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JOINT IMPLEMENTATION AFRICAN PERSPECTIVE

a cooperation between
ACTS and CICERO

involving

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FOREWORD

This book is a result of a constructive cooperation between the African Centre for Technology Studies (ACTS) in Nairobi, and the Center for International Climate and Energy Research (CICERO) in Oslo.

The report is built on several recent papers from the two institutions which have been presented at various international conferences. It is hoped that this book will assist in making the issue of Joint Implementation better understood among African countries and other, interested in what this mechanism might have to offer, beforethe upcoming discussions at the First Conference of the Parties to the United Nations Framework Convention on Climate Change, which is going to take place in Berlin, in March/April 1995.

We would like to thank our CICERO colleagues Jan Fuglestvedt, especially on chapter 1.3 and 3.3, and also Cathrine Hagem, Bjart Holtsmark, Lasse Ringius and Asbjørn Aaheim, for valuable contributions and assistance in writing this book.

........from ACTS ....

EXECUTIVE SUMMARY

The United Nations Framework Convention on Climate Change establishes no legal commitments for any of the Parties to reach specific targets of reduced greenhouse gas emissions. Although the Convention emphasizes the importance of immediate action by the industrialized countries, it is weak with respect to incentives for the industrialised countries to take the lead in fighting global warming. The distribution of costs and benefits between countries is essential for mobilizing collective action. For many political and economic reasons, the best international policies are those that are cost-effective and perceived as fair.

This book focuses on attractive greenhouse gas abatement arrangements under the UN Climate Convention, in particular the mechanism of Joint Implementation. Before it is concluded whether Joint Implementation is a useful and promising mechanism, it is necessary to understand the motives behind it, the opportunities for common benefits, as well as the need for equitable rules and regulations. Accordingly, a number of cost and benefit issues with regard to Joint Implementation are analysed.

It is concluded that Joint Implementation under certain circumstances is an effective and attractive instrument for reducing global greenhouse gas emissions. Joint Implementation may also create an opportunity to assist a large number of countries in becoming more energy-efficient and in promoting a sustainable development. However, it is essential that potential problems concerning proper selection of Joint Implementation projects, uncertain abatement effect and consideration of strategic behavior and incentive problems be addressed in an efficient manner.

Due to the climate conditions of Africa, and economies heavily dependent on natural resources, African countries are likely to be particularly vulnerable to climate change. Thus continued participation in the climate process will be in the interest of African countries. In the near future participation in JI demonstration projects should be an attractive option. Demonstration projects can also play an important role with respect to capacity building in African countries.

CHAPTER 1
INTRODUCTION

1.1 THE THREAT OF CLIMATE CHANGE

The threat of climate change was the reason for more than 150 countries to sign the United Nations Framework Convention on Climate Change (FCCC) in Rio de Janeiro in June 1992. The Convention calls for a global effort and cooperation to stabilize greenhouse gas (GHG) concentrations in the atmosphere at a level that would prevent dangerous anthropogenic[1] interference with the climate system. A stabilization of GHG consentration will imply a consireable reduction in the growth of emissions.

The Intergovernmental Panel on Climate Change (IPCC) affirms in their most recent report their earlier basic conclusions.[2] The report concludes *inter alia* that "a stable level of carbon dioxide concentration at values up to 750 ppmv[3] can be maintained only with anthropogenic emissions that eventually drop substantially below 1990 levels."

Unless strong counteractive measures are introduced the expected emissions in the coming decades will quickly outgrow the political commitments made by the Annex I countries to stabilize their GHG emissions. The expected global growth of carbon dioxide emissions - 21.7 billion tons in 1990, 25.1 billion tons in 2000, and 32 billion tons in 2010 - makes the present commitments under the FCCC seem highly inadequate.[4] Solving the climate change problem will necessitate significant changes in future energy consumption, as well as changes in the consumption behavior in many affluent societies. It furthermore presents an unprecedented challenge to cooperation between industrialized and developing countries.

A global stabilization of carbon dioxide emissions has been estimated to cost about 1.5 percent to

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[1] Anthropogenic means human made.

[2] WMO/UNEP (1994)

[3] ppmv = parts per million by volume. 750 ppmv is double of todays level.

[4] IEA, World Energy Outlook (Paris, 1994)

2.5 percent of the world GNP in the first half of the 21st century and about 3 percent in the second half.[5] The realization that financial resources are scarce, especially with regard to global environmental issues surrounded by scientific uncertainty, is therefore reflected in the Convention text. Among the principles adopted by the Parties, it should be taken 'into account that policies and measures to deal with climate change should be cost-effective so as to ensure global benefits at the lowest possible cost'.[6]

In 1992, the Intergovernmental Panel on Climate Change (IPCC) concluded that GHGs are accumulating in the atmosphere due to human activities. The IPCC also concluded that the global mean surface air temperature has increased by 0.3 to 0.6 ^{0}C over the last century. The rapidly increasing energy consumption in developing countries is expected to result in the developing countries accounting for more than 55% of the GHGs by the year 2000 and 79% by 2030. This scenario has increased the need for cooperation across national borders to increase energy efficiency and conservation, also in developing countries.

An illustration of the expected growth of carbon dioxide emissions is given in Table 1.1 below.

Table 1.1 World CO_2 emissions from industrial sources by region under different Scenarios (billion tons)

		% change 1990 - 2010		
Group of countries	1990	Refer-ence	High growth	Low growth
OECD	10.4	28.4	34.1	22.0
Former Soviet Union, and Central and Eastern Europe	4.8	-3.7	3.2	-7.1
Latin America	1.0	84.4	108.3	66.5
Africa	**0.7**	**81.5**	**106.0**	**64.0**

[5] Cline (1992)

[6] FCCC, Article 3.3

Middle East	0.7	117.7	150.2	93.4
East Asia	1.0	167.8	212.2	121.6
South Asia	0.7	148.8	221.9	101.3
China	2.4	109.3	130.4	69.5
World	**21.6**	**47.6**	**61.5**	**33.6**

Source: World Energy Outlook, International Energy Agency (1994). Totals may differ from the sum of individual components due to rounding of figures.

As stated in the table, Africa is on the low side both on todays emissions and on the expected growth of emissions. From Africa, Asia and Latin America, however, a large proportion of their emissions are coming from land use change as shown in table 1.2. The African contribution of carbon dioxide in 1990 was estimated to be about 7% of the world's total anthropogenic emissions including emissions from land use changes.[7]

Table 1.2 CO_2 emissions from Fossil fuels, industrial sources and land use change in1990. (billion tons)

Region	Solid	Liquid	Gas	Gas Flaring	Cement prod.	Land Use Change	Total
Africa	**0.27**	**0.26**	**0.05**	**0.0 5**	**0.02**	**1.50**	**2.15**
North & Central Am.	1.96	2.62	1.11	0.0 2	0.06	0.42	6.18
South Am.	0.07	0.35	0.10	0,02	0.02	1.80	2.36
Asia	3.15	1.95	0.39	0.07	0.26	2.60	8.41
Europe	1.97	1.62	0.62	0.02	0.12	-	4.35
USSR	1.33	1.24	1.13	0.04	0.07	-	3.81
Oceania	0.15	0.10	0.04	0		0.01	0. 30
World	**8.76**	**8.86**	**3.47**	**0.21**	**0.56**	**6.40**	**28.20**

Source: WRI (1992) Totals may differ from the sum of individual components due to rounding of figures.

[7] World Resources Institute (1992-93)

The low proportion of emissions from Africa should not, however, be a pretext for African countries to sit idle and leave the fight against global warming to other countries alone. Too much is at stake for Africa.

Scientists predict that global warming will seriously affect our ecology and infrastructure, and relate directly to important issues like food security, disaster preparedness, land and resources management, and institutional capabilities, among others. Climate change is therefore expected to have a profound impact on fragile economies and vulnerable societies found in many African countries. Many African economic systems, socio-cultural and political systems depend directly on the access to natural resources that support agriculture, industry and tourism. The very basis for agricultural production is stimulated by the soil conditions, the moisture, quality, texture and cultivability of which are vulnerable to climate change. Besides domestic animal farming and wildlife depend on water and natural vegetation whose availability are influenced by rainfall, soil productivity and humidity.

An African Climate Conference, organized in 1990 by the African Centre for Technology Studies and Woods Hole Research Center, concluded that "dry areas may become drier, while wet areas become wetter; as the agro-climatic zones shift, important cash crops may drop in yield; patterns of wildlife habitat and migration could alter, affecting national parks etc.; rising sea-level would increase flooding and salinization in many countries; and one might expect increasing severity of storms and increased variability in the weather."[8]

[8] International Conference on Global Warming and Climatic Change: African Perspectives, Nairobi 2-4 May 1990.

These fears were affirmed in the recent conference on "Policy Options and Responses to Climate Change" held in Nairobi in December 1994.[9] It underlined a number of expected impacts on African countries and agreed that:

> "Africa's ecosystems and socio-economic systems are most vulnerable to possible adverse effects of climate change. African countries must therefore be fully actively involved in the international negotiations on mitigation and adaptation to climate change in particular to ensure North-South equity."

The Conference also noted that:

> "African countries experience inadequate financial, technical and human capacities. The lack of these resources, make it difficult for African countries to assess and face the impacts of Climate Change. It is observed that the international programmes aimed at helping African countries to address these issues are insignificant compared to the scale of the problem. It is therefore considered critical that Africa is well represented and positioned in the International Conventions and possible Protocols relating to climate change."

The responsibility of the industrialised countries to developing countries is recognised and explicitly expressed in the Convention. The Convention also states that developing countries must give priority to the pursuit of their development paths and targets. Our advice is, however, that African countries should, with the assistance of mulitilateral and bilateral partners, strive to to develop approaches to GHG abatement, and institutional capacity to adapt to climate change.

[9] Conference organized by African Centre for Technology Studies together with Stockholm Environment Institute

1.2 THE CLIMATE CONVENTION

The ultimate objective of the FCCC is to stabilize GHG concentrations at a level which will prevent negative effects on our environment. The Convention adds that "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."[10]

The FCCC entered into force on 21st March 1994 after receiving more than fifty ratifications. As of 6 February 1995, no more than 26 out of the 49 African countries which had signed the convention, had actually ratified the FCCC. The first Conference of the Parties (COP) to the Convention will take place in Berlin from March 28-April 7, 1995.

The Convention establishes a global legal and institutional framework, to support action by Parties to the Convention, to reduce emissions of GHGs and/or to increase sinks of carbon dioxide to prevent global warming. The Convention emphasizes that the industrialized countries have the main responsibility for the historic and current emissions, and must take the lead in combating climate change, and that the first priority of the developing countries must be to take care of their own economic and social development. Annex I countries have therefore, agreed to adopt national policies and measures to mitigate climate change, and have recognized the importance of establishing a goal of reducing anthropogenic GHG emissions to 1990 levels by the year 2000.[11,12] However, the FCCC presently establishes no legally binding commitments to reduce GHG emissions. Until reduction targets are legally binding in terms of quantities and time framework the FCCC's role in curbing GHG emissions will be uncertain and the incentives for emissions reductions will continue to be weak and insufficient.

The choice of negotiating a "framework convention" implied that the Parties wanted to concentrate on the principal issues and leave aside more specific elements for a later stage, either for inclusion in protocols or in other types of agreements to be designed subsequently. This choice also gave the "language" a more general character, often leaving room for further discussions, as is the case for the concept of Joint Implementation(JI).

The FCCC establishes a number of important principles to guide the Parties in implementing the provisions and achieving the objectives of the convention. It should be noted that the concept of JI is not defined precisely, and criteria for JI projects are not yet decided upon. It is nonetheless evident that the concept of JI refers to activities through which one or more countries (the investing country) contributes to the reduction of GHGs emissions by paying for an emissions-

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[10] FCCC, Article 2

[11] Annex I countries are the OECD countries, except Mexico, as well as 12 countries from Central and Eastern Europe with "economies in transition".

[12] FCCC, Article 4.2 (a)

reducing or sink-enhancing project in another country (the host country), and that this activity is credited against legal commitments under the FCCC.

1.3 THE MAIN CATEGORIES OF GREENHOUSE GASES

The FCCC states in Article 3, paragraph 3 that measures and policies to mitigate climate change should cover all relevant sources, sinks and reservoirs. Thus, as a point of departure, all greenhouse gases except those gases covered by the Montreal Protocol on Substances that Deplete the Ozone Layer should ideally be included in the JI mechanism. However, the knowledge about the sources and sinks and the climatic impact varies with regard to the different gases. Thus, the selection of gases that should be considered in JI projects needs careful attention.

Globally, the most important GHGs for the direct radiative forcing of climate is carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and halocarbons (mainly chlorofluorocarbons (CFCs)). Figure 1.1 shows the direct radiative forcing from the changes in these gases since pre-industrial times. These gases have atmospheric lifespans that allow the gases to be well mixed in the atmosphere, and this climate impact is therefore not dependent on the geographical location of emissions. The climatic effect of measures to reduce emissions or increase the strength of the sinks will also be independent of location.Against this background, joint efforts and cooperation on the implementation of measures between countries are a vital requirement.

There are large variations in the scientific knowledge about the climate impacts of the various gases emitted into the atmosphere (hereafter named source gases). Several gases have, in addition to their direct radiative effect on climate, also indirect effects on climate through interactions in the chemistry of the atmosphere.[13] The source gases that affect the radiative

[13] Isaksen et al. (1992), IPCC (1992), Lelieveld and Crutzen (1992), Hauglustaine et al. (1994), Fuglestvedt et al.

balance of the Earth/atmosphere and thereby climate, may thus be divided into three groups:

i) GHGs that have a direct effect on climate due to their radiative properties. Source gases such as carbon dioxide (CO_2) and perfluoromethane (CF_4) belong to this group.

ii) Gases which have no or onelya negligible direct greenhouse effect, but which indirectly affect climate through impacting on chemical and physical processes in the atmosphere. Greenhouse gases (GHGs) and compounds interacting with solar radiation may thus be affected. Nitrogen oxides (NOx), carbon monoxide (CO) and non-methane hydrocarbons (NMHC) are examples of such source gases.

iii) Source gases that possess the ability of affecting climate both directly and indirectly. Methane (CH_4), chlorofluorocarbons (CFCs) and hydrochloro-fluorocarbons (HCFCs) belong to this third group.

Table 1.3 Direct and indirect effects of some greenhouse gases

	Direct effects	Indirect effects
Carbon dioxide(CO_2)	x	
Perfluoromethane (CF_4)	x	
Methane (CH_4)	x	x
Chlorofluorocarbons (CFC)	x	x
Hydrochloro fluorocarbons (HCFC)	x	x
Nitrogen oxide (NOx)		x
Carbon monoxide (CO)		x

(1994ab).

The climate gases that will be affected by the indirect GHGs through atmospheric chemistry are mainly ozone (O_3) and methane (CH_4), but HCFCs and hydro fluorocarbons (HFCs) may also be affected. Indirect effects are recognized as potentially important, but for several gases the scientific knowledge is still unsatisfactory.[14] Extensive research is going on to reduce the uncertainties in our understanding of indirect effects.

Many gases can potentially be reduced through JI projects. Based on the status of the current knowledge it will be prudent to include the following gases in JI projects:

* Carbon dioxide (CO_2)
* Methane (CH_4)
* Nitrous oxide (N_2O)
* Perfluorocarbons (PFCs)
* Sulphur hexafluoride (SF_6)
* Hydrofluorocarbons (HFCs)

[14] IPCC (1992), (1994)

1.4 THE INCREASING NEED FOR ENERGY IN AFRICA

Burning fuelwood, bagasse and other agricultural residues including cow-dung is a main energy activity and a well known technology in use in African countries. The future demand for electricity from rural and urban areas is on rapid increase, and the future mode of energy production for these areas is expected to be a major issue in the time to come. Household energy demand and consumption in Africa are on a steady increase although contributions to emissions of GHGs are still considered insignificant at the moment. In some parts of Africa biomass is the main source of household energy. Households in the continent consume over 70% of the total energy, and mainly for domestic use.[15] But, a majority of African countries whose economies are mainly agriculture-based, have also developed agricultural processing industries that consume energy in one form or another. Besides, some forest land is usually cleared for agricultural activities. Such practices, including combustion of fossil fuels, land-use changes and cement production, contribute significantly towards GHG emissions. As Africa aspires to develop, expand economic growth and improve the social welfare of her people, the demand for energy will progeresively increase. For example, attempts to expand agriculture and increase land-use changes have brought about asituation in which 40% of Africa's carbon emissions are considered to be from closed forest clearing, 33% from open forest clearing and the rest from the conversion of forest fallow agricultural land to permanent agriculture.[16]

Industry and mining are other sectors in Africa that consume energy for industrial operations and mining processes. These sectors play a major role in African economies in terms of employment creation, generation of revenue for the governments, sustainability of domestic markets with locally manufactured products, improvement in balance of payments by reducing dependence on imported industrially manufactured products, and to some extent, encourage exports. Industry has also been the force behind access to or acquistion of modern technologies, and it provides opportunities for technological development in Africa. However, the industrial sector in Africa contributes about 0.06% of the total global GHG emissions.[17] One of the main sources of the CO_2 in the industrial sector is the CO_2 produced during the high temperature decarbonisation of carbonates during cement production. The mining process usually release CH_4 trapped underground into the atmosphere. The mining of oil and minerals in some of the African countries is seen as a diversification of an economy dependent on agriculture, but, their emissions need to be carefully checked.

As Africa continues to plan urban centres as well as residential areas, energy is needed to decompose or incinerate municipal, domestic, hospital and industrial waste. Since the decomposition of domestic waste generates CH_4, which is a GHG, there is need to accumulate

[15] Karekezi (1994)

[16] The Biodiversity Support programme, 1993.

[17] Karekezi (1994).

domestic waste in rural areas of Africa in one central place for energy utilization and reduction of GHG emissions.

The transport sector in Africa is composed of road, rail, air and sea activities. This sector has continued to grow at a fast pace as means of opening up Africa to the rest of the world and international markets. The main type of energy used in the transport sector is oil although coal is also used by trains and steamers. As the transport network continues to expand in Africa, the need for energy also increases. JI projects yielding fuel-switching and energy efficiency improvements could be employed to encourage sustainable energy use, reduction in the use of coal and more manageable energy systems of advanced technologies that convert solid biomass into a low BTU gas through gasicification and the use of this gas to power gas turbines, emissions of GHGs will be reduced.[18]

Table 1.3 gives a tentative sketch of three different energy scenarios for the low income countries in Africa. The idea is to underline the importance of the future development direction, as the most important mitigation measure against global warming in Africa's low-income countries. One can say, in simple terms that Africa's climate policy today must aim at avoiding the trap that scenario 1 represents. Falling fertility rates and demographic transition can only be a result of economic development. From a climate perspective it is important that this transition starts as soon as possible. A switch from scenario 1 to scenario 3 is difficult to achieve, especially because of the high rate of population growth, though to some extent also because of the fact that the deforestation and desertification it might induce, may be irreversible processes.

Scenario 3 should also be strongly encouraged because of the large investments which will be channelled into energy development projects in the near future. Whether these investments are for "fossil fuel" solutions or more environment-friendly solutions will have both a global and local effect for a long time to come.

One of the most effective measures of curbing GHG emissions, consistant with most development policies, is to provide the foundation for a reduction of the population growth. Whether there will be 1.6 billion Africans or more than 5 billion in year 2100 will be decisive for the level of GHG emissions from the continent.

[18]Goldenberg (1994).

Table 1.3 A tentative sketch of three different energy scenarios for Africa

	Scenario 1 Stagnation	Scenario 2 Growth	Scenario 3 Sustainable growth
Basic scenario characteristics	Slow economic development. This causes the fertility to stay high (delayed demographic transition) Slow trans-formation archaic societies	A successful development policy. Emphasis on education and health of women. Economic growth and rapid falling fertility rates (a rapid demographic transition)	
Population year 2100	High growth 3,0 - 5,2 billions	Low growth 1,6 - 3,0 billions	
Energy	Basically woodfuels and charcoal used in households. Slow introduction of other energy sources	Large investments in energy supply, mainly based on fossil fuels	Large investments in energy supply, mainly based on renewable energy sources. Extension of the electrical grid
Land management and deforestation	Weak governmental institutions are not able to secure property rights to forests, or to yield any other protection of these resources. Agricultural practices are not becoming more efficient. High population growth give a rising demand for fuelwood and pressure on scarce and often vulnerable resources	Strong governmental institutions are able to secure property rights or to make societies taking care of their resources in a sustainable way. A low population growth give an opportunity for better planning and management of agricultural and forest resources. An electrical grid and renewable energy resources reliee pressure on fuelwood demand	
Vulnerability	High. The archaic societies are more vulnerable to climate change	Lower. Modern societies are less vulnerable to climate changes because they have better developed institutions and are open to changes in their environment	
GHG emissions	When development is delayed, the high population growth makes it more difficult to initiate effective abatement measures	High, but the low population growth gives possibilities to work for abatement measures	Low emissions, both due to low population growth and the use of non-fossil fuels in the main energy production.
Total contribution to global warming	High due to a large population, increasing deforestation and land use change	High due to the use of fossil fuels, but not necessarily higher than in scenario 1 because of lower level of population growth and less deforestation and land use change	Low due to low population increase, use of renewable sources of energy or low-emission sources, and good land and forest management

1.5 MERGING DEVELOPMENT PRIORITIES AND ADHERENCE TO THE CONVENTION

The FCCC has acknowledged that developing countries need to increase their consumption of energy to meet their development needs. At the same time, these countries should find ways of mitigating climate change. The important issue at hand is how this increased energy use can be environmentally sound, both globally and nationally, and at the same time consistent with economic and social development priorities**.** JI may contribute to sustainable development, as emphasized in "Our Common Future", the Brundtland Report by the World Commission on Environment and Development.[19]

At the moment, JI offers opportunities for African countries to initiate and design cost-effective projects in the energy sector and relating to land-use, in particular afforestation. But, the dilemma for African countries are limited financial, institutional and human resources to take on JI projects. African development concerns have been mainly constrained by rapid population growth, declining economic performance, unfavourable weather conditions, and insufficient food supply, which results in vicious cycles of poverty. African development priorities have therefore, been focused on:

-poverty alleviation;
-improvement in agricultural performance;
-enhanced food security;
-diversifcation of agriculturally based economy into other forms of economic activites.
-ensuring political stability;
-strengthening local institutional capacity and human resources;
-improving information and communication systems for technological development; and
-improving health and educational facilities.

