shortcomings in the project structure.

The project team of the National Dialogue actually included two separate project teams: the actual project team and the scientific support team (NRP Theme III Assessment). The researchers working on the NRP Theme III Assessment joined the COOL project team for the most part but both projects were formally separated in terms of management and budget. In retrospect, it might have been preferable to work with one project, one project team and one budget. This might have improved the co-ordination and scheduling of activities.

Backcasting and argumentation

The backcasting technique generates creativity, equal participation and an informal atmosphere. It also yields insights into the main problems and opportunities for the implementation of different options and the main themes for long-term policy making. However, backcasting does not necessarily articulate conflicting views and does not as such serve to deepen argumentation. This is because backcasting has a brainstorming character. The argumentation patterns became visible only after intervention from and analysis by the project team.

The role and tasks of the chair

The National and European Dialogue worked with chairs, who were recruited from the sectors or the scientific community, and who were not affiliated with the project team. This has proven to be an advantage and has without any doubt contributed to the continuity and quality of the dialogue process. A chair that has a record in the sector particularly contributes a great deal to participants' confidence and commitment as well as to the image and status of the dialogue. Hence, a chair from the sector is able to establish a strong link between the project team and the participants.

To chair and to facilitate are two different things. It is not advisable to combine both tasks, but instead to recruit facilitators from the project team in order to assist the chair.

Creativity

In the COOL dialogues there appeared to be a tension between problem structuring and problem-solving on the one hand and creativity on the other hand. Furthermore, tension exists between commitment and accountability on the one hand and creativity on the other. The following lessons can be drawn from this:

- In order to stimulate creativity, a process needs structure.
- Creativity requires that the participants feel at ease.
- Creativity requires a certain degree of expertise on the topic.
- Interests hamper creativity.

In the European Dialogue, the participants were invited to write down their vision and thoughts in a position paper. This appeared to be an adequate way of stimulating creativity.

Divergence and convergence

In the COOL dialogue it has been shown that divergence is only possible if the starting point is clear for all the participants. The COOL dialogue has also shown that divergence becomes more visible when the discussion becomes more definite, with a focus on the short term.

Ownership

Participants may feel more committed to a dialogue and its products when they have a real influence on the process. In the Global Dialogue it was quite difficult to get the participants to commit to the project. The continuity in attendance was rather low and the participants did not want to connect their names with the end product. The National and the European dialogues were much more successful in terms of making the participants the owners of the process. In the European Dialogue the continuity was still moderate, but the participants showed great commitment and were willing to connect their names with the end product.

A learning process?

Although it is hard to say at this stage of the process, it is possible to state that the dialogue has probably been a learning process for many of the participants involved. An important distinction is

- learning at the level of first order discourse (facts): did the stakeholders gain more insight into the technological options required to drastically reduce GHG emissions?
- learning at the level of second order discourse (values, emotions): did participants gain more insight into the different points of view and opinions related to opportunities for emission reductions?

It is too early to draw final conclusions with respect to both aspects of learning - but it seems that learning has taken place on both levels. Learning on an argumentative level particularly may be the strongest added value of COOL as compared to mere research on the potential options for emission reduction. After all, the dialogue has brought about patterns of argumentation with respect to options that are considered to have high potential in many studies but that prove to be controversial in the dialogue (e.g. biomass). The project team and the scientific support team have certainly learnt from the Dialogue, in terms of substance as well as on process.

Timing

The dimension of timing has received little attention in the preparations for the COOL project, as no direct link with ongoing climate change policy negotiations was aimed at. The timing of COOL has, however, been very unfortunate particularly for the Global Dialogue. Many participants were heavily involved in preparations for the finalisation of the Kyoto protocol negotiations (COP 6) and some were involved in the IPCC's Third Assessment. This had a negative impact on the ability to participate. In the European and National Dialogue the timing dimension did not play a prominent role. What may have affected the National Dialogue were the many controversial issues that the agricultural sector had to deal with.

5.3 Utilisation of knowledge

The three dialogues have dealt differently with the input and use of scientific information by the project team and the knowledge available among the participants themselves.

In the National Dialogue the scientific support team provided scientific information at specific moments in the dialogue trajectory (Future images, adjusting Future Images, calculating the contribution to reductions by different options) or on participants' request. At times, the scientific support team made spontaneous interventions, either because it felt that certain topics were neglected in the discussion, or to assist a dialogue group to structure the debate.

