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Implementing the Framework Convention on Climate Change Incremental Costs and the Role of the GEF

Irving M. Mintzer

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Working Paper
Number 4

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GEF Documentation

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This paper is the first among a series of GEF Working Papers to deal with the Program for Measuring Incremental Costs for the Environment (PRINCE). The GEF is a financial mechanism that provides grants to developing countries for projects aimed at protecting the global environment.

PRINCE was initiated in February 1993 at a workshop held at the Tata Energy Research Institute in New Delhi. It covers methodological studies, field tests, and dissemination related to the technical issues of measuring incremental cost. This is a concept central to the GEF; the two Conventions to which it is linked—the Framework Convention on Climate Change and the Convention on Biological Diversity; and the Montreal Protocol dealing with ozone depletion.

Participating governments provided US $2.6 million from the Core Fund for a three-year program. It builds on existing work concerning the phase-out of ozone-depleting substances and concentrates on the incremental costs of reducing the emissions of greenhouse gases. Parallel work will extend the concept of incremental costs to the protection of international waters and the conservation of biodiversity.

This paper provides the scientific background to the issues of global warming, proposes a calculus for estimating incremental costs, and highlights some of the key operational issues which the GEF must address in order to achieve the overall objectives of the Framework Convention on Climate Change.

The other Working Papers currently in the PRINCE series are numbers 5, 6, 7 and 8.

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Contents

Abbreviations

CFC	Chlorofluorocarbon
CGIAR	Consultative Group for International Agricultural Research
CH_4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
FCCC	Framework Convention on Climate Change
GHG	Greenhouse gas
GWP	Global warming potential
INC	Intergovernmental Negotiating Committee for the Framework Convention on Climate Change
IPCC	Intergovernmental Panel on Climate Change
N_2O	Nitrous oxide
OECD	Organization for Economic Cooperation and Development
PRINCE	Program for Measuring Incremental Costs for the Environment
UIAC	Unit Incremental Abatement Cost
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
USAID	United States Agency for International Development

1 Context: the Framework Convention on Climate Change

In June 1992, the Framework Convention on Climate Change (FCCC) was signed by 154 countries and one organization for regional economic cooperation at the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro, Brazil. This Convention was the first of a new generation of international environmental agreements that obligate developed countries to provide new and additional funds to developing countries to achieve global environmental benefits.

Article 21, paragraph 3, of the FCCC entrusts the Global Environment Facility (GEF) with the operation, on an interim basis, of the financial mechanism necessary for mobilizing and distributing these funds. *Article 4* outlines the specific responsibilities of developed countries and of the financial mechanism for implementing this agreement. This paper explores some of the issues facing the GEF as it takes up its responsibilities to fulfil the objectives of the Convention.

The Climate Change Convention will legally enter into force after it is officially ratified by at least fifty countries. During the interim period between the signing of the Convention and its legal entry into force, all activities associated with the Convention will be guided by the Intergovernmental Negotiating Committee for the Framework Convention on Climate Change (INC), and by the Climate Change Secretariat appointed by the Secretary-General of the United Nations. Once the Convention officially enters into force, the Conference of the Parties will become its supreme governing body. The first meeting of the Conference of the Parties must be held within ninety days of the legal entry into force of the Convention. Until this first meeting, the Convention's financial mechanism will be guided by rules of operation that are to be worked out between the GEF and the INC.

The objectives of the Convention and its financial mechanism

The formal objective of the Convention is quite broad. It is given in *Article 2* as follows:

> *The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner.*

The language of *Article 2* suggests that the implementation of the Convention should be based on the Precautionary Principle which states that actions should be taken in the present to avoid dangerous conditions that might otherwise occur in the future. Furthermore, in implementing the provisions of the Convention and any measures taken by the Parties to achieve its

objectives, *Article 3*, paragraph 2, specifies that the Parties shall be guided by a continuing concern for the special circumstances of developing countries and their vulnerabilities to the adverse future effects of rapid climate change.

The implementation of the Convention during the interim period has begun with the establishment of the financial mechanism and the reorganization of the INC. The GEF, in its role as the financial mechanism of the Convention, is charged with distributing the "new and additional resources" promised to developing countries during the course of the negotiations.

Fulfillment of the main objective of the Convention —the stabilization of greenhouse gas (GHG) concentrations in the atmosphere—can only be achieved through international cooperation on an unprecedented scale. In operational terms, the GEF's role in promoting this participation translates into using the funds raised from developed countries to underwrite some of the costs of measures undertaken by developing countries to reduce GHG emissions, or to enhance GHG sinks beyond the levels that would have been achieved without outside financial support.

The following chapters highlight some of the key operational issues which must be addressed by the GEF in order to achieve the overall objectives of the Convention:

- Chapter 2 summarizes the responsibilities of the financial mechanism for funding the full cost of some measures and the incremental costs of other measures specified in the Convention
- Chapter 3 discusses those elements of the science that determine the essential context in which measures to achieve the Convention's objectives must be placed
- Chapter 4 highlights some of the limitations of current scientific knowledge about global warming and their operational implications for the future GEF portfolio
- Chapter 5 proposes a simple calculus for estimating incremental costs
- Chapter 6 explores the issue of project criteria and the need for better information
- Chapter 7 discusses the proposed work program of the GEF on climate change and examines how its operation can strengthen the overall process of implementing the Convention
- Chapter 8 summarizes the conclusions, recommendations, and unresolved issues that emerge from this analysis.

2 The Responsibilities of the Financial Mechanism

Article 4 of the Convention lays out the specific but differentiated commitments that apply to developed and developing country Parties under the Convention. Developed country commitments include the contribution of funds laid out in *Article 4*, paragraph 3, which stipulates that developed country Parties shall:

> *provide new and additional financial resources to meet the agreed full costs incurred by developing country Parties in complying with their obligations under Article 12, paragraph 1. They shall also provide such financial resources, including (those) for the transfer of technology, needed by developing country Parties to meet the agreed full incremental costs of implementing measures that are covered by paragraph 1 of this Article, and that are agreed between a developing country Party and the international entity or entities referred to in Article 11, in accordance with that Article. The implementation of these commitments shall take into account the need for adequacy and predictability in the flow of funds.*

The measures specified under *Article 12*, paragraph 1, for which the full costs will be provided, refer to activities associated with the preparation of national inventories of:

- Anthropogenic GHG sources
- GHG sinks.

These inventories will include all GHGs not covered by the Montreal Protocol on Substances that Deplete the Ozone Layer.

In addition, *Article 12*, paragraph 1, indicates that developed country Parties shall bear the full costs incurred by developing country Parties in the preparation of national reports describing steps taken or envisaged by the developing country Parties to implement the Convention, and any other information that the developing country Parties consider "relevant to the achievement of the objective of the Convention."

The key clause of *Article 4*, paragraph 3, refers to the provision by the financial mechanism of the Convention of the full incremental costs of measures undertaken by developing country Parties to:

- Develop, update, and publish the national inventories of sources and sinks mentioned in *Article 12*
- Formulate, implement, publish, and update national programmes to mitigate climate change by addressing either sources or sinks, and to facilitate adaptation to climate change
- Promote and cooperate in the development, application, and diffusion of technologies, practices, and processes that control, reduce, or prevent anthropogenic emissions of GHGs not covered by the Montreal Protocol
- Promote sustainable management, including the conservation and enhancement of sinks and reservoirs of GHGs not covered by the Montreal Protocol

- Prepare adaptive responses to climate change, including the development of integrated management plans for coastal zones, water resources and agriculture; and protect and rehabilitate areas affected by drought, desertification, and floods
- Take climate change into account in social, economic, and environmental policies; and use appropriate methods to minimize the adverse effects of measures implemented to mitigate or adapt to climate change on national economies, public health, and the environment
- Promote scientific, technological, socioeconomic, and other research intended to further the understanding of climate change and the social and economic consequences of various response strategies
- Promote the exchange of relevant scientific, technological, technical, socioeconomic, and legal information related to the climate system and climate change
- Promote education, training, and public awareness related to climate change and to "encourage the widest participation in this process, including that of non-governmental organizations"
- Communicate to the Conference of the Parties information related to implementation.

Paragraphs 1 to 3 in *Article 11* define how the financial mechanism will relate to the Conference of the Parties during the interim period. *Article 11*, paragraph 4, specifies that, at its first session, the Conference of the Parties will evaluate the arrangements made by the GEF during the interim period and decide if these arrangements are to be maintained. Within four years thereafter, the Conference of the Parties will conduct an overall review of the financial mechanism and make any adjustments deemed appropriate.

Negotiating history of the incremental cost clause

The text of the Convention dealing with financial mechanisms was negotiated at length over the full course of the INC process. It is important to review the evolution of the language concerning the financial mechanism that remains in the agreed text of the Convention in order to understand the cost components and the range of measures that the Parties intended to be financed by the GEF.

As the concept of the financial mechanism evolved during the negotiations, all Parties recognized that developing countries would be asked to take actions designed to reduce the risks of rapid climate change. Both developed and developing countries agreed that actions aimed at achieving global benefits would impose costs on developing countries which they would not otherwise have borne in order to meet merely their own national development objectives.