The recognition that Africa's emissions will continue to grow in future to allow for economic growth for the alliviation of poverty, should not be construed to imply that Africa's contribution to GHG emissions, which, at present is relatively small, should not be checked and controlled. The JI mechanism could be used to incorporate Africa's development priorities such as the ones mentioned above. These mechanisms could then start to incorporate African development priorities inmeasures of compliance with the Climate Convention. The following might be taken as guiding issues, in the formulation of JI projects in Africa:

-issues related to land use directly influence the management of public and private forest reserves. Thus land policy reform could be a basis for JI projects, as a basic strategy in the abatement of GHG emissions;
-the agricultural and livestock sectors involve activities which often form the economic lifeline on the continent but are at the same time recognized as sources of methane and other GHGs;

[19] World Commission on Environment and Development (1987).

-proper maintenance of forest reserves will provide carbon sinks and carbon reservoirs for global emissions of GHGs; improved management of the livestock sector will more directly limit national emissions of GHGs;

-the industrial, transport and energy sectors have significant and growing emissions, and they need to be specifically considered in the formulation of JI projects. For example, the recycling of industrial wastes and by-products that would produce harmful gases, their conversion into safe material, or the consumption of their gaseous releases, would form a fitting subject for a JI initiative. The transport sector, which particularly emits carbon dioxide (CO_2), should be a target of JI projects. Nitrous oxide (N_2O) emanates from the combustion of petroleum fuels[20] and this needs to be checked. The energy sector in Africa is considered to be one of the most significant in GHG emissions. This is because energy is widely used in the form of as domestic, industrial, transport and aviation fuels.

African countries, therefore, need to pursue effective negotiations at the COP with the industrialised countries, on the basis that the suppression of carbon emissions from industry and transport, is an important measure in the implementation of the Climate Convention, and should thus be accorded priority in JI initiatives.

[20] Zhou (1994)

CHAPTER 2
AFRICA AND CLIMATE CHANGE

2.1. THE AFRICAN ENVIRONMENT

"Climate change" refers to permanent changes in the traditional mean climatic conditions of the local environment.[21] Such changes will have major impacts on the environment. The Global Environment Monitoring System (GEMS) has made environmental assessments in the last 15 years.[22] The assessments of the impacts of global warming and climate change, the pollution of urban air and freshwater resources, the rate of degradation of tropical forests and the numbers of threatened species, including the African elephant, show a dramatic shift and reallocation of natural resources. This is because the ecosystems, natural resources, socio-economic and related activities are invariably adapted to the normal conditions of the local environment. In the recent and ongoing climate change debate and negotiations, the majority of African policy-makers have partially attributed their national socio-economic constraints, in relation to climate change, to droughts, floods, diseases, pests and other calamities. In an attempt to address these disasters, African national development plans have, as a general rule focused on alleviation of poverty, improvement of social welfare, and investment in income generating activities.

The continent is prone to a high degree of vulnerability to natural climate events. Africa faces severe land degradation resulting from agricultural activities, deforestation, human settlements, desertification, poor crop choices, and poor land practices. As scientists have noted, land deterioration is a severe threat to climate stability, Africa has a role to play in stabilising global climate conditions. The establishment of the African Centre for Meteorological Research and Development (ACMAD), by the OAU and the CEA, based in Niamey, Niger; the Drought Monitoring Centres of twenty-two countries in Eastern, Central and Southern Africa located in Nairobi, Kenya and Harare, Zimbabwe; AGRHYMET Centre in Niamey, IGADD, SADCC among others have been established for this purpose..

However, the majority of the regional and national climate change studies are financially and technically supported by United Nations bodies, Non-Governmental Organisations (NGOs), private individuals, and institutions outside Africa. It should be noted that the data required for multidisciplinary climate change studies, and for climate change monitoring and research facilities in Africa, is largely inadequate. More information on climate change issues needs to be generated and disseminated, and more awareness should be created through public education.

The availability of relevant information on climate change, would facilitate the determination of the vulnerability and strength of African natural resources, ecosystems

[21] Okoth-Ogendo, Ojwang and Silveira,(1994).

[22]UNEP (1993).

and national economies, in relation to climate change. It is, however, hardly possible to obtain such in relation to limited infrastructure, crippling research institutions, deteriorating economic activities, and unstable
political regimes. Yet African countries, by ratifying the Climate Convention, have assumed the responsibility of the undertaking national and/or regional climate change impact assessments; and for this purpose they will have to generate relevant information that can be used in monitoring climate change.

2.2. AGRICULTURAL PRODUCTION

The majority of the African countries are dependent on agriculture for their economic prosperity. The impact of climate change on agricultural systems occurs through a combination of increased atmospheric concentrations of $C0_2$, changed weather patterns, and change in cropping systems and marketing conditions. These factors lead to a distinct unpredictable pattern of agricultural practice. A study carried out in Niger, on the effects of rainfall change on agriculture, found that the timing of rainfall events for tilling the land, planting crops, weeding and crop harvesting were important in Africa.[23]

But, as climate change is expected to change weather patterns mainly through changes in temperature and precipitation, with possible significant changes in radiation and humidity, there would be a dramatic shift in agricultural output in Africa, since crops have different moisture requirement.[24] Untimely rainfall and temperature patterns would distort seasonal calendars for the African farmers. For example, a crop like millet is particularly sensitive to reduced rainfall during reproductive stages of growth. In Kenya, the driest 10% of the year overlaps with 30%-70% reduction in maize yields, and 15%-60% forage yields.[25]

There are potential effects of climate change on maize and a range of cash crops in Kenya, just like any other African country with similar climatic conditions.[26] Crop-climate simulation models indicated that maize production in Zimbabwe was correlated to land

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[23] Silvakumar, 1992.

[24]Hulme, M., et. al., 1994

[25]Akong'a, et. al., 1988.

[26]Ottichilo, et. al,. 1991.

use practices subjected to changes in water resources.[27] Climate change resulting from ehanced atmospheric CO_2 will contribute to changes in agro-climatic resources that would entail spatial shifts of land-use zones in Africa.

[27]Dowining, 1992.

The decline in agricultural production and food security in Africa, poses severe threats to the social and economic situation. For example, the effects of climate change on agricultural productivity in South Africa, Lesotho and Swaziland would significantly decrease food security. In South Africa alone, 89% of the land area is at present used for agriculture with about 35,000 ha of land lost annually to urban and industrial exapansion and afforestation.[28] Besides vulnerability to climate change, the increased demand agricultural land is pressurising agriculture into marginal areas with greater sensitivity to climate change.

2.3. WATER AVAILABILITY

The surface water runoffs in Africa will be greatly affected by changes in rainfall regimes. As a consequence of climate change and global warming, rainfall is expected to increase in gross amounts. But, the change in rainfall will be uneven and may decrease in some areas, Africa included. Scientists note that changes in rainfall will affect soil moisture, extreme events (floods and droughts), reservoir storage, ground water recharge, water quality, irrigation demand and rainfed agriculture.[29] Besides, changes in temperature, wind speed, humidity and the nature of distribution of vegetation will also affect water availability and runoffs. Studies examining the potential impact of climate change on African river discharge show that runoffs in the semi-arid areas of the continent are highly sensitive to fluctuations in rainfall, and to a lesser extent, temperature.[30] For example, rainfall increases of 20-30% produced runoff increases of 30-50% while decreases in rainfall of 9-24% produced decreases of runoff of 15-59%.[31]

Rivers and wetlands in Africa are important as a resource, and as a habitat for wildlife. These are evidenced by the Sudd swamp on the Nile, the Okavango delta in Bostwana and the inner Niger delta. Studies on the implications of climate change for wetlands, national parks and sea-levels, indicate that, elevated temperatures produce a fall in river flows of at least 10%, and increases in open water evaporation of 14%.[32] These would lead to a decline in surface water resources, groundwater recharge, and a higher likelihood of salt accumulation and inflows of sea water. These effects, as a result of climate change, will have significant implications on African water supply systems and habitats, on waterfowl and on commercial fishing. These problems may be intensified by other factors, such as population growth, construction of new water dams, etc.

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[28]Hulme, et. al., 1994.

[29]Hulme, et. al., 1994.

[30]Sircoulon, 1987.

[31]Lins, 1991.

[32]Hulme, et. al., 1994.

2.4. NATURAL VEGETATION

Natural vegetation in Africa supports potential economic resources. Changes in climate may significantly shift these potential resources. For example, a range of environmentally-related activities emanating from natural vegetation include: wildlife habitat, tourism, agricultural potential, and lumbering. Any shift in climate as predicted, will significantly affect these potentials in Africa.

An analysis of climate change and vegetation impacts have inted that:[33]

> "changes in global vegetation patterns due to climate change would affect Africa's economic resources and potentials. Significant change in natural vegetation in Africa, occurred south of the Sahara. Along the Southern margins of the Sahel, Tropical Savannah shifted to Desert. In the Central African Republic and in parts of Eastern and Southern Africa, Tropical Savannah became Seasonal Forest. Changes in the Tropics between Forest and Savannah, ... were determined by the magnitude and the direction of the change in rainfall".

2.5. PESTS AND DISEASES

Africa's climate encourage the endemicity of vector-borne diseases and water supply problems. Poor sanitation and hygiene, as well as poverty have accelerated the reproduction of pests and diseases at an alarming rate. Climate or water-related diseases have affected the lives of the majority of the African population. Frequent occurrences of epidemics of yellow fever, cholera, river blindness, bilharzia, malaria and tuberclosis, pose a severe threat to human life in Africa; and climate change would enhance these conditions. Malaria, one of the most devastating vector-borne diseases affect the majority of the African population. Expected changes in climate, will indirectly affect mosquito breeding through changes in temperatures, vegetation, water levels and breeding sites.[34]

The incidence and distribution of pests and diseases, as a result of climate change, will undermine crop yields, due to plant diseases. And, because of inadeqaute pest and disease control technologies in Africa, there will be higher economic losses in the continent.

2.6. FISHERIES

As noted in this chapter, the impact of climate change will accelerate evaporation, affect rainfall and runoff patterns. Important commercial fish species are likely to be affected. Sea level changes are also likely to relocate coastal wetlands, marshes and shallows

[33] Monserud, et. al., (1993)

[34] Martens, et. al., (1994)

that are important habitats for fish breeding and other important marine life. Most African coastal fisheries are productive and highly exploited for commercial purposes and for subsistence. Estimates show that about 270 kilo-tonnes of marine fish are caught in the East African region every year.[35]

2.7. SEA LEVEL CHANGES

[35] Monserud, et. al., (1993)

It has been illustrated that a significant degree of climate change would expose African rivers and low-lying coastal zones to risk of inundation.[36] For example, the implications of sea level rise for the Nile Delta would significantly affect the population dependent on the Nile, and undermine economic activity and the rate of future coastal development.[37] The farms and settlement schemes protected by dykes would require heavy financial investments for upgrading them. The impacts of climate change in South Africa, would raise the sea level by between 50-135 cm in Cape Town.[38] Small islands such as Seychelles and Mauritius could disappear as a result of sea-level rise, caused by climate change. Adequate planning needs to be done in advance for necessary adjustment to the effects of climate change.

Climate change in Africa is likely to affect coastal countries such as Nigeria, Senegal, Cote d'Ivoire, Ghana, Liberia, Togo and Benin.[39] Coastal cities such as Lagos, Banjul and Dar-es-Salaam are vulnerable to sea level changes. These cities are already experiencing heavy soil erosion, and severe social and economic disruption.[40]

[36] Titus, (1990)

[37] Sestini, (1992).

[38] Hughes, et. al., (993)

[39] Monserud, et. al., (1993)

[40] Chidi Ibe, (1991)

CHAPTER 3
THE THEORY OF JOINT IMPLEMENTATION

3.1 THE LEGAL BASIS FOR AND THE CONCEPT OF JOINT IMPLEMENTATION

All countries want to make the most out of their financial resources. This reasonable wish is also reflected in the FCCC.[41] The Convention commits all Parties to "Formulate, implement, publish and regularly update national and, where appropriate, regional programmes containing measures to mitigate climate change by addressing anthropogenic emissions by sources and removals by sinks of all GHGs ...."[42] Even if this clause lacks concrete commitments like quantitative targets, time qualifications, priorities, kinds of measures to be taken, etc., it urges Parties to engage in a process. Failure by a Party to enter into such a process will be open and known to other Parties and the world at large, through stck-taking at the Conferences of the Parties. This situation represents a clear political push to Parties to participate in ways of meeting the objective of the Convention.

By the general call for "the widest possible cooperation by all countries and their participation in an effective and appropriate international response, in accordance with their common but differentiated responsibilities and their respective capabilities and their social and economic conditions",[43] the FCCC clearly recognises the freedom of country Parties to decide on, ways and means of how to fulfil their commitments.

It should be noted that neither the concept of JI, nor the criteria for the mechanism, are defined in the FCCC.[44] However, the basic idea is rather simple: the country that pays for abatement abroad (the investing country) will reduce its costs needed to meet its legal commitment under the Climate Convention, while the country carrying out the emission reduction (host country) may, in addition to reducing the threat of global

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[41] FCCC, Art. 3.3.

[42] FCCC, Article 4.1(b)

[43] FCCC, Preamble

[44] Art. 4.2 (a) reads: 'The developed country parties (...) commit themselves specifically as provided in the following (...) These parties may implement such policies and measures jointly with other Parties and may assist other Parties in contributing to the achievement of the objective of the Convention'. Furthermore, it reads that '(...) The Conference of the Parties, at its first session, shall also take decisions regarding criteria for joint implementation (...)'.

warming, gain from local environmental improvements, economic benefits and technological innovations. In the case of carbon sequestration, other benefits might also be gained.

JI may reduce the global costs of achieving a GHG emissions reduction goal, but does not necessarily lead to lower global emissions. The global emission depends on the reduction targets which are agreed upon under the Convention. By reducing costs, however, the obstacles to the implementation of a global climate policy become smaller, which again may have implications for the willingness of countries to participate, and may lead to a more ambitious reduction target.
The idea of joint implementation is to separate the commitment of each country Party with regard to limitation of net GHG emissions, from the implementation of measures. This implies that a country with high marginal abatement costs may cooperate with another country Party where the same reductions can be obtained at a lower cost. Most abatement measures will also have other effects that are economically and environmentally positive, and thus form a basis for collaboration betwenn Parties.

The least ambitious system for joint implementation is an agreement between two countries. The investing country would, through an agreed sharing of costs and benefits, finance a project giving a reduction of GHGs and/or increase of carbon sinks in the host country. The climate effect of the project should, in order to be credited under the FCCC, be open to verification, and possible non-approval by the Conference of the Parties. The Convention identifies three main groups. These are: The Annex I countries: the OECD Countries (minus Mexico) and the countries with an economy in transition to a market economy; the Annex II countries: the OECD countries (minus Mexico); and the Non-Annex countries: the developing countries. Within the non-Annex countries group, the Convention also distinguishes between the developing countries and the least developed countries. The latter group have no time limit for reporting on their plans and measures to meet the objectives of the Convention.[45]

JI allows all countries, Parties to the FCCC to participate in its processes. In fact, it will work better the more the countries participating. However, there is no consensus within the Intergovernmental Negotiating Committee (INC), an interim meeting forum examining and pre-negotiating issues of relevance to the FCCC, as to whether or not JI should be extended beyond the Annex I parties.[46]

It seems likely that the FCCC will develop through the following four phases in the future:[47]
-phase I is similar to the present situation; no countries have legally binding commitments,
-phase II is the phase where all Annex II countries have legally binding commitments,
-phase III is the phase where all Annex I countries have legally binding commitments, and
-phase IV is the phase where all countries have legally binding commitments.

It is not certain when the FCCC can be expected to develop from phase I to phase II, and it is even more uncertain if, and when, the FCCC might develop from phase II to phases III and IV.

[45] FCCC, Article 12, paragraph 5

[46] see UNGA/49/485 para 38

[47] A phased development of JI is discussed in P. Vellinga and R. Heintz (1993).

But phase II does not have to be very far into the future. At present, there is broad support within the INC for initiating negotiations on a global warming protocol signalling strengthened commitments at the first meeting of the COP in the Spring of 1995. Should negotiations on a global warming protocol be initiated in March-April 1995, it is not unlikely that they might be completed only in 1997 or 1998.[48]

[48] Kåre Bryn, Head of the Norwegian Delegation to the INC, in *CICERONE* (1994)

3.2 THE EVOLUTION AND MOTIVES OF JOINT IMPLEMENTATION

The costs of reducing GHG emissions vary considerably across national borders. Countries in which electricity supply is mainly based on nuclear or hydro power have smaller potential for reducing GHG emissions than countries in which electricity supply is based on fossil fuels.

The costs of emissions reductions thus vary considerably as some countries might switch from coal to gas in power plants at a low cost, while others will have to reduceemissions, for example in. transport activities at a high cost. To require the same reduction in all countries would therefore be unreasonable, because the "cleanest" country would have to pay the highest price. Moreover, it would not be cost-effective, because the "clean" country could reduce an equivalent amount of global emissions of GHGs in another country at a lower cost.

In negotiations, each Party will be endeavouring to understand the motives and the rationale behind proposals made by other Parties. If a Party feels that these motives are legitimate and acceptable, it will be easier to enter into a constructive discussion on the proposal itself. What then, were the motives for introducing the concept of JI in the climate negotiations? There have certainly been a number of motives, of true concern both for our global environment, and for national interests. One of the main motives was to find viable and operational mechanisms to meet the objective of the Convention. Another was the concern for cost-effectiveness, and the wish to involve as many countries as possible in fighting global warming.

If we were also to look at the specific economic interests, of a small developed country, there seems to be at least three main reasons why Norway, who introduced the JI concept into the negotiations of the FCCC, did and still does advocate the concept of JI.

Firstly, Norway has a 'clean' energy production based on hydroelectric power, previously large investments in pollution control and high fossil fuel prices. Hence it is costly to reduce emissions of greenhouse gases in Norway compared to other countries. Because GHG emissions have the same global effect regardless of their geographical origin, it is considered an inefficient use of scare resources to reduce emissions where this is most expencive.

Secondly, Norway is a large exporter of oil and gas. The oil is of the "light" category with a low sulphur content,, which is preferred among other oils types because it is less polluting. Both the oil, and especially the gas, are much preferred to coal with respect to emissions of carbon dioxide and other pollutants. An emission target including the off-shore fossil fuel production in the North Sea will not only have considerables economic consequences for the country, but could also restrain a fuel-switching from coal to gas in Europe.

Thirdly, emission reductions in Norway will mean very little by themselves. This is true for most other countries too. It is therefore imperative to find ways whereby a maximum number of countries can find incentives to curb greenhouse gas emissions in a cost-effective way.

3.3 GREENHOUSE GASES AND GLOBAL WARMING POTENTIALS

There are large variations in the scientific knowledge about the climate impacts of the various gases emitted into the atmosphere. Several gases have, in addition to their direct effect on climate, also indirect effects on climate through interactions in the chemistry of the atmosphere.

The INC recommends that all relevant gases in the context of climate change should be included in measures to mitigate climate change. INC also recommends that the climatic effect of the various gases relative to carbon dioxide given as Global Warming Potentials (GWPs) should be used in estimates of contribution to the enhanced greenhouse effect. Due, however, to the nature of the atmospheric effects and insufficient knowledge of such effects, the GWP concept cannot be used for all source gases that enhance the greenhouse effect.

TheGWP index was introduced as a tool to enable policymakers to compare the potential of the various well-mixed source gases to affect climate. It is a relative measure since it expresses the climate effect as compared to the effect of a reference gas. It is derived from the globally-averaged net radiative fluxes at the tropopause. Thus, it is a global measure that describes the effects on the whole surface-troposphere system. It expresses the cumulative radiative effect of the gases over a chosen time horizon. In IPCC (1990) this was defined as the time integrated commitment to climate forcing from the instantaneous release of 1 kg of a trace gas expressed relative to that from 1 kg of CO_2.

