

## Argentina: Environmentally Sound Transport Management in the City of Buenos Aires

**Partner Organisation:** City of Buenos Aires  
**Project Period:** September 1999 - June 2001  
**Financial Contribution:** DM 350,000

### Project Brief

Between twenty-five and thirty percent of CO<sub>2</sub> emissions world-wide are attributable to the transport sector. It is the only CO<sub>2</sub>-emitting sector which is continuing to grow largely unabated – in contrast to the original assumptions made at the beginning of the 90s. For 2010, the IEA (International Energy Agency) is forecasting a 30% increase in transport-related energy consumption compared to 1993. The proportion of mineral oil products consumed by the transport sector is set to rise from the current 55% to 58%. Enormous growth rates will be seen in threshold countries, and even more so in developing countries. All the more reason to welcome Argentina's voluntary commitment to emission control, which is attracting attention in the international discussion on climate change. In Buenos Aires, the managerial staff in the municipal administration are eagerly pursuing a proactive approach: contributing to global climate protection within the framework of national objectives and supporting environmental protection efforts at local level. This commitment is also expressed through the project "Programa de Aire Limpio de la Ciudad de Buenos Aires", presented at the Fourth Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change in Buenos Aires in November 1998.



Practical experience with sustainable urban transport concepts has been in short supply in Argentina. Economic instruments are not being applied extensively enough, the use of environmentally sound technologies (for example city buses powered by CNG - Compressed Natural Gas) has made little headway, and the selection and evaluation of instruments for planning and managing the urban transport system are still in their early stages. The project in Buenos Aires aimed to address all these issues.

Substantial results of the project are: 1. Economic and fiscal instruments are discussed in the government of the city of Buenos Aires. 2. Adapted suggestions on the introduction of environment-friendly technologies are compiled (on the basis of the experience gained in pilot projects). 3. An emission control system is prepared for implementation. 4. Measures for planning and organising urban traffic are selected and evaluated. 5. The instruments and measures mentioned (results 1 - 4) are evaluated regarding their environmental effects.

Substantial recommendations of the project have been taken up by the city. In some fields of sustainable transport management the city of Buenos Aires remains interested in collaborating for further improvements.

## India: Reduction of Greenhouse Gas Emissions in Karnataka

**Partner Organisation:** Tata Energy Research Institute (TERI), New Delhi and Bangalore

**Project Period:** October 1996 - September 1999

**Financial Contribution:** DM 630,000

### Project Brief

The environmental problems of Bangalore are of course not as severe as in other Asian mega-cities. Nevertheless, this town of nearly 5 million inhabitants has to make decisions now to ensure sustainable development for the future because of rapidly growing problems.



A German technical co-operation project supported TERI in Bangalore in advising industry in the state of Karnataka on how to benefit from energy efficiency improvement. Traffic and waste management are emphasised in this climate change measure, both activities using the same infrastructure of TERI.

The environmental problems in the greater area of Bangalore are so complex and varied, and the number of existing initiatives is so large, that the fields of activity have to be systematically prepared and preselected in order to avoid the risk of producing random, isolated individual results which are unsustainable and have no broad impact.

The main focus of the project was the implementation of pilot schemes and the evolution of action plans for replication on a wider scale, in turn leading to the reduction of GHG emissions in Bangalore.

Four pilot projects were conducted in the following areas:

- Solid Municipal Waste Management
- Health Care Waste Management
- Reduction of Emissions from Two/Three Wheelers
- Awareness and Education

The greatest potential for GHG reduction was discovered in commercial composting plants and through fitting vehicles with emission reduction devices.

# INDIA

## REDUCTION OF GREENHOUSE GAS EMISSIONS IN BANGALORE CITY

*Partner Organisation:* Tata Energy Research Institute (TERI)

*Project Period:* October 1996 – August 1998

*Financial Contribution:* DM 630 000

### **BACKGROUND**

The environmental problems of Bangalore are not as severe as those of other Asian mega-cities. Nevertheless, due to rapidly growing problems this city of 5 million has to lay the groundwork now to ensure sustainable development for the future.

Since no major industry is located within city limits, solid waste and transport are the single most important contributors to GHG emissions in Bangalore. About 2,000 t of waste are currently generated daily. Over 75% consists of fermentable organic matter. Traffic contributes about 51% of CO<sub>2</sub> emissions. It also produces another 256 t of noxious substances per day.

After compiling a greenhouse gas (GHG) inventory for Karnataka province during the first phase of the project, the second and main phase focused on identifying and implementing four demonstration projects. These

projects were intended to impact directly on the respective target group, to demonstrate new solutions to existing problems, as well as to stimulate discussion on environmental policy.

The demonstration projects were selected carefully in order to avoid producing random, isolated individual results that are unsustainable and have no broad impact. Energy efficiency was not part of the project since it has been addressed already in a different cooperation project with TERI.

### **OBJECTIVE**

The main focus of the project was the implementation of pilot schemes and the evolution of action plans for replication on a wider scale, in turn leading to the reduction of GHG in Bangalore.

### **MAIN ACTIVITIES**

Implementation of four pilot projects:

1. Solid Municipal Waste Management
2. Health Care Waste Management
3. Reduction of Emissions from Two/Three Wheelers
4. Awareness and Education

### **SUMMARY OF FINDINGS**

There exists considerable potential for GHG reduction from the disposal of municipal solid waste (MSW). Only about 70% of the 2,000 tonnes of MSW generated per day is collected for disposal by City Corporation. The GHG emissions stemming from solid waste are significant, mainly because quite a large quantity - as much as 400 tonnes - is burnt openly.

### **Exhaust Emission Test**



TERI



The **solid waste management study** had three components:

The first component looked at the implementation of pilot schemes for the **management of solid wastes at a local level** in some of the developing layouts. This, in turn, facilitates the

**GHG Emissions Abated from Composting Projects**

Project Implemented	GHG Emissions (Pre Project, tonnes/yr)	GHG Emissions (Post Project, tonnes/yr)	Net GHG abated (tonnes/yr)
Ramamurthy Nagar	33.35	0.00	33.35
BDA Project	37.50	0.00	37.50
Industrial township	12.50	0.00	12.50
Total GHG Emissions abated			83.35

reduction of GHG, which would have been emitted by burning these wastes. With the establishment of a solid waste management scheme, covering 1,100 houses overall in three housing developments, the wet waste generated from these households was aerobically decomposed. This reduced GHG emissions to zero.

The second component looked at the management of solid wastes generated in large industrial canteens, hotels and restaurants.

**Biomethanation** was one of the options considered for the management of these kinds of wastes. Assessments carried out at Hindustan Aeronautics Limited (HAL), Indian Telephone Industries (ITI), various star hotels and marriage halls led to the conclusion that three more biomethanation plants of 730 tonnes per year capacity can be established. Only in the case of the marriage halls was the establishment of biomethanation plants not feasible.

The third component looked at the larger issue of **solid waste management of the city**. A project proposal for a consultancy project was put for-

ward. The focus of the proposal was to evolve an effective procedure and management process for a sustainable and cost-effective long-term solid waste management strategy in the city. The more critical problems appear to be in the area of disposal of

solid waste, closely interlinked with the collection and transportation to the disposal site. The key issues to be kept in mind are the inability of the Bangalore City Corporation (BCC) to bear any burden of huge costs and therefore the neces-

sity of involving the private sector.

The most viable, cost-effective and practical solution appears to be setting up a number of large mechanical composting plants to process the bulk of the garbage produced. If properly conceived and implemented, it appears that not only the transportation and disposal costs could be resolved very effectively at lower cost to BCC, but could even lead to profit genera-

**GHG Abatement Potential from Establishment of Biomethanation Plants**

Project Implemented	GHG Emissions (Pre Project, tons/yr)	GHG Emissions (Post Project, tonnes/yr)	Net GHG abated (tonnes/yr)
HAL Project	370.00	20	350.00
ITI Project	92.40	5	87.40
Hotels and restaurants	1016.60	54	962.60
Total GHG Emissions Abatement Potential			1,400.00

tion. Private sector initiative and involvement will be central to this strategy.

The second demonstration project focused on the **reduction of GHG emissions from hospital waste**. Bangalore City has seen a tremendous increase in the number of health care settings / hospitals in the past decade. The city has several hospitals of varying sizes, health centres, nursing homes, clinics, polyclinics, etc.,



which generate about 25 tonnes of waste per day, i.e. 9125 tonnes a year. At present, there is no provision under municipal law for the collection of hospital waste, and the hospitals resort to open burning to render the waste innocuous, thus releasing about 7500 tonnes of GHG per year.

The thrust of the hospital waste study was to reduce significantly the open burning of waste. This was achieved through training and implementing

**sion from the transport sector.** The main mode of transport in Bangalore is two wheelers. They constitute over 80% of total vehicles registered in Bangalore. Due to inadequate public transport services, auto rickshaws form the intermediary mode of public transport. The Bangalore Metropolitan Transport Corporation (BMTTC) buses constitute only 0.5% of total vehicles.