This realization provoked negotiations on several related issues. The first was the question of whether developed countries would make available "new and additional resources" to cover these costs or whether the costs would be covered by existing flows of Official Development Assistance (ODA). In December 1991, at the Fourth INC Session, the Ghanaian Chairman of the Group of 77 and China issued a statement proposing that the article of the Convention dealing with the Specific Commitments of Developed Country Parties include the following language about how developed country Parties should:

> *through their assessed contributions to the International Climate Fund, specific to this Convention, expeditiously mobilize and provide on a grant basis new, adequate, and additional financial resources to meet the full incremental costs of developing country Parties to take measures provided for in this Convention; to cover the costs of adaptation and mitigation measures that may be needed as a result of the adverse effects of climate change; and the direct and indirect social and economic costs, including opportunity costs, to developing countries that may result from the implementation of the Convention.*

During the remainder of the Fourth Session and throughout the first part of the Fifth Session of the INC, held in New York in February 1992, the debate on the financial mechanism focused on a series of questions raised by the December statement of the Group of 77. These included:

- Should the contributions by developed countries be voluntary or obligatory?
- Should there be a separate climate fund or should an existing entity (or entities) be designated as the

financial mechanism of the Climate Change Convention?

- Should the developed countries pay the full costs, the incremental costs, or the agreed costs of measures undertaken by developing country parties to the Convention?

During the first part of the Fifth Session in February 1992, Portugal, speaking on behalf of the European Community, linked its support of "new and additional resources" to the use of GEF as the financial mechanism under the Convention, and to limitations placed on the powers of the Conference of the Parties. The British delegate urged that the provision of additional resources be conditional on developing countries meeting the reporting requirements outlined in other articles of the Convention. These issues were not resolved, and at the close of the February session, square brackets still remained in the draft text surrounding alternative wording on the following issues:

- Whether developed country contributions to the financial mechanism would be voluntary or assessed on a mandatory basis
- Whether these contributions would be clearly separate from and additional to ODA
- Whether the developed country contribution would cover the full incremental costs or only the agreed part of those costs
- Whether or not these funds would be made available on a grant basis
- Whether they would be designed to cover both adaptation and mitigation costs due to climate change
- Whether other parties and international organizations would provide additional contributions on a voluntary basis.

In April 1992, the Organization for Economic Cooperation and Development (OECD) held an informal meeting in Paris to try to agree on a common position. This was followed by an invitation from the INC Chairman, Jean Ripert, to the Expanded Bureau of the INC to resolve the remaining differences before the resumption of the Fifth INC Plenary Session. During this meeting of the Expanded Bureau, the outlines of a number of fundamental compromises began to emerge.

At the resumption of the Fifth Plenary Session of the INC in New York at the end of April, Jean Ripert presented a Chairman's Draft of the proposed convention. A complex series of compromises covering many of the outstanding issues in the negotiations had been formulated by Ripert. This draft on the financial mechanism became the text of *Articles 4*, *11*, *12*, and *21*. It stipulated that in light of the common but differentiated responsibilities of the Parties, developed countries would pay, through the financial mechanism of the Convention, the agreed full costs of reporting measures and the "agreed full incremental costs of other measures taken by developing countries to implement the provisions of the Convention," and to advance the overall objectives of the Convention. The draft noted that the developed country contributions would represent "new and additional" funds and that the GEF would be designated as the financial mechanism on an interim basis. It did not foreclose the option that another entity (or entities) could be similarly designated in the future. This compromise text also indicated that the Conference of the Parties would evaluate the performance of the GEF, its criteria for project selection, and its modalities of operation.

In the final compromise on financial aspects of the Convention, all parties achieved some of their original objectives. Developed countries were satisfied that the GEF would be designated as the financial mechanism, centralizing control of the funds, assuring efficiency in operations, and reducing the likelihood that facilities and administrative efforts would be duplicated—as might occur if several entities were designated to implement the financial aspects of the Convention simultaneously. The developed countries were also pleased that there would be no specific assessment of contributions to a separate climate fund —either within or outside the GEF.

For their part, developing countries were satisfied that the funds available to them to meet the demands of the Climate Change Convention would be new and additional resources, and not funds redirected from other flows of ODA. They were also encouraged by the broad language committing the developed country Parties to provide the agreed

full incremental costs of "implementing measures" to achieve global environmental benefits and to advance the overall objectives of the Convention. All parties approved the plan to review the arrangements periodically, beginning at the first Conference of the Parties.

3 Global Warming: Implications of the Science

The "greenhouse effect" is the name given to a geophysical process that has been essential to the evolution of life on earth. For two billion years, natural background concentrations of certain gaseous compounds have trapped heat close to the earth's surface, warming the planet. These gases, principally water vapor, ozone, and carbon dioxide, are transparent to incoming sunlight in the short-wave portion of the electromagnetic spectrum. But they absorb and re-emit some of the outbound, long-wave, infra-red radiation from the earth's surface. Part of this infra-red radiation is re-emitted upward toward outer space; the remainder is re-emitted downward toward the planet's surface.

For millennia, this downward re-emission has been sufficient to raise the average temperature at the surface by about 33°C (59°F) above what it would otherwise have been. Without this natural greenhouse effect, the average temperature on earth would have been about -18°C, and water would have been present only as ice. The natural greenhouse effect allowed liquid water to remain stable over most of the earth's surface, providing the fundamental substrate for biological activity as we know it.

Greenhouse gases and the climate problem

Climate change *per se* is not a problem. Climate has been changing constantly for hundreds of millennia. As a result of the slow advance of natural processes, the planet has warmed and cooled, passing regularly from ice ages to warm, interglacial periods. Most of these changes have been slow transitions that often spanned thousands of years. These gradual transitions have allowed life on earth to adjust relatively smoothly to each new climatic equilibrium. Nonetheless, during these transitions, the boundaries of ecological communities have shifted; the associated human cultures have flourished and, occasionally, disappeared.

But recently something important has changed. During the last two centuries, the natural greenhouse effect has become the "greenhouse problem." In the foreseeable future, rising concentrations of greenhouse gases (GHGs) threaten to induce rapid shifts in global and regional climate regimes, disrupting ecosystems and inflicting significant economic damage on the affected societies.

A new situation with uncertain and perhaps unpredictable levels of danger has evolved. Since the beginning of the Industrial Revolution, GHG emissions from human activities have grown steadily. Because the rates of emissions of these gases have exceeded the ability of natural processes to remove them from the atmosphere, their atmospheric concentrations have increased, enhancing the natural greenhouse effect (Houghton, Jenkins and Ephraums 1990). The build-up of these gases creates the greenhouse problem and, if current trends continue, may warm the planet at an unprecedented rate. Most business-as-usual scenarios suggest a warming of between 2° and 5°C during the next century. This could change traditional regional climates dramatically in as little as a few decades.

Although the precise local manifestations of global warming due to GHG buildup cannot be predicted with any confidence today, the potential magnitude and rate of change threaten extensive damage to vulnerable areas, especially in developing countries. The scale of damage and the associated "adjustment costs" are difficult to calculate. The problem is complicated because in many cases, unmanaged ecosystems and human communities will find it difficult or impossible to abandon their traditional homes and migrate to more hospitable conditions at a rate that is commensurate with the changes happening around them.

Global warming: an accumulation problem

Although most of the international debate has focused on emissions of carbon dioxide (CO_2), several other anthropogenic compounds also contribute, albeit to a lesser degree, to the risks of rapid climate change. These include methane (CH_4), nitrous oxide (N_2O), tropospheric ozone, and the chlorofluorocarbons (CFCs).

Greenhouse gases have some of the characteristics of both stock and flow pollutants, but on a time scale of relevance to investment decisions and public policy, they are best treated principally as stock pollutants. The main risks of global warming stem from the effects of the long-term increase in their atmospheric stocks and not from their short-term, month-to-month, or year-to-year fluctuations.

The continuing disequilibrium in the climate system, caused by the heat-trapping effect of the *accumulation* of various GHGs could, in a period of several decades to a century, exceed some critical but as yet indeterminate threshold of sensitivity and push the system into a dangerous domain of relatively rapid climate change. This triggering could be characterized by non-linear responses to even small additional changes in GHG concentration; changes which could induce disproportionate regional shifts in precipitation, runoff, and the frequency of what are termed extreme-weather events.

The fact that the risks are associated with the accumulation of GHGs in the atmosphere suggests that it is necessary to see the problem in a context that goes beyond the pattern of current emissions, and to understand the historical pattern of past emissions. King and Munasinghe (1992) point out that, in trying to establish responsibility for the risks of global warming, "part of the equity question will be the past or *historical* responsibility of countries for the present accumulation."

Who contributes to the increasing risks?

GHG emissions occur in all countries and in all sectors of national economies. Because the gases are relatively long-lived (and thus well mixed) in the atmosphere, the risks associated with a unit of emissions are irrelevant to the location of the source or the type of activity that generated the pollutant in the first place.

Nonetheless, emissions are not evenly divided among countries, regions, or ethnic groups. Historically, more than 75 percent of all anthropogenic GHG emissions have resulted from activities in the developed world. Today, about two-thirds of all anthropogenic emissions originate in the industrialized countries; the per capita emission rates of developed countries are from five to one hundred times higher than those of developing countries. However, due to the faster rate of growth of population and the ongoing pattern of industrialization in developing countries, their aggregate annual emissions may exceed those of developed countries by some time in the twenty-first century.

Greenhouse gas emissions occur during nearly all economically important activities. The largest proportion of these emissions is produced during the extraction, transport, and use of commercial fuels. Approximately 75 percent of current global energy use involves fossil fuels. Whenever these fuels are burned, CO_2 is released into the atmosphere.