The atmospheric lifetimes of the various GHGs vary considerably (from about 1/2 year to 50 000 years). The GWP values will therefore depend on the time horizon is chosen. The GWPs are usually given for the horizons 20, 50, 100, 200 and 500 years. When GWPs are used in order to compare emissions on a common scale, attention should therefore be given to the choice of horizon, and whether several horizons should be used. If only one time horizon will be used, a horizon of 100 years should be chosen in accordance with the recommendation by INC in 1994.

Table 3.1 shows GWPs for some of the gases recommended for JI projects. The last IPCC report[49] revealed that the GWP of most greenhouse gases is 5 to 30% greater than previously believed. In the case of methane, however, the GWP is twice as much,cause it stays in the atmosphere for a longer time than previously anticipated.

INC also recommends that both emissions and uptake of gases should be incorporated into the greenhouse inventories for the countries. Increased capacity of the sinks is only possible for CO_2. Absorption of CO_2 from the atmosphere will increase as long as the biomass stock is increasing.

[49] IPCC (1994)

Table 3.1 GWPs for some of the gases recommended for JI projects.

Gas	Chemical formula	Lifetime (years)	Global Warming Potential (Time horizons)		
			20 years	100 years	500 years
Methane	CH_4	14.5±2.5[50]	62	24.5	7.5
Nitrous oxide	N_2O	120	290	330	180
HFC-125	C_2HF_5	36	4800	3200	1100
HFC-134	$C_2H_2F_4$	11.9	3100	1200	370
HFC-134a	CH_2FCF_3	14	3300	1300	420
Sulphur hexafluoride	SF_6	3200	16500	24900	36500
Perfluoromethane	CF_4	50 000	4100	6300	9800
Perfluoroethane	C_2F_6	10 000	8200	12500	19100
Perfluorocyclobutane	c-C_4F_8	3200	6000	9100	13300
Perfluorohexane	C_6F_{14}	3200	4500	6800	9900

Source: IPCC (1994)

[50] The extension of the chemical lifetime due to the CH_4/OH feedback is taken into account.

3.4 JOINT IMPLEMENTATION PROJECT TYPES

JI should reduce global GHG emissions in a cost-effective manner. The purpose of this section is to discuss under which conditions JI can realize this objective. A realistic strategy for an analysis is to focus on the fundamental issues facing all categories of JI projects, even the 'simplest' project types. Subsequently, after finding ways to handle the basic issues, more complicated JI project categories and additional problems related to these can be dealt with.

JI projects are divided into categories based on 'simplicity' depending on the size of 'transaction costs'.[51] Furthermore, JI projects are organized according to the following two dimensions:

1) the type of countries involved (where the main groups are Annex II countries only, or Annex II countries and all other countries that are Parties to the Convention),
2) project categories (where the main categories are fossil fuel saving, changing industrial technologies, carbon sink enhancement, or changing agricultural practices).

Taking a closer look at possible project categories, the most important GHG abatement option is reduced combustion of fossil fuels associated with production and consumption of goods and services. The major GHG released from fossil fuel production, transport, distribution and combustion is carbon dioxide. Also some methane and nitrous oxide are released. The principal ways of reducing fossil fuel consumption are fuel-switching and energy efficiency improvements.

Another project category is sink enhancement, where net anthropogenic release of carbon dioxide is reduced through carbon fixation in biomass or changes in land use and management practices. There are further potential problems related to baseline definition and calculations for carbon sequestration projects. Next, there are possibilities to change agricultural practices and reduce emissions of carbon dioxide, methane and nitrous oxide. Finally there is a potential for GHG emissions abatement through changing industrial technologies. Some abatement options and examples are given in Table 3.2.

The most practical way to estimate reduction in carbon dioxide emissions from reduced fossil fuel combustion in category 1) is to employ consumption data from the relevant sources. The carbon content of various fossil fuels is well known and the monitoring possibilities will depend on the availability and quality of consumption data. Estimation of nitrous oxide and methane emissions is more complicated since the emissions are more technology-specific, and vary with, among other things, the combustion conditions. Controlling and verifying emissions will have to rely on measurements and site inspections.

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[51] The transaction costs for JI can, in general terms, be defined as the total administrative costs for all parties involved in the development, implementation, control and verification process of a JI project. This is total project costs less economic expenses in strict terms, such as project investment costs and operation and maintenance (O&M) costs for some time horizon.

Table 3.2 JI project categories

JI Project category	Abatement options	Examples	Greenhouse gases	Monitoring possibilities
1) Fossil fuel saving: - Fuel switching. - Energy efficiency improvements.	- Develop renewables. - DSM.[a] - Reduce losses in energy supply sector.[b]	- Substitute gas for coal in a thermal power plant. - Replace traditional light bulbs with high-efficiency CFLs.[c]	- Carbon dioxide - Nitrous oxide - Methane	- Consumption data. - Site observations.
2) Changing industrial technologies.	- Replace process technologies. - Modify products and related technologies.	- Replace older aluminum production technologies.	- Perfluorocarbons - Sulphur hexafluoride - Hydrofluorocarbons	- Site observations.
3) Carbon sinks enhancement.	- Afforestation or reforestation. - Changes in land use and management practices.	- Reforest degraded grasslands. - Increase carbon sequestration in soils.[d]	- Carbon dioxide	- Remote sensing. - Field observations.
4) Changing agricultural practices.	- Develop new crop variants. - Collect and	- Develop rice variants that generate less methane emissions.	- Carbon dioxide - Methane - Nitrous oxide	- Field observations. - Remote

	combust methane emissions.	- Employ methane from dung and wastes as energy source.		sensing.

[a] Demand Side Management.
[b] Losses in conversion, transportation, and distribution.
[c] Compact Fluorescent Lamps.
[d] One option is application of phosphorus.

Change in GHG emissions from modifying and replacing industrial technologies in category 2) can be estimated from technology data and site observations. Emission reduction is technology-specific and must be controlled from site observations, engineering data and emission measurements for each technology.

The increase in the relevant type of biomass in category 3) can be calculated based on species and local ecological conditions. Total carbon fixation can then be estimated from the carbon content of the specific biomass type. Forestation and changes in land use can be inspected by remote sensing in combination with field observations. Compared to the earlier project categories monitoring may be somewhat more complicated.

GHG emissions abatement in category 4) can be estimated from model calculations calibrated on field observations. With respect to changes in agricultural practices and effect on emissions of carbon dioxide, methane and nitrous oxide, remote sensing is also an option, but site observations and estimates are likely to be more important since emission sources and the relations between agricultural activities and emissions are more complicated and ambiguous than for other project categories.

From present knowledge and monitoring possibilities, project categories 1) and 2) are less complicated, as regards inclusion in JI arrangements, than project categories 3) and 4). Based on these dimensions, four main JI project types can be defined (Table 3.3). Apart from project Type IV, which concerns a regime of tradeable GHG quotas, unlikely to be established in the near future, the project types are organized according to increasing transaction costs; they are lowest for Type I and highest for Type III. Type I is the simplest project type, whereas there are significant baseline and control problems for Types II and III. There may be additional monitoring problems for Type III projects which are mostly forestation projects.

Table 3.3 JI project types classified according to rising transaction costs.[a]

JI project dimensions	FCCC Parties involved	GHGs abatement category
		- Fossil fuel saving.

Type I	Annex II countries	- Changing industrial technologies.
Type II	All countries	- Fossil fuel saving. - Changing industrial technologies.
Type III	All countries	- Carbon sink enhancement. - Changing agricultural practices.
Type IV	All countries	All categories

[a] Transaction costs are lowest for Type I and highest for Type III.

For type I JI projects, only the Annex II countries are involved. The host country must consequently be an OECD country (except Mexico). GHG emissions are abated through fossil fuel saving, either through increasing energy efficiency or fuel switching, or through changing industrial technologies.

At the project level a simple JI project example would be fuel-switching for an existing power plant, e.g. substituting a gas-based technology for a coal-based technology in a electricity-generating thermal power plant. If there is no change in the amount of electricity produced, the GHG abated can be calculated as the difference between the emissions from the coal and gas combusted by the power plant.

Type II projects have higher transaction costs than Type I projects because all Parties to the FCCC can participate, even those countries that have not established a national emission target. In this case defining the baseline is much more complicated than for Type I projects since developing countries are not obliged to report national emission targets to the COP.

For Type III projects the countries involved and the institutional setting are similar to Type II projects, but the abatement mechanism is, instead, carbon sink enhancement, or changes in agricultural practices. The prevailing project category is forestation.

3.5 INSTITUTIONAL ISSUES

Principal among the objectives that have been discussed so far for JI are the following: identifying and initiating cost-effective opportunities for reducing GHG emissions, supporting sustainable human and economic development, and encouraging participation of private capital in JI projects.[52] Other elements of JI which have been focussed

[52]Ramakrishna (1994), Wexler et al. (1994).

on are the discussions on the concept of incremental costs and how JI might influence development priorities of developing countries

A majority of African institutions are, however, constrained by the number of available professionals. To some extent, legal structures may also be rigid and inflexible, making institutional operations difficult. These impediments are actually likely to reduce the possibilities to initiate JI projects.

Governments, Non-Governmental Organizations (NGOs) and Community level groups from developing countries, have been active at INC meetings and working groups, but may not have proposed the necessary institutional strengthening required for African countries to cooperate within a JI framework. They have, however, underlined the need to focus on national priorities and strategies, in relation to sustainable development, also when JI projects are considered.

The JI project criteria that finally are agreed upon will determine in what way states, private companies, international organizations and non-governmental organizations (NGOs) might participate in JI projects. Depending on the final choice of such criteria, the incentives to initiate JI projects will be weak or strong, and will accordingly determine how powerful JI projects will be as an instrument for reducing global GHG emissions.

Both Working Group I and II of the IPCC suggested that it was the responsibility of the collaborating governments, in JI projects, to ensure that the projects undertaken were consistent with national priorities for sustainable development. While this suggestion is sound in theory, it fails to fully take into account the fact that governmental institutions in many developing countries are subject to major limitations. Such limitations include: large-scale poverty; shortage of government finances; ineffective management of public resources; political instability; shortage of technical know-how and inefficient administrative capabilities.
These issues should therefore be raised when the COP is discussing the definition of JI. Many possible arrangements to institutionalise JI have been proposed and considered since the concept appeared for the first time. Proposals have ranged from purely bilateral arrangements that involve no international institution or organisation to a global Credits Bank.[53] The advantages of establishing a market place for JI projects have also been examined. It is assumed in the discussion below that JI projects will be institutionalised within the FCCC. However, the degree of institutionalisation may vary considerably.

The bilateral JI arrangement is one in which an investor and a host country agree on an investment project. How project costs and GHG emissions abatement credits are shared is left to the two countries themselves to decide. The project is reported to the COP by the two countries.

More complex bilateral arrangements are also possible. Proposals for a 'Clearinghouse' are based on the perceived need for international verification of the information given on

[53] Hanisch et al. (1993), Mintzer (1994).

JI projects, especially with respect to the effect on GHG emissions. The notion of a Clearinghouse refers to an international organisation which collects information on JI projects. A Clearinghouse might, in more complex versions, bring together investing and host countries, set prices on JI projects, and regularly monitor all JI projects. A global Clearinghouse would most probably be institutionalised within the United Nations system, and perform control functions as well as certain market functions.

A more complex and more ambitious version of a multilateral arrangement is the establishment of a Credits Bank for investments in JI projects.[54] Investing countries could make deposits in the bank and receive credits for GHG emissions abatement. The bank will evaluate investment projects suggested by potential host countries, and the bank decides which projects to participate in. Based on a portfolio of investment projects and their features with respect to costs and GHG emissions abatement, the bank will calculate the average interest on the deposits, namely the amount of credits due for each amount invested. By taking the average over the many projects, the risk in terms of uncertain emission abatement effect, and credits given, is shared among investing nations.

Any of the above arrangements for JI projects will have to be institutionalised within the broader international framework defined in the FCCC. A broader concept of JI includes a regime in which private companies, international organisations, regional economic organisations, multilateral funding mechanisms or nongovernmental organisations are involved in one or more project-relevant activity.

Regional and Global Regimes

A future JI regime should be so designed as to feature the institutional options that are considered most attractive. A global JI regime based on group-specific commitments may be most advantageous. When building a JI regime within the FCCC, two groups of countries are essential, namely a group investing in JI projects and a group of countries in which JI projects are carried out. Compared to global regimes, one significant advantage of regional regimes is the relative homogeneity among its members. Members of a regional regime are likely to be relatively alike in terms of level of economic development and, therefore, in terms of their willingness to pay for environmental protection. Due to their common history a number of historical ties often exist among countries in a region, and regional groups might benefit from already existing institutions and organizations. Specifically, it might be advantageous that arrangements for monitoring and verification of JI projects be embedded in regional governmental arrangements.

Because there is a large variation in GHG emission reductions costs between countries,

[54]Hanisch et al. (1993).

cost-effectiveness implies larger reductions in some countries than in others. In case countries with relatively low GHG emissions reduction costs do not become party to any international arrangement to control GHG emissions, a significant potential for cost-effective emission reductions or carbon sink enhancement will be missed. Countries with such potentials, such as those in Eastern Europe and the developing regions, are accordingly being considered as suitable places for JI projects. At the same time, the European Union (EU) and the OECD countries are being considered as a group of countries which might invest in JI projects. As Table 3.4 depicts, the OECD countries have also been considered as a group in which JI projects might be carried out.

Table 3.4 The participation options in a global JI regime

Group of countries/Role of countries within a JI regime	Group of countries investing in JI projects	Group of countries in which JI projects are carried out
OECD	x	x
Former Soviet Union/ Central and Eastern Europe		x
All other countries		x

A global JI regime, which would make it possible for JI projects financed by the OECD countries to be implemented in the former Soviet Union, Central and Eastern Europe or all other countries, holds the biggest potential for JI as an instrument for global GHG emissions reduction.

A global JI regime is one that is open to all those states that are willing to accept the membership conditions of the regime. Within a global regime there will be a large variation in GHG emissions reduction costs between countries; this makes a global regime attractive to both investing and host countries, at least from a pure cost-effectiveness perspective. A global regime does not have to impose uniform behavioral rules and standards on regime members. Within a global regime, some countries could be bound by one particular set of rules, while another group of countries could be bound by a different set of rules. Furthermore, concern for political and economic feasibility supports such a regime-building process. As the distinction between the expected phases of JI implicitly recognized, it is to be expected that a global regime of uniform rules and commitments will be preceded by a phase of non-uniform rules and commitments.

The principal limitation of any global JI regime is the heterogeneity of members as well as the high number of regime members. Everything else being equal, countries at different levels of economic development stand on different levels in terms of resources available for environmental protection, and, therefore, will also differ in terms of their willingness to pay for environmental protection. This might influence also the attractiveness and willingness to undertake JI projects. A second, somewhat different, limitation of global regimes concerns the decision rules used by many global regimes. Often global regimes use decision rules which are slow and cumbersome in practice. But the combined effect of unevenness of concern for environmental protection, unevenness with regard to ability to pay for environmental protection, and large variation in GHG emissions reduction costs might make a global JI regime an attractive option.

In addition to the attractiveness of cost-effectiveness, it is perhaps just as important that a global regime creates the opportunity to assist the highest number of host countries in becoming more energy-efficient, and as a way of achieving a sustainable human and economic development.[55]

The African situation

[55] Parikh (1994).

It is obvious that institutions for JI projects in Africa will require technical and financial assistance from industrialised countries. It is worth noting that, as Africa's economic performance has been declining steadily for the past three decades,[56] stable institutions are needed to reverse these poor economic trends. It will be necessary to effect policy reforms and enhance institutional capability in such a way as to match current trends in international trade. Perhaps the weakest point in the continent's management has been its slow pace of adaptation to international economic and political changes.[57] Attitudes to institutional change in Africa should become more responsive, and should take paths informed by concerns for sustainable development. Institutional requirements for JI projects in Africa should come to be viewed as one avenue towards the enhancement of technological development, innovation and reforms.

Institutional requirements

In order to meet some minimum requirements for the COP's authorization of JI arrangement under the FCCC, it will be essential to keep records of reported JI projects, to perform some control and verification functions, and to prepare information needed for the COP to award credits according to agreed criteria. The COP should therefore create a mechanism to facilitate such functions. In this respect, several organizational alternatives are possible, even if the COP may prefer to be the only authoritative body. The experiences with the Montreal Protocol indicate that the Parties to the FCCC may choose the COP as the authoritative body, while the preparatory work needed for its decision-making will be entrusted to a specialized organization, perhaps created for that particular purpose.

The experience from relevant international environmental agreements, as well as the complexity of many JI-relevant issues, underscores the need for a specialized JI-secretariat. Such a JI-secretariat should be financed by a group of most committed countries. This secretariat might report to a special Committee on implementation under the COP if so decided. Such a Committee, consisting of a limited number of country Parties elected for a limited time period by the COP, might be of significant assistance in performing control and verification activities. Depending on the nature of the institutional arrangement for JI that finally will be created by the COP, the Committee/JI-secretariat might, for instance:

- provide information on reported JI activity to all interested parties as well as the public;
- coordinate the development of a common reporting format;
- examine the validity of the baseline established in JI-projects, that is reported by the participating countries;
- coordinate control and verification activities as decided, and report to the COP; and
- prepare and recommend credits to be awarded by the COP.

Until legally binding commitments have been agreed upon by the Parties, the Committee/JI-secretariat might be entrusted to initiate pilot projects conducted through a pilot phase. Such a pilot phase will make it possible to experiment with various ways in which JI might serve the objective of the FCCC once legal commitments are introduced.

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[56]Juma, Torori and Kirima (1993).

[57]*Op.cit.*

If given a broader mandate, the Committee/JI-secretariat might also collect information on the externalities of JI projects, the local economic and environmental benefits as well as the costs of projects, their positive or negative impact on the development priorities of the host country, how projects have affected the local population, and other important aspects. However, this would imply a larger budget and seems not to be a feasible option for the near future.

3.6 REPORTING AND VERIFICATION

Most environmental treaties have a poor record of effective implementation control. The inclusion of effective mechanisms for compliance and implementation control is often hampered by the reluctance of some states to cooperate. Their arguments essentially reflect opposition to what they perceive as foreign influence over the management of their national resources.

Relevant experience from the environmental field shows that an international regime's built-in procedures do serve to create an efficient implementation control system. As to those agreements which relate to national measures with transboundary effects, emphasis should be put on establishing prior notification and consultation arrangements. Attention should in addition be given to the development of reporting and fact-finding procedures. At present there are no rules or regulations developed for implementation control under the FCCC.[26]

It is a reasonable assumption that JI projects will require extensive examination of their GHG abatement effect and perhaps also their externalities. This requirement must at the same time be weighted against the need to respect the choice of countries as to how they want to give information on the management of their natural resources, and the pursuance of their national development objectives. A system which takes such concerns into account should be built on a foundation of mutual trust and a concern for cost-effectiveness. This could imply that the implementation control system for JI projects should consist of two main parts:

-a reporting system by the Parties cooperating in a JI project; and
-a verification system based on a random choice of projects for evaluation.

Reporting

It seems preferable to organize reporting as a three-step process. The first step could be a 'note of information'. Such a note of information should be made by the Parties planning a JI project, and be forwarded to the designated JI organization under the FCCC. It should be publicly available, and might be limited to information on key elements such as who the participants are, the kind of project planning, the expected results, where the project is located, and the time schedule.

[26] Article 13 of the Convention reads: 'The Conference of the Parties shall, at its first session, consider the establishment of a multilateral consultative process, available to Parties on their request, for the resolution of questions regarding the implementation of the Convention.'

The second and main communication could be an official report by the participants to the COP made in accordance with an established reporting format. The participating Parties could, if they so wish, invite any NGO, research institutions or others to participate in the reporting. To gain sufficient credibility for the mechanism it is necessary that the reporting requirements are carefully considered. Reporting requirements should include *inter alia*:

a) provisions for transparency, meaning that any third party should be able to reconstruct and verify the information given;
b) information on the baseline, sufficient to reconstruct and evaluate its validity;
c) information on arrangements between the participating Parties if an incentive contract or other agreements have been made;
d) information on the projected emission savings, and on how these are calculated; this will be monitored over the lifetime of the project;
e) information on the externalities of the project; alternatively the benefits/ drawbacks of the project might be left to the participating parties to decide; and
f) broader environmental impact assessments and evaluations of how the projects fit in with national development priorities.

Because JI projects might perform better or worse than expected, a third and final report could be made on the basis of the completed project where actual emission reductions are established. The report will give the possibility to award credits only on the basis of after-the-fact emission reductions. Alternatively the final report might adjust the quantity of earlier awarded credits.

Verification

Accurate and relevant information reported by the Parties themselves should be the primary tool for verification of the GHG abatement effect from JI projects. The main report must meet some agreed technical standards established by the COP. Adherence to this reporting format should be a prerequisite for receiving emission credits. A Committee on implementation should also have the authority to request further information or clarification from the reporting Parties. Based on an acceptable report, the Committee/JI-secretariat could prepare a recommendation for awarding credits to the COP. If such procedures are followed, verification practice would normally not be overly complicated or expensive.