Several short-term strategies for the mitigation of vehicular emissions were identified and assessed:

**GHG Abatement Potential from Segregating Hospital Waste**

Project Implemented	GHG Emissions (Pre Project, tonnes/yr)	GHG Emissions (Post Project, tonnes/yr)	Net GHG abated (tonnes/yr)
St. John's Medical College Hospital	398.13	82.78	315.35
Bowring Hospital	265.32	56.6	208.2
Chinmaya Mission Hospital	16.5	4.2	12.3
Total GHG Emissions Abatement Potential			575.0

- **Conversion of two stroke engines to four stroke engines:** this option was found economically unsuitable, since retrofitting a two stroke vehicle with a four stroke engine is more expensive than purchasing a new four stroke two-wheeler.

effective waste handling procedures in three hospitals, whereby the small quantity of hazardous waste was separated from organic waste. Such segregated non-hazardous waste is allowed to be collected by city municipality and disposed off in the same manner as other municipal solid waste (which does not involve burning). This results in the reduction of GHG emissions in the city.

The third demonstration project dealt with the **containment of GHG emis-**

- **Hot air injector:** this seems to be a feasible option. However, it still has to be reviewed by an experts committee before it can be marketed.
- **Private vans for office goers:** due to judicial, economic, and attitudinal concerns, this option is not feasible at this time.
- **Point-to-Point bus services:** due to problems with the bus company and logistic problems, this option is not feasible at this time.

**CO<sub>2</sub> Mitigation Options**

Activity	Total Emission Reduction (tonnes of CO <sub>2</sub> eq)	Activity cost \$US/ton of CO <sub>2</sub> eq
Community Composting Plant, 1.0 t per day capacity	1,875	102
Biomethanation Plant, 2.0 t per day capacity	1,300	101
Commercial Composting Plants	90,000	17.75
Reduction of Open Burning of Hospital Waste	7,000	10.29
Fitting Vehicles with Emission Reduction Devices	10,715	14.0
Private Buses for Office Goers	6	129
Point to Point Bus Services	7.2	542
Pedestrian Plaza	137	0



- **Pedestrian Plaza:** due to the opposition of the shop owners, who believed that banning the movement of vehicles on their street would reduce sales drastically, this option could not be implemented.

In addition to identifying the options, a proposal for a **vehicular emissions scenario** was put forward. Since vehicular emissions are the main source of pollution in Bangladesh, due to the absence of major polluters such as industries and thermal power plants, the study was planned with the objective of demarcating certain traffic-congested areas in the city. It also emphasised the effect of vehicular emissions on the environment and on the health of citizens. Total emissions reduction and cost of each of the activities carried out are summarised in the table above.

The fourth demonstration project comprised several **awareness and education** activities. One of the major drawbacks for any project implementation in India is a lack of awareness. It is therefore critical that awareness activities be carried out. The project took a three-pronged approach to implementing this part of the study.

Through a programme called “**Environmental Awareness through Action-oriented Projects for Students**” (EAAPS), the project aimed to reach the youngest part of the population. It sought to achieve comprehensive environmental education through the actual involvement of students with civic groups, individual households, commercial establishments, educational institutions, and civic bodies such as the Bangalore City Corporation (BCC), Transport Department and Forest Department.

The EAAPS activity managed to create awareness among participating students about the environmental problems of indiscriminate dumping of solid waste, cutting of trees, over usage of plastics and vehicular pollution.

A **newsletter** called TERISCRIBE was published as part of the project. It had a readership of about 2,000 people. 500 copies of this newsletter were sent to research institutions, NGOs, educational institutions, government departments, industries and other agencies involved in environmental protection. The articles carried in the newsletter are on topics related to GHG reduction, with each issue focussing on a particular theme.

Finally, numerous **workshops, seminars, training programmes, and talks** were conducted as part of the project. Overall, 2,500 participants from public and private institutions attended the events.

#### **OUTLOOK**

This project illustrates the difficulty of operationalising the global-local nexus of climate change activities. A significant reduction of GHG emissions was not achieved during the course of the project due to lack of ownership on part of the project partners. This stems from the problematic nature of addressing local and global issues simultaneously. Stakeholders and decision-makers are preoccupied with burning problems at the local level, thus unable to focus on global, seemingly removed topics. The win-win character of activities addressing local and global environmental issues simultaneously needs to be demonstrated clearly before similar approaches can be used sustainably in future projects.

## **Ostafrika: Möglichkeiten der Verringerung von Treibhausgas-Emissionen durch Power Pooling in Ostafrika**

**Partnerorganisation:** Tanzanian Ministry for Energy and Mineral Resources

**Projektzeitraum:** April 1999 - Dezember 2001

**Finanzierungsbeitrag:** DM 550 000

### **Kurzbeschreibung des Vorhabens**

Neben der Nutzung von Holz gehört auch in Afrika die Verbrennung von fossilen Energieträgern zu den Hauptursachen von Treibhausgas-Emissionen.



Seit einigen Jahren arbeiten die ostafrikanischen Staaten Kenia, Uganda und Tansania auf politischer und wirtschaftlicher Ebene stärker zusammen, unter anderem auch im Energiesektor. Im März 1998 beschlossen die Regierungen der drei Länder, einen regionalen Masterplan für den Elektrizitätssektor aufzulegen. Ziel dieses von der Weltbank finanzierten Planes war die Ermittlung, inwieweit durch eine Zusammenarbeit im Elektrizitätssektor sowohl Treibhausgase reduziert als auch andere ökologische und ökonomische Vorteile genutzt werden können.

Der im März 2003 veröffentlichte Abschlussbericht kam zu dem Ergebnis, dass die Minderung von Emissionen im ostafrikanischen Stromverbund auch wirtschaftlich attraktiv sein. Da der Energiesektor in Ostafrika aufgrund von Liberalisierungsprozessen im Umbruch ist, bietet sich im Moment auch eine gute Gelegenheit für eine Implementierung von Maßnahmen zur Emissionsminderung.

Neben der wirtschaftlich interessanten Minderung von Emissionen hat ein solches "no-regret"- Projekt weitere Vorteile einer Bündelung des Energiesektors ermittelt. Die Umsetzung des Masterplans kann auch dazu beitragen, die Versorgungssicherheit im Energiebereich zu erhöhen und durch eine veränderte Energieproduktion lokale Umweltschäden zu reduzieren. Nicht zuletzt ist die Bereitstellung von preiswerter und sicherer Energie einen Beitrag zur Armutsminderung in den betroffenen Ländern.

Als positiven "Nebeneffekt" ermittelte das Projekt Möglichkeiten für die Durchführung von CDM-Projekten in der Region. Es wurden sowohl größere als auch mehrere Kleinprojekte (weniger als 15 MW) - besonders im Bereich der Wasserkraft - identifiziert. Der Abschlussbericht enthält eine Liste von möglichen CDM-Projekten.

Allerdings werden die Länder bei der Durchführung dieser Maßnahme mit institutionellen, technischen, politischen und nicht zuletzt finanziellen Probleme konfrontiert sein, zu deren Überwindung der Aufbau von Kapazitäten und den Transfer moderner Technologien notwendig ist. Die Nutzung finanzieller Ressourcen der Klimarahmenkonvention und des Kyoto-Protokolls können die Umsetzung des Masterplans entscheidend unterstützen.

## Philippines: Country Measures – CO<sub>2</sub> Mitigation Options

**Partner Organisation:** Department of Energy, Manila, Philippines

**Project Period:** November 1993 - December 1995

**Financial Contribution:** DM 450,000

### Project Brief

In order to evolve scenarios for CO<sub>2</sub> mitigation programmes, the energy and power sector of the Philippines has been analysed to obtain a comprehensive set of figures. With this database it is possible to look for measures with a high impact on CO<sub>2</sub> reduction, at the same time determining which measures are most economic. The analysis of fossil-fuel burning in the country shows that the power sector, transportation, and the industrial/commercial sector contribute about 1/3 each of total CO<sub>2</sub> emissions. In order to evolve strategies for mitigation programmes, a number of different scenarios were considered which involve different sources.



In technological terms, the 16 scenarios drawn up were classified into three groups:

- Energy conservation in end-use sectors
- Energy switching from high-carbon fuels to low- or even no-carbon energies
- Energy conservation in the power sector

The project in the Philippines was the first of its kind under the GTZ programme.

## **The Philippines:**

### **Country Measures - CO<sub>2</sub>-Mitigation Options -**

*Partner Organisation:* Department of Energy, Manila, Philippines

*Project Period:* November 1993 - December 1995

*Financial Contribution:* 450 000

The analysis of fossil fuel burning in the country shows that the power sector, transportation, and industrial/commercial sector contribute about 1/3 each to total CO<sub>2</sub> emissions. In order to evolve strategies for mitigation programmes, a number of different scenarios were considered which involve different sources. These mitigation options can be classified according to special claims.

First of all, it must be borne in mind that all measures are interlined with many other economic and social issues. A successful project must therefore meet certain conditions other than the environmental conditions seen at first glance.

In terms of profit, however, the measure should be attractive for private or public investors. If a measure under consideration has a high impact on CO<sub>2</sub> mitigation, this is all the better, because this indicates a large market potential. In addition, the number of individual investment schemes needed to achieve these impacts should be small, minimising logistical difficulties in project implementation. And, of course, the measure should have no negative side effects for any part of the society.