Traditional fuels such as fuelwood, crop waste, and dung constitute approximately 12 percent of global energy use. The combustion of fuelwood is often done in an unsustainable manner, leading to additional net emissions of CO_2. Crop waste and dung, on the other hand, are usually cycled on an annual basis between the atmosphere and the biosphere, thereby causing no net release of CO_2. Hydropower and nuclear electric systems account for most of the remainder of the world's annual use of commercial energy; these two technologies also contribute GHGs to the atmosphere in amounts that are relatively small but not in themselves insignificant.

But GHG emissions are not caused only by energy use. An increasing proportion of emissions occurs in the transport sector. Automobiles and airplanes are responsible for large quantities of emissions of CO_2, carbon monoxide (CO), and the chemical precursors of tropospheric ozone.[1] Rising demands for personal mobility have led to the expanding use of automobiles and airplanes in the last several decades. This continuing trend is likely to result in increasing emissions from the transport sector for at least the next thirty years.

Agricultural activities are another major contributor of GHGs, being responsible for a large fraction of the anthropogenic emissions of methane. Principal methane sources include the anaerobic digestion of organic material in wet soils (for example, during paddy rice cultivation), and the enteric fermentation of grains and other plants in the gut of domestic ruminants. Nitrous oxide emissions result mainly from bacterial denitrification of certain types of fertilizers, especially those synthesized from anhydrous ammonia.

Activities in the forestry sector also contribute to GHG emissions. The decomposition of forest litter produces emissions of both CH_4 and CO_2. Inefficient burning of biomass fuels under less than stoichiometric conditions results in emissions of CO_2, CH_4, and CO.

The activities of government agencies are themselves important sources of GHG emissions. Through the utilization of large vehicle fleets, and the maintenance of office buildings, manufacturing facilities, military bases, and other operational units, government departments are the largest single emitters of GHGs in many countries.

Industry also contributes to GHG emissions, being the principal user of CFCs. However, the most dangerous of these will soon be controlled by the terms of the Montreal Protocol. Industrial processes are major consumers of commercial energy and thus a major source of CO_2, CO, N_2O, and the chemical precursors of ozone.

Housing and households are also major emitters of GHGs. Residential combustion for heat and light results in emissions of CO, CO_2, and ozone precursors. Household refrigeration and the fabrication of many household goods also involve CFCs, and the decomposition of organic wastes from household activities ultimately produces methane.

Since the activities that produce GHGs are so pervasive in modern and traditional economies, it will be difficult to control and impossible ever to phase them out completely. Indeed, emissions are likely to rise in aggregate and on a per capita basis as incomes rise, especially in developing countries. The only plausible short-term objective for developing countries with regard to the climate problem is to slow, to the extent possible, the rate of growth in these emissions while meeting national objectives for economic development.

The different fates of greenhouse gases in the atmosphere

The chemical, physical, and biological properties of each of the GHGs in the atmosphere are different. The processes by which they are taken up by the terrestrial and aquatic biota or converted to different chemical species vary widely. The average residence time of these pollutants ranges from a few years for methane to several centuries for N_2O, CO_2, and the CFCs.

The radiative effect of their buildup also varies from gas to gas. The relative strength of this time-integrated effect can be compared for each gas to the radiative effect of a unit increase in the concentration of CO_2. This relative strength is measured by an index called the global warming potential (Houghton, Jenkins and Ephraums 1990). The aggregate effect of increasing emissions of any number of GHGs can be roughly estimated by applying the global warming potential (GWP) index to the buildup of each gas, aggregating the results, and estimating the equivalent level of buildup for CO_2 alone, which would have about the same overall warming effect.

[1] Although not itself a greenhouse gas, carbon monoxide is important to the greenhouse problem because of its effect on another atmospheric constituent: the hydroxyl radical (OH). Hydroxyl is the principal sink for methane (and many other pollutants) in the atmosphere, but it reacts preferentially with CO. By scavenging OH from the atmosphere, emissions of CO increase the residence time and the effective rate of buildup of atmospheric methane.

In practice, the calculation is more complicated than the above statement suggests. This is because in the real atmosphere, the overall radiation balance is a complex non-linear function of a set of closely coupled elements whose relationships are not well understood at this time. Some recent evidence suggests, for example, that the estimated GWP of each GHG is sensitive to:

- The time horizon of integration
- The assumed trajectory of future emissions of that gas
- The assumed background concentrations of other greenhouse gases.

As a consequence of these and other interactions, we may use the GWP to estimate an approximate carbon-equivalent concentration, if we recognize that the resultant value is only a rough approximation of the relative strength of the effects on the atmosphere.

The vulnerability of developing countries

The global warming due to anthropogenic emissions of GHGs will be small relative to the natural background greenhouse effect (33°C). This enhanced warming could, however, still have a significant impact on local and regional climates. The Scientific Working Group of the Intergovernmental Panel on Climate Change (IPCC) estimates that, if current trends continue, the planet will be committed to a warming of between 2° and 5°C by the middle of the next century (Houghton, Jenkins and Ephraums 1990). This change in average global surface temperature is only an index of the scale of future changes in climate. A change of 2° or 3°C may not seem like much but its effects could be quite dramatic. As a comparison, the climate of the Little Ice Age of the fourteenth to seventeenth centuries occurred in conditions that, in terms of the global average surface temperature, differ from today by only about 1°C. Nonetheless, during some particularly cold bouts in this medieval period, the water in the Baltic Sea froze over, allowing Northern Europeans to cross the Baltic by foot or sled from the Continent to Scandinavia.

The world has survived climate changes of up to 5°C in the past. But these were usually spread over periods ranging from five to fifty centuries. The current debate centers on the effects of such changes in a period of five to fifteen decades. Human and other natural systems have not substantially increased their adaptive abilities. Thus the extent of the economic damage and the disruption of ecosystems which could result from the associated changes in seasonal temperatures, wind regimes, ocean currents, and precipitation patterns will be determined by a combination of the rate and the magnitude of future effects.

The severity of the effects of global warming will not be evenly distributed geographically. The IPCC analysis suggests that the warming at the poles will be two to three times the global average, while warming in the tropics will be only 50 to 75 percent of the global average. This does not mean that the effects of the warming will necessarily be less severe in the lower latitudes. Indeed, some suggest that the direct effects of warming may be worse in these areas because human and other systems are already stretched closer to the limits than can readily be tolerated.

In any event, as mentioned before, some of the effects of global warming will depend principally on the magnitude of the change, and others on the rate. On average, the extent of global sea-level rise will principally be a function of the magnitude of the warming. Sea-level rise will occur as a function of two processes:

- Thermal expansion of the upper mixed layer of the ocean
- Melting of landed glaciers.

The IPCC estimates that a eustatic or average sea-level rise of between 20 and 70 centimeters is likely to occur in the next century (Houghton, Jenkins and Ephraums 1990).

Most of the world's population lives within 75 kilometers of the coast and would thus be exposed to great risk from sea-level rise. But it is not the global average sea-level rise which will determine the extent of damage in most countries. It is the low-lying island states and countries with large, flat deltaic regions facing the sea which will be especially vulnerable. Developing countries as a group are likely to be the worst affected.

The extent and severity of the damages for each country will be determined by a combination of regional factors

and local conditions. Geologically speaking, some coastlines are rising while others are subsiding. In areas where tectonic movements are causing an upthrust of the underlying geological formations, the effects of sea-level rise will be minimal. Furthermore, even for countries like Bangladesh, where a large proportion of the population lives in a very exposed deltaic plain, the extent of the damage will be a complex function of the state of human preparedness, the nature of development along the coast, the kinds of natural ecosystems in coastal regions, and the types of coastal defenses that are erected (Warrick and Rahman 1992).

Other physical impacts of global warming will depend more critically on the rate of change than on the absolute magnitude. Global warming will cause alterations in the patterns of upper atmospheric winds and ocean currents in ways which may alter the timing, availability, and distribution of precipitation. This, in turn, may affect the regional availability of freshwater resources in significant ways. For regions with shared international freshwater resources and, in particular, where the average runoff is already committed and the demand for freshwater is rising, changes in precipitation may significantly increase cross-border tensions between states. It is unlikely that climate change will cause wars over water, but for regions like the Jordan-Litani River system, any future shortfall—even one of limited duration—could instigate the onset of hostilities that have been simmering for years due to relations strained over other issues (Gleick 1992).

Perhaps the most important impact of global warming on developing countries will be the frequency, severity, and duration of extreme-weather events. Based on available data, their frequency and the economic damage caused by them have been increasing steadily in this century for all types of weather related disasters except hurricanes (Mintzer 1990). Some recent analysis suggests that the severity of hurricanes too could increase in a world warmed by the enhanced greenhouse effect. Developing countries are often ill-prepared for such occurrences and could, partly as a result, suffer disproportionately more damage than would a developed country (Mintzer 1990).

The unpredictability of regional impacts

Much time, money, computer resources, and talent have been invested during the last decade in creating models for future climate change. Nonetheless, it is impossible today to predict the timing, severity, or pattern of the regional distribution of impacts with any certitude. Despite the additional resources that will be devoted to research on these issues in the near future, this uncertainty is likely to persist for decades to come.

Whether or not the world is on the edge of dramatic change in global climate, it is certain that droughts, floods, typhoons, cold snaps, hot spells, and wind storms will continue to occur in the future. Prudent public policy can, however, reduce their damage by moving national economies toward greater preparedness and resilience. In addition, the rate at which the risk is increased by GHG buildup can be moderated by policies that slow emissions growth. Measures can be taken now, as the FCCC suggests, to reduce future GHG emissions and to enhance natural sinks. Carefully selected, these measures will bring economic rewards to the implementing country even if past GHG emissions do not pose a threat.