Reporting on a JI project and its GHG abatement effect may be a complicated and difficult task. The JI mechanism should therefore also have a system for reassessment of reports, control of data and on-site inspections. Such an extraordinary verification procedure should be a responsibility entrusted with the Committee, having a representative number of seats for the different groups of countries.

These extraordinary verification processes should include on the spot checks, and different categories of JI projects may be randomly chosen at irregular intervals. Such control or fact-finding missions intended to resolve uncertainty regarding the effects of JI projects might, for example, be modelled after the OECD environmental performance reviews, where experts representing three member countries, the secretariat and independent experts make a report on another member country.

3.7 PARTICIPATION OF PRIVATE ENTERPRISES

This section considers the type of national framework that would best stimulate the involvement of private enterprises in initiating and financing JI projects.

Similar to other environmental regimes, the rules of the FCCC apply, in the first instance, to actions of states. It is the responsibility of the states to ensure that parties under their jurisdiction, frequently private enterprises, comply with the prescribed rules, such as those establishing a global JI regime. Assuming that a JI mechanism is operational under the FCCC, an investor country will receive credits for JI investments undertaken by a private enterprise in a host country. The investor's government will have to determine criteria for the approval of such investment schemes undertaken by the enterprises, and settle on an 'exchange rate' between such credits, and a change in national regulations affecting the private enterprise.[27]

In the host country the state and involved private enterprises will benefit from JI arrangements in terms of transfer of technology and know-how, reduced local pollution, and in general a share of the GHGs abatement cost saving for the investing country.

In the present phase I, where no Parties to the FCCC have legally-binding commitments, some private enterprises have already engaged in offsetting investments, denoted as *OI* in Table 3.5. These are investments to reduce GHG emissions in another country, undertaken by a private enterprise at its own cost. The motivation for such investments can be an expectation of future restrictions on GHG emissions, and the establishment of a credits mechanism. Enterprises in the vanguard of such investments could make extra profits in future markets and, as discussed below, might earn public relations benefits related to 'a green image'. The investment in *OI* can be compared to other investments undertaken by companies under uncertainty, where an expected profit must be anticipated.

In phase II, with an operational JI mechanism, governments, international organizations and private enterprises can be involved in various ways in the financing of JI projects. One option for JI projects is for a government, as part of a bilateral arrangement, to invest in a JI project which is carried out by the host country's government, or one of its state institutions. In Table 3.5 such JI project settings are named JI^{State}. The investor government can instead contract a private enterprise in the host country, or private enterprises in both the investing and host countries, to

[27] An example of this would be a Norwegian company employing oil-based heaters in the production process. The company is facing new restrictions on emissions of air pollutants. Then the company makes JI investments in Kenya, giving both national and global benefits, if this is a much cheaper way of reducing emissions than in its own production process. The government is credited the reduced GHG emissions in Kenya, and transfers some of this benefit to the company by allowing reduced GHG emissions in Kenya to count as fulfilling (part of) its obligations to reduce emissions of air pollutants in Norway.

operate the JI project, denoted as JI^{Contract} in the table. Depending on the documented GHG abatement effect from the JI project, the investing country should receive emission abatement credits.

Table 3.5 Different settings for Joint Implementation projects with respect to financing and operation.

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="2">OPERATING AGENT
IN HOST COUNTRY</td></tr>
<tr><td>The state</td><td>Private enterprises[a]</td></tr>
<tr><td rowspan="2">FINANCING AGENT IN INVESTOR COUNTRY</td><td>The state</td><td>JI^{State}</td><td>JI^{Contract}</td></tr>
<tr><td>Private enterprises</td><td>-</td><td>$JI^{\text{Enterp.}}$
OI</td></tr>
</table>

[a]This may also be private enterprises in the investor country.

The most promising and interesting JI option for private enterprises is $JI^{\text{Enterp.}}$ in which private enterprises are induced to finance and carry out JI projects. In this case, private enterprises finance and operate JI projects in a host country, given incentives established by the government in the investing country. The private enterprises may face, or anticipate that they will face, restrictions on emission of pollutants in terms of taxes or quotas of GHGs. In principle, as long as a linkage between the regulations and JI investments is established, any other type of government regulation that is costly to the enterprises can be employed to give private enterprises incentives to undertake JI projects. The enterprises will have incentives to invest in JI projects, as long as the investment cost is lower than the possible gain of modifying national regulations, for example through lobbying. The incentives can be in terms of tax credits or increased domestic quotas of GHGs (or eventually less reduction in domestic emissions required from the private enterprises).

Anticipation of future regulation is a significant reason why private enterprises might be interested in investing in JI projects, and there are a number of reasons why enterprises anticipating regulation might want to be involved in JI projects. Moreover, private enterprises may even choose to do so before regulation under the FCCC becomes mandatory. One alternative is for private enterprises to engage in OI. Private enterprises might want to be involved in JI projects to acquire, maintain, or improve their image as environmentally responsible companies. Private enterprises are interested in getting 'eco-labelled' by the government as this improves their 'green image', and might have a positive impact on consumer behavior and consequently improve their market position.

Private enterprises may also consider that other issues are important when making decisions about financing JI projects. During an initial phase of voluntary measures and regulations, private enterprises may acquire useful experience which they could draw on when regulation later becomes mandatory. In a situation with no mandatory rules and regulations, they may gain useful experience that can help them identify and explore the most effective approaches to JI. In a more regulated business environment later, it might be costly to make mandatory investments in JI. Furthermore, by pointing to their experience with JI, enterprises might attempt to influence the way a government designs rules and regulations for JI. Finally, the private companies with the best JI performances will probably be the strongest candidates for government investments in JI.

There are indications that private enterprises may finance JI projects even before binding rules are agreed to within the FCCC, that is in Phase I as discussed in chapter 1. The Clinton Climate Change plan does not rely on any compulsive measures but, should it become justified later, binding regulations will in all likelihood be introduced by the Clinton administration.[28] At present, the private sector in the United States seems to be anticipating future binding domestic climate change regulations. It should also be noted that the Clinton administration has established 'groundrules' for JI projects, commonly known as the United States' initiative on JI, and has initiated bilateral arrangements with developing countries.[29] In line with this domestic development, the United States may at some future point have a considerable interest in getting binding rules and commitments within the FCCC, that can harmonize the costs of regulation across countries, at least within the group of OECD countries.

28 Clinton and Gore (1993).

29 Department of State (1993) and (1994), Costa Rican Office for Sustainable Development (1994).

CHAPTER 4
JOINT IMPLEMENTATION AS A WIN-WIN GAME

4.1 THE PRESENT STATUS OF JOINT IMPLEMENTATION

The various commitments flowing from the Climate Convention, do make a case for JI - a term whose full implications have yet to be determined. It appears that the Convention does not refer to JI as a term of art; it merely states that the Parties listed in Annex I may "implement their policies and measures jointly with other Parties and may also assist other Parties, in contributing to the achievement of the objective of the Convention". JI, in this regard, is by no means a standard category; it is merely a signification of the collaborative initiatives which the countries in question can undertake with other countries. In its principle JI has been built around cost-effectiveness; the market advantage that is likely to be realised if certain specially selected collaborative endeavours on the stabilisation of GHG emissions are undertaken between different countries.

4.2 THE ARGUMENTS ON THE CONCEPT OF JOINT IMPLEMENTATION

The introduction of the concept of JI has been met with criticism and many shortcomings have been noted. However, much criticism has assumed that JI would be conducted free of rules and without criteria. Many skeptics have assumed that JI would not be a controlled mechanism.

Some developing countries have expressed reservations about JI. They fear that JI might make industrialized countries able to continue to increase GHG emissions, while it may retard industrial development in the South. Some also suggest that JI projects might divert host countries from their development priorities, and that development assistance resources will increasingly be spent on solving global environmental problems. Furthermore, concern has been voiced over sovereignty issues such as long-term foreign contracts for management of national resources, and that cheap options for reducing emissions will be exploited by industrialized countries, while host countries later will face only the most costly abatement options.[30] [31]

[30]Matsuo (1994).

[31] Confer the 'cream skimming' problem discussed in chapter 4.4.

Most of the above-mentioned reservations can be questioned. This said, JI *might* have a negative impact with regard to two of the above-mentioned issues. First, there is a possibility that JI might be a slowing factor for innovative technological change in industrialized countries, which may otherwise be driven further by the high costs they are facing in reducing GHG emissions nationally. On the other hand, new market opportunities in host countries might instead spur technology development. One could also claim, and hope, that lower costs of abatement might lead to a more ambitious global target, and thus stimulate technological progress, as well as participation of more countries. Secondly, on the issue of "additionality", one may fear that new funds for global environmental issues might reduce the level of Official Development Assistance (ODA). Some industrialized countries have given genuine, new and additional resources to the GEF, while others have not. The best way to meet this problem is to enhance the transparency of the statistics of the OECD, as well as all measures of implementation taken under the FCCC.

Developing countries with a potential to become very large emitters have insisted that they will not act to slow the growth of their GHGs, unless the industrialised countries show leadership by lowering their own emissions first. The credibility of the Annex I countries will be damaged if they are not prepared to reduce domestic emissions, even as they consider JI.

Potential effects for investing countries

For investing countries, a strong incentive to participate in JI projects is the cost-saving potential. An agreement to reduce GHG emissions jointly with other Parties to a given level might be achieved at a lower price than if those countries were obliged to only use domestic measures. If JI is not an option there might be a lower level of commitment among countries during future protocol negotiations, thus leading to a less ambitious global GHG emissions reduction target.

Investing countries may hope that, by committing themselves to invest in emissions abatement projects, other nations will be encouraged to contribute. In this way, global warming could be further reduced and the costs hereof would be more evenly shared among countries. Investments in JI activities might also prove to be economically beneficial and result in extended trade and economic cooperation between the parties engaged in JI projects. While climate and economic benefits are the most obvious, and therefore have received most attention, advantages of technological and institutional nature, and of developing understanding and knowledge, should not be neglected.

On the other hand, the investing country might fear a possible reduction in economic growth since, at least in the short term, national investments in GHG abatement measures could create new jobs and activity in other sectors. Investing countries will also forego a potential benefit when carrying out abatement projects abroad, because reduced emissions of GHG also mean reduced emission of other 'national' pollutants. The risks and uncertainties of transaction costs, implementation performance, and emission leakages may often make investing countries think twice before they engage in JI activities, especially if the risk is not shared with other nations.

Potential effects for host countries

Countries who believe that JI have more negative than positive effects might choose not to participate in this activity. However, there seems to be a number of advantages for countries deciding to participate in JI projects. Advantages may include reduced negative impact of global warming, local and national benefits in the area of environment, economy, technology, trade and social development, decrease in fuel dependency and job creation. On the other hand, participation in JI might imply that other projects will be given less priority.

JI offers an option that developing countries should avail themselves of, for the transfer of environmentally-benign technology. While the thinking in the industrialised countries has focused on only a narrow category of possible JI projects, there are several other areas, in particular (and with respect to Africa) industry and transport, in which beneficial projects could be formulated. If JI is to become an important mechanism under the Convention, it will have to facilitate the formulation of projects which closely reflect the national priorities of the countries of the South. The developing countries will require technological, management, and policy-making assistance to enable them to attain greater efficiency in the use of energy. This will enhance the means for the attainment of sustainable development.

An investing country must as a point of departure cover the *incremental cost* of a JI project. This is defined as the difference in net benefits (total national benefits minus total national costs) between the JI project and the best alternative project for the host country. If the incremental cost is exactly covered in addition to the share of global benefits, the host country will be equally well off accepting the JI project as rejecting it. However, the host country must receive some of the benefit for the investing country (in terms of cost saving) and be better off with than without the JI project to be willing to participate. The JI might also prove to be an opening for increased flow of private capital investment to the host country.

There might often be various spin-offs form JI projects, such as new flows of investments, and transfer of new and more efficient technologies, that are difficult to estimate and thus are not added to national benefits in the calculations. Consequently such benefits can make the host country better off accepting the JI project, even if the agreement between the participating countries is based on incremental cost. Also the so-called "no-regret" investment options might be accepted to induce earlier emissions abatement than otherwise possible. What might look like a "no-regret" option might not be implemented due to institutional and other barriers to such investments.[32]

It is likely that most host countries will be developing countries or countries undergoing the process of transition to a market economy. Some of these countries may have older polluting technologies and thus gain from a transfer of better technology and know-how.

[32] Confer the ILUMEX project reported in Selrod and Skjelvik (1993).

Through JI projects, host countries will often acquire more efficient technology, reducing production costs. This may also help the industry to develop further, create new jobs and meet other development needs. This new technology will often be more cost-effective and more environment-friendly than the previous one, reducing future economic costs of environmental protection and restoration. More energy-efficient technologies will also help to reduce fossil fuel dependency. Transfer of technology from the North to the South, although involving some complications, is a high priority of many developing countries.[33] JI might also provide a channel for mutual exchange of knowledge between the North and the South.

Many developing countries and countries with economy in transition are concerned over growing environmental problems. Many East and Central European countries have considerable pollution problems from combustion of fossil fuel. JI projects in the area of fuel switching will undoubtedly reduce air-pollution, regarded as a significant health problem, and improve the local environment. This is also true for many of the cities in developing countries. Many developing countries to a large degree rely on their natural ecological systems. These systems are often vulnerable to climate change and variability. Global warming might be a serious threat to food security, and may also cause land degradation. JI projects can increase global GHG abatement measures and reduce the threat of global warming.

JI projects might often be a source of new job opportunities. New initiatives may be created, both related to the JI project and as result of generally increased activity. Increased knowledge and interest in technology development and cooperation may be created, and reduce potential conflicts due to local environmental pollution.

Equity

[33] See for example Juma, Ojwang and Karani (1994).

JI projects should be initiated on the basis of a negotiated contract between the involved countries. The COP must agree on some minimum requirements for the criteria of the JI mechanism to avoid a system whereby some countries may be able to serve their own interest at the expense of others.[34] Such contracts should contain incentives for both sides and be open to the COP for their general information and possible comments. Many countries have a limited capacity to engage in development projects. JI might divert some projects to lower priority than intended. However, this will be on the basis of the host countries' preferences as they are offered a new alternative to the previous setting.

The argument that JI might mean increased foreign influence over management of national resources is not an important objection to the mechanism as such. It may be an argument in specific cases and it will then be up to the host country to decide whether to participate in the proposed project. However, most countries in the world have already decided to participate in a variety of international cooperation and trade arrangements.

Summary of potential advantages and disadvantages

The foremost advantage of JI is that GHG emissions might be reduced cost-effectively. Because JI lowers the costs of abatement, it becomes both politically and economically more attractive for investing countries to participate in fighting climate change and to cooperate within the framework of the FCCC. As a consequence, countries might decide on a more ambitious global reduction target.

[34] Selrod and Torvanger (1994).

Advocates of JI have claimed that this mechanism has the potential to accomplish a number of tasks.[35] JI will establish a market for investments, will stimulate a search for cost-effective projects across national borders, transfer of efficient and clean energy technologies, and provide additional financial resources to host countries. Due to technology transfer, JI might provide local, positive environmental and developmental side-effects, and create incentives to improve the management of carbon sinks. Finally, it can serve as an instrument for mobilising private capital steering new and additional resources to host countries. Table 4.1 summarises some of the pros and cons of JI.

Table 4.1 Potential advantages and disadvantages of JI

Country type	Potential advantages	Potential disadvantages
Global level	- Increased activity to reduce GHGs - Encourage commitments from other countries - Reduces costs - Increases incentives to develop new technologies?	- Leakage problems; problems of control and verification - Reduce incentives to develop new technology?
Investing country	- Cost savings - National share of global climate benefits - Possible new export and investment markets	- Reduced national economic growth? - Credits uncertainty; risk of inefficient implementation of projects - Uncertainty relating to transaction costs - Reduced abatement of other (local) pollutants? - Project information distortions, project may cost more than anticipated
Host country	- Additional financial resources - Cost savings from more efficient technologies - Transfer of technology and know-how - National share of global climate benefits - Decreased fuel dependency - National/local environmental benefits - Job creation - Institutional capacity building	- Distortion of own preferences - Increased foreign influence over management of national resources - Uncertain global equity effect

[35] For an interesting discussion on Joint Implementation and possible effects on different levels, see Vellinga and Heintz (1994).

Source: Selrod, Ringius and Torvanger (1994).

4.3 ASYMMETRIC INFORMATION AND POTENTIAL INCENTIVE PROBLEMS

The existence of asymmetric information and incentives for parties undertaking JI projects to take advantage of this may lead to inefficiencies, *inter alia* in terms of uncertain GHG abatement effects of the projects, and in terms of reducing the cost saving potential of JI projects. Asymmetric information refers to the likely situation that the host country has more accurate information on the JI project costs and GHG abatement effect than the investing country and the COP. One way for a country to take advantage of asymmetric information is to try to reduce its cost share of global climate measures. An important issue is therefore the potential of incentive contracts designed to reduce such problems.[36] Another issue is the extent to which one will be able to reduce the incentive problems through establishing specific JI criteria or through institutional arrangements.

The first topic considered in the following concerns incentives for the parties reporting a JI project to the COP. The second relates to political decisions at government level in the host country, and the last topic relates to potential incentive problems between an investor and a host country in a bilateral setting.

Incentives for investor and host to overstate the potential of JI projects

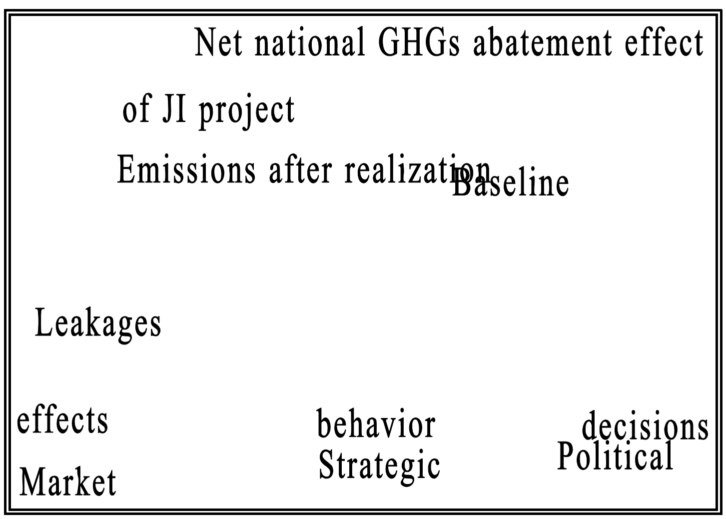
In a bilateral setting investing and host countries will prepare a JI project and report the project and estimated GHG abatement effect to the COP. After the JI project is initiated, there will be a monitoring process to determine its actual GHG abatement effect as a basis for a later report. Incentive contracts based on after-the-fact control of the GHG abatement effect may play an important role and reduce the incentive to overstate the abatement potential of projects.

Since the COP will have less project background data than the participating countries, and since it will be impossible to control all JI projects, both the investor and host will have incentives to overstate the potential of the project in terms better emissions abatement effect. Asymmetric information and less-than-perfect *ex post* control increases these incentives for both the investor and host. On the other hand the investor has an interest in keeping the estimated GHG emission abatement effect of the project low in negotiations with the host so as to get a better bargaining position and cut down the price the host can charge. On the part of the investor such strategic behavior may partially counterbalance the incentive to overstate the potential of the project to the COP.

'Political distortions' and baseline problems

[36]An incentive contract can be defined as a contract between two or more parties designed to reduce or correct incentives due to asymmetrical distribution of information that can cause inefficiencies. An example related to JI projects is a contract including contingencies on the success of the project. Thus the host country could receive a bonus if the project upon after-the-fact control satisfies the planned abatement effect.

Some issues associated with planning and political decisions are more pronounced at the national level than at the firm level. In Figure 3.1 the determinants of the net national GHGs abatement effect of a JI project are shown in principal terms, where the net national abatement effect is defined as baseline emissions subtracted emissions after realization of a JI project. Emissions after realization of a JI project can be higher than anticipated due to leakages. Leakages can be defined as a lower-than-planned or calculated GHGs emission abatement effect at the national or global level. In the literature leakages are commonly discussed only in terms of market effects (e.g. effect on relative prices of energy sources, and as a consequence of this, consumer reactions and changes in 'terms of trade'),[37] but strategic behavior and political decisions are also included as determinants of leakages.
In general terms the baseline may be affected by political decisions and the possible existence of JI-financing of no-regrets projects, which are projects that are profitable under ordinary market conditions. In the following we consider a baseline that is determined *ex ante*, that is before any JI activities are undertaken. The baseline can only be modified later in particular circumstances. However, the discussion of leakages concerns an *ex post* situation, where JI projects have been or are being implemented.



[37] For a general discussion of leakages and baseline definitions the reader is referred to e.g. Barrett (1993a), Bohm (1994a) and (1994b), Kuik, Peters and Schrijver (1994), and Selrod and Torvanger (1994).

Political decisions at the national level may reduce the abatement effect through leakages. A government in a host country may, through its planning, economic policy (e.g. market interventions) and political decisions be influenced by external funding and implementation of JI projects, or at the anticipation of such funding. Since JI projects *inter alia* have local economic and labour market effects, and may have some national effects, it can be rational for the government to let its policies be influenced by such external funding. Such influence is more likely the larger the total JI funding is. These effects will make the calculation of the emission abatement more complicated and uncertain, in particular for developing countries, which do not have a national emission target as a foundation for a baseline.