Looked at from a more technological aspect, the 16 scenarios drawn up were classified into three groups:

- Energy conservation in end-use sectors
- Energy change from high-carbon fuels to low- or even no-carbon energies
- Energy conservation in the power sector

Naturally, each option has distinct costs and social benefits as well. It is essential then to compare these costs with the impact on CO<sub>2</sub> emissions. In detail, the scenarios analysed the following options:

1. Demand-side management, covering measures such as the replacement of energy-intensive refrigerators, electric motors and air conditioners by highly energy-efficient apparatus. Taken together, these options represent a general improvement in fuel combustion and electricity use, including in processes and industry.
2. Switching fuel to renewable energies or natural gas, which means replacing fossil-fired power plants with hydro, geothermal, wind-powered or natural gas combined-cycle turbines, and the dissemination of photovoltaic solar home systems in the residential sector.

Efficiency can be improved in power generation and transmission, including the reduction of transmission losses in the grid or increasing the number of co-generation plants, for example. It should be realised that changes in interest or in the supply situation can result in a completely different situation for mitigation projects. For example, the range of conceivable options may extend from a scenario in which the society profits from private investments to one which has only a low impact in spite of high public investment. It is very clear therefore that it is important to select precisely the right option.

Most projects need investment in the early stages, and the investor is also faced with future costs for operation and maintenance. At first sight, these internal costs seem to be clear. On the other hand, however, the external costs of emissions contributing to global warming and climate change are a matter of discussion. The environmental manual, a software tool for analysing internal and external costs, has been introduced both in the energy sector and in industry.

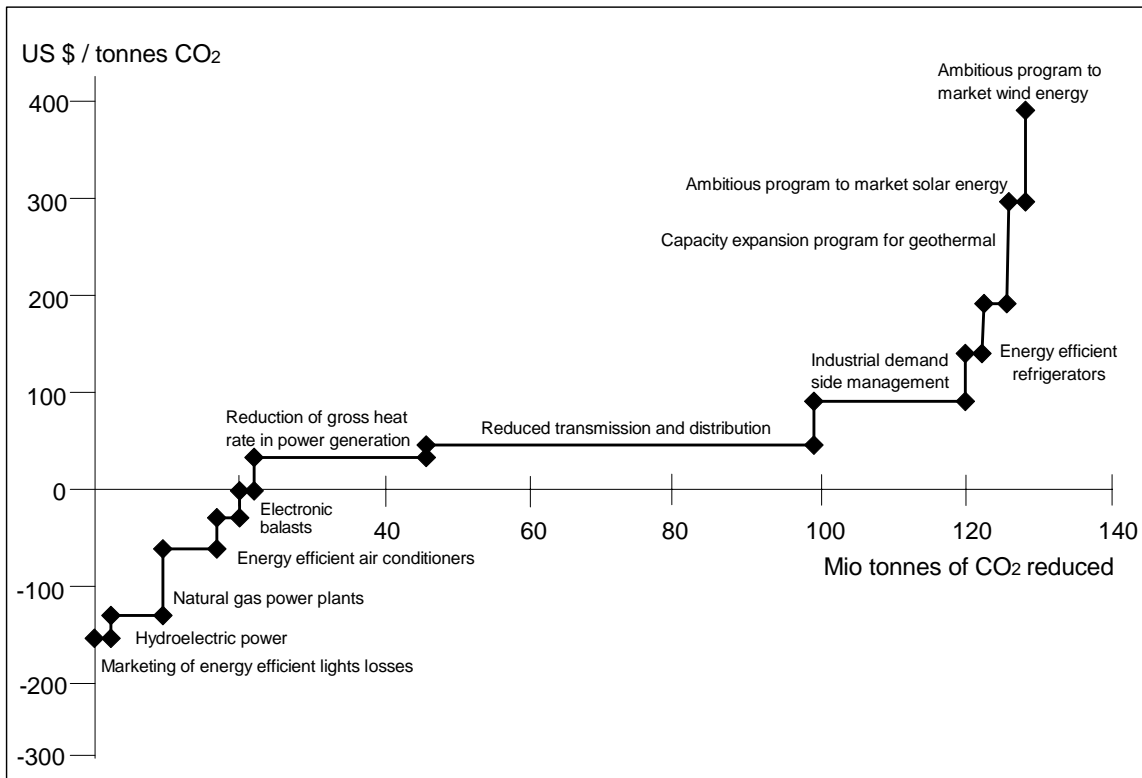
A common regime for rating scenarios is to compare the long-run marginal costs (LRMC) per tonne of CO<sub>2</sub> saved over a period of 30 years. In the chart, the lines representing different scenarios provide an initial indication of CO<sub>2</sub> mitigation options. However, these are greatly dependent on special assumptions made for key factors such as market potential or implementation time etc. In other words, these results can be very speculative and may fluctuate over a wide range. In total, 12 scenarios were investigated with respect to long-range marginal cost analysis for CO<sub>2</sub> mitigation from fossil burning.

These scenarios - options 1 to 12 in the figure - can be interpreted in the following way:

- A *reduction of gross heat rate in power generation in combination with reduced transmission and distribution losses* has the largest impact over a period of 30 years. This option accounts for 60 % of the levelised CO<sub>2</sub> mitigation potential.
- A *capacity expansion program for geothermal, hydroelectric power, and natural gas power plants* has the third largest CO<sub>2</sub> mitigation potential of 18 %. These three scenarios reflect the extension plans for the next decades.
- An *industrial demand-side management programme* aiming at fuel and electricity savings also has a potential of 18 %.
- A residential demand-side management programme results in a quite small impact of about 5 %. This programme combines the *marketing of energy-efficient lights, electronic ballasts, and energy-efficient air conditioners* as well as *refrigerators*.
- An *ambitious programme to market solar energy and wind energy* has a very marginal impact of 0.15 % and results in particularly high social costs per tonne of CO<sub>2</sub> saved. For example, this scenario assumes a number of more than 200,000 solar systems to be sold over a period of 30 years. However, for private rural households it is a financially attractive investment.

Mitigation potentials of the transport sector were not considered in these studies, nor were measures to increase CO<sub>2</sub> sinks, for example by planting trees.

External Cost Factors used in study (estimated in US \$ per ton)	
CO <sub>2</sub>	30
SO <sub>2</sub>	3,000
NO <sub>x</sub>	2,400
CH <sub>4</sub>	330
N <sub>2</sub> O	8,100
Particulates	600



### Levelized 30 Years CO<sub>2</sub>-Mitigation

The suggested measures are financially attractive for public or private investors. Energy conservation and loss reduction, for example, are suitable options with little capital. The results of these studies therefore suggest concentrating on such measures first.

In the residential sector there are good prospects of being able to implement energy-saving measures without public assistance because of private technology transfer. With respect to high energy rates of about 11 % per year up to 2010, a detailed analysis of costs and technologies for the industrial and power sectors has to be carried out now to identify suitable options

## Zimbabwe: Options for Greenhouse Gases Mitigation under Power Pooling in Southern Africa

**Partner Organisation:** Ministry of Energy and Transport Southern Centre for Energy and Environment (SCEE)

**Project Period:** September 1996 - September 1999

**Financial Contribution:** DM 540,000

### Project Brief

The project was conducted by the Zimbabwean Government with technical assistance from GTZ. It identified the extent to which regional cooperation in the electricity sector can be utilised as a vehicle for greenhouse gas mitigation, among all major Southern African Development Community (SADC) states which are members of the Southern African Power Pool (SAPP). If appropriate measures are introduced, local environmental benefits and greenhouse gas (GHG) emissions abatement can be additional benefits to SAPP member states besides regional demand-supply balancing and higher security and quality of supply.



The objective of the project was to enable decision-makers in the SAPP power sector to utilise the options for the reduction of GHG emissions.

The project was implemented in three phases:

**Phase 1:** An inventory of GHG emissions from the power sector was compiled, using 1994 as the base year.

**Phase 2:** Regional power sector expansion and baseline GHG emissions were defined.

**Phase 3:** Proposals for measures to implement regional mitigation options were put forward.

The major options considered for regional mitigation were to be feasible.

1. Substitution of coal with gas and hydro in the business-as-usual (BAU) case,
2. Conjunctive operation of wind and hydro plants,
3. Operation of wind/gas plants used for pumped storage,
4. Residential switch to gas.

The quantified results showing which options have the greatest potential for GHG mitigation are presented in the report available for download. The Environmental Manual for Power Development was used in the project as the major tool to analyse scenarios of various possible power mixes in SADC.

