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**Contribution from Working Group III: Policy-Relevant Scientific Questions in Climate Change Response**

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## *Introduction*

Background
Working Group III activities formally started in December 1998 with the Lead Authors (LAs) meeting hosted by the TSU in Bilthoven. The Netherlands. Zero-order drafts (ZODs) were submitted by June 15, 1999. Informal review of ZOD will be completed by August. Reviewers' responses to ZOD and necessary improvements will be discussed at the 2nd LAS to be held in Lillehammer, Norway, in September 1999.

The diverse set of issues involved in climate change mitigation is organized into ten chapters. Chapter I provides an introduction and overview to the WG III report. Chapters 2 through 9 are devoted to specific problem areas ranging from technological and economic potential to reduce greenhouse gas emissions to assessments mitigation costs associated with different institutional arrangements and implementation instruments. Finally, Chapter 10 is intended to provide a synthesis of the current state of scientific knowledge on climate change mitigation with a view to using this information in the Synthesis Report to answer a list of policy-relevant scientific questions (PRSQs), officially approved by the IPCC. This presentation offers an overview of WG III activities organized along those PRSQs.

Policy relevant scientific questions related to climate change response can be structured as follows:
**What** the response should be? Response options in managing the climate change problem can be classified into three major categories. The first category is called mitigation. This is the central subject of the present volume of TAR. The major form of mitigation is to reduce emissions of greenhouse gases, especially, of carbon dioxide that represents a major share in today's and an increasing share in future's emissions. The second type of mitigation responses involves activities that enhance natural processes of $CO_2$ uptake, mainly in terrestrial ecosystems and soils, commonly caned sinks. We can consider these measures as soft geo-engineering. The third type of mitigation action is hard geo-engineering and includes direct manipulation of atmospheric or oceanographic processes and range from modifying radiation processes to enhancing $CO_2$ uptake by oceans. While soft geo-engineering is acknowledged in the Kyoto Protocol as a legitimate mitigation response, hard geo-engineering has so far been hardly considered in the climate policy discussions.
The second major category of climate change response is adaptation. This includes a broad range and a wide variety of measures that reduce a region's or sector's sensitivity to climate change by reducing the scales of activities affected by changing climate, sealing off activities from direct influences of climate, and changes in behavior, technology, and institutions as attempts to adapt to changing climatic patterns. This is the subject of WG II in TAR and these issues are considered in the present chapter only to the extent they need to be in order to discuss mitigation policies in a meaningful way.
As it is apparent from all three volumes of TAR, profound uncertainties and downright ignorance characterize our present knowledge of the causes, processes, and impacts of climate change, not

to mention the costs of mitigation climate change damages, and adaptation. The third major category of climate change response is learning. This involves investments to acquire new information about all aspects of biogeochemical, geophysical and socioeconomic aspects of climate change. Improved knowledge is indispensable for a better assessment of risks posed by climate change, the costs and benefits of alternative courses of action, and for an efficient and equitable management of the problem It follows from the above that climate change policy must involve elements of an three and the basic framework is decision making under uncertainty, and learning. With a view to the long-term nature of the problem decision making does not revolve around finding the optimal solution for the next 100 or 200 years.

The key question for climate policy is what short-term measures offer a reasonably large room of opportunity for decision making in 10-20 years for mid-course corrections in the light of new information. This sequential nature of decision making has crucial implications both for decision analysis providing guidance for climate policy as well as for mechanisms and institutions for its implementation. This broad analytical framework offers the best opportunity to derive useful information regarding the right balance between mitigation and adaptation. Finding the right balance will provide the answer to the central question of climate policy formulated in Article 2 of the FCCC. Another valuable output of sequential decision models is the value of information related to different unknown or uncertain components of the natural and socioeconomic processes involved in climate change. These analyses provide monetary estimates of the losses policy makers could avoid if they had reliable information on a particular, currently uncertain component. Results of these studies can thus guide allocating scarce research funds according to in which areas would be an early resolution of uncertainty most beneficial for policy making. Recent results in these areas are presented and assessed. The central theme is mitigation versus adaptation, that is presenting insights offered by the scientific community to strike the right balance between efforts to reduce emissions and to adapt to changing climate. Since this kind of analysis involves issues explored both in WG II and WG III, they will be addressed in the synthesis report in more detail, Although adaptation and leaning as response options will prop up in the rest of this section, remaining subsections will mainly deal with key issues of mitigation responses. They all imply that there is an assumed constraint for atmospheric concentrations of GHGs or a clearly specified target for emissions.

**When?** Assuming there is agreement on the need to undertake climate change mitigation actions, the first question is related to timing: How should these actions be scheduled? When should be different policies initiated and implemented? What are the advantages and drawbacks of early versus delayed action? Considering the broad range of possible policies and measures, what are the relative merits of undertaking some of them earlier while others later. All these questions are part of what has become know as “when flexibility" of climate policy. A frequent misunderstanding in climate policy equates mitigation with emission reduction. Clearly-, emission reduction is one form of mitigation but mitigation involves a much broader portfolio of actions. The central question of this debate is the following: if emission reductions are not costless, what is the most efficient strategy? Should societies suffer the costs of near-term emission reduction or should they invest in creating opportunities that will allow future cuts in emissions at a much lower price. In this context, the second strategy does not involve inaction in climate policy at all, but analytical results are often interpreted as they did imply inaction.