Policy changes affecting the net abatement effect of JI projects are difficult to monitor and control. By assumption these policy changes are a rational response to incentives that make them profitable, and are due to limited monitoring and control abilities by the investor and COP. In such a situation an important issue is the potential of incentive contracts to induce a host country to refrain from political decisions which reduce the net national abatement effect of one or more JI projects.

There is also room for strategic behavior by the host government in a 'game' of baseline calculations with investing countries or enterprises. In such a situation future JI funding may be influenced and increased. One example of this can be to exaggerate project costs and 'turn' no-regrets projects into projects that need external funding to be realized, thus earning extra profits.

Carbon sequestration projects have larger baseline, control and verification problems than most other JI project categories. The main feature of these projects is carbon sink enhancement, mainly in the form of forestation. In some respects control might be more complicated, for example long-term monitoring of forest areas, for which it may be necessary to verify the long-term net sequestration of carbon. The earlier mentioned incentive contracts should be applicable for these projects with the purpose of inducing the host country to avoid forest and national policies inconsistent with the planned sequestration under the JI project. Such policies might for instance consist of plans to increase logging in other forest areas that may reduce the forest cover and long-term carbon fixation in those areas.

Incentives for investor and host in a principal-agency framework

A branch of the incentive contract literature is the principal-agency literature.[38] In the standard example a firm can be the principal and one employee the agent. This

[38] Surveys of this literature can be found in, for example, Hart and Holmström (1987), Kreps (1990) and Rasmusen (1989).

literature deals with how to design a compensation scheme that motivates the agent to act in the interest of the principal, given asymmetric information that leads to unverifiable efforts. The contract cannot be made contingent on efforts since efforts are unverifiable. Even if the output can be exactly measured, the effort cannot be measured if output also depends on some variable that cannot be observed with certainty. Due to uncertainty and incomplete contracts agents do not bear the full consequences of their actions. The agent may have some degree of risk aversion. Risk aversion can be defined as reluctance to accept risk, for instance measured as the extra compensation required to accept a risky option of the same expected value as an option of certain value.[39] Thus a risk averse agent requires extra compensation, i.e. insurance, to accept risk in terms of payment that depends on the uncertain output resulting from effort and some variable that cannot be observed. On the other hand, the principal would prefer that the agent bears the full consequences of the effort to give incentives to work hard. Thus there will be a tradeoff between incentives and insurance, and the incentive contract has to strike a balance between these considerations.

[39] Moreover a risk neutral agent requires no compensation to take on risk as long as the expected outcome is equal to the certain outcome.

Let us now relate the principal-agent literature to the analysis of JI contracts between an investor and a host (where both the investor and host may be countries or firms). In such a setting the investor and host negotiate a contract on a JI project, after which the host exerts some effort to implement the project. Afterwards, the investor (and COP or any designated body) is assumed to be able to observe the output of the project (i.e. the GHG emissions abatement effect), but, due to monitoring problems, the exact effort of the host cannot be determined. The project output is uncertain since it depends both on effort and some variable that cannot be directly observed, or that is excessively expensive to monitor and verify. Thus it is not possible to let the payment to the hosts depend on their efforts, and there will be an incentive for the host to exert too low effort, and thereby gain a rent.[40] The rent increases the project cost for the investor, and cost minimizing will not be obtainable. Consequently, the potential cost saving of JI projects for the investor is reduced.

Given a risk averse host and imperfect effort control, the inefficiency in terms of a non-minimized project cost can be reduced through formulation of incentive contracts. Private information held by the firms may be beneficial for the firms if they are chosen to be a host for a JI project. One type of strategic behavior is to abstain from investing in less polluting technology so as to avoid revealing their private information. Strategic behavior of the potential host firm may therefore have an adverse effect on global emissions.

Asymmetric information is not just costly for the investor, but also generates uncertainty related to the abatement cost per unit and the total abatement achieved by the project. The uncertainty could be reduced by establishing a Credits Bank that receives funds from the investors and implements several JI projects. By taking the average over many projects the risk in terms of uncertain abatement effect is shared among the investors. Furthermore, a single investor in the form of a Credits Bank could reduce the rent due to asymmetrical information, and consequently reduce incentives to abstain from no-regrets investments.

From this analysis we find that asymmetric information between parties to a JI contract can reduce the potential global cost saving, since the most cost-effective projects are not carried out first. Furthermore, asymmetric information leads to inefficient implementation of some of the chosen projects. Thus the cost per unit GHG abatement for the investor would not be minimized. Furthermore, strategic behavior of the host could lead to uncertain abatement outcomes for the investor (and at the global level). The risk of such effects can be reduced through a Credits Bank institution, and can then be shared among all investors.

4.4 UNCERTAINTY

Two important types of uncertainty related to planning and implementation of JI projects

[40] Rent can be defined as payment to the host in excess of what is necessary to induce the host to carry out the JI project, given full information.

are uncertain investment costs and uncertain operation and maintenance (O&M) costs. There is also uncertainty related to the size of transaction costs and the existence of no-regrets projects. And even further, there is the possibility that host countries without present commitments anticipate future targets, the so-called cream skimming problem.

Uncertain future prices

Due to uncertainty related to future prices and other conditions there is an extra value associated with a flexible GHG abatement strategy. This may affect the ranking of different JI project categories. A flexible JI strategy is characterized by choosing JI projects where the O&M share of the total cost is high compared to the investment share. If such a flexible strategy is chosen there is an opportunity to regret if conditions change and make another strategy attractive. If, on the other hand, one chooses JI projects where the share of investment is high, the opportunity to regret and choose another strategy is lower as long as the investment is assumed to be 'sunk cost'. [41]

JI widens the available climate measures, thus extending the possibilities for flexible strategies. It may also favor general domestic measures compared with inflexible agreements with host countries. It seems that flexible alternatives mainly will exist within countries that commit themselves to targets. This is not because flexible alternatives are unavailable in, e.g., developing countries, but rather that the type of measures that allow for flexible strategies, such as general economic measures, *inter alia* carbon tax, will not be appropriate for JI. Uncertainty can favor, e.g., fuel switching JI projects, since the O&M cost of these is relatively more important than the investment cost, as compared to, e.g., energy efficiency improvement projects, where investment cost is relatively more important than O&M cost.

Uncertainty can also be reduced through project diversification. A country that initiates a number of abatement measures with uncertain costs should aim at making the uncertainty of its total portfolio of measures as small as possible.[42] Then, it is the correlation between this particular measure and all the other measures that counts. In other words, the uncertainty of a given measure may be attractive if it counterbalances the uncertainty of other measures, because it thereby reduces the total uncertainty of all the measures.

Introduction of JI may contribute to stabilizing the uncertainty of climate measures by extending the availability of alternative measures. Moreover, attention to this aspect may provide guidance to how an efficient JI regime should be designed, namely to diversify all measures on a world scale in order to minimize the total uncertainty. From this point of view, the' perfect' JI regime would be the establishment of a Credits Bank that 'traded' abatement projects subject to JI.

[41] An investment is 'sunk cost' if it has no alternative value. Thus the capital is assumed to have no second-hand value.

[42] Wilson (1984) provides a framework for a practical application of this result.

Uncertain transaction costs

In the process of planning, developing, implementing, monitoring and controlling JI projects there are transaction costs.[43] In principle, transaction costs should be included in the total JI project costs to find the abatement cost per unit of emissions for the JI project, which is a main criteria for the acceptance of the project and selection of the project in a portfolio of possible JI projects. Some degree of 'economics of scale' is likely to exist for transaction costs associated with JI projects. Thus the transaction cost share of total costs is probably larger for small-scale JI projects than larger JI projects. This means a relatively disadvantage to small projects compared to larger projects.[44] In general transaction costs may significantly reduce the number and types of interesting and acceptable JI projects. Due to 'economics of scale' effects (i.e. information gathering, human skills, experience, etc.) and smaller incentive problems in a Credits Bank setting, transaction costs may be reduced and more potential JI projects be acceptable.

Transaction costs (and other project-related costs) cannot be known with certainty when planning and developing JI projects. The abatement cost per unit might also be uncertain due to baseline uncertainty and/or uncertain emission abatement effects from a JI project. This type of uncertainty will have implications for the comparison of projects with different profiles, and the optimal choice between them. If there is some risk that the cheapest JI projects are no-regrets and do not qualify for credits based on after-the-fact control, there may be a biased selection of projects where the most cost-effective projects are not attractive to investors.

The 'cream skimming' problem

JI implies that the least-cost abatement alternatives on a world scale are initiated first. Most of these low-cost alternatives are expected to take place in developing countries. This situation has brought forward the question of 'what will the situation be when developing countries shall meet their commitments some time in the future; will JI leave only the most expensive projects to the previous host countries'? This is refered to as the 'cream skimming' problem.

First, this is a problem only for countries without present commitments that anticipate targets in foreseeable future, e.g. European countries in transition toward market economy. Second, if these countries are certain about how much to abate in the future and what the cost will be, they will be able to account for a premium which compensates the future extra cost that accrues because the 'best' projects are not available anymore. Third, new and attractive abatement alternatives may occur in the future due to technical progress. Forth, if a developing country in the future will accept an emission target, it will be a country with improved economic capacity to deal with emission

43 Confer Barrett (1993b).

44 Confer the discussion in Bohm (1994b).

reductions. Fifth, the host country might want to share credits and bank them for future use instead of receiving other benefits through project negotiations. In other words, the cream skimming problem might occur as a consequence of uncertainty for a limited number of countries.

4.5. JI AND NATIONAL CAPACITY BUILDING

TO BE FURTHER DEVELOPED BY ACTS

Africa needs to build the capacity to formulate, negotiate and execute JI projects. The perception of JI as targeting projects that are not part of the national priorities, in the developing countries, is bound to be a set-back to initiatives in capacity-building for the abatement of GHGs. So long as these countries continue to have serious problems associated with lack of infrastructure, shortage of management skills and technical know-how, their enthusiasm for the commonplace JI-type projects, is likely to be low. The important activities to be involved are: the of management personnel; re-organisation of administrative structures; improvement of institutional capability; and effecting of appropriate policy reforms.

With adeqaute capacity for JI formulation, negotiation and implementation, Africa would acquire new awareness, relevant to the pursuit of more enlightened strategies of sustainable development. Such a shift in the development paradigm would facilitate the restructuring of African economies, so as to accommodate enterpreneurial partnerships designed to promote technology transfer, within the framework of JI projects.

The realisation of adequate capacity in Africa, for designing JI projects may lead to a significant demand for energy-efficiency equipment, to a strengthening of regional co-operation, and to a reduction in fuel needs; and this is likely to bring about a notable degree of compliance with the objects of the Convention.

JI and national capacity building should accomodate current measures of international economic reform, international scientific and technological development and cooperation already established and initiated for capacity building. However, the involvement of North-South, South-South, East-West research and development programmes, with more emphasis on issues of technology transfer, mainly based on well integrated systems of science and technology policy, would promote JI and national capacity building without necessarily focussing on cultural variations, varied economic life styles, and market driven systems for national capacity building.

It would therefore be appropriate to propose that, JI and national capacity building should include certain elements such as:

.focus on global, regional and national sustainable development without enhancing inequalities between the privileged few, and the remaining majority;

.reducing major barrieres for economic, institutional and scientificcooperation and encouragement of technology transsfer between countries;

. promotion and strengthening of infrastructure and endogenous science and technology capabilities ;

. international collaborative science and technology programmes that would include the North and the South as equal partners; and,

. strenghthening local indigenous capability, exchange of technical expertise, mobilisation and effective utilisation of local national resources.

African States will need to incorporate these elements in their conception of JI, at the COP negotiations on the Climate Convention. This approach should prove beneficial to their economies, to their capacity to implement the Convention itself and to their scientific and technological development. African governments should be seeking JI projects that would contribute towards national capacity building. Designed development processes and strategies as described in some of the development plans, aim at achieving sustainable development as proposed by agenda 21. Some of the indicators for JI and national capacity building would include:

. projects and systems that would contribute towards the maintenance of the environment, the biosphere, atmosphere, geosphere, hydrosphere and biodiversity;
. systems aimed at improving food production with less ecological damage;
. means for improving farming and agricultural techniques, sound irrigation systems and proper soil use;
. programmes for afforestation, reforestation and reclamation of deserts into productive agricultural land;
. applications of biotechnology to food, health, pollution and waste control;
. establishments of energy and transport systems mainly based on renewable energy sources that are viable and maintainable;
. better land and urbanisation practices, uses and policies;
. effective use of information technology; and,
. regular updates of environmental monitoring and assessment policies.

The JI for national capacity building in Africa will have to conform to the ecology of African Savannahs. Some attempts by Global Change System for Analysis, Research and Training (START) have identified relevant areas to be:[45]

. carbon sequestration
. biogenic emissions
. pyrogenic emissions
. land-use change; and,
. herbivory.

The understanding of the African Savannahs will assist a great deal in understanding issues related to climate change and therefore reinforcing the design of JI projects relevant to the Savannah ecology.

The African governments could use JI as a step towards seeking benefits of technology trasnfer. The opportunity may occur for the African States to say yes or no to JI for national capacity building, but, this is a critical chance before the CoP to assess the potentials for building indiginous scientifc information on natural and man made paradigms affecting the environment. It would be appropriate for JI systems for national capacity building to provide opportunities and potentials that would:

[45] Wandiga, (1994).

. enable national scientists improve the understanding of national and regional environmental change, and thus it would be useful to develop the necessary knowledge base for scientific assessments upon which national and regional policy options for mitigation or adaptation to global climate change can be developed;

. promote the necessary institutional frameworks at the national and regional level for the scientific community to develop a research and development agenda on national and regional issues of global importance;

. promote education and training programmes, create public awareness nation-wide i norder to foster a better understanding of the Earth as a complex system and how it is regulated by interdependent physical, chemical and biological processes, as well as the socio-economic factors affecting the system; and to stimulate cross-disciplinary training and education that will make the way for collaborative global change research involving both natural and social sciences; and,

. build national and regional capabilities to develop relevant data bases to global climate change that will keep track of the natural and anthropogenic emissions and uptakes of greenhouse gases; to develop a network within each region which links together national data bases of relevance for regional modelling and other forms of analysis.

CHAPTER 5
CASE STUDIES

5.1 THE GEF AND THE JI MECHANISM

The financial mechanism under the FCCC is the Global Environment Facility (GEF) of the World Bank, United Nations Environment Programme and United Nations Development Programme. This mechanism shall as defined in Article 12 of the Convention provide resources on a grant or concessional basis, including the transfer of technology to the developing countries, Parties to the Convention.

The Convention has no clear terms or strategies for implementation of the commitments which, under Article 4, paragraph 1, fall on Parties, in accordance with "their common but differentiated responsibilities and their specific national and regional development priorities, objectives and circumstances". Such responsibilities include:

i) the periodic publication of national inventories of GHGs;
ii) formulating national and regional programmes for the mitigation of climate change;
iii) promoting development of technologies that reduce and prevent emissions of GHGs;
iv) promoting the sustainable management, conservation and enhancement of GHGs;
v) promoting exchange of relevant information related to the climate change; and
vi) promoting and cooperating in education and public awareness related to climate change.

Article 4, paragraph 3 states that: "The developed country Parties and other developed Parties included in Annex II 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 for the transfer of technology, needed by the 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 and the importance of appropriate sharing among the developed country Parties."

Most of the industrialised countries regard their contribution to the core fund of the GEF as their above mentioned funding obligation under the Convention. The cost-effectiveness of measures will be judged from a global rather than a national standpoint, and funds will cover the incremental costs of measures. Although the term "agreed full incremental cost" is established as a guiding principle for GEF funding, it is not easily defined as discussed later in this chapter.

Within the area of climate change the GEF might, with their relatively scarce resources, want to give priority to support for development of national reports and a limited number of mitigation measures. Such support might be as a leverage for capturing global benefits from regular development projects or through demonstration projects, *inter alia* on the introduction of new technologies which may have both global and national benefits. The financing of adaptation measures, which will focus on national, rather than global benefits, might be left for funding from national sources and ordinary development assistance.

Joint Implementation projects may be a supplementary source of attracting resources to reduce emissions of GHGs or to enhace sinks of carbon dioxide.This mechanism is delt with in Article 4, paragraph 2 of the Convention. On the general level JI may serve two purposes:

- allow for cost-effective implementation of measures under the Convention; and
- to provide funding for climate related projects for countries where financial sources are scarce or lacking.

The potential size of such resources may be many times as large as the funds available under the GEF. There are no commitments on any Party under the Convention to engage in JI projects. Such cooperative measures are based on mutual interest and benefits and should be based on a contract between the Parties involved.

The objective of JI is similar to that of the GEF in the sense that its main focus is the global environmental benefits rather than national benefits. There are, however, a need for national incentives both for an investing and a host country to engage in a JI scheme. The main incentives of the investing countries is recieving credits for reduced GHG emissions obtained in the host countries, while the host countries will gain from various national benefits consistant with their development priorities. These aspects are also delt with earlier in this report.

The following sub-chapters are giving some insight in pilot projects or fesibility studies in Europe, Asia and Latin-America. These are intended, *inter alia*, to give a better knowlewdge of possible future Joint Implementation projects, and how such project may serve both national and global interests. The first two projects are World Bank/GEF projects, the coal-to-gas coversion project in Poland and the ILUMEX project in Mexico, introducing high efficiency light bulbs. The other two are bilateral studies, one fuel-switching in Brazilian Amazonia and one on reforestation of degraded grasslands in Indonesia.

5.2 THE COAL-TO-GAS PROJECT IN POLAND[46]

Poland's energy economy is dominated by domestically produced coal. Even though the industrial structure is biased towards energy and coal intensive industries, the share of coal is artificially high and the related pollution problems are enormous. Some estimates puts Poland as the world´s eight largest source of anthropogenic carbon dioxide emissions.

One of the reasons for the widespread use of coal is the use for space heating. The use of gas and oil was held back with the aim limiting foreign exchange expenditures on energy imports. Removal of the direct regulation of fuel use will result in a shift from coal to gas or oil. Due to a lower price, coal will remain the preferred fuel for relatively large boilers, where economies of scale offsets the higher costs of coal handling and emission control equipment. Also in small boilers, coal has until recently been the preferred fuel for economic reasons, but higher coal prices will reduce its use in the long term.

Environmental standards and effective enforcement will be phased in over many years. This will accelerate the price-driven conversion of small boilers from coal to gas. Emissions of sulphur dioxide, nitrogen oxides and particulates, as well as carbon dioxide are taxed. The fees on carbon dioxide are, however, still only of symbolic nature. The other fees could have some, albeit small effects on conversion from coal to gas.

There are several obstacles to conversion from coal to gas. They include lack of access to financing, budgetary procedures of publicly owned heating companies, and lack of price incentives. Cost savings in heat production are not felt at the consumers end because heat prices are subsidized. Only the local authorities have a well defined interest in reducing costs, but often lacks the financial means for investment. For the immediate future, the conversion of coal to gas will not be financially attractive without taking into account the global warming considerations and/or local pollution effects.

The Global Environment Facility (GEF)

One of the priorities of the GEF is to assist in reducing emissions of greenhouse gases. One of the least-cost options for reducing carbon dioxide emissions in Poland is to encourage a more rapid transition from coal to gas. GEF is distinguishing between different types of investments. This investment is justified in a country context, but the country would need to incur additional costs to bring about additional global benefits. The additional costs of accommodating global concerns would be eligible for GEF funding, provided they are within the cost-effectiveness guidelines.

The GEF Coal to Gas Conversion Project

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[46] This sub-chapter is based on a Report on World Bank Appraisal Mission to Poland on the GEF Coal to Gas Conversion Project by Selrod and Sørensen (1993).

The project will encourage coal to gas conversions for small to medium-sized heat plants (boilers). The total financing plan is USD 52 million, of which the local counterpart funding is USD 26 million. The total amount of grant is USD 26 million of which USD 25 million is from the GEF and USD 1 million a cofinancing from the Government of Norway.

During project preparation preliminary results showed that, without GEF financing, the rate of return for typical coal-to-gas conversion projects ranges between 2 and 8%. To achieve a rate of return in the range of 15 to 25%, the GEF concessional financing should cover about 40 to 70% of the total project cost, corresponding to a cost effectiveness of the GEF related incremental cash flow of the project lifetime of US$ 15 to 70 per ton removed carbon dioxide.

The objectives for the project are formulated in four parts:
a) to decrease emissions of carbon dioxide;
b) to introduce the technology of gas-fired boilers for production of heat and electricity in exchange for coal-fired boilers;
c) to build the institutional capacity for technological change and improvement of energy efficiency; and
d) to establish an organizational structure for replicating the GEF concept to other investment projects yet to be identified nationwide.

The baseline

For defining the GEF contribution, it is necessary to define the baseline scenario or the reference situation. For this project,the baseline is founded on: a) continued use of the existing boilers or b) an estimated mix of existing old boilers, new coal-fired boilers and new gas-fired boilers. As many boilers are old, new investments will have to be made over the next years. New coal-fired boilers are readily available in Poland. Without external financing, the predominant choice of technology would for many years ahead seem to be the coal-fired boilers.