# SOUTHERN AFRICAN POWER POOL

## OPTIONS FOR CLIMATE CHANGE MITIGATION UNDER POWER POOLING IN SOUTHERN AFRICA

*Partner Organisation:* Ministry of Energy and Transport, Zimbabwe  
Southern Centre for Energy and Environment (SCEE)

*Project Period:* September 1996 – September 1999

*Financial Contribution:* DM 540 000

### **BACKGROUND**

Originally known as the Southern African Development Coordination Conference (SADCC), the Southern African Development Community (SADC) was formed in Lusaka, Zambia, on April 1st, 1980, following the adoption of the Lusaka Declaration - **Southern Africa: Towards Economic Liberation** by the nine founding member States. Current member states are Angola, Botswana, Democratic Republic of Congo (DRC), Lesotho, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe. Each member state has responsibility to coordinate a sector or sectors on behalf of the others

The Energy Protocol governs the administration of the SADC energy sector. One of the main objectives of the SADC Energy Protocol is cooperation in the development of energy and

power pooling to ensure security and reliability of power supply. In fulfilment of this objective, the electricity utilities in the region have established the Southern African Power Pool (SAPP). The SAPP brings the following advantages to the region:

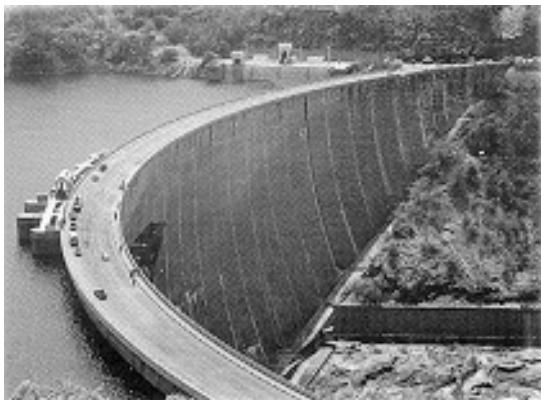
- Demand-supply balancing by facilitating electricity flow from surplus areas to deficit areas in order to cover deficits resulting from unexpected climate variability such as drought or from technical problems
- Economies of scale
- Security and quality of supply

If appropriate measures are introduced, local environmental benefits and mitigating the emission of greenhouse gases (GHG) can be additional benefits.

The power sector is the leading contributor to GHG emissions in SADC, and it also represents an area where SADC cooperation has been most successful. It was therefore important that this sector's contribution to the regional GHG emissions be properly documented and opportunities for regional cooperation for emissions reduction and avoidance be identified. This was done alongside an assessment of the technological and economic benefits SADC would derive from any activities to mitigate climate change under its power pooling arrangement.

This project sought to identify the extent to which regional cooperation in

### **Kariba Dam**



Zimbabwe Encyclopaedia



the SADC electricity sector could be utilised as a vehicle for GHG mitigation. It was conducted in most SADC states that are members of the SAPP.

**OBJECTIVE**

The objective of the project was to enable decision-makers in the SAPP power sector to utilise the options for the reduction of GHG emissions.

**MAIN ACTIVITIES**

The project was implemented in three phases:

*Phase 1:* An inventory of GHG emissions from the power sector was compiled, using 1994 as the base year.

*Phase 2:* The regional power sector expansion and baseline GHG emissions were defined.

*Phase 3:* Proposals for measures for implementing regional mitigation options were put forward.

**SUMMARY OF FINDINGS**

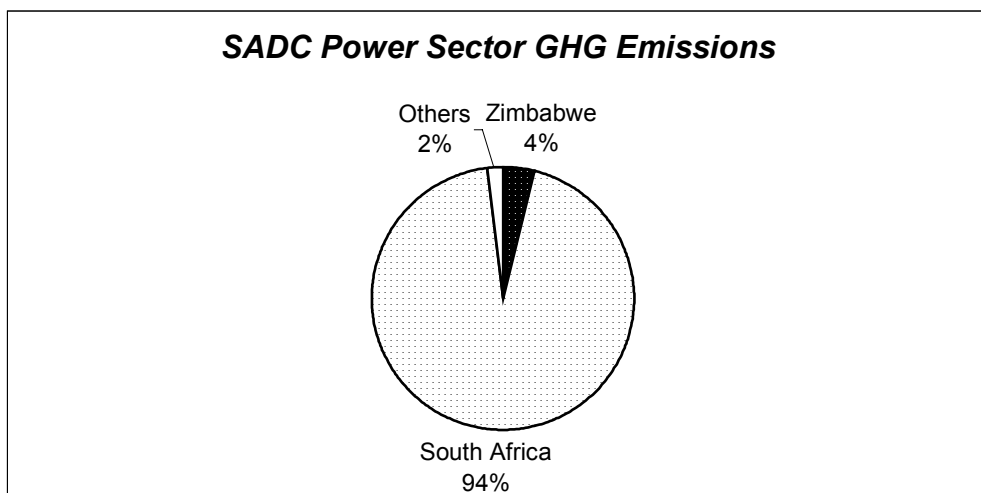
*Phase 1:* In the base year for this study (1994), total GHG emissions from the SADC power sector were estimated at 159,555 Gg of CO<sub>2</sub> equivalent, in the form of CO<sub>2</sub> (153,335 Gg or 96.1%), N<sub>2</sub>O (1.1%) and the balance made up of methane (2.8%). Coal thermal power plants contributed 98.8% of the CO<sub>2</sub> equivalent emissions. Diesel and gas turbine thermal plants contributed only 0.58% and 0.42%, respectively.

The majority of coal-fired power plants operated in the region use pulverised coal steam turbines. Plant efficiencies range from 23% for small plants to 36% for larger plants. South Africa, with its huge coal thermal plants contributed 94% of the regional CO<sub>2</sub> equivalent emissions, Zimbabwe 4%, with the balance being shared among the remainder (see chart).

*Phase 2:* The region's energy demand is projected to grow from 205 TWh to 292 TWh in 2020 (an average growth rate of 1.54% p.a.). This is based on the projected population growth rate of 2.9% per annum, the current low (average 7%) access to electricity by the household sector and an average GDP growth rate of about 3.2% per annum (African Development estimates). This is a business-as-usual scenario in which the maximum demand is taken as a summation of the individual utility expansion plans without any deliberate environmental considerations, demand side management nor likely impact of increasing regional electricity trade.

The regional expansion plan was taken as the aggregation of the national plans. The regional load is expected to grow from 31,868 MW in 1997 to about 53,215 MW in the year 2020. The expansion program is dominated by coal-based generation plants. Capacity from new hydro plants over the same period will total 4,047 MW.

There is extensive electricity trading in





the SADC region already. This trade consists mostly of bilateral arrangements. In 1994, ESKOM of South Africa was the largest exporter, exporting 2,628 GWh, followed by the DRC (1,278 GWh), Zambia (855 GWh), and Namibia (28 GWh). However, with the completion of the inter-connectors to Zimbabwe and South Africa in 1997, Mozambique becomes the second largest exporter.

### ***Dying Trees at Lake Kariba***



Holger Liptow

*Phase 3:* Regional options for GHG mitigation are those that require the participation of two or more countries to be feasible. These include:

- Joint investments in lower carbon or no carbon power plants
- Power import/export agreements from lower carbon sources
- Import/export of low carbon fuels for power generation
- Coordinated system dispatch or control and management to reduce GHG emissions

The baseline (business-as-usual) case requires the installation of 7,068 MW of thermal plant fired on coal and 4,047 MW of hydro plant by 2015.

About 863 MW of gas plant is installed in the same period. Based on available resources, there is potential for 18,000 MW of hydro plant and 2,465 MW of gas-fired plant. GHG emissions could thus be reduced by substituting this hydro and/or gas based generation for coal generation. Apart from the prohibitive capital costs, hydro dams are also associated with other negative environmental costs such as displacements of populations, destruction of vegetation and submergence of tourist attractions. The Congo and Zambezi rivers, however, have potential for significant run-of-river power plants with minimal adverse environmental effects. Nuclear power has not been considered as a mitigation option because of the problems of waste disposal and the stigma attached to the technology.

Potential regional mitigation projects will, thus, include hydro, gas, renewable energy (wind) projects and inter-connectors for imports/exports. **Mitigation scenarios** were developed through various combinations of the mitigation plants identified, conjunctive operation of wind and hydro plants, operation of wind and gas plants to provide pumped storage, and encouraging the residential sector to use gas for cooking/heating instead of coal-based electricity. The specific options considered were:

1. **Displacement of coal with gas and hydro from the business-as-usual (BAU) case:** This would entail replacing the new coal plants in South Africa after 2004 with gas from Kudu in Namibia and/or Pande in Mozambique. Some coal-fired South African plants would be re-powered with gas.
2. **Conjunctive operation of wind and hydro plants:** A wind farm (350 MW) would be used to enable hydro power stations such as Kariba to run for shorter periods. As a result more water would be stored in Kariba. This increases the generation efficiency of the hydro station.



Coal-based generation would therefore be reduced.

**3. Operation of wind/gas plants used for pumped storage:** This option results in the inefficient coal-fired plants running for shorter hours, leading to an emission reduction of 42%.

**4. Residential de-marketing to gas:** This option would involve the construction of a gas pipeline from Pande in Mozambique to Zimbabwe and South Africa. Households would be encouraged to use the gas for cooking and other heating applications instead of electricity.

### **GHG Emissions (million tonnes)**

	BAU	SC 1	SC 2	SC 3	SC 4
<b>2000</b>	173	173	173	173	173
<b>2005</b>	179	172	177	175	177
<b>2010</b>	189	167	187	183	188
<b>2015</b>	104	161	202	195	202
<b>2020</b>	239	186	236	229	236

Scenario 1 (SC 1) results in the largest reduction in emissions, amounting to 53 million tonnes of CO<sub>2</sub> equivalent or a 22% reduction compared to the reference case. This is due to the large number of hydro and gas options in this scenario. Scenario 3 (SC 3) also provides a significant reduction in emissions (10 million tonnes or 4%). The other two scenarios provide only marginal reductions (3 million tonnes or 1%) annually at the end of the study period in 2020. Scenario 2 (SC 2) is cheapest to implement at -\$110/t CO<sub>2</sub>. Scenario 4 (SC 4) costs -\$107/t CO<sub>2</sub>, while both Scenario 1 (SC 1) and Scenario 3 (SC 3) have positive costs of \$59/t CO<sub>2</sub> and \$74/t CO<sub>2</sub> respectively.