The situation is comparable to that facing a young and healthy family. It is fairly certain that in the years to come, some members of the family will fall ill; yet it is impossible to predict who it will be, or how severe or long-lasting the illness will be. Statistically, we can determine which individuals are most likely to be affected by different types of disease. But in practical terms, only two precautions can be taken to reduce the expected value of damage from illness. Both strategies involve an application of the Precautionary Principle.

The first strategy is to promote good health for each family member through nutrition, education, and exercise. These measures are most likely to succeed if complemented by the avoidance of habits that are known to increase risks, such as smoking, excessive drinking, and the use of dangerous drugs. And whether or not any individual suffers from disease in the future, these measures will add to the economic value of his or her productivity.

The second strategy is to spread the risk over a pool of individuals larger than a single family by buying health insurance. In this way, even if an extreme eventuality befalls one individual, the financial damages will be cushioned by contributions from others.

The Climate Change Convention argues for a similar application of the Precautionary Principle at the global level. The GEF is charged with making investments to strengthen national programs of economic development, improve resilience to unexpected weather conditions, alter patterns of industrialization to reduce the rate of emissions growth, and develop adaptive responses to conditions that could be triggered by anthropogenically induced climate change or by other more "natural" causes. Given the fundamental and irreducible uncertainty in the present situation, the specific challenge assigned by the Convention to the GEF is to underwrite the agreed full incremental costs of such investments, leaving the basic investment (the part which delivers benefits captured solely by a local economy or enterprise) to be covered by local resources.

4 Global Warming: Operational Considerations

The complex multi-dimensional risks of rapid climate change pose a difficult challenge to the GEF. The greenhouse problem is not simply a technical question. There exists no single "best-valued" response to the uncertain future changes in global and regional climate regimes.

No single best strategy

Several response strategies are available to reduce the risks of rapid climate change, three of which can readily be identified (King and Munasinghe 1992):

- *Abatement strategies.* These include measures which:
  - (i) Reduce GHGs (or lead to a shift from high to relatively low GWP gas emissions); and
  - (ii) Enhance GHG sinks.
- *Mitigation strategies.* These include measures which prepare societies to:
  - (i) Control future damages, for example, the construction of coastal defenses to protect against sea-level rise; and
  - (ii) Adapt to new conditions, for example, the cultivation of drought-resistant cultivars.
- *Compensation strategies.* These allow the beneficiaries of activities which have historically contributed to the accumulation of GHGs to offset the damage borne by those affected by the impacts of climate change. Examples include subsidies for the transfer of new technologies, or incentives for their introduction in developing countries.

The GEF is charged in *Article 4*, paragraph 1, sections b, c, d, e and f, with the responsibility for underwriting all three types of response strategies. This taxonomy of response strategies need not be considered mutually exclusive. Some of the projects implemented by the GEF will have elements drawn from more than one type of strategy. A project designed to breed and plant drought-resistant trees, for example, would also include abatement (sink enhancement) and mitigation (adaptation) aspects. Projects with multiple components could have aspects which fall into different categories. For example, a project to develop and demonstrate an advanced biomass gas turbine, or a solar photovoltaic power plant to replace a conventional coal electric plant, may contain some components that constitute abatement measures and others which represent a compensation scheme to promote technology transfer (King and Munasinghe 1992).

The benefits of responses to global warming

Responses to global warming can generate a wide range of benefits at the national and local levels, not all of which can be readily quantified or monetized. An afforestation project, for example, in addition to sequestering atmospheric carbon, can lead to progress toward other development goals, such as the improvement of agricultural productivity through reduced downstream soil erosion and the sustainable provision of fuelwood. These secondary benefits may have no obvious links with the principal purpose of the carbon sequestration project.

In some cases, the secondary benefits could be more important to the local economy than the effects of GHG reduction. The principal benefit of a project to develop a drought-resistant cultivar in a region where rainfall is unreliable could be the stabilization of annual agricultural yields in a decade or less. A project to provide an early flood-warning system in a deltaic region prone to typhoons and storms could produce most of its observed benefits during annual periods of stormy weather that show no historical pattern of correlation to the buildup of GHGs. The benefits to be derived from adapting to future global warming might remain unrecognized and seem unnecessary for another thirty to forty years.

After this period, however, the value of such projects might be critical to local survival in a warmer world. How then should the costs of such projects (and their benefits) be accounted for today? Should a (speculative) estimate of future benefits in a highly uncertain but potentially more hostile environment be discounted back to the present at the social rate of discount? Or is some other measure of their value more appropriate?

Projects originally conceived to respond to global warming may have other values equally hard to quantify but just as real from a policy standpoint. Some projects could provide direct and indirect "use value" to a local economy by introducing a valuable technology that would not otherwise be established in a particular country or region (Pearce 1992). It is not obvious how one might quantify and integrate considerations of such value into the standard methods of project evaluation.

Other benefits are even harder to monetize. An abatement project that opens up or maintains the option of deploying an advanced technology could provide information to governments on the structure of successful policies and on institutional changes that could improve the efficiency of domestic resource utilization, both technically and economically. This "option value" is a very real national benefit that may or may not have global ramifications (Pearce 1992). Should this "option value" be recognized and somehow included in the calculation of net incremental costs?

Harder still to assess are projects that create what Pearce has characterized as "existence value"—the value of just knowing that some traditionally important element of national culture has been maintained. If a deforestation project promotes sustainable management of renewable outputs from a fragile rainforest that harbors a number of endangered species, the project may capture an important social benefit just by reassuring the citizenry that the rainforest will remain intact. If a geothermal development project allows a government to forestall strip-mining of surface coal in an ecologically sensitive area that also contains the ancient religious ruins of an indigenous civilization, the project may capture a benefit for the descendants of that civilization by providing the assurance that their ancient holy places and traditional culture can survive (at least temporarily) the onslaught of modern civilization. Again, how can the existence value of the rainforest or the ancient relics be incorporated into the calculus of incremental costs?

The inadequacy of conventional cost-benefit analysis

For all these reasons, projects designed to respond to the risks of global warming must be evaluated with special care. At the project or enterprise level, conventional methods of cost-benefit analysis may give an incomplete and distorted estimate of the value of such projects (Howarth and Monahan 1992). Even beyond the difficult valuation issues outlined above, persistent uncertainty across all dimensions—scientific, economic, financial, and political—complicates the cost-benefit calculus. Scientific uncertainty about the relationships between future emissions and GHG concentrations, and between concentrations and regional impacts, makes it difficult to estimate the expected value of damages that could result if the proposed project were not undertaken.

Economic uncertainty about the baseline scenario makes it difficult to estimate the marginal economic costs of various responses to the marginal damages that would have resulted in the absence of the project. It is similarly difficult to estimate the marginal benefits of implementing the project because the analysis requires the evaluation of a hypothetical, counterfactual situation.[2]

[2] Ken King, conversation with author, 1992.

Financial uncertainty about the appropriate allocation of joint products—both joint costs and joint benefits— makes rigorous allocation of benefits and costs between environmental problems wholly arbitrary. For example, how much of the benefits and costs of CFC-reduction measures should be allocated to responses to the global warming problem as opposed to the ozone depletion problem?

Similarly, the allocation of joint benefits (or costs) from a particular project between the national and global levels must also be somewhat arbitrary. The allocation must depend in part on what is assumed not just about the project or the national program of which it is a part, but also on the assumptions about what the rest of the world is doing at the time that the project is undertaken.

Finally, uncertainty about the policy environment in which the project will be implemented makes it difficult to evaluate "systemic effects." If the project is an isolated demonstration, it will have less impact than if it is the vanguard of a major policy reform. If it establishes new institutional relationships (for example, by improving coordination among the activities of the agriculture, forestry, and energy sectors) or alters traditional planning practices in an existing institution (by introducing, for example, least-cost, integrated resource planning in an electric utility), the project could have long-term effects on the macro economy that are very difficult to capture in a cost-benefit analysis. Nonetheless, these systemic effects may be more important in the long run than any of the project-specific benefits that are more easily quantified.

A third important problem with the traditional cost-benefit approach is the need to choose a discount rate for comparing future economic costs and future environmental benefits. Norgaard and Howarth (1992) have argued that there is no simple and consistent way to choose an appropriate discount rate that reflects the objectives of sustainable development as understood in the Climate Change Convention. They suggest that in the case of long-term global environmental problems, a discount rate of zero or even a negative value may be justified. However, it is not clear what the meaning of a negatively discounted ton of future CO_2 emissions really represents.

The problem of conflicting criteria

International concerns about the risks of global warming embodied in the Convention introduce multiple criteria that could generate irresolvable conflicts at the level of operational decision-making. The Convention recognizes international concerns about cost-effectiveness in the allocation of scarce financial resources. It stresses the importance of economic efficiency in choosing strategies to stabilize future GHG concentrations while maintaining the prospect of sustainable economic development. And it emphasizes equity considerations that are sensitive to the special concerns of developing countries and economies in transition. If any one of these factors were given primacy, the overall objectives of the Convention could not be achieved.