However, as new environmental standards already are phased in over the next few years, the conversion to gas is not unlikely for many boilers owned by the state or the municipalities. The costs of conversion to oil/gas may also be assisted through national subsidies from the revenue of fees and penalties of pollution. This is especially the case in the heavy polluted areas, where conversion to gas will have significant impact on the local health and environment. This is also in line with the Polish policy as a signatory to the FCCC.

Even if the economics of conversion to gas-fired boilers may seem to give a low rate of return for some time to come, the above mentioned elements indicates that the most correct baseline scenario might be a mix of old and new coal-fired boilers and new gas-fired boilers. With the uncertainties of the current situation in a country, which is undergoing a major process of restructuring, it is perfectly possible to draw up a variety of valid baseline scenarios. In addition, it would probably be difficult to obtain universal agreement on a single baseline. The continued use of existing coal fired boilers (the business-as-usual scenario) was therefore chosen as the baseline scenario.

In addition to the projects directly supported by the GEF-funds, one would also expect that the replicability effect of the project results in a generally higher speed of conversion from oil to gas.

The reduction effect of this process was not estimated.

Criteria for selection of projects

The beneficiaries of GEF assistance would be non-industrial public and private institutions or enterprises. GEF assistance seeks to demonstrate inter-fuel substitution possibilities and technological innovation, combined with improvements in overall energy efficiency as means of reducing carbon dioxide emissions. In order to comply with the general GEF criteria and to adapt to the specific Polish situation, the following rules have been adopted for selection:

* Only small and medium sized heating plants which can not be eliminated and connected to a district heating system qualify. There are other programmes in place for converting district heating systems from coal to gas.
* Only projects using technologies mentioned below, would normally qualify. A coal-to-gas conversion using an other gas boiler technology would not qualify.

The chosen technologies include cogeneration of heat and electricity and condensing gas boilers. Cogeneration of electricity and heat employing a gas turbine or gas engine has the advantage of reducing carbon dioxide emissions both at its site and by replacing coal in the central generation of electricity. Natural gas cogeneration and condensing boilers are proven technologies in the West, but are new technologies to Poland. Cogeneration of electricity and heat is in Poland based on coal fired plants only. Cogeneration is therefore currently only taking place in major plants.

National incentives

The selection of projects will also depend on local priorities, mostly based on local environmental benefits and the capability to produce the national/local counterpart financing component.

The project will give global environmental benefits, thus also including benefits for Poland. Poland is, as a signatory to the FCCC, committed to contribute to the objectives of the Convention.
National environmental benefits from the project are reduced emissions of sulphur dioxide, nitrogen oxides and particulates. It will reduce the impacts of acid rain, which concerns both the national and regional environment. The reductions will also improve the local air quality and give positive health effects and less damage to crops, vegetation and buildings. Priority in Poland has been given to reduce emissions from big power plants, from major industries and large district heating plants. The reduction of emissions from small plants resulting from the GEF project is supplementary to the current national policies.

One of the objectives of the GEF is to provide assistance to the transfer of new technologies to the recipient countries. By funding investments in technologies, new to the recipient country, the project provides the benefit of dissemination of technical knowledge. It should be stressed, however, that the dissemination effect is only feasible if the economies of the technologies are such that investments are profitable on their own merits. Small scale cogeneration units on gas are in the West not universally profitable, but may be profitable in Poland, depending on local circumstances. Condensing boilers are generally not profitable compared to traditional boilers given the current energy prices. Both technologies could, however, prove to be economically feasible in a situation of higher energy prices.

Incremental cost calculation

The GEF assistance will provide the incremental funding to either make the individual projects with global benefits economically viable, or to modify already viable projects to enhance the capturing of such benefits. The funding will provide incentives to undertake the conversion from coal to gas firing for boilers, whose owners could not achieve acceptable rates of return without concessional funding. Economic analysis of the pilot projects showed that they, without GEF grants, would be unprofitable. In a Western type economy, a yardstick for profitability would be to test if the projects give an internal rate of return (IRR) in line with current commercial bank's lending rates plus an allowance to cover the risks taken by the investor. In Poland's economy a more judgmental method has to be followed, as there are important imperfections on the capital market.

The World Bank(WB) has suggested that the GEF grant should secure an IRR on the investment to arrive at 15% (real rate of return). To determine the GEF contribution, for each project, a cash flow analysis over the project lifetime will be carried out, and the GEF contribution determined to meet the target IRRs.

Cost-benefit analysis

For each individual project meeting the GEF criteria imply a full analysis of the financial feasibility, the local environmental impacts and the global costs and benefits. Because of the difficulties in defining appropriate costs for the damage caused by emissions of sulfur dioxide, nitrogen oxide and particulates, it was agreed only to include avoided environmental fees in the cost benefit analysis. The environmental fees levied in Poland are probably lower than the costs of damage caused by the pollutants. This implies, that the cost-benefit analysis underestimates the total benefits of the programme.

The costs of reducing carbon dioxide emissions are in the project calculated by comparing costs over the lifetime of the investments in the baseline with the costs resulting from investing in a new technology resulting in lower carbon dioxide emissions. The cost comparison between the baseline and the projects is made by implying that energy prices and all other cost factors remain at current levels. Alternatively, the cost calculations could be made by using forecast values for energy prices and other costs over the lifetime of the project. There is, however, a host of problems in making and obtaining an agreement on a forecast of energy prices. The method of using current energy prices constitutes a compromise.

Financial plan

A financial analysis of the condensing boiler project, shows that it needs a grant of USD 200.000 in order to produce an IRR of 15%. The grant is equivalent to a grant of USD 32 per ton of reduced carbon dioxide emissions when comparing the emissions from a continued use of the existing coal fired boilers. A financial analysis of the cogeneration project, shows that it needs a grant of about USD 3 million to secure an IRR of 15%. The grant corresponds to USD 69 per ton of reduced carbon dioxide emissions per year.

The counterpart funding is expected to be mainly subsidized loans from the National

Fund/Ecobank, both drawing on resources from pollution fees and penalties from industry, from the Regional State Authority and a small part from the boiler owners.

Table 5.1 Financial plan for the Coal-to-Gas Project

Financing sources	Technology	
	Cogeneration	Condensing
Cost per project (thousand. US$)	4,860(100%)	385(100%)
Grant	3,050(63%)	200(52%)
Counterpart funding	1,810(37%)	185(48%)
Typical counterpart split		
National Fund/Ecobank	1,458(30%)	147(38%)
Regional State Authority)	109(2%)	0
Minimum owners contribution	243(5%)	39(10%)

Calculated global effects

The WB has calculated the so called Global Performance Ratios. For each project this ratio is calculated as the present worth of incremental costs (investment and operating costs) associated with the projects divided by the discounted sum of the yearly reductions of carbon dioxide emission achieved by the proposed investment. A project lifetime of 17 years and a 15% discount rate were used. The figures were for the condensing boiler and the cogeneration respectabely USD 32 and USD 69 per ton of carbondioxide reduced.

These ratios are low compared to typical Norwegian ratios of about USD 200 per ton of carbon dioxide reduction, and demonstrate the cost effectiveness of implementing a joint strategy for reducing carbon dioxide.

Institutional structure

The Ministry for Environmental Protection, Natural Resources and Forestry will have the overall responsibility for all project activities, including those of the implementing agency, the Bank for Environmental Protection (Ecobank/BOS). The Ministry will be responsible for monitoring and reviewing project activities and products to assure that they are accomplished with high quality and in a cost-effective and timely manner.

As implementing agency, the Ecobank has multiple roles and responsibilities both during project setup and during the implementation phase. Ecobank will develop and refine standardized procedures and forms for replicating projects, develop and implement a marketing plan. The Ecobank will also have a primary role in collateral funding for GEF projects at market interest rates, at subsidized rates, or both. Most GEF projects will be within funding limits set for subsidized rates. The Ecobank will negotiate funding packages for the projects together with the National Fund and the Regional State Authorities. The Ecobank will submit quarterly progress reports to Ministry and the World Bank summarizing project status, including funds committed and spent, and projected and obtained results. The role for the Technical Advisory Panel is to review all projects for compliance with technical requirements and also to assess the cost-effectiveness in conjunction with Ecobank.

Verification and monitoring of results

As soon as a contract for participation in the coal-to-gas conversion programme is signed, the boiler owner is obliged to start monitoring GHG emissions as well as other pollutants. A monitoring design will be an integral part of the concept of the projects supported under this programme. The Inspectorate for Environmental Protection will establish a process of verification of systems operation, cost-effectiveness and monitoring of emissions. This "verification" process might be yearly for all project, or for some of the projects chosen randomly.

Project sustainability

To obtain a maximum replicability of the project, it was agreed that a strong marketing effort should be initiated to make the GEF concept known to boiler owners and others who can identify potential conversions and encourage applications. A number of marketing strategies were initiated. The ECOFUND (The Polish Debt for Environment Swap) may be a major source of funds to assure sustainability and extension of the GEF project objectives. Because ECOFUND provides grants on a somewhat similar basis to GEF, and with global considerations it may collaborate with GEF also to fund coal-to-gas conversion projects that are non-economical from a national perspective. ECOFUND may also choose to fund future projects after the GEF project is completed, thus providing post-GEF project sustainability for technologies that have not yet become profitable by the end of the GEF project.

Concluding remarks

The difficulty encounted in defining a baseline for carbon dioxide emissions needs to be stressed. The possibilities for continued use of coal in small boiler installations depend on energy prices, taxation, nation-wide as well as local environmental rules and the practical enforcement of such rules. Some of these factors are bound to change over time and the baseline will consequently also change. The GEF programme has independently of these conceptual and practical difficulties the advantage of accelerating conversion from coal to gas by providing financial assistance. It could also entail an increased penetration of new and efficient technologies because of the demonstration effect. It is, however, difficult to define any carbon dioxide credits unequivocally for investing countries derived from such a scheme.

5.3 THE ILUMEX PROJECT IN MEXICO[47]

Mexico is heavily dependent on fossil fuels for its electricity generation. Fossil-fuel fired power plants produced in 1992 roughly 100 terawatt-hours (TWh) out of a total generation of 120 TWh. Oil, naphtha, coal and gas have a proportion of about 76, 13, 10 and 1% respectively. The hydrocarbon based electricity sector is estimated to account for roughly 70 mill. tons of carbon dioxide emissions per year.

The combustion of fossil fuel for power generation gives serious local pollution problems, which the Mexican authorities have started to address. The National Environmental Institute (INE) has introduced national standards and regulations also for the power stations of the Federal Electricity Commission (CFE). A shift towards more environmentally benign fuels, that is conversion to gas or lighter oil with less content of sulphur, is, however, expected to be slow. Elimination of cross-sector subsidies on electricity may also help in reducing the impacts through lower growth in electricity demand. Emissions in Mexico do not seem to cause transboundary air pollution of any magnitude.

Fossil-fueled power plants are projected to remain a major source for generating electricity in Mexico. CFE operates with an annual growth rate of 5.3 % in electricity demand, which means a need to add 14,000 megawatts (MW) to the power system over the next 10 years. Generating new electricity requires an average investment of US$ 1,000 per kilowatt, and massive investments, in the order of USD 3 bill. per year for generation, transmission and distribution are needed to meet this demand. Mexico has implemented, with the assistance of the World Bank (WB), several energy conservation projects.

To assist in the demonstration of possible JI projects, the GEF and the Government of Norway have decided to support the ILUMEX-project. The agreement between the cooperating Governments is, however, in no way prejudicial to the positions that they may take in the relation to the role of Joint Implementation under the FCCC.

Objectives

The objectives of the project are:

a) demonstrate the technical and financial feasibility of reducing emissions of greenhouse gases (GHG) and reduce local environmental pollution through widespread installation of compact fluorescent lamps (CFLs);

b) build the institutional capacity for technological change and energy conservation through;

c) establish an organizational structure for replicating the project nationwide and as a learning experience for possible replication in other countries.

Of the least cost options to reduce the emissions of GHGs is probably investments in energy conservation. However, the technology of the ILUMEX project and the institutional and societal barriers to subscribe to this new technology has not been successfully demonstrated on a large commercial scale in developing countries.

Project description

The project will replace about 1.7 million ordinary light bulbs with compact fluorescent light bulbs (CFLs) in the two cities of Monterrey and Guadalajara. These CFLs can provide similar or better quality of lighting while consuming 75% less electricity and lasting 10 to 13 times longer. The project will be carried out by the CFE, while the borrower for Mexico will be Banco Nacional de Obras y Servicos.

The project concentrates on the residential sector. The electricity consumers will be offered the CFLs at an up-front rebate of approximately 46% on average. They may pay cash or over a periode of 2 years along with the electricity bill. The payment will show that the purchase creates a net positive cash flow to the consumer. It is estimated that this phase I of the ILUMEX project will be finalized in two and a half years after project start. The project is, however, structured to ensure that 50% of the original investment will be replenished by project revenues; that is: customers payment for the CLFs. The Ministry of Finance and the CFE have decided, if not budget constraints makes it impossible, to grant the other 50% for implementation of a similar size project (phase II) a second time in the areas of the two cities.

With the reflow of funds from the projects, the concept might expand further to the residential sector throughout Mexico. A revolving pool of funds may ultimately be used also to initiate replacement in the non-residential sector.

Phase I of the ILUMEX project will reduce electricity consumption by about 123 gigawatt-hours (GWh) per year. A later diffusion of the technology throughout Mexico is expected to result in even larger benefits. For every 10 million light bulbs replaced, this technology is estimated to save about 720 GWh per year in thermal generation.

The project should prove itself as a simple and replicable set of demand side management measures that save resources and create national and global environmental benefits at little or no cost. A relatively rapid replication in Mexico is anticipated as the CFE operates nationwide and has the necessary skill and experience to carry out such a project. It is also expected that the project will demonstrate a viable concept to other developing countries. No policy or institutional reform is needed for project implementation.

Project costs and financing

The CFE has designed an administratively inexpensive structure for the project. The goal is to keep administrative costs below 10%. The projected cost per light bulb is US$ 10, but the actual cost will probably be lower. The cost calculation is presented in the table below.

Table 5.2 Costs of the ILUMEX project

Component	**Percent**	**US$ mill.**
Purchase of the CLFs	76	17.63
Project equipment	2	0.41
Consultant services, monitoring, evaluation etc.	5	1.01

Engineering and project support	8	1.93
Direct project implementation	9	2.02
Total	100	23.00

The total financing plan for the project is USD 23 million, of which the local counterpart funding is USD 10 million. The total amount of grant is USD 13 million of which USD 10 million is from the GEF and USD 3 million as a cofinancing from the Government of Norway.

The grant funds would be used to finance the rebate to be made available to the participants, with is estimated to amount to USD 10.6 mill. The difference, USD 2.4 mill., will be used for the same purpose in a phase II of the project.

Project benefits

Apart from the significant global and national environmental benefits, there are also significant economic savings for the consumer as well as the utility and the Mexican society at large. Mexico is a signatory to the FCCC. This means that the country, when the Convention enter into force, *inter alia* is committed to formulate and implement national or regional programs containing measures to mitigate climate change. Even if no quantification or qualification of commitments are mentioned, countries will have to communicate on their actions to the Conference of the Parties of the FCCC. This project may add favorably to the communication of the Government of Mexico to the COP of the FCCC.

Global benefits

It is calculated that phase I of the ILUMEX project will give a total direct reduction of carbon dioxide emissions of about 700,000 tons over the 6 years period that the CFLs are estimated to last, or about 120,000 tons per year over that period. The project will also give some reductions of methane emissions. These figures are likely to increase through the diffusion effect of the project.

These calculations, made by the CFE, are based on assumptions about number of lamps replaced, average wattage reduced per replaced lamp, average usage of lamps of 4 hours a day, the fuel savings of the power plants most likely to be affected by the reductions in power demand, and several technical factors.

In addition to the emission reductions resulting directly from the project, the project will have an indirect effect by speeding up the diffusion of efficient lighting technology in Mexico. This effect is difficult to quantify today. However, CFE has calculated that if the ILUMEX project was carried out successfully on national level, the reductions of emissions of carbon dioxide would total about 6,800,000 tons over the 6 year period, or 1,140,000 tons per year. The revolving fund and the direct sales of CFLs from the company will directly and indirectly spur further diffusion of efficient lighting technology.

National benefits

The project will give national environmental benefits through reduced emissions *inter alia* of sulphur dioxide by about 3,000 tons annually or about 18,000 tons in the estimated 6 year lifetime of the CFLs. It vill also give reduced nitrogen oxides by about 205 tons a year or about 1.230 tons in the 6 year period, and finally reduced emissions of particulates by approximately 240 tons a year or 1,440 tons in the 6 year period. These reductions will improve the local air quality, give positive health effects and less damage to crops, vegetation and buildings. The reduction of emissions from the power plants in the project area will add favourably to the national initiatives to deal with these environmental problems.

The project will also give substantial economic benefits. These benefits applies to: (i) the electricity consumers which will have a comparable or improved quality of light delivered at reduced cost; (ii) the utility which will be able to postpone investments by 100 megawatts and save the costs to produce and distribute 169 GWh of electricity annually. It will also help to reduce the impact of reducing subsidies on electricity for low income customers as the utility is committed to reduce the present cross subsidies among customers. The utility will further benefit from the institutional and technological learning derived from this project.

An unofficial economic evaluation of the project has been carried out. The result shows that the internal rate of return (IRR), exceeds 56 % for all events considered; for CFE the IRR will exceed 39% for all probable events, and for the participants the minimum IRR calculated was 62%. The project has thus very attractive internal rates of return for all parties involved, and the results are very robust even under pessimistic assumptions.

Risks

The total direct emission reductions caused by the project could be less than calculated for several reasons. The main risks lies in that CFE will not be able to sell all of the CFLs, or that CFLs will fail under the Mexican power system conditions, which has rather high voltage fluctuations. Delays in replacement or use of the CFLs less than 4 hours a day will only delay the emission reductions as long as the lifetime of the CFLs are not affected. The replacement may also cause behaviour adjustments by the consumers, which could lead to diminished emission reductions. Due to lower costs, consumers may want to choose to burn lamps longer each day, instal lamps with greater light output and/or increase the number of lamps. There is also uncertainty about the long-term effects of the project, whether the consumers will continue to use CFLs in the future and buy them at full costs. Thus the total future net effect of the ILUMEX project on the GHG emissions is very difficult to calculate today.

The baseline scenario

To define the GEF contribution, it is necessary to agree on the baseline scenario or the reference situation. For this project, the baseline scenario is the emissions from the sector without the ILUMEX project. That is roughly 70 mill. tons of emissions of carbon dioxide annually. The ILUMEX project will reduce the projected increase of emissions by about 120.000 tons per year over the projected 6 year period of the project. However, it is possible that measures could be taken in the future to reduce emissions from the power plants. The fuel mix of the affected power plants could change in the future towards fuel with less carbon content. Plans and figures for this is not developed, and it seems unlikely that such changes will take place in the near future.

The rationale for GEF funding

The ILUMEX project is considered economically viable from the country perspective, and is not normally eligible for GEF funding. The rationale for GEF funding is the perceived barriers to initiate and manage the project. The most important of these barriers are: (i) the lack of information about the technology and how it may work; (ii) the high initial investments; iii) the uncertainty of customers willingness to pay high initial costs,and of their consumption behavior; and (iv) national investment constraints imposed on CFE for macroeconomic reasons.

The preconditions for a successful project were in place - domination of hydrocarbon based electricity generation; rapid increase in electricity demand; a private sector looking for cost reducing options; increased national priority to reduce local air pollution; and a set of social benefits which could be included. The GEF and the WB would be able to show an economically sound option to reduce GHGs through less demand for thermal generation which could also be applicable to other developing countries.

For these reasons, participation from GEF seemed essential to a) realize the reductions of GHG and b) obtain the benefits related to reduction of local pollution and penetration of energy efficient technology. The project has been considered and approved by the STAP and by the GEF participating countries.

Incremental cost calculation

The GEF assistance will provide the incremental funding to either make projects with global benefits economically viable, or to modify already viable projects to enhance the capturing of such benefits. The calculations show that the ILUMEX project is very profitable to Mexico.It is therefore a negative incremental costs related to reductions of greenhouse gases in this project. This implies that the demonstration value should be regarded as the major reason for financing the project from GEF funds.

This does not mean, however, that the ILUMEX project could not be feasible in a Joint Implementation context. Because of the barrieres to a national implementation, the level of external funding necessary would probably be subject to negotiations. The result would be influenced on how Mexico values the local benefits, and the reduction costs in alternative projects of reducing greenhouse gases in other countries. The annual benefits related to penetration of energy efficient technology could be seen as bringing resource savings closer to the present, represented by the realization of savings caused by the project in one year. According to unofficial calculations, the present value of this accounts to USD 5.7 million based on 10% real discount rate.

It is difficult to estimate the annual local benefits from reduced emissions of sulphur dioxide, nitrogen oxides, particulates and other air pollutants. An indication of the value of these benefits could be the costs of plans for further reductions of these emissions. The local environmental benefits can be estimated to be between zero and the cost related to emission reduction efforts that would otherwise be implemented, and is thus hard to quantify today.