### **OUTLOOK**

This project has demonstrated some of the opportunities that exist for the SADC region for GHG mitigation. These options can be realised by utilising the huge hydro potential in the region, particularly from the Congo and the Zambezi rivers, and through developing the recently discovered gas resources in Namibia, Mozambique and Tanzania. Renewable energy, particularly wind, also has a significant role to play. The huge coal reserves will continue to play a major role in the power sector, especially in light of the droughts that have been experienced in the region in the past.

From the region to benefit from the diversity of its energy resources, more emphasis should be placed on constructing and strengthening inter-connectors to facilitate power flow from surplus to deficit areas across the region. More benefits can also accrue to the region from closer cooperation by SADC power utilities through SAPP. International assistance to the region can also be accessed to:

- Strengthen the SAPP to move towards a 'tighter pool' with collaborative planning and smoother operational and electricity trading protocols.
- 'Buy down' the investment costs for inter-connectors and resource development since these bring about global benefits in the form of GHG emission reduction.
- Increase the region's access to modern energy technology for GHG mitigation through improved power generation efficiency.

## India: Sustainable Transport in Delhi and Mitigation Options of Greenhouse Gases

**Partner Organisation:** Tata Energy Research Institute (TERI), New Delhi

**Project Period:** January 1998 - August 2000

**Financial Contribution:** DM 420,000

### Project Brief

With over 2.32 million registered vehicles in Delhi as of 30th March 1995, the city has the largest vehicle population in the country even though it ranks third in the list of mega-cities in the country after Mumbai and Calcutta.



Traffic congestion has become a common sight and a problem that commuters have to put up with every day. To provide an efficient and environmentally sound transport system is now a matter of great urgency in Delhi, without which it would be difficult to achieve quality urban life for inhabitants and to sustain economic growth.

Against this background, GTZ supported the city of Delhi and TERI to draw up a plan for a "Sustainable and Environmentally Sound Transportation System for the City of Delhi" in consultation with relevant stakeholders.

The main objective of the project was that the key institutions responsible for developing, planning and implementing transport policies in the city agree to a package of measures by means of which sustainable mobility and improvement of air quality along with the reduction of greenhouse gases (GHG) is achieved.

TERI proposes drawing up a plan for a sustainable and environmentally sound transportation infrastructure for the city of Delhi. The development of such a plan would require the involvement of relevant local authorities, throughout the project, so as to ensure their endorsement and subsequent implementation of the plan.

In consultation with the Steering Committee created as an advisory body, four areas for short- to medium-term intervention were identified for more detailed evaluation:

- Reduction of urban congestion through traffic management,
- Augmentation of public transport,
- The role of non-motorised transport systems,
- Promotion of cleaner fuel and engine technologies.

Various options in these areas were studied in detail including their effect on the GHG emissions from the transport sector in Delhi. The extension of public transport together with replacing diesel by natural gas have the greatest potential to reduce the burden on the environment.

# INDIA

## SUSTAINABLE TRANSPORT IN DELHI AND MITIGATION OPTIONS OF GREENHOUSE GASES

*Partner Organisation:* Tata Energy Research Institute (TERI)  
*Project Period:* January 1998 – June 1999  
*Financial Contribution:* DM 420 000

### BACKGROUND

The city of Delhi has been experiencing an exponential growth in the registration of motorised vehicles since 1970/71. With over 2.32 million registered vehicles in Delhi as of March 1995, the city has the largest vehicle population in the country. In fact, the growth of vehicles has been faster than that of its population. 10% of all motorised vehicles in India are licensed in Delhi, even though only little more than 1% of the population lives there.

As a result, energy consumption and pollutant emissions from road traffic are higher than from electricity generation and industry, accounting for two thirds of the total. Levels of exposure to pollutants are often several times higher than the Indian threshold limit value.

Public pressure to attend to the environmental problems appears to be

growing, however, not (yet) at the cost of restricting traffic. The predominant, but not unanimous opinion is that traffic must on the contrary be allowed to flow more smoothly. Virtually no attention is paid to the question of climate change in the planning and organisation of urban transport. As the immediate local environmental and transport problems are so very pressing, they seem to leave no room for action against climate change.

The key question in dealing with this issue is to what extent there is a synergy in the solutions to urban air pollution problems and global warming problems.

Not too many people have recognised that in many cases contributions to global climate protection can be achieved in parallel with reductions in local environmental pollution without additional expenditure if urban transport is organised differently.

To address this question, a study was devised and implemented by TERI.

### *Intersection in Delhi*



Udo Becker

### OBJECTIVE

The overall scope of the project was to draw up a plan for a “Sustainable and Environmentally Sound Transportation System for the City of Delhi” in consultation with relevant stakeholders.

The main objective of the project was that the im-



portant institutions responsible for developing transport policies, planning and their implementation in the city agree to a package of measures by means of which sustainable mobility and improvement of air quality along with the reduction of greenhouse gases (GHG) is achieved.

### **MAIN ACTIVITIES**

The project focused on the three following areas of activity:

1. Carry out a comprehensive review of the policy initiatives taken by the various authorities to effect improvements in the transportation system in Delhi.
2. Identify the constraints that inhibit the development of a sustainable and environmentally friendly transport system.
3. Suggest policy changes and institutional arrangements to address these constraints and devise strategies for upgrading the transportation system together with a time-bound program for their implementation.

### **SUMMARY OF FINDINGS**

In consultation with the Steering Committee created as an advisory body, four areas for short- to medium-term intervention were identified for more detailed evaluation:

1. **Reduction of urban congestion through traffic management:** Traffic restraint and demand management measures, and parking management of commercial areas on major arterial roads.
2. **Augmentation of public transport:** Financial outlays for more buses and use of market-based instruments to meet the Supreme Court's directives (see below) with emphasis on cleaner buses and other measures to encourage public transport on designated corridors and facilitate a shift from individual to public transport.
3. **The role of non-motorised transport systems:** Cost-benefit analysis of providing cycle tracks.

4. **Promotion of cleaner fuel and engine technologies:** Use of progressively stringent emission standards for new vehicles and periodic inspection and maintenance of in-use vehicles.

The options identified above were evaluated in terms of their effect on energy use and emissions. Due to the difficulties in quantifying the implications of traffic management options and the role of non-motorised transport, these options were analysed separately as pilot projects.

Against the baseline (BL), the following options were evaluated based on assumptions by judgement and expert opinion:

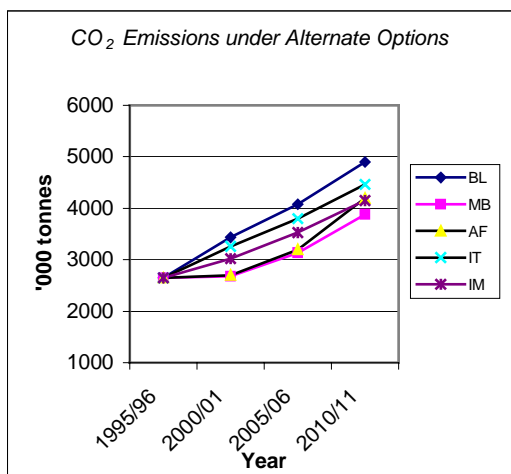
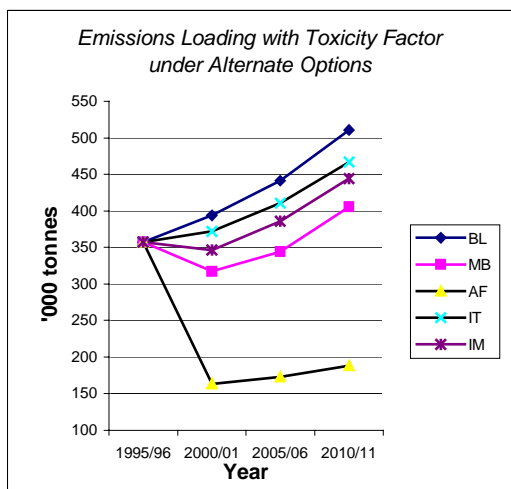
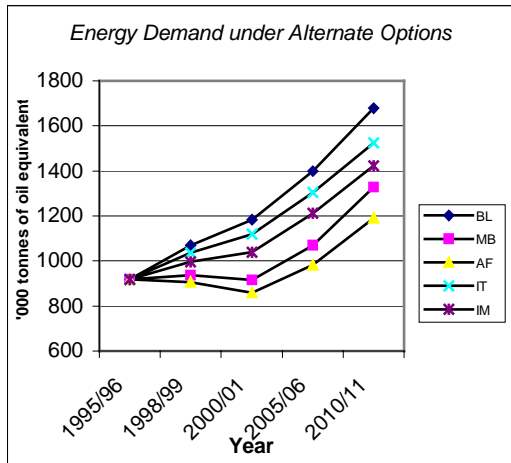
**More buses (MB):** The city is supposed to have 10,000 public buses starting April 2001 as per Supreme Court Directive.