If the financial mechanism of the Convention were to apply only the narrow criterion of cost-effectiveness in allocating resources, projects would be selected on the basis of producing the lowest average cost per ton of carbon-equivalent emissions reduced. This would create a portfolio composed of cheap, currently cost-effective projects (the so-called Type I Projects defined in chapter 6). Most funds would be oriented primarily to "leak-plugging" and "good housekeeping" projects designed to improve the efficiency of currently operational "dirty" facilities. (Indeed, if the estimated internal rate of return on such projects is high enough before consideration is given to their global environmental benefits, some of these projects might be implemented even without GEF subsidies, and could appropriately be counted in the baseline menu of national activities.) However, a rigid emphasis on simple cost-effectiveness would reward the country or countries which have done least to be good environmental citizens to date and have, as a result, the largest reservoir of past inefficiencies and the greatest variety of easy fixes. Indeed, to minimize the total transaction costs of a GEF program with limited funds, one might argue that the entire portfolio should be composed of leak-plugging projects in a single country, probably one that has been especially inattentive to the environment.

Given the current size of the Global Environment Trust Fund and the scale of the expected replenishment, it is possible that the greatest benefits could then be achieved by investing only in the simplest and

cheapest projects in one or two of the largest and most polluting countries. Such a strategy would clearly produce large carbon emissions reductions in the short term. But it could also lead to over-investment in inexpensive measures with few long-term benefits.

The opportunities for energy conservation and reduction of aggregate GHG emissions in developing countries are numerous and critically important, but they are also unfortunately limited. Since per capita demand for energy and associated GHG emissions will inevitably rise with the growth of industrialization in many developing countries, and since many national populations are unlikely to stabilize before the middle of the next century, aggregate emissions in these countries will almost certainly increase. This increase will be unavoidable unless substantial investments are made not only in efficiency-improving technologies but also in low-emissions technologies that utilize annually-cycled flows of renewable energy.

Furthermore, concentrating investments in one or even a few countries with a wide range of cheap opportunities for emissions reductions would do little to advance the Convention's long-term objective of stabilizing future concentrations and maintaining broad participation in the process. If many countries see themselves excluded from future investment, they will undoubtedly question their own efforts to save the global environment at the cost of more pressing national development concerns.

The IPCC Scientific Assessment makes clear that from a scientific standpoint, the overall objectives of the Convention can only be achieved through the widest possible cooperation in an international strategy to reduce the risks of rapid climate change. Any policy, protocol, procedure, or operational guideline which decreases the likelihood of sustained participation in the process by a significant fraction of the world's population will necessarily reduce the probability of fulfilling the Convention's objectives. Concentrating GEF investments in one or two countries could have exactly this result.

A second alternative is to be guided by the principle of economic efficiency. This would suggest that the GEF seek to invest up to the point where the long-term marginal benefits of future emissions just equal long-term marginal abatement costs, and also equal long-term mitigation costs. This theoretically optimal value is remarkably difficult to calculate when the benefits of avoided emissions as well as the damages due to future emissions are both uncertain and essentially unknowable.

The evaluation of marginal costs necessary to apply this criterion is further complicated by the fact that any estimates are also likely to change dramatically during the period of interest for today's investments. Some evidence suggests that these future changes in expected costs will vary according to the strategy chosen to respond to the risks of climate change. Systemic effects that reflect the impacts of integrating a new type of technology into an existing institution or national infrastructure may significantly affect the observed costs and benefits. And these systemic effects may differ radically among countries and even among institutions within a single country. In a national utility grid, for example, the introduction of intermittent renewables may have one effect in a system served mainly by intermediate-load, oil- or gas-fired thermal power plants, and another quite different effect in a system consisting mainly of baseload geothermal, hydro, or nuclear plants.

At the global level, decisions that seem completely irrelevant to the project in question may strongly affect the cost and benefit functions. The long-term carbon abatement costs of solar photovoltaic systems, for example, may be quite sensitive over the next several decades to the decisions made in the next three to five years that affect the rate of development of niche markets. Decisions made today to support the purchase of significant quantities of photovoltaic devices to displace the use of fossil fuels in developing countries could significantly reduce future production costs.

But the value of these solar devices and the size of the niche markets they penetrate may themselves be quite sensitive to other, seemingly unrelated decisions, such as the design and manufacture of key end-use devices. For example, the decision to encourage the production in China of inexpensive, high-efficiency refrigerators that do not use CFCs may affect the future rate of release of ozone-depleting substances, the level of baseload energy demand, and the average

rate of CO_2 emissions from the power sector in China. The decision to fund the development of this innovative refrigerator technology is likely to be taken quite separately from the decision about energy supplies and global warming. It is more likely to be made in response to a "separate" atmospheric problem—the risks of stratospheric ozone depletion.

However, recent research suggests that ignoring the connection between the physical aspects of these two problems by selling inefficient refrigerators in developing countries and fueling them with coal-fired electricity could make both the ozone and the climate problems worse. In China, for example, approximately 7 percent of urban households had refrigerators in 1975. In 1989, the figure was almost 40 percent. If this trend continues, and relatively inefficient refrigerators using CFCs are fueled by inexpensive coal-fired electricity, the emissions of both CO_2 and CFCs will inevitably rise in the country.

The rapid, non-linear response of the atmospheric system could significantly increase the costs of future responses to both problems. A recent analysis suggests that tropospheric warming due to CO_2 emissions from fossil fuel use is likely to create conditions which could give rise to an Arctic ozone hole unless both CO_2 and chlorine emissions are curbed. The combination of ozone depletion in the northern hemisphere and global warming due to the buildup of GHGs could cause economically significant damage in China as well as in many other countries.

Since the risks of global warming are tied to this type of non-linear response mechanism in the atmosphere, special consideration must be given to those investment strategies that minimize the likelihood of crossing the uncertain but expected threshold of concentrations that could trigger rapid climate change (or ozone depletion). The GEF must, in project selection, emphasize options that provide an alternative to the use of fossil fuels in the long term. This is necessary even if it leads to investment decisions that are not the cheapest, most cost-effective sources of carbon reductions in the short term.

The implicit objective of the Convention—to achieve the broadest possible participation in the international response to global warming—highlights the importance of equity considerations in the operation of the financial mechanism. Although the contribution to global warming varies across countries (and across sectors within countries), and the damages from global warming will vary among regions and across generations, it is politically important for the success of the Convention process for GEF investments to support measures taken in each region and in many countries and sectors.

In practice, each developing country that signs the Convention will expect to receive a share in the financial support offered by the GEF. However, not all countries will be able to present investment opportunities which would lead to an economically efficient portfolio in the long term. Nonetheless, the GEF will have to develop—with the support and guidance of the INC—criteria for future investments that represent a compromise between short-term cost-effectiveness, economically efficient industrial development, and broad political support.

A taxonomy of countries and projects

To achieve this balance, the GEF may need to develop a taxonomy of countries and projects that would allow it to allocate funds equitably. Although not all countries have the same mix of project opportunities, early screening activities indicate that all countries do have a number of abatement and mitigation opportunities that can be exploited at relatively low direct costs. Early experience with the Pilot Phase of the GEF has identified a large number of projects which can be grouped into distinct classes. These projects share the potential to reduce emissions or enhance sinks at total direct costs (annualized capital charges plus running costs) of about US $10 per ton of carbon equivalent avoided or absorbed.[3]

The GEF could further classify such "inexpensive" projects in terms of their ability to address traditional externalities and to acquire knowledge that would reduce the cost of future projects. The overarching rationale for project selection within this class of opportunities could be to gain information which has value beyond the cost of damages avoided due to CO_2 abatement. GEF projects could be evaluated

[3] Ken Newcombe, conversation with author, 1992.

for the information they provide about ways to limit future transaction costs by:

- Eliminating institutional obstacles to efficient markets
- Reducing the costs of entry into new markets
- Providing a better understanding of the available resource base of solar, wind, hydro, biomass, or geothermal energy
- Capturing economies of scale in production through mass manufacture
- Providing an improved understanding of related problems or eliminating in part their adverse environmental impacts
- Establishing new institutional relationships, for example, through new forms of private-private or public-private partnerships that facilitate the development of advanced technologies specifically adapted to the circumstances of developing countries
- Improving the ability of existing institutions to manage small decentralized projects by bundling or packaging them into programs that could be implemented with a regional institution serving as a central link between local authorities and enterprises in different areas
- Increasing local institutional capacity to monitor, review, evaluate, and adjust projects to the physical, biological, and social environments in host countries.

Similarly, the GEF could identify and categorize adaptation projects as potential investments. This class of projects has a value beyond the estimate of damages avoided. These projects make national economies more resilient to those weather related hazards that may increase in frequency or severity as a result of global warming, but which can be expected to recur even without any dramatic change in climate. In this regard, the GEF could seek to stimulate learning about preventive activities, including measures to:

- Improve productivity in agriculture and forestry in the face of uncertain climatic conditions in the future such as droughts, floods, storms, and extreme variations in temperature
- Improve food productivity by reducing crop losses due to pests and predators whose destructive capacity could increase in a warmer world
- Increase the efficiency of water use and the efficacy of international agreements concerning the sharing of freshwater resources
- Increase the effectiveness of coastal protection systems and minimize the vulnerability of coastal zones to weather related damages
- Reduce the vulnerability of human communities to the vectors of diseases that might proliferate in a warmer world
- Increase the level of education and awareness among the populations of vulnerable areas in order to improve their capacity to identify, develop, and implement responses, as well as learn from locally-adapted response strategies in other regions.