In the European Dialogue, only the Energy group made use of a permanent (natural sciences) support group. The Transport group did not have permanent support but invited experts on certain topics based on the requests of the participants (i.e. ICT, globalisation, and European institutions). The participants themselves gave several presentations. The scientific interest of the energy group was rather technologically and economically oriented. The transport group had a more institutional and social interest and focus.

In the Global Dialogue knowledge input was prepared and presented by the project team or other scientific experts invited by the project team. Knowledge input was mainly supply-driven. The knowledge level and expertise of the participants themselves has been high. The participants viewed the process as a way both to obtain and to review the latest relevant scientific information. The starting point for the participants in the global dialogue was clearly different from that in the other two dialogues. The participants saw their own role as reviewing and reflecting upon the scientific presentations. Participants saw themselves in this way contributing to the work of the project team instead of the other way round, as was the case in the other two dialogues.

Three important lessons can be drawn from the COOL Dialogue with respect to knowledge input and utilisation. The first lesson is that in a stakeholder dialogue, it is important that the information offered to the groups is compact, tailor-made and easy to understand. If not, the participants will not use it. Specific lessons are:

- Oral presentations turn out to be far more effective than mere presentations on paper;
- The use of interactive tools increases the attention and involvement of participants;
- Presentation skills are far more important than in a 'normal' scientific setting;
- Limiting the amount of information is crucial; too much information is clearly counterproductive.

For the researchers involved in the dialogue to be able to take the above-mentioned points into account, a certain attitude is required. It is not sufficient for the project team alone to be aware of the above-mentioned facts. Invited speakers and supporting scientific teams need to be aware of them too. Interest in the process is necessary, along with a clear customer orientation, the willingness to iterate, to engage in interaction with the participants and, above all, to invest time in preparation. Experience and a positive outlook stimulate such attitudes more than instructions from a project leader or a research plan.

The second lesson is that it is not easy to provide heterogeneous groups with an equal knowledge base at the start of the dialogue. For this purpose, the National Dialogue distributed a package of fact sheets among the participants. However, the fact sheets were hardly used and the differences in knowledge still existed.

The third lesson relates to the timing of scientific input. As mentioned above, the principle of competence suggests that, right from the start of the dialogue, participants need to have equal access to scientific information and about the same minimal knowledge base. This is unlikely to be the case, particularly for heterogeneous groups. Therefore, the National Dialogue provided a fair amount of scientific information at the start of the dialogue. That this information met with some resistance and was underutilised was partly due to its quantity and partly due to the lack of communicative experience on the side of the scientific support team. In retrospect, however, dialogue design and structure must be held responsible for the most part. Participants did not have adequate opportunities to express and discuss their mutual expectations, concerns and viewpoints at the start of the dialogue with respect to its substantial focus and schedule. Once this took place over the course of the dialogue, the participants seemed to be more open to scientific information and to reflect upon it.

In the European Dialogue, the process did not start with future images, but with a list of possible inclusions for future images. This gave the participants greater opportunities to express their own opinions and points of view. As such, the experiences in COOL suggest that stakeholders will only absorb (factual) scientific information if they feel that their own feelings and resistance are heard and recognised. Certain issues in the dialogue may require repetition and iterations. Certain information does not reach participants the first time. Providing information on more than one occasion in a variety of ways adapted to the needs of participants and the course of the process itself, proved useful. Presentations by the participants themselves on topics of their own interest and expertise also turned out to be very useful, not only in terms of content but also in terms of increasing both their commitment and active involvement. At the same time there is the risk that the information provided has a "bias" resulting from the specific background of the participants. The role of the scientific support team could be to provide additional information if this is available.

Two observations can be made in addition to these lessons. Firstly, in a dialogue such as COOL participants have greater need for rough estimates than scientists would like to provide or believe are scientifically possible. Input in the form of such rough estimates may be necessary for bringing the discussions a step forward. Scientists must be willing to make rough estimates and explain their underlying assumptions and the importance of uncertainties.

Secondly, scientific input must be diverse not only in terms of discipline, institution or presentation but also in terms of geographical background. This became very clear in the global dialogue. Where the messenger comes from is as important as the content of the message itself.

5.4 Three-level interaction

In the construction phase the COOL Project chose the so-called ‘COOL Light Structure’. This meant that not much time and energy was spent on co-ordination, harmonisation and interaction of the three different projects. With regard to output, the ‘COOL Light Structure’ was a sensible choice, given the time constraints of the participants as well as the project teams. A more intensive co-ordination and interaction between the three projects may have put a burden on the separate projects.