**Promote Alternate Fuels (AF):** Alternative fuels such as Compressed Natural Gas (CNG), propane and electricity will be introduced in the city by 2001 and its penetration will increase gradually.

**Improved Technology (IT):** Four-stroke engines will meet half of the total demand by two-wheelers in 2001 compared to about 7% in 2000. In 2011, the two-stroke technology will be completely phased out.

**Inspection and Maintenance (IM):** Periodic inspection and maintenance of vehicles in use will improve the overall engine efficiency along with reduction in tailpipe exhaust emissions from 2001. An overall GHG emissions reduction of 7-12% is expected.

The figures below summarise the findings.



The table below gives the matrix of options with assigned ranks. Given the assumptions considered for each option, augmentation of public transport appears to be the most attractive option along with the introduction of cleaner fuels such as CNG, propane

and use of electricity for battery-operated vehicles. It is interesting to note that even though the results are purely illustrative, by and large the rank order of different options considered here would remain unchanged with changes in data input assumptions given the large variation in the energy-emission results under each option.

### Ranking of Options for Prioritisation

Options	Total energy savings	Reduction in emissions of	
		WOT*	CO <sub>2</sub>
MB	2	2	1
AF	1	1	2
IT	4	4	4
IM	3	3	3

\*Weighted overall toxicity

Each of the options identified above was assessed for feasibility and recommendations were put forward.

### Augmentation of Public Transport:

- For the purposes of achieving best air quality it is not necessary for the governments to mandate the use of any specific fuel or engine technology. Governments should only set the standards for engines and fuels. The choice of technologies that would meet those standards should be left to the car manufacturers and refineries as well as to fleet providers. This would also provide the flexibility to absorb newer technologies and location-specific solutions as and when they develop.
- The public bus operators in the city must improve their performance both in terms of using the existing fleet more efficiently and in terms of lowering their operating costs. Also increases in revenue should be considered to make the purchase of buses a viable proposition.
- The state government should consider a sales tax waiver on CNG buses and on CNG fuel, along with an interest subsidy scheme to make the showroom prices of CNG and diesel buses comparable.



- To ensure that the shift from private to public modes is realised, the ownership and utilisation of personal vehicles should be discouraged through raising taxes and fees. The additional revenue should be used to finance the augmentation of public transport in the city.

#### **Traffic Management at Intersections:**

- Priority to public transport and high occupancy vehicles
- Banning turns and activating slip lanes
- Synchronising traffic signals
- Area licensing scheme
- Parking control
- Encouraging car pools
- Improve pedestrian facilities and provide adequate information to users for encouraging public transport

#### **Parking Management**

Using Yusuf Sarai market as a pilot study, the project team devised a parking management plan to reduce the congestion due to unorganised parking. The following is a summary of the recommendations put forward in an action plan:

- Reorganisation of existing parking lanes
- Additional parking sites
- Parking charges
- Pedestrian facilities
- Restriction of loading and unloading of goods vehicles

#### **Non-Motorised Vehicles (NMVs)**

- Streamlining the process for the application for NMV small loans
- Provision of organised and guarded parking for NMVs in commercial and residential areas

- Closer coordination between the Transport Department and Ministry of Environment and Forests in Delhi to incorporate NMV-appropriate landscaping measures in urban reforestation programs
- Speed enforcement, with special attention to buses
- Development of a coherent transport policy that integrates the needs of NMV and public transport users based on an assessment of social and environmental costs of motorised transport
- Development of a mechanism where urban planning and transport plans are open to public scrutiny and peer review
- Review of current standards on mixed traffic management to incorporate latest research findings and upgrade the standards to international levels.

#### **Cleaner Fuel and Engine Technologies**

Improved engine technology and cleaner fuel quality has to go hand-in-hand with improved roads and traffic flow management. In other words, though it is important to address supply side technological intervention to improve air quality it is not sufficient. Demand management measures using a combination of market based instruments as well as command and control regulatory measures are also vital to reduce emissions.

#### **OUTLOOK**

Further activities following from the study are under consideration (10/2000).

## Tanzania: Technological and other Options for the Mitigation of Greenhouse Gases in Tanzania

**Partner Organisation:** Ministry of Tourism, Natural Resources and Environment  
Department, Tanzania; Centre for Energy, Environment, Science and Technology (CEEST),  
Dar es Salaam

**Project Period:** June 1994 - March 1996

**Financial Contribution:** DM 490,000

### Project Brief

Neither the production of greenhouse gases nor their reduction is a technological problem alone. In Tanzania, as well as in many other countries, market and institutional barriers are important obstacles to technological innovation. Because of weak structures, the clear economic and environmental signals have not initiated the necessary impetus to bring about a change of parameters and new developments.



A multicriteria analysis was carried out to produce a ranking of the different mitigation options that are now under consideration. The study identified the characteristics and costs for a number of technological and other measures to reduce the emission of greenhouse gases in Tanzania and came up with several recommendations: First of all, the efficiency of the existing power generating system should be increased by repowering and improving generation and distribution. Second, the implementation of combined-cycle turbines as well as more efficient use of energy in industry should be pursued. Efficiency improvement in electricity generation is ranked highly because of its broad acceptance. Being a large-scale and centralised technology, it is easier to take a decision on implementation than in the case of decentralised technologies.

The highly relevant sector of forest and land management, however, is faced with significant barriers to implementation. Acceptance and dissemination are crucial factors here which have to be taken into account. The same is true for nearly all measures in the household sector. For the industrial sector, on the other hand, efficient energy use is a very significant measure with high additional economic benefits.

Furthermore, it is recommended to develop a mitigation strategy to be implemented by the government in connection with its activities under the United Nations Framework Convention on Climate Change.

**Tanzania:**

**Technological and other Options for the Mitigation of Greenhouse Gases in Tanzania**

<i>Partner Organisation:</i>	<i>Ministry of Tourism, Natural Resources and Environment: Department of Environment, Tanzania; Centre for Energy, Environment, Science and Technology (CEEST), Dar es Salaam</i>
<i>Project Period:</i>	<i>June 1994 - March 1996</i>
<i>Financial Contribution:</i>	<i>DM 490 000</i>

Neither the production of greenhouse gases nor their reduction is a technological problem alone. In Tanzania, as well as in many other countries, market and institutional barriers are important obstacles to technological innovation. Because of weak structures, the clear economic and environmental signals have not initiated the necessary impetus to bring about a change of parameters and new developments.

This is true for the implementation of new and renewable energy technologies as well. An evaluation of projects carried out in Tanzania showed that dissemination of such technologies has to face a number of constraints. Among these, a lack of funds or huge investment costs are quite familiar, however. But very often, implemented systems have failed because of bad maintenance or a sudden change in energy demand and supply.

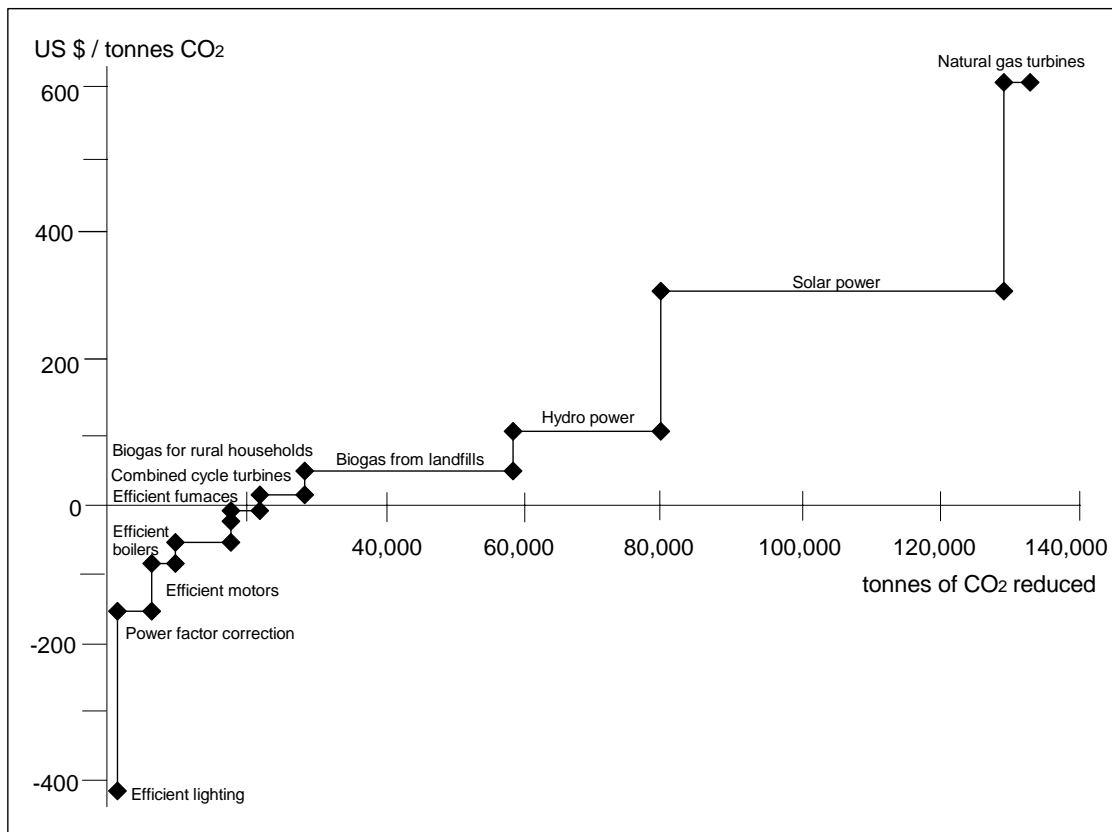
With a view to global warming and climatic changes, the massive employment of such technologies is under discussion again. However, bearing in mind some negative experiences in former projects, each technology should now be considered in a wider context. The necessary know-how for operation of the technology is an important factor, of course, but the expertise to manage such a technology change in its entirety is also a critical factor.