Beyond grouping projects in these or similar classes, it may be operationally important for the GEF to establish a taxonomy of host countries that share common characteristics. By classifying countries in this way, it would be easier to avoid subsidizing the replication of each type of project in different countries. For this purpose, countries could be grouped along several interactive dimensions which could include some or all of the following:

- Geographic distribution
- Income per capita and its rate of change
- Stage of market development, including such aspects as the tradition and history of market mechanisms, economic efficiency of national policies, and degree of price liberalization
- Availability of energy resources, current mix of fuels, and principal patterns of consumption
- Degree of urbanization
- Average educational level, particularly for women
- Rate of growth in population.

Such a grouping of projects and countries would facilitate coordination in project selection and help to develop a balanced portfolio. The GEF can do most to advance the overall objectives of the Climate Change Convention by supporting a mix of projects ranging from those which offer inexpensive, short-term carbon reductions, to others which lay the foundation for capturing more substantial, long-term benefits. These larger, long-term global benefits will result from shifting national economies to development trajectories along which GHG concentrations can be stabilized at levels that do not

exacerbate the risks of anthropogenically-induced climate change. But affecting this shift in trajectory will, in some cases, require institutional restructuring, policy reform, and capacity building, as well as the development of technologies to improve efficiency and emit less GHGs.

Meeting this challenge and making a smooth transition to a sustainable, low-emissions trajectory will require the development of a comprehensible and transparent calculus for estimating the agreed incremental costs of appropriate measures, and distributing the necessary resources to developing countries as an incentive to implementing them.

5 The Calculus of Incremental Costs

Before estimating the incremental costs of a measure, project, or program, it is necessary to develop a framework within which to place specific elements of total costs. This chapter proposes some simple operational definitions along with a taxonomy of costs and benefits. It then discusses some of the constraints in characterizing the damage function associated with rapid climate change, identifies the cost frontier for GEF projects, and finally highlights some of the special considerations applicable to developing countries.

A taxonomy of costs and benefits

As the negotiations concerning the financial mechanism of the Climate Change Convention proceeded, there was a general realization that "new and additional funds" would have to be made available to developing countries as an incentive for measures to provide global environmental benefits above and beyond those actions required to meet their national development goals. It was also recognized that some of the measures that might be taken for the purpose of achieving global environmental benefits might simultaneously generate local benefits—both economic and environmental.

In the case of many abatement and mitigation measures, some of these economic and environmental benefits will be appropriated as short-term direct benefits by the local economy in the implementing country, creating valuable goods and services in an efficient and cost-effective manner. But most of the long-term benefits that result from reducing the risks of global warming will devolve to other regions of the global economy and the global environment, and will be essentially invisible to the local economy of the implementing country.

For reasons discussed before, it is extremely difficult to estimate with any confidence the value of either the global environmental benefits, or the long-term indirect benefits to the local economy. It is, however, possible to estimate today the cost of proposed investments and alternatives. It may also be possible to estimate the direct short-term benefits to the local economy.

Incremental costs

The Convention does not obligate the GEF to underwrite the full cost of measures taken by developing countries in fulfillment of their obligations under the Convention. (An explicit exception is made in the case of measures taken to provide national emissions inventories and certain other reports.) The GEF is, however, charged with the responsibility of financing the incremental cost of measures taken by developing countries to achieve the overall objectives of the Convention. In order to fulfill this responsibility, a proposal follows for an operational definition of incremental costs as it may be applied to proposed GEF projects.

Because the economic value of the mix of global and local benefits resulting from GEF investments are difficult to determine, the GEF could use a method for analyzing incremental costs that focuses strictly on the estimated costs of proposed projects and

compares them to the costs of the next best alternative that delivers the same service to the local economy. Specifically, the *gross incremental cost* of a proposed GEF project could be defined as the *difference* between the total cost of measures taken to implement the proposed project (which will deliver a mix of local and global benefits) and the cost of the least expensive, locally available alternative that could deliver the same principal service to the local economy, and which would be implemented absent an international subsidy, being part of the country's baseline development plan.[4]

Let TC_p = Total discounted cost of the proposed GEF project

TC_A = Total discounted cost of the least expensive alternative project capable of delivering the same principal service to the economy

GIC_P = Net present value of the gross incremental cost of the proposed GEF project

Then $GIC_P = TC_P - TC_A$.

King (1992) offers an alternative similar to this proposed definition of gross incremental cost that is applicable at the project level (noting that it only applies fully to mutually exclusive sets of alternative projects). He notes that many analysts have focused attention on the net cost of proposed projects (total costs minus domestic benefits) and mistakenly identified these as the incremental costs. He then proposes a refinement to the concept of incremental cost as being the incremental cost less the incremental domestic benefits.

There is much merit in King's approach. Recognizing that projects funded by the financial mechanism of the Convention can, like many other public works, have multiple benefits, it is important to separate those benefits that are inextricably connected to the objectives of the Convention from the benefits that devolve solely to the local economy. For example, a project to improve the efficiency of an industrial installation and, in the process, to substitute natural gas for coal in on-site boilers, will have several important benefits. It will reduce CO_2 emissions as a result of both fuel substitution and improved efficiency. In addition, it will generate a direct financial benefit to the enterprise —the economic value of the fuel saved. The GEF should pay the cost of the improvements in efficiency and the boiler retrofits, as well as any training necessary to use the new devices. But it would only seem fair that the estimated net present value of the direct economic benefits from the GEF project that are in excess of the net present value of the direct economic benefits of the baseline alternative, such as the avoided cost of the unburnt fuel, should be deducted from the GEF subsidy to the project. Thus the gross incremental cost of the project less the direct economic benefits to the implementing country or enterprise could be defined as the net incremental cost or just the *incremental cost* for the purposes of the financial mechanism of the Convention. Thus,

Let GIC_P = Net present value of the gross incremental cost of the GEF project

DEB_P = Net present value of the direct economic benefits of the GEF project in excess of the direct economic benefits of the baseline alternative

IC_P = Incremental cost of the GEF project

Then $IC_P = GIC_P - DEB_P$.

The advantage of this incremental cost approach compared to the net cost approach is that it can be applied equitably with information that is likely to be available to task managers and project developers. It does not rely on a speculative estimate of uncertain future damages or unknowable global benefits. To the extent that this approach ignores the unquantified (and often unquantifiable) value of the systemic effects of the GEF project, it may overstate the incremental costs and the appropriate GEF subsidy.

[4] It is implicit in this context that the least-cost alternative project would be unlikely to deliver the same benefits as the proposed GEF project to the global economy or the global environment.

Unit Abatement Cost and Unit Incremental Abatement Cost

King (1992) has proposed several useful metrics for comparing the relative cost-effectiveness of proposed GEF projects. He suggests the concept of Unit Abatement Cost as a measure of the overall economic attractiveness of a proposed project. The Unit Abatement Cost is defined by King as follows:

Let UAC_P = Unit abatement cost

TC_P = Total discounted project cost

DB_P = Total discounted domestic benefits

AE = Physical quantity of emissions avoided or absorbed by the project

GV = Total value of one unit of GHG abatement or absorption

Then $UAC_P = (TC_P - DB_P)/AE$.

King suggests that the project is economically attractive if:

$$GV > UAC_P.$$

King proceeds to refine this metric further by defining the Unit Incremental Abatement Cost (UIAC) for projects in which incremental benefits exceed incremental costs, as follows:[5]

Let IC_P = Incremental cost of project P

IDB_P = Incremental domestic benefits of project P

IAE_P = Incremental quantity of emissions avoided or absorbed by the project

Then $UIAC = (IC_P - IDB_P)/IAE_P$.

The UIAC concept, King suggests, may be used to justify the choice of the more expensive of two mutually exclusive projects, if

$$GV > UIAC.$$

Direct, indirect, and joint project costs

Article 4, paragraph 3, of the Convention stipulates that the GEF will pay the "agreed full incremental costs" of measures taken by developing countries to meet the objectives of the Convention. The introduction of the word "agreed" into this paragraph was intended to indicate that the developing country and the GEF would need to reach consensus on the proposed project and its estimated incremental costs.

In addition to the direct costs of a proposed project—capital and running costs of the hardware, software, and personnel training—the Convention suggests a number of other indirect and joint costs that can appropriately be included in the financing arrangements. Indirect costs include the measures or activities that might be undertaken in conjunction with a proposed project in order to facilitate the later deployment at lower costs of similar technology in related applications. These indirect costs are associated with measures to eliminate market failures, including actions taken to improve the flow of information, lower barriers to market penetration, and improve the efficiency of local markets or institutions.

Some of these measures may, however, generate important short-term benefits to the local economy or relieve other local environmental problems. The Convention was not intended to underwrite these strictly local benefits. The part of the indirect costs which generate these additional benefits may be treated, in accounting terms, as joint costs.

One of the factors which complicates the calculation of such joint costs is the presence of systemic effects resulting from the introduction of the project. Systemic effects are the impacts of specific projects or measures on the existing institutional infrastructure which change the value (and potentially the cost) of a project over time. For example, a project

[5] In this context, the incremental project cost, IC_p, is not defined as net of incremental domestic benefits.

which introduces energy-efficient lighting into a utility service territory may change both the scale and magnitude of the future load curve. It may also change the planning practices of the utility in ways which open up previously "forbidden" or invisible options. The presence of these new options and the altered shape of the load curve may change both the estimated value and the cost of the energy-efficient lighting. Since the size of future benefits and the precise magnitude of joint costs will be difficult to determine in an objective fashion *a priori*, an arbitrary rule is proposed below for allocating the associated costs between the GEF and the country or enterprise implementing the project.