The size of the total foreign grant is USD 13 mill. The annual grant costs per ton of saved carbon dioxide emissions will then vary between USD 21 and 27 depending on the discount rate.

Reduction costs in other countries.

Costs of reducing carbon dioxide emissions in other countries could give an indication of the willingness to pay for reductions in Mexico. A study for some OECD countries has been made on the required carbon dioxide tax per ton to stabilize emissions at their 1988-level in the year 2000. The taxes were assumed to be implemented in addition to existing taxes.

For example were the required tax rates in 1989 USD per ton carbon dioxide needed to stabilize the emissions at their 1988 level in yaear 2000 for some countries as follows: The US 9USD; Japan 43 USD; Germany 30 USD; France 38 USD; UK 7 USD and the Netherlands 18 USD.

These tax rates should be corrected for the rate of inflation up to 1993 to make them comparable with possible annual reduction costs in the ILUMEX project. There may be single projects in each country with a lower cost of reducing a ton of emissions of carbon dioxide than the tax rate. These tax rates, however, give an indication of the differences in marginal costs of reducing carbon dioxide emissions between the countries. Some of the required tax rates in 1995 are lower than the calculated costs in the ILUMEX project, when USD 13 mill. grant is assumed. However, most of the tax rates in year 2000 are higher than these costs.

Research projects in Norway have calculated the required tax in the year 2000 to stabilize the Norwegian carbon dioxide emissions at 1989-level in the year 2000 at approximately USD 184 per ton. A stabilization of the carbon dioxide emissions from the OECD-countries as a whole will require a carbon dioxide tax at about USD 60 in the whole OECD-area. These taxes are higher than the calculated costs in the ILUMEX project. The annual marginal costs per ton carbon dioxide reduction in the Polish Coal to Gas Conversion project was calculated to about US$ 32 and USD 69 for the the to facilities respectively.

Verification and monitoring of results

A monitoring and reporting design will be an integral part of the project. Because of the demonstration character of the project, it will probably be reviewed by GEF participant countries for potential replicability. It is therefore important that the project should have a comprehensive monitoring and evaluation program to evaluate project impacts and benefits. Such a program should be established in accordance with international procedures and requirements. The program should include pre- and post-evaluation of GHG emissions and other air pollutants. Recognizing the importance of this activity for producing verifiable project results, CFE should establish an independent monitoring and evaluation team. The process should be transparent and open to verification.

Concluding remarks

Defining a baseline scenario has been easier in the ILUMEX project than in the Poland Coal to

Gas Conversion project. A possible future switch of fuel from oil to natural gas is the most uncertain factor in this respect. Such a switch seems unlikely to be implemented in the near future because of high costs and the need for additional gas pipelines.

There is, however, a large uncertainty concerning the future net emission reductions caused directly and indirectly by the project. The diffusion effect of the project could be substantial, but will be hard to calculate. However, there are also possible effects in the form of behaviour adjustment by the consumers resulting in a higher consumption. It is also uncertainty related to whether the electricity consumers will continue to by CFLs, but at full costs. The size of such effects is difficult to predict. Should these effects, which is only possible to determine after some time, be counted in a Joint Implementation context, the definition of carbon dioxide credits for donor countries must be adjusted through an evaluation several years after the formal completion of the project.

Because of the high profitability of the project, there is a negative incremental costs related to it. This indicates that in a broader Joint Implementation context it would be very difficult to rank projects from the size of their incremental costs.

5.4 FUEL-SWITCHING IN BRAZIL

A feasibility study on future options for Joint Implementation projects between Brazil and Norway has been carried out by CICERO in collaboration with Biomass Users Network (BUN) in Sao Paulo.[48] The motives behind the study, financed by the Norwegian Ministry of Foreign Affairs, is to increase our experience and knowledge of possible future Joint Implementation projects. The study demonstrates some opportunities for fuel-switching from diesel to biomass in the power generation sector in Brazilian Amazonia as abatement measures to reduce emissions of carbon dioxide and nitrous oxide, and indicates the potential for such fuel substitution.

Fuel-switching

Production and consumption of fossil fuels are the main sources of emissions of the GHGs carbon dioxide, nitrous oxide and methane. The most important scheme for reducing emissions of GHGs is thus to reduce combustion of fossil fuels. Fuel-switching projects are projects in which the energy input is changing from a carbon-rich fuel to a carbon-poor fuel, or to a fuel without net emission of GHGs (such as biomass).

Reduction in carbon dioxide emissions from fuel-switching projects can be estimated from energy use data from relevant generators, heaters, vehicles or other machinery. The carbon content of various fuels is well known, and provided that the availability of consumption data is satisfactory, the emission savings are easy to calculate. Estimation of nitrous oxide is more complicated since this is more technology-specific and varies with the combustion conditions.

The situation in Amazonia[49]

The use of diesel for electricity production makes up about 1% of electricity production in Brazil. The main share of 95% is produced by hydropower while the remaining 4% is produced by coal and fuel oil combustion. Though diesel oil constitutes a very small fraction of total electricity consumption in Brazil, it takes a large share of electricity consumption in rural frontier regions, especially the North region. About 85% of national consumption of diesel for electricity production was consumed by isolated generator systems in the North Region in the 1980-85 period (Ponte (1992), p. 60). In 1985, diesel oil produced about 956 GWh of electrical energy, or about 21% of electrical energy in the region (Eletronorte cited by Ponte (1992), p. 65, table V).

The demand for diesel for electricity production may be expected to increase rapidly in the future as rates of economic expansion and population growth are expected to continue to be well above the national average due to the process of frontier expansion. Transports of diesel in this region are in themselves extremely energy-consuming. High transportation costs is one reason for diesel oil being subsidized by around 15% in Amazonia.

In addition to producing about 2.75 tonnes of carbon dioxide per m^3, combustion of diesel (especially in suboptimal plants) releases considerable amounts of carbon monoxide, both contributing to the greenhouse effect and local pollution. Furthermore about 0.6 kg nitrous oxide (N_2O) is released through combustion of one m^3 diesel.

As the rural frontier in the North may be expected to expand well into the next century, there is a demand for more efficient and less environmentally harmful sources of electrical energy. In addition, as electricity production based on diesel oil is very common in rural regions all over the world, an analysis of more environmentally benign alternatives for Brazil may provide important background material for possible JI projects also in other countries.

Objectives of the study

The point of departure of this study is the fact that the combustion of diesel for electricity production in the rural areas of Brazil causes substantial emissions of carbon dioxide and other GHGs that also contribute to local pollution problems. Biomass-related electricity production represents a feasible and cost-effective alternative which may recirculate carbon through burning and revegetation and thus eliminate net emissions of carbon dioxide and other gases. In addition it might contribute to economic development by providing employment.

Among the tasks to be addressed in the study to clarify the potential of the projects as possible future JI projects are:

1. calculate a baseline of emissions in the absence of the project as a basis for the estimation of emission savings;
2. calculate total emission savings of CO_2 and N_2O by their Global Warming Potentials;
3. calculate the costs of projects;

4. evaluate other environmental and developmental benefits;
5. consider the total profitability of projects
6. give suggestions on how emission savings from possible future JI projects under the climate convention may be transformed to credits for the investing country.

Technological options

In this chapter, two main technological options are presented:
a) Conventional steam-turbine thermoelectric plant fueled with conventional biomass residues;
b) Internal combustion motors fueled with natural vegetable oil.

The projects of Ariquemes, Amapa, Sinop, Tailandia, Denpasa, and Guajara belong to option a), whereas the Mogno project belongs to option b).

Greenhouse gases considered

The greenhouse gases considered under the present project are carbon dioxide (CO_2) and nitrous oxide (N_2O). Tables 5.3 and 5.4 below give a summary of the pertinent data collected for the Brazilian Northern Region, which includes the following states: Amazonas, Acre, Amapa, Para, Rondonia, Roraima and Tocantins. These data also include information concerning the use of diesel oil for electricity generation in that region, and specific emissions of GHGs associated to the use of this fuel.

Table 5.3 Data on diesel-based electricity generation in the Amazon region

Consumption of diesel for electricity generation in Amazonia in 1993 [1000m^3][50]	494.4
Total consumption of diesel oil in Brazil for all purposes in 1992 [1000 m^3][51]	25,450
Electricity generated in diesel-fueled engines in 1993 in Amazonia [GWh][52]	1,435
Carbon content in diesel oil[53]	85%
Nitrogen-to-carbon molar ratio in diesel[54]	0.0002
Heating of N_2O relative to CO_2 per molecule[55]	320

The carbon content of diesel oil is 85% and nitrogen content 0.017%. However, the greenhouse effect of nitrous oxide is 320 times that of carbon dioxide. For the Amazon region, diesel-based electricity produces on average 0.91 tonne of CO_2/MWh. The greenhouse net effect of nitrous oxide is thus 6.4% compared to CO_2, both produced from diesel-based electricity in Amazonia.

Table 5.4 Estimates of GHGs emissions from the diesel-based electricity generation in Amazonia

CO_2[million tonne/yr] (0.85 x 494400 m^3 x 0.852 tonne/m^3 x 44/12)	1.31
CO_2[tonne/MWh] (1.31 x 10^6 tonne/yr / 1.435 x 10^6MWh/yr)	0.91
N_2O [tonne/yr] (0.0002 x 1.31 x 10^6)	262
N_2O [million tonne/yr of CO_2 equivalent] = (263 x 320 CO_2/N_2O)	0.084
N_2O/CO_2 GHG net effect = (0.0002 x 320)	6.4%

Based on this data, the gross emissions of CO_2 and N_2O associated with burning of diesel oil used to generate electricity in that region was estimated. The amount of diesel used for electricity generation in the Northern region in 1992 corresponds to just 2.4% of all diesel consumed in Brazil for all purposes in 1992.

The fuel-switching projects

The Ariquemes project

The Sathel company has a 14 MW thermoelectric biomass-fueled plant installed in Ariquemes, a city of 100,000 inhabitants located in the State of Rondonia. It intends to expand the installed capacity of this thermoelectric plant to 28 MW. The expansion will retain only a 6 MW unit from the existing system and add 22 MW of power. Since Ariquemes City is starting to receive its energy from a nearby hydro-electric power plant, Sathel intends to send electricity from its thermoelectric plant to Bom Futuro, a village 80 km from Ariquemes. Currently, all electricity at Bom Futuro is generated through diesel units.

The Amapa (Santana) project

The Santana Project is located at the city of Santana situated 30 km from the city of Macapa - the capital of the state of Amapa. The project consists of the construction, in two phases, of a 15.5 MW steam power plant capacity fueled by bark from Amapa Florestal e Celulose - AMCEL, a private wood-chip exporting factory owned by the CAEMI group. Today, AMCEL is buying electricity from CEA (Electric Company of Amapa). Although all electricity is supplied by a 40 MW hydroplant during 9 months of the year, in the peak of the dry season, from October to

November, the system requires thermal complementation (three gas engines, 18 MW each).

Biomass-based electricity generation at the city of Sinop

In 1985, a large ethanol plant was assembled at the outskirts of the SINOP city, located 400 km north of Cuiaba, the capital of the state of Mato Grosso. The ethanol plant which was designed to use cassava as a feedstock, operated for less than one year because enough feedstock was not available in the region at a competitive price. In 1993 the plant was acquired by 3 agricultural cooperatives headed by COMICEL (Cooperativa Agricola Mista Celeste). The new owners are going to use millet as a feedstock for ethanol production and at this moment it has just started to operate. According to COMICEL, ethanol production from millet grain will not demand all the steam and electricity installed potential at the factory. One boiler and one turbine will be enough to produce all the energy services for the process. COMICEL is willing to generate and sell electricity to the Mato Grosso State utility (CEMAT), using steam produced in the reserve boiler.

Use of residues from palm oil industries to produce electricity for the Tailandia city in the state of Para

In the state of Pará, 130 km west of the Brasilia-Belem highway there is a complex of 2 palm oil processing plants owned by Companhia Real de Crédito Agricola. The two plants are located 20 km north of the city of Tailandia. For the processing of palm oil, it is necessary to produce steam and electricity. From the biomass residues available (11.5 tonnes/h of fibre; 4.3 tonnes/h of shell and 10.8 tonnes/h of empty bunch (dried to 40% moisture)) only the last one is not yet utilized as fuel. The empty bunches are presently returned to the soil to act as a soil nutrient. The city of Tailandia is electrified through diesel motors. It is not yet economically attractive to connect it to the grid in the near future. Due to the presence at modest distance of the palm oil industries, one possibility is to construct a thermoelectric biomass-based power station capable of utilizing the residues and power the city of Tailandia. The technology analyzed is steam turbine generation. The generation potential of the available empty bunches is 6 MW.

A cogenerating system on the oil palm estate 'Denpasa'

DENPASA has got a palm oil factory located in the state of Pará. The Acaca unit has an installed capacity to process 10 tonnes of fresh fruit bunches (FFB) per hour, but it is planned to soon double this capacity. In Acara and its surroundings there is no electricity supply from the regional utility. At present the factory uses diesel generators as the main source of electricity. The proposed technology is based on biomass fired boilers coupled with steam turbines. From the biomass residues at the plant, composed of fibre, shells and empty bunches, only the first two will be used to satisfy current and future internal needs of steam and electricity.

Electricity generation at the city of Guajara Mirim

The city of Guajara Mirim is located at the state of Rondonia near the border of Bolivia. Electricity is supplied respecitvely by CERON (Companhia de Eletricidade de Rondonia) and by Cooperativa Eletrica through diesel powered motors coupled to electric generators, in the two cities. Connection of Guajara-Mirim to the Grid is not expected to happen soon. There is a significant refrained demand for electricity. Biomass residues and cut trees are abundant in the region. The proposal is to install a thermoelectric plant of 8 MW capacity powered by biomass wastes and residues which will produce steam to drive turbines coupled to electric generators. Electricity can be sold to the city of Guajara-Mirim and to Guarayamerim in Bolivia. Presently the Bolivian city is supplied by 2.8 MW diesel powered motors.

Electricity generation for the Mogno farm
The Mogno farm is located in the extreme north of Mato Grosso state, at 100 km from the border with the state of Pará, and 60 km away from the city of Alta Floresta. Cocoa, coffee agriculture and cattle-ranching are practiced in an extensive way. The owner of the farm is considering to construct a meat storage facility in Alta Floresta city. Alta Floresta is electrically supplied by diesel motors and a link with the National Grid will possibly be postponed to after the year 2000. The existing diesel-based electric system serving Alta Floresta is barely able to supply power in the off peak hours. Electricity may be acquired from the electric grid of Alta Floresta but without any guarantee that electricity will be available, mainly during the peak-hours, which requires the installation of diesel based electric generators. With the commercial availability of diesel type engines powered by vegetable oil 'in natura', a new alternative can be proposed. Vegetable oil can be produced in the farm through, for example, rice, corn or mamona crops. Mamona is a nonedible fast-growing plant. Total electricity produced (5,100 MWh/yr) will require 1,200 tonnes of vegetable oil. This amount of oil can be obtained in 11,100 ha of corn plantation (108 kg/ha).

Conclusions

Our main conclusion is that many fuel-switching projects in Amazonia are both economically and environmentally interesting and that they, if implemented, will benefit both the local environment through reduced pollution, and the global environment through reduced emissions of greenhouse gases.

The various aspects are in the following summed up across the fuel-switching projects.

Local environmental aspects
Substituting biomass fueled electricity generation for diesel based electricity generation means reduced local emissions to air of carbon monoxide, sulfur oxides, nitrogen oxides, polynuclear aromatic hydrocarbons (PAH), and some heavy metals from diesel.[56] However, some particulates, nitrogen oxides, PAH and other hydrocarbons, and carbon monoxide are released to the atmosphere from combustion of biomass. The net effect on local air quality will depend on the relative contribution of air pollutants from the two energy sources and the application of purification technologies. The net effect is likely to be positive in terms of an improved local air quality.

Social aspects
Most of the projects will each generate some tenths of jobs since biomass fueled electricity generators are more labor intensive than diesel units.

Economic aspects
Including investment costs, fuel costs, and Operation&Maintenance costs, the energy levelized cost of the fuel-switching projects varies between 35 and 200 USD per MWh.

Baseline and GHGs emissions abatement effect
The baseline definition employed in this report relates to present emissions of GHGs at the micro level. Thus the baseline is defined as GHG emissions from existing diesel fueled electricity generators that may be replaced with biomass fueled generators. GHG emissions abatement is

then calculated as the reduction in GHG emissions due to the reduction of diesel consumption replaced by consumption of biomass. Combustion of biomass is not assumed to generate net emissions of CO_2 to the atmosphere since the released carbon should be sequestered in new biomass through regrowth of plants and reforestation. The annual CO_2 abatement effect of the fuel-switching projects ranges from 970 tonnes to 106,000 tonnes. The annual N_2O abatement effect of the projects ranges from 0.19 to 21 tonnes.

Profitability and comparison between project alternatives
There is a large variation in the profitability of the fuel-switching projects, not including environmental benefits and social benefits for the local communities. The Mogno, Tailandia and Amapa projects seems to be profitable and should be undertaken without any external JI funding, These projects would consequently be problematic with respect to GHG emission credits for any JI investor. The Denpasa, Guajara, Ariquemes and Sinop projects are not profitable given the premises of the calculations, and could thus be considered for external JI funding. The abatement cost of the latter projects varies between 14 and 76 USD per tonne of CO_2, and between 13 and 72 USD per tonne of CO_2 equivalent (i.e. including both CO_2 and N_2O). Considering a 15% subsidy on the diesel oil price at present, the abatement cost per ton of carbon dioxide could be further reduced if this subsidy was to be reduced or removed, or eventually, more fuel-switching projects could be made profitable without external funding.

The fuel-switching projects in a Joint Implementation setting

The most promising projects in terms of unit abatement cost and small likelihood of realization without external funding could be chosen for a more elaborate study based on the present feasibility study of future options for JI fuel-switching projects in Amazonia. One possibility is to prepare one of the projects as a pilot project. This project should demonstrate the most important elements in a JI project realization (*inter alia* involving unknown barriers to implementation, negotiations on credits, the definition of control and verification systems, etc.) Apart from the credits, not being claimed, this might give valuable information on the much discussed issue of the size of transaction costs. Transaction costs are for the most part due to barriers in host countries and investing countries. For the purpose of choosing pilot projects a few of the projects in this feasibility study should be considered more closely. In such a case the most representative projects should be chosen to learn as much as possible about this category of projects in Brazil and possibly also in other countries.

An additional possibility is to employ the new elaborate studies of the most promising projects in this study to develop further projects, which at a later stage can be forwarded as JI project candidates for interested hosts to gain GHG credits. Before such JI projects can be forwarded, the COP must develop criteria that make the mechanism of JI operational, and potential host countries must have legally binding commitments to curb their GHG emissions.

The recommendations from this study with respect to preliminary qualification as JI projects are formulated as a priority list based on increasing abatement cost per unit of GHGs: 1. Sinop, 2. Ariquemes, 3. Guajara, and 4. Denpasa. Further analysis of these projects may lead to changes in the priority list due to uncertainty related to economic data and various non-economic barriers to implementation of projects. The Amapa,Tailandia and Mogno projects are less attractive projects in terms of JI due to being profitable without JI funding.

5.5 THE REFORESTATION PROJECT IN INDONESIA

The clearing and conversion of forests is a major source of carbon emissions in many developing countries. There is, however, considerable uncertainty about the quantity of the emissions. A study sponsored by the United States Government in the "F-7 countries" (Brazil, China, India, Indonesia, Malaysia, Mexico and Thailand), gave an estimate of 837 million tonnes of carbon emissions from deforestation and logging in these countries in 1990, while the carbon sequestration from the forest growth was estimated at 374 million tonnes.[57] The "F-7 countries" currently represent an estimated two-thirds of the annual deforestation of closed moist forests. In Indonesia, the study found that the emissions in the base year were 182 MtC/yr, while carbon sequestration, through tree plantations, agroforestry and continued forest growth, led to carbon uptake of 92 MtC/yr. The net committed emissions were as a result found to be 90 MtC/yr.

As Indonesia possesses the second largest forest expanse after Brazil, a number of other studies have also been initiated in this sector. Japan Overseas Environmental Cooperation Center have together with Indonesian authorities *inter alia*. made predictions of source and quantity of carbon uptake by forests as shown in table 5.5.[58]

Table 5.5 Present Condition of CO_2 uptake by Forests

Category	Scenario	Million hectar	MtC/yr
Natural regeneration	High	17.30	86.5
	Low		51.9
Forest plantation	High	4.13	16.7
	Low		9.2
Total	High	21.43	103.2
	Low		61.1

Source: IEA and Indonesian Ministry of State for Population and Environment (1992).

Norwegian and Indonesian institutions have recently completed a report under the project "Ecostrategies for terrestrial CO_2-fixation in Indonesia"[59]. It is divided into four interlinked parts, containing further information on: scenarios for environmentally sound forest management, vegetation mapping, estimation of CO_2 net fixation and cost-effectiveness analysis. The report argues that besides the assumed CO_2-sequestration following an establishment of a tree layer, Indonesian grasslands are interesting because they at present generally seem to have low environmental and economic values. The authors claims that utilization of these lands probably will lead to less conflicts than utilization of any other land area in the country. A reforestation of grasslands is also expected to give many positive social, economic and environmental effects.