A multicriteria analysis was therefore carried out to produce a ranking of the different mitigation options that are now under consideration. The study identified the characteristics and costs for a number of technological and other measures to reduce the emission of greenhouse gases in Tanzania. For the future, it is intended to combine these findings with scenarios in national development plans. One of the scenarios drawn up now, however, involved regional collaboration, and therefore the effects of such cooperation have to be investigated in addition.

The main objective of the abatement study, as mentioned above, was to evaluate the costs of different options to limit the emission of several greenhouse gases. Furthermore, it may help to develop a mitigation strategy to be implemented by the Government in context with its commitments under the United Nations Framework Convention on Climate Change.

The analysis of Tanzania's economic structures shows a strong dependence on external factors. For the scenarios, two types of trends concerning the external environment were assumed, one relying on improved terms of trade, the other on periodic fluctuations. In other words, the first type represents a balanced growth scenario, whereas the second is more compatible with accelerated structural reforms.

A combination of these two types results in a composite development scenario which is more relevant for Tanzania. It is characterised by a predominance of structural reforms in the short term, followed by a more balanced growth in the long term. It also covers aspects of regional cooperation. Examples of cooperation initiatives between countries are the East African Community and the Southern African Development Community (SADC). Another one includes multilateral and international bodies.



**Savings of CO<sub>2</sub>-Mitigation**

These aspects are included because of the fact that mitigation measures cannot be handled on an isolated national level. In most cases, economic development is associated with technological change, and economic cooperation very often also means technology transfer. However, socio-economic factors are of similar importance. A successful measure depends on the constraints and opportunities for the diffusion of different technologies within sectoral development.

For the composite scenario, certain economic assumptions were made as to growth rates. Though agriculture will increase output, its share in total production will decrease from 47 % (1990) to about 36 % in 2020. The shares of manufacturing and construction as well as the energy sector will increase from 14 % to 23 % during the same period. The economic analysis was carried out for the following sectors in the country: energy, agriculture and livestock, industry, forestry and land, service.

In the context of social and environmental considerations, energy is a key component of the economic development strategy. The power sector, mostly hydro-electric schemes, had an installed capacity of 570 MW in 1994. Nearly one third of stations, however, are grid-connected or isolated thermal power stations, many of which are old. To reduce emissions, a retrofit of these facilities could improve the efficiency of combustion.

Replacement of the old plants with hydropower would be a very effective measure, as would power sharing with neighbouring states. However, implementation of these options is not very likely in the near future because of high costs. Other mitigation options for the energy sector comprise energy efficiency in end-use sectors such as households and industry. In addition, the implementation of clean energy sources such as solar energy and wind power or mini hydro and biomass were considered, and a fuel switch to natural gas was also examined.

The unit cost of introducing a technology provides a basis for comparing the various options. In this context, costs reflect real prices as well as the social benefits of energy production and utilisation. Cost curves were therefore constructed which allow the identification of least-cost options to meet the reduction goals for greenhouse gases.

The cost curves for the energy sector are shown in the figure. As can be seen, there are five options with negative costs. They include, for example, efficient boilers and lighting, efficient motors and furnaces. However, most industries in Tanzania have to increase productivity and to decrease energy costs. Therefore, such options should be implemented in any case, because total benefits exceed the investment costs.

For the industrial sector, the study identified cement production as well as pulp and paper industries as significant sources of greenhouse gas emissions.

In the cement industry, automatic control systems could reduce fuel consumption and improve productivity. A fuel switch from oil to natural gas and the recovery of waste heat can avoid further emissions. In the pulp and paper industry, optimised recovery boilers can decrease energy consumption.

Greenhouse gas mitigation options in the forestry and land use sector rely on two measures: management of the existing carbon stock, and expansion of carbon sinks. This means, for example, better agricultural and land use management. Agro-forestry can be an answer in some cases, or afforestation and even urban tree-planting. Incidentally, the creation of CO<sub>2</sub> sinks by afforestation also provides new raw material for pulp and paper production.

As a result of the multicriteria analysis, some preliminary suggestions can be made. First of all, the efficiency of the existing power generating system should be increased by repowering and improving generation and distribution. Second, the implementation of combined-cycle turbines as well as more efficient use of energy in industry should be pursued. Efficiency improvement in electricity generation is ranked highly because of its broad acceptance. Being a large-scale and centralised technology, it is easier to take a decision on implementation than in the case of decentralised technologies.

The highly relevant sector of forest and land management, however, is faced with significant barriers to implementation. Acceptance and dissemination are crucial factors here which have to be taken into account. The same is true for nearly all measures in the household sector. For the industrial sector, on the other hand, efficient energy use is a very significant measure with high additional economic benefits.

## China: Options for Greenhouse Gas Emissions in Jiangsu - Zhejiang - Shanghai - District

**Partner Organisation:** Government of Zhejiang Province, People's Republic of China; Environmental Science and Engineering Institute at Zhejiang University, Hangzhou

**Project Period:** December 1994 - April 1997

**Financial Contribution:** DM 700,000

### Project Brief

Under the Framework Convention on Climate Change, the People's Republic of China shall communicate to the Conference of the Parties – as shall all other parties to the Convention – a national inventory of greenhouse gas emissions by sources and sinks. The Sino-German Joint Project has provided detailed information to supplement other studies required as a background for the national communication document.

This is more than simply an inventory, however. The project has not only produced an inventory of GHGs, it has also identified technological options to reduce emissions in the provinces of Zhejiang and Jiangsu as well as in the Greater Shanghai Area. Additionally, strategies were developed which will convert these options into actual measures for the reduction of greenhouse gas emissions.

The region studied is one of the most developed in Southeast China. Its economics are quite different from the average standard of the country. That is why this region was chosen. For this purpose, as a first step inventories of greenhouse gases were compiled for the year 1990, and mitigation options identified for the period up to 2010.



**People's Republic of China:  
 Options for Greenhouse Gas Emissions in Jiangsu-Zhejiang-Shanghai-District**

*Partner Organisation:* Government of Province Zhejiang, People's Republic of China;  
 Environmental Science and Engineering Institute at the  
 Zhejiang University, Hangzhou

*Project Period:* December 1994 - April 1997

*Financial Contribution:* DM 700 000

Under the Framework Convention on Climate Change, the People's Republic of China is obliged to submit a national communication to the Conference of the Parties of the Framework Convention on Climate Change. The Sino-German Joint Project has provided detailed information to supplement other studies required as a background for the national document.

This is more than simply an inventory, however. The project has not only produced an inventory of GHG, it has also identified technological options to reduce emissions in the provinces of Zhejiang and Jiangsu as well as in the Greater Shanghai Area. Additionally, strategies were developed

which will convert these options into actual measures for the reduction of greenhouse gas emissions.

The region studied is one of the most developed in Southeast China. Its economics are quite different from the average standard of the country. That is why this region was chosen. For this purpose, as a first step inventories of greenhouse gases were compiled for the year 1990.

In 1990 there were 123 million people living in an area of 210,700 km<sup>2</sup> in the Jiangsu-Zhejiang-Shanghai district. The total generating capacity for electric power was 14,320 MW, with fuel consumption of 2,983 PJ. The net emissions of CO<sub>2</sub> were 271 million t, CH<sub>4</sub> 3.3 million t, and N<sub>2</sub>O 22,000 t.