Before taking up the allocation rule, however, it is important to establish the accepted range of indirect costs that can appropriately be introduced into the economic calculus of GEF-supported projects. These include, *inter alia*, the following elements:

- Activities to promote and cooperate in the "development, application, and diffusion, including transfer, of technologies, practices and processes that control, reduce, or prevent anthropogenic emissions of greenhouse gases"
- Activities and measures to promote "sustainable management, and promote and cooperate in the conservation, and enhancement...of sinks and reservoirs of greenhouse gases...including biomass, forests, and oceans as well as other terrestrial, coastal, and marine ecosystems"
- Activities that "take climate change considerations into account, to the extent feasible, in...social, economic, and environmental" policy formulation
- Measures that "promote and cooperate in scientific, technological, socio-economic and other research, systematic observation, and development of data archives related to the climate system"
- Initiatives that "promote and cooperate in education, training, and public awareness related to climate," including those activities that promote the "full, open, and prompt" exchange of scientific, technological, socioeconomic, and legal data or expertise.

These aspects of *Article 4*, paragraph 1, suggest that GEF project loans should support the building of institutional capacity in developing countries, as well as the expeditious development of new partnerships between governments and enterprises which would facilitate the transfer of advanced technologies. *Article 4* also empowers the GEF to finance the implementation of resource surveys and the analyses of existing resources, the formulation of innovative policy initiatives to integrate considerations of the climate issue into national development strategies, and the establishment of broad educational programs to heighten public awareness of the implications of rapid climate change. Such programs can, and should, be designed to encourage the broadest possible participation in these processes, including that of non-governmental organizations (United Nations 1992).

Since some of the activities listed above will have both national and global benefits, it is necessary to weigh carefully the share of gross incremental costs that should be agreed for financing under the Convention. Few of the shared benefits of these activities will have easily measurable direct economic effects on the local economy. To avoid an extended analytic process that might lapse into an intellectual quagmire, one possible rule for dividing such joint costs could be to split them in half. If the implementing country wished to include such activities as part of the agreed incremental costs, the estimated investment could be divided equally between the GEF and the host government. Compared to the financing of hardware and equipment, such an arrangement might more easily be implemented for underwriting these "soft" costs because they can often be paid in local currency rather than from scarce foreign currency reserves.

Calculating the shadow price for GHG abatement

Anderson (1992) has suggested two alternatives for calculating the value of GHG emissions which can be avoided or reabsorbed. The first approach is best applied when a clear threshold of danger or vulnerability from GHG accumulation has been conclusively established through a consensus among the scientific community or the through the political process of the negotiations of the Convention. Anderson estimates the value of one unit of GHG abatement as the cost of deploying a backstop, low-emissions technology for a period long enough to postpone crossing the agreed threshold of danger by one unit of time. He treats this

parameter as a proxy for the size of the carbon tax that would be needed to bring forward the date of full deployment of renewable or zero-emissions technologies to replace fossil fuels. Following the Hotelling rule for valuing depletable resources, he estimates this proxy for the carbon tax, C_t, as follows:

Let n_T = Marginal cost of non-fossil, backstop technology in year T

f_T = Marginal cost of fossil technology in year T

T = Year in which the baseline or business-as-usual scenario would cross the threshold of dangerous accumulations

r = Real discount rate

Then $$C_t = (n_T - f_T)(1 + r)^{-(T-t)}.$$

In this formulation, C_t represents the shadow price of measures to delay the crossing of the danger threshold. It also represents the upper limit on the reasonable value that could be set for the UIAC. This innovative approach is elegant and intrinsically attractive. But it is difficult to apply at present when there is no consensus on either the magnitude or the expected date of crossing the danger threshold in the baseline scenario.

The second approach offered by Anderson for estimating the shadow price of emissions reductions is more easily applied in present circumstances, and does not require a direct estimate of the damages due to global warming. This alternative does, however, require two other pieces of relatively uncertain information, being critically dependent on:

- The prospective costs of solar or other non-carbon backstop technologies
- The time profile of future investment in these technologies.

Anderson notes that the future costs of the backstop technologies will vary over time, depending on their application or market niche. The profile of future investments will be determined by a variety of factors including the future price and availability of fossil fuels, the Research & Development policies of governments, and the investment strategy of the GEF itself. Based on a series of simulation studies of different distributions of investments in solar, wind, biomass, and other renewables, Anderson estimates a stream of values for avoided emissions starting at US $35 per ton of avoided carbon emissions today, rising at a rate of approximately 10 percent per year to a limit of approximately US $600 per ton in then current dollars. Alternatively, he suggests a constant figure of US $35 per ton, so long as this figure is not discounted in cost comparisons based on net present value analysis. Although other analysts have suggested possibly lower costs for solar and other backstop technologies, these estimates could serve as a useful upper limit on Unit Incremental Abatement Costs funded by the GEF.

Uncertainties, non-linearities, and surprises

As the Danish atomic physicist Nils Bohr once noted, the only thing which is certain about the future is the persistence of uncertainty. With respect to climate change, the main uncertainties pertain to regional impacts. Scientists cannot yet predict these with any confidence and are unlikely to be able to do so for many decades. The same can be said of any estimate of the value of expected future damages.

What is perhaps equally troubling is the inability of scientists to identify or quantify the principal feedback mechanisms that could trigger an accelerated response to future emissions. The threshold of concentrations marking the danger point before rapid climate change and the extent of future damages cannot be determined. Most scientists agree that there may be feedbacks, both positive and negative, that are still unknown, but which could significantly alter the response of the climate system in the future.

Absent this information, but aware that local and regional climates are the physical manifestation of interactions between a complex set of closely coupled non-linear systems, it is highly probable that there could be major surprises ahead in terms of climate. It could be that all the unknown factors will be negative feedbacks that damp out the effects of global warming due to the continued accumulation of GHGs. It is more likely that some of the feedbacks will be

positive and, at some future point, may trigger (at least temporarily) a rapid deterioration of some regional climate regimes.

The uncertainty regarding the threshold of dangerous accumulations and its rate of approach affects the estimates of the value of avoided emissions. Anderson estimates that a delay of one decade in crossing the threshold (for example, if it were fifty years hence instead of forty years) would lower the value of avoided emissions to about US $12 per ton. By contrast, an acceleration in crossing the threshold would raise the value of avoided emissions to approximately US $75 per ton.

The optimal value and the most appropriate rate of discount to apply will remain a matter of judgement. Only the results of future climate research and investigations into the manufacture and deployment of backstop technologies will allow a refinement of these estimates in the future.

Special concerns of developing countries

As developing countries consider measures to address the risks of global warming, they are confronted by several hard choices. The immediate pressures of survival caused by crises in health, education, nutrition, energy, and sanitation outweigh any competing claims on the limited funds available.

Some of the largest consumers of capital in the developing world are electric utilities. These institutions are also a major source of GHG emissions. Like many institutions in developing countries, the electric utilities are in a triple bind (Jhirad and Mintzer 1992):

- They are chronically short of capital, especially hard currency
- They are suffering from declining technical and economic performance
- They face calls for increasingly stringent environmental regulation.

Like other institutions in this predicament, electric utilities will be reluctant to invest scarce hard currency in new emissions-reducing technologies. They will be more responsive to such environmental requirements if:

- They are subsidized by the GEF
- The domestic share can be contributed in local currency
- The domestic share can be used to cover the indirect costs that will make direct investments more effective.

The GEF can facilitate their involvement by:

- Including some of the indirect costs in the project package
- Encouraging policy reform
- Providing training and support to local managers.

6 Issues Shaping the GEF Portfolio

Several issues will shape the portfolio of the GEF as it moves beyond the Pilot Phase to GEF II. A key question relates to the balance to be achieved between so-called Type I and Type II projects.

Type I and Type II projects

During the pilot period, a distinction was established between Type I and Type II projects. In Type I projects:

- Domestic benefits are greater than national costs
- Distinct global benefits also exist.

Examples include waste-reduction and efficiency-improving projects, and cover measures such as the capture and commercial sale of flared gas. These projects usually have low UIAC and are, in principle, economically attractive for the implementing country or enterprise even without GEF support.

In Type II projects:

- National costs exceed direct domestic economic benefits
- The sum of global and domestic benefits exceed national costs.

Projects of this type include most photovoltaic applications, wind electric systems, biomass use, afforestation programs, fuel cells, and some advanced efficiency-improving technologies (Anderson 1992).

Anderson emphasizes the important differences in the implications and roles of the two types of projects:

- *Type I projects.* These are likely to have a predominant effect on local environmental problems and are critical for meeting the needs of national economic development. They are projects of the kind typically financed by Official Development Assistance.
- *Type II projects.* These principally address global environmental problems. They are more speculative in their economic returns and less likely to be funded by traditional forms of development assistance.

As Anderson notes, Type II projects are appropriately a higher priority for the GEF. Although they are typically more complex and more expensive per unit of emissions reduction or sink expansion, these projects have the potential to reduce the long-term costs of the required transition to non-fossil fuels. Type II projects may also open up new markets for joint commercial development by enterprises in developing and industrialized countries. Thus, if supported by the GEF in a way which encourages participation by private enterprises, such projects can be a fulcrum for sustainable development in many countries.

Contributions by the GEF to Type II projects can lead to future reductions in the cost of follow-on manufacturing. These future cost reductions, capturing economies of scale in manufacturing that are the result of "learning by doing," represent an important global

benefit that will remain hard to quantify for many years (Anderson 1992).