Being aware now of the complexities involved and the effort required in order to carry out three projects such as COOL, it is clear that another design is needed for three levels of interaction. There has to be a simplification of the design. A dialogue project on two or three levels may have to focus on a well-defined issue and a clear description of the kind of interactions required as well as their expected gains. Another possibility would be to use the methods of interviewing and active observation, focused on people working at more than one level; how do they deal with different levels? What are their difficulties and what strategies do they use to cope with these?

5.5 Conclusions

A comparative evaluation of the three COOL dialogues suggests some major lessons for carrying out future participatory work involving integrated assessment. Before this concluding section considers this in more detail, it makes some general and major observations with respect to the dialogue process, not only for those who participated in the dialogue itself but also for those who were involved from the very start.

The most important lesson learned is probably that preparation pays off. Good preparation implies firstly that even in the initial stage of writing a project proposal it is worthwhile anticipating in a rather detailed way what types of activities should be included. It is also worthwhile to try and estimate the time involved in order to manage and carry out different tasks. In addition, there should be sufficient time and personnel available for all activities, from the actual start of the project through to the reporting phase. A good insight into the actual activities that are likely to take place as well as the time such activities might take is invaluable in terms of calculating a realistic project budget. Projects such as COOL may easily suffer from a budget deficit, which may be explained by shortcomings during the preparation phase. This may imply that getting a project of the ground may take some time. The two-year period that it took to get COOL started was probably somewhat too long, but this time was used in order to draft and redraft proposals and budgets, and to openly discuss uncertainties and doubts within the team as well as with the NRP. In addition to a gradual improvement of the project overview, trust building proved to be vital in this phase. In retrospect, COOL has also benefited from this long and uncertain period of preparation.

Once the project has begun, sufficient time is needed to prepare for the actual dialogue. In the case of the National Dialogue in particular, it took a long period of time to fine-tune the project design. This certainly contributed to a relatively smooth dialogue process.

The second major lesson from the COOL process is that it pays to invest in participants' involvement. This implies, among other things, that participants know what they are doing at each stage of the process and that they are assisted in preparing effectively for dialogue meetings. It also implies that the meetings' agenda needs to be planned in close co-operation with both chairs and participants, that dialogue meetings are characterised by a variety of issues for discussion - although not too many - and that participants are encouraged to present their own views and experiences. Although COOL has made a serious effort to invest in participants' involvement, the previous sections indicate that at this point further improvements are required. One point which needs special attention is that dialogue meetings should be structured in such a way as to balance the presentation of scientific information, brainstorming activities (such as constructing future images and backcasting) and the articulation of diverging views through argumentative debate.

The third major lesson relates to the role of scientific information in the dialogue. The communication of scientific information is extremely relevant in a dialogue on scientifically complex issues such as climate change. The European dialogue would have benefited from a more structured approach with respect to the contribution of scientific information. However, the effectiveness of scientific communication depends on two factors: Firstly, it has to be communicated in a way that people can relate to, e.g. well presented, limitation of information quantity etc. This is difficult for scientists, especially if they have to perform in heterogeneous groups. Secondly, and even more importantly, the dialogue participants should be open to receive scientific information and to reflect upon it in a meaningful way. In a demand-driven dialogue, this is only the case once the members of the group have found an audience for their own needs and wants with respect to the dialogue, their expectations, views and maybe even their hobby horses. Here also-in retrospect - a point for improvement has been identified.

The fourth major lesson is to recognise the limitations of the project in good time. Do not try to achieve too much in too little time! In retrospect, it was the right decision to reduce expectations during the preparation phase with respect to three-level interaction. Expectations were too high in terms of what could be achieved in just one meeting, particularly with respect to the National Dialogue. In retrospect again, with regard to the Global Dialogue in particular, plans to present too much scientific information were over ambitious. This meant that too many presentations took place at the expense of reflection and debate. Therefore, on this point too, further improvements need to be made.

It could be argued that some of the lessons from the COOL project are not that new. Some mistakes could certainly have been avoided. However, participatory integrated assessment is an interdisciplinary challenge and, as such, still in a pioneering stage. The mistakes might be forgiven by the many participants who have evaluated the COOL project in mainly positive terms. The mistakes may look familiar to colleagues in this field who know, better than we do, that knowledge gained from literature is not at all equivocal to practical experience. The achievements are more important than the errors. At this stage of reporting, it is not yet certain as to whether COOL will be able to make a difference to Dutch climate change policy in a European and a global context. However, the lessons from the project still stand and may inspire others to develop and improve approaches and methods for participatory integrated assessment.