Specific scenarios describing possible future situations for grasslands are presented, and includes a general outline of an alternative with planted fast growing trees. A general ecological assessment shows that this plantation alternative is not the best choice if the objective is to increase biodiversity or some other environmental indicators. However, there will be a relatively rapid sequestration of carbon amounting to 5 MtC/yr, provided plantation of 3000 km^2 annually until 2003. This is a very high figure compared to the annual emission from fossil fuels and cement production of 15 MtC/yr.[60] The sequestration of carbon under this particular scheme is only for 10 years, as the trees will be harvested at that age. From an economic point of view, this alternative is highly profitable, giving an internal rate of return of about 20% p.a. This alternative should thus be labeled as a "no regret option".

The search for projects under the umbrella of the Global Environment Facility, possible future projects under the mechanism of Joint Implementation under the FCCC, and the interesting research on carbon sequestration forms the basis for an ongoing feasibility project aimed at the development of a full scale project on reforestation of degraded grasslands.

This feasiblity study to develop a framework and concrete recommendations for a possible full scale project on reforestation of degraded grasslands is organized under a Memorandum of Understanding between the Republic of Indonesia and the Kingdom of Norway on cooperation in the field of environment. It is jointly executed by the Indonesian Ministry of State for Environment and the Norwegian Directorate for Nature Management, acting on behalf of the Norwegian Ministry of Environment. The responsible implementing agency is the Center for International Climate and Energy Research - Oslo (CICERO).

The project will seek to identify viable mechanisms for carbon dioxide fixation, taking into account environmental and biological diversity values, national development objectives and national economic benefits. Our hypothesis is that there are four main benefit components related to this project: i) economic value, ii) environmental and biodiversity value, iii) carbon dioxide fixation, and iv) value as a model project.

Vegetation type and environmental concerns

Sequestration of CO_2 is possible in many vegetation or forest types. The different benefit dimensions important for choosing a vegetation type are CO_2 fixation capacity in the short and long term, ecological value and biodiversity, and economic value in terms of logging. The investment costs, operation&maintenance costs, time horizon (life cycle), and ecological cost (e.g. in terms of pesticide use) may vary between the vegetation types and the areas/localities. Low-productive grasslands is the most likely area candidate, but there may be other alternatives like degraded/overlogged forest.

The property rights of the area for the project must be clarified so that the legal use of the area can be approved. One consideration is the possible present use of the area by local dwellers. The social cost and benefits of the project must be included in the project evaluation, both locally and nationally. The project may for instance influence the availability of local labour opportunities and incomes. In addition to ecological and social costs and benefits there are economic costs and benefits. The economic benefits depends on the vegetation type and the site of the project. In the case of a fast-growing tree plantation close to its markets a high market value may be anticipated.

The economic, ecological and social costs and benefits must be weighted together to give a decision background, also for the comparison with other alternatve projects. The economic costs and benefits can be calculated through a cost-benefit analysis framework. For this purpose we must decide on a time horizon and discount rate for the analysis. The discount rate employed by Asian Development Bank and the World Bank, and by Indonesia should be considered. Consideration must be given to the inclusion of uncertainty in the analysis, for example through different scenarios for future timber prices.

Accounting CO_2 fixation

The calculation of CO_2 fixation is not straightforward, especially in the long term. The first main element is fixation in the standing biomass on the area, which after e.g. reforestation of a grassland area typically has a lifecycle where a fast growth phase is followed by a mature phase, and eventually a decline in biomass. In the long-term CO_2 fixation in the soil may play an important role. A program for monitoring carbon fixation in soil throughout the reforestation phase and afterwards could be included in the project with the aim to learn more. At the end of the lifecycle, logging may take place, but a new growth phase might be initiated through natural regeneration and assisted planting. The second main element relates to the afteruse of the timber produced. If it is used for house construction or other longlived objects the CO_2 fixation process can be calculated to last longer than the normal lifecycle of trees. If, on the other hand, the timber is used as firewood, the net fixation is only given by the standing forest biomass. However, there may be reduction in total emissions if the firewood is substituted for coal for heat generation purposes.

Emissions baseline

A reduction of CO_2 emissions is relative to some reference situation, which is commonly named the baseline. Thus the baseline defines the emission level for some year or the emission path over some period of time in the absence of any externally financed projects to reduce emissions. The baseline must consequently be based on emission projections, preferably for all GHGs. As part of the obligations under the FCCC Indonesia needs to develop a national GHG emissions baseline and communicate this to the COP of the FCCC. Due to the contrafactual nature of the baseline definition and uncertainty with respect to future development there are problems involved in its operationalization. A large project might, for instance, divert other investments in the area or in other areas or economic sectors, which may influence total GHG emissions. Furthermore, there may be plans to develop the areas, *inter alia* for agricultural use. These plans may be too ambitious and thus less realistic. For the present project we need to define the baseline. A practical solution is to use the local *status quo* as the baseline, and thus assume that the area in the absence of the project will stay as grasslands for the foreseeable future. The baseline must be based on evaluations by the Indonesian authorities.

Verification and credits

In the case of a future Joint Implementation scheme, the emission reduction is compared to the baseline and reported to the COP of the FCCC. When the criteria for the mechanism for JI is decided upon by the the Parties, the report should be given to a designated institution. The emission reduction credits might be negotiated between Norway and Indonesia. This could be based on a set of rules agreed upon by the Conference of the Parties or be left for negotiation between the two nations. The simplest rule of thumb is to make Norway's credits equal to the total GHG emissions reduction as compared to the baseline. The emission abatement effect is probably to some degree uncertain. Norway and Indonesia must agree on how to share this risk, which may be interpreted as a credits uncertainty or a cost uncertainty reaching some emission abatement target.

Credits will depend on the long-term fixation of carbon dioxide in the standing forest biomass. Especially for trees with a relatively short rotation time natural regeneration and assisted planting thus becomes important. Consequently the reforestation program must give strong enough incentives for maintenance and regeneration of the forest after logging.

Cost sharing

The total economic costs of the project consist of investment costs and operation&maintenance costs. The investing Parties' cost share must be negotiated with Indonesia. A precondition for such a Joint Implementation project is that Indonesia is better off accepting the project than in the baseline situation without the project. One obvious model is for the investing party to pay the incremental cost of the project, which is the total additional cost of implementing the project relative to the baseline, corrected for any difference in local benefits related to the project and the baseline situation. If the baseline is grasslands with no local benefits the incremental cost is the total economic cost of the project subtracted future income from e.g. logging. A simpler model is for the investing party to pay the investment costs, whereas Indonesia pays the operation&maintenance costs and receives the full income from logging. A problem for these calculations is the different rates of return on investments required for implementation in different countries. A reforestation project with an internal rate of return at 20% would probably be carried out in Norway but not necessarily in Indonesia due to a higher discount rate, capital shortage, and other factors. The incremental cost is zero if a discount rate of less than 20% is applied when the internal rate of return is 20%.

5.6 ASSESSMENT OF THE CASE STUDIES

The experimental phase with JI already shows this concept to hold real potential for international co-operation in the stabilisation of global climate change.

The Coal-to-Gas Project in Poland, for example, is an initiative for the drastic reduction in the emission of GHGs from fossil fuels. If this project succeeds, the polluting effect of coal will be substantially cut down, and its role in industry will be increasingly taken over by gas, which is a much cleaner fuel. In this way, an important contribution will have been made towards the reduction of GHGs, and the global atmosphere will be much better, in terms of environmental safety.

As the project will involve major costs, it is not possible for Poland, to undertake it all on its own. Poland, by itself, lacks both the technological and financial capacity for implementing such a project. Since the project has both a national economic/environmental importance, and a global environmental advantage, it follows that the beneficiary nation should make a real contribution to the success of the project. It is envisaged that Poland's counterpart funding will be in the sum of USD 26 million, to match the grant of USD 26 million.

It may be thought that such a division of financial responsibility fails to carry the spirit of JI, insofar as the overwheliming part of the burden falls on Poland and on GEF--an international public source. However, the Coal-to-Gas Project may be seen not quite so much as a model JI project, but rather as an example on situations which may justify a JI initiative. The project clearly demonstrates that an initiative of this kind requires special co-operative arrangements, and that JI would be an appropriate mechanism for effecting such co-operation. In that event, the public character of the project would be replaced by a more contractually--based arrangement, in which two or more countries, by private-sector or other institutional arrangements, agree on a sharing formula for carrying the burdens of a major GHG--abatement project.

The clear-cut contribution of the Coal-to-Gas Project, in relation to the reduction of GHG, is shared also by the ILUMEX Project in Mexico. Mexico's heavy dependence on fossil fuels makes that country a major contributor to the concentrations of GHGs in the global atmosphere. Where GHGs emanate from known, technologically manageable sources, such as fossil fuels, the success of the Climate Convention will depend on appropriate collaborative initiatives for sharing the technological and financial burdens, with the object of effecting definite reductions to levels of GHG concentrations. The ILUMEX project is designed to enhance considerably the level of lighting-energy efficiency, thus averting large-scale emissions of GHG during the generation of lighting energy.

The local component in the financing of the ILUMEX Project stands at USD 10 million, with a grant sum of USD 16 million. Once again, this division of responsibility appears inconsistent with the characteristics of a true JI project, in which two or more countries, by private arrangement, determine the contribution of each party. However, the ILUMEX Project is only experimental, and its real significance may be regarded as the identification of an appropriate subject of JI co-operation.
What are the cardinal principles emerging from the Polish and Mexican models?

The two initiatives are well selected as examples of spheres of human activity that call for international co-operation in the reduction of GHGs. Both of them start from baselines of very considerable environmental pollution, occasioned by the use of fossil fuels. A definite formula is presented for the substitution of fossil fuels, and for the provision of alternative energy. The initiative, of course, takes considerable financial outlays, as well as specialised technology. It is quite clear that the individual countries affected would not be able to carry the burden of implementing such projects, all by themselves. It is, therefore, in the public interest that the operation of the Climate Convention should provide a formula of co-operation, which enables several countries to implement the projects.

JI, if accepted by the Conference of the Parties, is a potential formula for implementing such important projects. JI, in this regard, will not only enable the benefiaciary country to play a definite role in the reduction of GHGs, but will also facilitate the country's capacity-building for an enhanced, individual role in GHG management.

Whether or not JI ought to be adopted, in such situations, should be judged on the basis of the available alternatives. The countries of the South, in particular, will be unable to undertake GHG--management initiatives that are too technically complex, or too expensive. These countries, if they are to fully participate in the implementation of the Climate Convention, will need support either from private national sources, or from public financial arrangements. Both these sources of assistance should be available to the developing countries; and hence JI remains a real option for them, in their endeavours to participate in the reduction of GHG concentrations.

FURTHER TEXT TO BE SUPPLIED BY ACTS

CHAPTER 6
JOINT IMPLEMENTATION IN AFRICA

6.1. INTRODUCTION

The growing popularity of Joint Implementation, as a conference subject, since the United Nations Conference on Environment and Development, is evidence of the widespread expectation that this mechanism will derive a major boost from the Conference of the Parties (March-April, 1995), and thereafter become, perhaps, the standard device of North-south co-operation in the implementation of the Climate Convention.

Indeed, JI preparations have gone well beyond the conference aspect. "Informal" JI co-operation ventures have already been launched in optimistic initiatives. Such cases will serve as lessons on JI's prospects as a practical formula for resolving global climate change problems, and far dealing with developmental issues related to North-South relations.

6.2. THE NEED TO PARTICIPATE

JI offers opportunities in areas of fuel switching, energy efficiency and afforestation programmes. At the implementation of the Climate Convention, it is most likely that, of the the economic sectors to be affected will be the energy sector. States compliance to the Convention will imply that energy policies are developed and effectively put into place. Africa's energy demand continues to grow in direct proportions to industrialisation and economic growth and development. Africa's full participation in the implementation of the Convention and designing of JI projects in the energy sector, may induce sustainable energy use patterns and access to new technologies that will assist in reduction of GHG emissions. The current measures of international economic reform, international scientific and technological development and cooperation as advocated for by international treaties, may assist Africa in getting back to economic recovery path through economic re-orientation, institutional, legal and administrative re-organisation.

6.3 PROSPECTS AND PROBLEMS

FURTHER TEXT TO BE COORDINATED BY ACTS

A few of the studies conducted in Africa to address climate change issues, have poorly been coordinated and as such have not been able to provide adequate required framework for the development of coherent and effective continental response to the the issue of climate change.[61] Although, some African leaders have participated at major international climate change conferences and some of the African scientists have participated at IPCC process that provide scientific assessment, impacts, response and policy options to climate change, their input and contributions might have been limited with inadequate climate information available on Africa. Recent studies of the Climate and Africa Project coordinated and administered by ACTS and SEI in eight African countries: Uganda, Seychelles, Zimbabwe, South Africa, Ghana, Cameroon, Algeria and Morocco, do indicate that a lot more studies on Africa in relation to climate change and policy responses need to be carried out and information widely circulated throughout the continent to create awareness of Africa's vulnerability to climate change, the impacts of climate change on Africa's resources and sea level changes. Further studies would intensify public education, training and information dissemination.

The emissions inventory studies in Tanzania and Uganda being undertaken by UNEP and financially supported by the GEF and a GHG policy research project of the African Energy Policy Research Network (AFREPREN) supported by the Swedish Agency for Research Cooperation with developing countries (SAREC), are not sufficient studies for the entire continent. Although, UNDP is developing a climate project that will focus on Sub-saharan African countries including Kenya, the process has been slow faced with limited financial resources and project logistical problems. The Inter-governmental Authority on Drought and Development (IGADD) which is composed of member states: Kenya, Djibout, Ethiopia, Kenya, Somalia, Sudan and Uganda, is concerned with developing regional strategy that combat desertification in arid and semiarid lands vulnerable to frequent droughts and high rainfall variability.[62]

This initiative require studies to generate relevant data for effective planning and policy making.

text to be incorporated in chapter 6 by ACTS as seen fit

JI offers opportunities in areas of fuel switching, energy efficiency and afforestation programmes. At the implementation of the Climate Convention, it is most likely that, of the the economic sectors to be affected will be the energy sector. States compliance to the Convention will imply that energy policies are developed and effectively put into place. Africa's energy demand continues to grow in direct proportions to industrialisation and economic growth and development. Africa's full participation in the implementation of the Convention and designing of JI projects in the energy sector, may induce sustainable energy use patterns and access to new technologies that will assist in reduction of GHG emissions. The current measures of international economic reform, international scientific and technological development and cooperation as advocated for by international treaties, may assist Africa in getting back to economic recovery path through economic re-orientation, institutional, legal and administrative re-organisation.

As land-use changes in Africa affect and influence both public and private resource management, it may be possible through JI mechanisms to adopt and develop better land-use practices, better crop choices, agroforestry and forest management. These would enhance carbon sinks and reservoirs that would significantly highlight Africa's effort and contribution to the reduction and stabilisation of GHG emissions. A majority of African countries' economy are based on agriculture, wildlife and fishing. All these activities are affected by land-use practices. And, as development, in all its human, social and economic aspects are the priorities for African nations, Africa should see how JI as a mechanism could be applied to eradicate poverty through improvement of eduaction, health, better housing, employment opportunities and better management of natural resources and increased food and agricultural productivity.

Africa's ecosystems and socio-economic systems are very vulnerable to possible adverse effects of climate change. Full participation and involvement by African nations in the international negotiations on mitigation and adaptation to climate change may ensure equitable resource flows from North to South, enhance transparency for Annex I Parties in the manner in which they present their information and also make adequate commitments that would reduce the risks of climate change.

Below follows the available figures from the African countries.xxxxxxxxxxxxxx

Table 5.x CO_2 emissions from Land Use Change in Africa (1990; mill. tons pr. year)

Country	**Emis-sion**	**Country**	**Emis-sion**	**Country**	**Emis-sion**	**Country**	**Emis-sion**
Algeria	X	Djibouti	X	Madagascar	120	Somalia	5.2
Angola	33	Egypt	X	Malawi	58	South Africa	X
Benin	9.5	Eq. Guinea	1.8	Mali	7.7	Sudan	98
Botswana	2,6	Ethiopia	30	Mauritania	X	Swaziland	X
Burkina Faso	17	Gabon	30	Maritius	X	Tanzania	21
Burundi	0.5	Gambia	1.9	Morocco	X	Togo	2.9
Cameroon	60	Ghana	31	Mozambique	30	Tunisia	X
Cape Verde	X	Guinea	37	Namibia	X	Uganda	10
C. African R.	13	Guinea-Bissau	18	Niger	7.4	Zaire	130
Chad	15	Kenya	13	Nigeria	270	Zambia	27
Comoros	X	Lesotho	X	Rwanda	2.1	Zimbabwe	16
Congo	12	Liberia	39	Senegal	11		
Cote d'Ivoire	350	Libya	X	Sierra Leone	4.6	Africa Total	1500

Source: WRI-1992. X: not available

Capacity building in Africa has been recognised by international treaties including Agenda 21. The FCCC provides African States with the opportunity to enhance capacity building programmes in areas related to climate change issues. Since the implementation of the Convention obligations will depend on the capacity of nations to do so, Africa may use JI mechanism to build capacity that would lead to demand for energy-efficiency equipment, to strengthen regional cooperation and to reduce fuel needs. However, capacity in Africa need to be considered interms of both human, institutional and related infrastructure.

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CHAPTER 7
POLICY RECOMMENDATIONS

It is urgent that the Parties to the Climate Convention find mechanisms which will create the necessary incentives for countries to cooperate in reducing global warming. As predicted by the International Energy Agency, the future global growth of carbon dioxide clearly indicates that strong measures are needed.

Because of large variation of GHG emission reduction costs between countries and because realization of financial resources is difficult, a cost-effective response to the threat of global warming is the most promising route to take. The motives behind the introduction of JI are to find a viable and operational mechanism to reduce the threat of global warming. An equal per capita reduction of GHG emissions would mean a very unequal economic burden on countries. It is therefore argued that this mechanism must be cost-effective and fair so that countries that have invested heavily in energy efficiency and reduction of pollution will not have to suffer due to higher abatement cost for their remaining reduction options.

In the near future, the FCCC may establish legally binding commitments to reduce emissions of GHGs for all Annex II countries. It is important to realize that it will be these countries which will finance JI projects. These commitments will be stronger if some of them could be met cost-effectively through JI, and not just by domestic measures alone.

Due to the climate conditions of Africa, and economies heavily dependent on natural resources, African countries are likely to be particularly vulnerable to climate change. Thus continued participation in the climate process will be in the interest of African countries. In the near future participation in JI demonstration projects should be an attractive option. Demonstration projects can also play an important role with respect to capacity building in African countries. Thus JI should be looked upon as a possibility for increased North-South cooperation with shared benefits. In addition to reducing the threat of global warming, it offers an opportunity for increased flow of financial resources and technology, job opportunities as well as improved local environmental and social conditions.

The JI mechanism should be allowed to develop gradually by initiating a number of demonstration projects to be reported to the COP for scrutiny. In this way rules and criteria could be developed on a basis of sound experience.

It is essential that potential problems concerning proper selection of JI projects, uncertain abatement effect, consideration of strategic behavior and incentive problems will be addressed in a more effective manner. To that end incentive contracts between the investor and host, and adequate monitoring and verification capabilities must be developed. It seems plausible that these issues can be solved in a satisfactory way and that the possible advantages and benefits of JI certainly are larger than some of the perceived problems and disadvantages.

It is concluded that Joint Implementation under certain circumstances is an effective and attractive instrument for reducing global greenhouse gas emissions. JI may also create

an opportunity to assist a large number of countries in becoming more energy-efficient and in promoting a sustainable development.
Based on the status of the current knowledge it will be prudent to include carbon dioxide, methane, nitrous oxide, perfluorocarbons, sulphur hexafluoride and hydrofluorocarbons in JI projects.

Furthermore, based on the present knowledge and monitoring possibilities we find that the project categories fossil fuel saving and changing industrial technologies are less complicated to include in JI arrangements than carbon sinks enhancement and changing agricultural practices

JI projects will require examination and control that is more extensive compared to what usually is the case in relation to implementation of Parties' treaty obligations. These requirements must be balanced against the need to respect how countries wish to inform on their management of natural resources as well as how they pursue their national development objectives. Such a system might be found in a combined reporting and verification system based on mutual confidence.

In order to achieve a credible system that is acceptable to the Parties, carefully designed reporting obligations should be developed and agreed upon by the COP. Apart from the reporting of the Parties participating in a JI project, an implementation control should allow for independent reassessment of reports by a designated body under the COP. This activity should be conducted as randomly chosen spot checks. This designated body should be a Committee on Implementation under the COP. A JI-secretariat should also be established to serve as an information center on JI activity and assist the Implementation Committee and the COP in the tasks discussed in this chapter.

The first COP should make decisions as to the establishment of these bodies. They may initiate a constructive phase I period during which demonstration projects and further discussions on JI may help all Parties evaluate the possible benefits from JI and the question of how JI may best serve the objective of the FCCC.

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