Calculating incremental costs: the problem of the baseline

To calculate the incremental costs of a proposed project, it is necessary to have something to compare it to. When two alternatives are mutually exclusive, the situation is relatively less complex; for example, when a decision is required to replace a proposed coal plant for electricity with a geothermal or natural gas system.

When, however, the alternatives offer advantages in different but related areas, the pros and cons can acquire a daunting complexity. A possible situation could involve a choice between replacing an old oil plant with a new, advanced combustion turbine that burns natural gas, or investing in a program of energy-efficient lighting.

In both cases, the comparison is very sensitive to a series of input assumptions. The most important of these constitute the baseline against which the proposed investment will be compared. King and Munasinghe (1992) observe that the selection of the baseline may alter the estimated value and costs of the proposed programs or measures. If the baseline is built on current trends, it may ignore simple, cost-effective reforms which are not due to global warming. If, on the other hand, the baseline assumes that "best practice" technology is employed, only theoretically "true" incremental costs will be calculated and the resulting picture will be wholly divorced from reality. King and Munasinghe conclude that the baseline chosen will reflect a number of operational considerations, and no uniform homogeneous rule can apply.

The calculation of the baseline scenario for any country is necessarily problematic because it involves a counterfactual analysis. It is difficult to ascertain the policies and projects that would be implemented absent the GEF subsidy. Indeed, the availability of the GEF subsidy may induce countries to politicize the characterization of their baseline scenarios in order to maximize the expected subsidy. Even without such concerns, serious questions arise over whether the baseline should include all negative-cost measures that would be economically advantageous for the country to implement even without an international subsidy, or only those measures in which the government vests sufficient importance to allocate some of its chronically scarce investment funds.

The importance of better information

Investment decisions made by the GEF will unavoidably be made in the face of continuing uncertainty. The uncertainties persist through every level of the analysis. There are fundamental scientific uncertainties about the workings of the climate system and the relationship of the greenhouse problem to other atmospheric problems, including stratospheric ozone depletion and acid deposition. There are technological uncertainties about the characteristics, costs, and availability of a variety of response options. There are economic uncertainties concerning the rates of growth of national economies and of national energy demand as well as price levels, elasticities, and population distributions among income groups. Finally, there are uncertainties about the policies that will be implemented by governments—both with respect to climate change and to national priorities.

In the face of these uncertainties, perhaps the most valuable thing that the GEF can do is to invest in better information. In terms of the evaluation of all Type II projects, but especially in the case of solar, wind, and biomass systems, better information about the resource base is urgently needed. Very few developing countries have up-to-date and accurate data on solar availability, wind regimes, soil characteristics, land-use patterns, or precipitation trends. Resource surveys conducted by local institutions are an inexpensive solution which could dramatically improve the ability of domestic experts to evaluate future project alternatives.

Innovative and systematic programs for project monitoring and evaluation are essential to the long-term success of the GEF. Such programs should include an emphasis on costs and emissions but also highlight the lifetime and performance of projects. The ability of projects or new systems to fit in smoothly with local institutions will also be important to evaluate. By developing well-documented data on the performance of different designs under alternative conditions, GEF task managers will get a better idea of what works, what doesn't, and how costs can be reduced in the

future. Training local institutions, including universities, independent research institutes, and non-governmental organizations to perform these monitoring and evaluation tasks could increase local levels of competence and build a broad base of local support for the GEF.

Investment criteria and project selection

The principal goal of GEF projects should be to work toward the overall stabilization objective of the Convention. Although emphasis must therefore be placed on investment in innovative technologies that can have a large impact on future emissions, substantial investments should also be made to increase the local capacity to develop, manage, and evaluate these innovations. In some cases it will make sense to invest in Type I projects that offer the potential for inexpensive early emissions reductions or sink enhancements. Such projects will be especially interesting if they offer new information about how to overcome market failures, increase the efficiency of existing institutions, or facilitate the adoption of innovations by indigenous communities.

The GEF could also underwrite some experiments in the financial bundling or packaging of small projects in order to minimize transaction costs and spread the opportunities for participation in the overall process.

One of the obvious keys to reducing future costs of Type II projects will be through technology demonstrations which graphically illustrate the potential of the chosen technology. In doing so, it is not necessary to employ the most advanced or radical design. It may even be more valuable to employ well-tested designs in systems that involve innovative institutional relationships, advanced training programs, sophisticated monitoring systems, and challenging approaches to integrating such innovations into local communities. In this way, it may be possible to maximize learning by doing while minimizing the chances of outright failure.

7 Proposed Work Program

The principal elements of the GEF work agenda related to the issues discussed in the foregoing chapters will be carried out through the Program for Measuring Incremental Costs for the Environment (PRINCE). The GEF Administrator, working closely with the Chairman and members of the Scientific and Technical Advisory Panel (STAP) of the GEF, will undertake a series of special studies covering key methodological, strategic, and institutional issues raised by the development of an operational definition of agreed incremental costs. Specifically, the PRINCE program will include:

- Conceptual and methodological studies regarding pragmatic options for defining full incremental costs
- Studies outlining procedural and institutional options for reaching agreement on incremental costs, and means by which conflicts could be resolved
- Recommendations on specific approaches for involving the private sector
- Recommendations on new and innovative approaches to financing agreed incremental costs
- GHG-abatement strategy studies developed on a country basis
- Seminars, workshops, and other modes of training.

In terms of building local capacity, the GEF could consider facilitating the formation of a network like the Consultative Group for International Agricultural Research (CGIAR) to build on the expertise already available in certain regions. The competence of existing institutes could be enhanced to serve as focal points for the regional development of key technologies, such as renewable and energy-efficient technologies. Such institutes could also serve as repositories of data for monitoring and evaluation activities. By principally employing citizens of the host region, these institutes could make a major contribution to its human capital, and also increase public awareness about the climate problem. These institutes could also be used to encourage and facilitate the emergence of new partnerships between private enterprises in developing and developed countries.

By encouraging local enterprises to participate in these partnerships, the GEF could increase their learning experience, help them to capture economies of scale in the production of advanced technologies, and improve their economic competitiveness on a global scale. These new partnerships would have the added benefit of building closer trade ties between developing and developed economies. If such partnerships are successful, the shared economic rent from these innovative technologies could help to offset the net capital outflow that now proceeds from South to North.

Strengthening the Convention process

By distributing investments among the Bank's regions and among countries with different historical experience, the GEF could illustrate the varied responses to the global problem of climate change. By offering participation in innovative investments to a broad cross-section of countries, the GEF could help many countries to "buy in" to the Convention process.

If the GEF succeeds in developing a carefully balanced selection of project technologies, much new information will be gained about resources, emissions characteristics, and the costs of various response strategies. This information could point the way toward smooth transition strategies by minimizing avoidable mistakes, and spreading the economic rewards of innovation over many sectors. This would help individual countries recognize new opportunities and keep their options open while contributing to global efforts to reduce the risks of rapid climate change.

Through its support of the indirect costs of national response strategies, the GEF could help its members to identify, test, and evaluate innovative strategies for regulatory and institutional reform. Many of these response strategies could create benefits for the local economies which adopt them, benefits that go far beyond their effects on GHG emissions or reabsorption by natural sinks.

8 Conclusions and Recommendations

The risks of rapid climate change are principally associated with the accumulation of carbon dioxide and other GHGs in the atmosphere. The timing and extent of future regional impacts are presently unknown and will remain uncertain for decades to come. Feedbacks and other complex interactions between the climate system, the ocean, and the biota may accelerate the pace of climate change, and trigger a non-linear response to even small future increases in concentration.

All countries contribute to the emissions of GHGs. Economically important activities in all major sectors of the economy release such emissions. In the last two centuries, emissions of these gases, especially due to activities in developed countries, have transformed the natural background greenhouse effect into the greenhouse problem. As a result of this historical accumulation, national economies and natural ecosystems are threatened by the risks of rapid climate change.

The GEF, designated as the interim financial mechanism of the Climate Change Convention, has an instrumental role to play in mobilizing the international response to global warming. The GEF is charged with financing the full cost of reporting requirements under the Convention and the agreed full incremental costs of measures taken by developing countries to achieve the overall objective of the Convention. The relevant measures are outlined in *Article 4*, paragraph 1, of the FCCC.

The incremental costs of measures taken to achieve the objectives of the Convention should be defined as the difference between the full cost of those measures, and the sum of the cost of the least expensive way to deliver an equivalent economic service to the local economy, plus the direct, short-term economic benefits to the local economy that would result from the proposed measures.

The incremental costs of measures covered by the GEF should include both the direct costs of hardware, software, and training, as well as the indirect costs associated with overcoming market failures, institutional obstacles, and other barriers to market penetration. These indirect costs are identified in the Convention as including measures to promote technology development and transfer; resource assessment and data collection; training and scientific exchange; and enhanced public awareness of the climate problem. Where such indirect costs clearly generate both local and global benefits, the GEF should pay up to one-half of the incremental costs.

The GEF should encourage and underwrite projects which generate valuable new information on:

- Advanced technologies and their deployment
- Innovative adaptive responses
- Institutional reform
- Successful technology transfer.

The GEF should also support the development of local capacity, and the creation of new partnerships

between governments and enterprises in developing and developed countries. An especially valuable approach to achieving this goal would be for the GEF to support the formation of a CGIAR-type network of institutions of high repute to provide expertise on the deployment and application of renewable energy and energy-efficient technologies.

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