The issues involved in “when flexibility" are complex and highly contentious. They range from poorly understood processes of technological innovation and development, the economic aspects of technological development and diffusion, the inertia involved in social processes, lifestyles, and infrastructure fostering or blocking new technologies. The most important insights from recent analyses of “when flexibility" are summarized.

**Where?** The next key aspect of mitigation responses to climate change is the location of mitigation efforts, and has become known as “where flexibility ". With a view to huge differences between levels of economic development, technological status, patterns of energy

use and the resulting spread of marginal costs of GHG emissions across countries, economically efficient mitigation policy would allocate any given amount of reductions in such a way that the marginal cost of abatement would be equal across au emitting units, in this context across all countries. The FCCC explicitly specifies this requirement and the Kyoto Protocol provided several avenues for flexible allocation of emission reduction across countries. While the basic economic principles of “where flexibility" are clear, there are numerous economic, technological, and especially political issues that make it highly debated. Pertinent literature on the topic is summarized.

**Who pays?** Probably no other aspect of climate mitigation response gave rise to so much and so emotional scientific and political debates than that of equity versus efficiency. Existing international agreements require that both should be observed. While equity concerns are present in the adaptation versus mitigation as well as in the early versus delayed response dilemmas, they culminate in establishing reference points for mitigation commitments. The reference point, compared to which commitment takers will need to reduce their emissions or enhance their sinks, determines how much effort will be needed and what are the associated costs under different flexibility arrangements. The distribution of global mitigation commitments across countries largely determines the “who pays" question, while the introduction of possible flexibility instruments will influence the magnitude of costs.

Two major schools of thought characterize the scientific literature in this filed. The first one bases its argument on historical responsibility, some general principles of fairness (eg. per capita emission rights in the past, present and/or future), or on some development concerns and allocates baseline commitments (basically emission rights) according to a selected equity principle. Flexibility in the mechanism or ways of implementation would then be allowed to increase the cost-effectiveness to the extent they do not harm the underlying fairness arrangement.

The second approach seeks cost-effectiveness already in the initial allocation of emission rights and tries to accommodate fairness concerns in the implementation. It is discussed to what extent these and other aspects of the equity versus efficiency debates can provide insights for the policy process.

**How?** The next issue closely related to the “what, when, where and who pays" questions is how mitigation responses should be implemented. Among the many aspects of actual implementation, technology stands out as the single most important one. Given the pervasive nature of GHG, especially carbon emitting activities in the present-day economies, the bulk of mitigation will involve replacing carbon/GHG intensive technologies with energy efficient, low carbon and ultimately non-carbon technologies. In the context of this section, international issues of technological diffusion and deployment are addressed, This involves transfer of existing technologies over the short term as well as specially targeted development and transfer of new technologies over the long run. Opportunities and pitfalls of these processes at the international level are summarized.

**In what context?** Although there is broad agreement that climate change could become a potentially significant problem, and governments, businesses, and other social actors already devoting considerable amount of attention to it, climate change as an environmental risk is at best moderately high on the political agenda of most countries. Therefore it is crucial to explore potential implications of various climate policy responses for other social, economic, and environmental problems that rank high on the political agendas today and in the future. Climate policy instruments and measures will most certainly fail if they undermine the international competitiveness of an export-oriented country or if they jeopardize the potential for fast socioeconomic development and catch-up in a less developed country.

A well-recognized difficulty in climate-related decisions and in analyses to support them stems from the fact that majority of economic and political decisions, especially at national and regional levels, are taken by largely ignoring or just marginally considering their potentially

significant climatic implications. Energy, agriculture, transport, housing and many other policies at the national level are examples of these kinds of decisions. National climate policy cuts across them to the extent emissions constraints will affect future decisions in those areas. It would go far beyond the scope of this chapter to look at non-climate decisions in detail, but the most important implications of other policies for climate policies, primarily mitigation responses need to be considered. The interaction of climate policy with other current problems and possible repercussion of efforts to solve the most burning ones of other problems for climate change and climate policy are explored

**Towards what objective?** The resolution of uncertainties about the significance of anthropogenic influence on the global climate system on the one hand, and improved knowledge about environmental and socioeconomic implications of the resulting climatic change on the other, will to a large extent determine whether stabilization of atmospheric GHG concentrations at a high or low level will be required compared to historical and present levels.

Given the broad range of socioeconomic scenarios with which a very broad range of not impossible GHG emission trajectories are associated, their relationships to currently plausible stabilization targets provide a very wide range of possibly needed mitigation efforts. They range from no climate mitigation effort at all to urgent, significant and possibly expensive efforts. The most important insights on mitigation related to high versus low stabilization levels are summarized.

The FCCC provides the general framework for policy responses at the global scale and the Kyoto Protocol specifies a number of issues within the general framework while leaving others open. By signing the Kyoto Protocol, parties agreed on initial steps regarding the following questions:

What response? The Kyoto Protocol allows for two forms of mitigation: emission reductions and sinks; it does not provide for hard geo-engineering.

When? The short-term reduction targets in the Kyoto Protocol are considered to be modest by some and very ambitious by others as effective early emission reduction targets in the portfolio of early actions. The Kyoto Protocol leaves the long-term mitigation portfolio, and thus questions of delayed effective emissions unresolved.

Where? The Kyoto Protocol allows different flexible mechanisms to be applied among different groups of parties to the protocol.

Who pays? Annex B of the Kyoto Protocol provides a list of countries with quantified emission limitation for reduction commitments. These countries have to cover the costs of those mitigation targets irrespective of where implementation takes place.

How? The Kyoto Protocol allows for technological transfer.