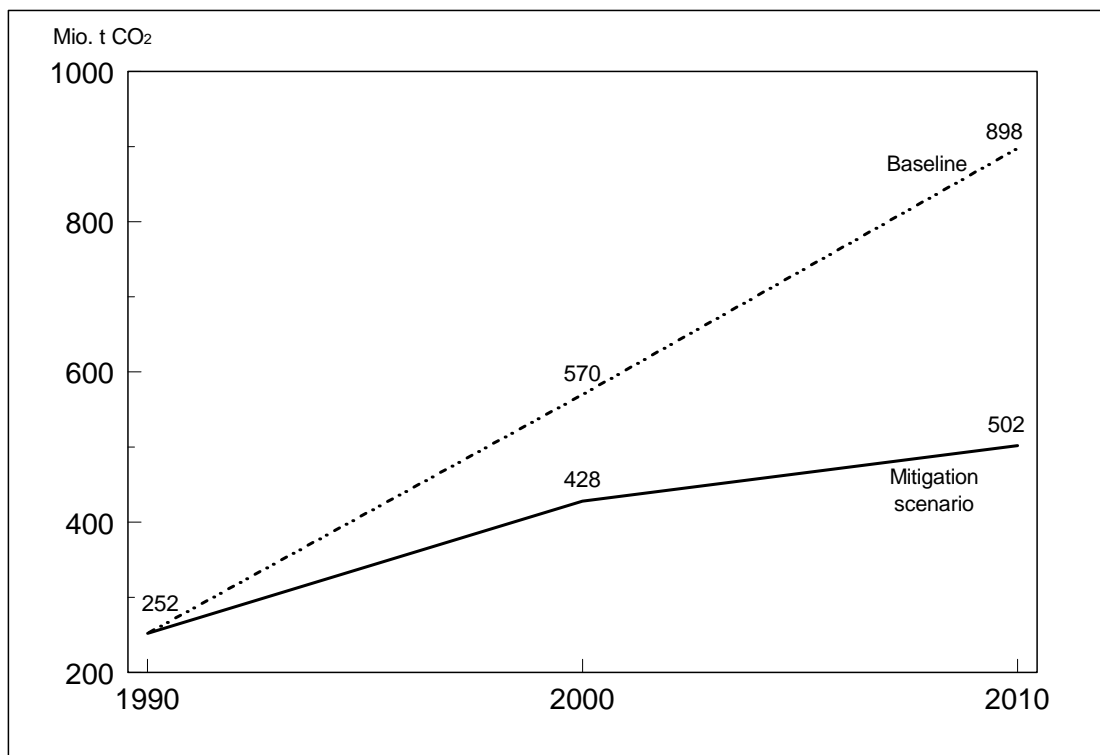
These figures show that the district accounts for approximately 10 % of China's total emissions.

Examining the matter in more detail, energy consumption is responsible for 92 % of all CO<sub>2</sub> emissions in the district. Consequently, the focus of reduction measures lies on the energy sector in this field. On the other hand, the emission of CH<sub>4</sub> is closely connected with flooded rice fields. This is the primary source, and it contributes 53 % to total methane emissions. However, it is also a very old source, because rice cultivation has been practised for thousands of years.

Looking to modern times, CH<sub>4</sub> emissions associated with fuel leakage and production processes are an important factor. Bearing this in mind, the industrial sector and transportation also appear to be promising areas for effective methane reduction measures. In total, energy consumption and industrial processes amount to 13 % of CH<sub>4</sub> emissions. Additionally, wastes contribute another 19 %.

As mentioned before, energy consumption is the main source of CO<sub>2</sub> emissions. This sector comprises transportation as well. Calculations of industrial emissions, on the other hand, covered iron and steel, nitric acid, cement and lime production only.

The mitigation scenario emphasises the raising of energy efficiency in the power sector, industry and the civil sector as well as improving the energy mix to obtain a lower carbon intensity. Details are outlined below.



CO<sub>2</sub> emissions under BAU scenario and mitigation scenario in Jiangsu-Zhejiang-Shanghai district

### Energy Efficiency

#### Coal-fired power plants

Efforts at mitigating CO<sub>2</sub> emissions from the electric power sector in the JZS district should be focused on reducing the energy consumption rate for coal-fired power plants. The improvement of generating units will be carried out in two steps. In the first period from 1990 to 2000 the improvements are concentrating on the rational use of energy. The mitigation technologies include an increase in the operating efficiency of large domestically made generating units by lowering the plant-internal losses. It is planned to phase out medium- and low-pressure generating units and to put into operation more high-parameter large-capacity generating units. In the second period from 2000 to 2010 measures will be directed at further lowering the coal consumption rate. This will be achieved by installing super-critical pressure coal-fired units, oil-gas-burning combined cycle generating units, promotion of the use of Integrated Gasification Combined-Cycle (IGCC) generating units, and electricity transmission from the Three Gorges Hydropower Station.

Going by the previous measures, compared with the level of energy conservation in fuel-fired plants in 1990 the amount of energy conservation will reach 25 million t/a in the year 2000 and nearly 105 million t/a in 2010.

#### Industries

Various technologies aimed at reducing the unit energy consumption of the main products of the six major energy-consuming industries (iron & steel, petrochemicals, chemicals, construction materials, light industries and textiles) were studied in this sector. According to the projected energy conservation rate and energy consumption, the degree of CO<sub>2</sub> reduction is estimated at 71 million t/a in 2000 and at nearly 161 million t/a in 2010.

#### Civil sector

Besides the energy sector and the industrial sector, the civil sector is an important sector for CO<sub>2</sub> emissions. Technologies for energy conservation and emission mitigation in the civil sector mainly cover the following aspects: civil structure, lighting, electrical household appliances and small-scale combustion. By 2000, the total CO<sub>2</sub> reduction achievable will be 31.3 million t/a. By 2010, the total CO<sub>2</sub> reduction could be 82.1 million t/a, equivalent to 30.4 % of total emissions in the whole JZS district in 1990.

### **Alternative Energy**

It is estimated that by 2000 the total added amount of alternative energy (hydropower, solar energy, tidal energy, wind and biomass) will reach 5.78 Mtce, accounting for 2.6 % of total energy supply in 2000, resulting in the reduction of CO<sub>2</sub> emissions by 13.6 million t/a, equivalent to 5.0 % of CO<sub>2</sub> emissions in 1990. By 2010, the total added amount of alternative energy will reach 17.3 Mtce, resulting in the reduction of CO<sub>2</sub> emissions by 47.7 million t/a, which is equivalent to 17.3 % of total CO<sub>2</sub> emissions in 1990.

Solar energy and biomass will account for the largest proportion of alternative energy in 2000. As time passes, the proportion of wind energy will gradually increase, while that of hydro energy will decrease since it will have been explored almost completely in this district.

The economic indices of technological options, "raising the efficiency of energy use" and "using renewable energy sources", were also investigated. The technological measures aimed at mitigation fall into three categories in terms of investment. The first category includes technological renovation and new projects to raise the efficiency of energy use. The net cost in this category is negative. The investment in technology can be paid back from economic returns resulting from energy conservation. The responsible agencies will concentrate on implementation of these options. The second category covers technologies for developing hydropower and wind energy. The net cost is positive. Loans should be supported by central government. In the near future, the main development efforts will be directed at setting up small-sized hydropower and wind power stations. The third category covers solar energy and tidal power stations. Mitigation effects are very good. The study suggests that special preferential policies should be applied to investment in these technologies.

From the data above it can be concluded that improving energy efficiency will be the main mitigation measure in the near future, and its effect will increase over time. Generally there is much room for improvement since the high level of CO<sub>2</sub> emission per unit of GNP is 4.40 kg per US\$, which is well above the level in West Germany in 1988: 0.59 kg/US\$. Thus considerable reductions can be realised with better processes, improved technology and the rational use of energy.

# Factsheet

## Factsheet

Factsheet

## REDD – Reducing Emissions from Deforestation and Degradation in Developing Countries

### Scenario

At the 11th Meeting of the Parties to the UN Framework Convention on Climate Change (COP 11), Papua New Guinea and Costa Rica, supported by several developing countries, tabled a proposal for including emissions from avoided deforestation in any compensation scheme under the UNFCCC. It leaves open whether that should happen under a separate forest protocol or as a part of an overall post-2012 protocol under the Convention. The proposal argued that time is pressing for the last natural forests, and that including deforestation avoidance would help to integrate developing countries into the efforts to reduce greenhouse gas emissions. The proposal was welcomed by most Parties.

Forests cover approximately four billion ha or 30% of the Earth's land area. Gross annual deforestation is 13 million ha, equivalent to nearly 1% annual losses of the world's primary forests (1,439 million ha). Forests represent a carbon pool of 1,037 Gt CO<sub>2</sub>, which is more than the CO<sub>2</sub> amount in the atmosphere. Deforestation is the second single important source of greenhouse gas (GHG) emissions, estimated to be responsible for approximately 20% of all human-induced CO<sub>2</sub> emissions, two thirds of this effect being attributable to the loss of tropical forests.

Deforestation is expected to lead to micro-climatic changes, biodiversity losses, and changes in the water regime. As an aggravating feedback effect, climate change itself may lead to a die-off of forests in tropical areas, which could trigger a chain reaction that is difficult to stop.

The majority of deforestation and forest degradation is due to the direct and indirect effects of policies outside the forestry sector as well as socio-cultural factors. For the



individual agent, the over-use of forest resources follows economic rationality, sometimes sustained by traditional land use patterns. Unchecked deforestation and forest degradation are usually symptoms of poor governance and legal uncertainty. As a rule, for individuals, deforestation is profitable – however, it inevitably leads to macroeconomic welfare losses.

### Projects

So far, a wealth of experience has been gathered and important lessons can be learned from past projects geared towards forest protection and sustainable forest management. However, REDD stands for a new approach within international development assistance.

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and Development

Two of the most outstanding programmes are:

The **Pilot Program to Conserve the Brazilian Rain Forest (PP-G7)**, planned in the late 1980s, launched at the Rio Conference on Environment and Development in 1992, and started in 1995. The PP-G7 has been implemented jointly by Brazil and seven donor countries (one of them being Germany, which has contributed over 80% of the budget of USD 428 million). The program's objectives are as follows:

- Experimenting with and demonstrating ways of protecting Brazil's rain forests and using them in a sustainable fashion
- Protecting and conserving rain forest natural resources
- Strengthening civil society and public institutions involved in environmental protection of Brazil's rain forests
- Supporting scientific research and disseminating findings to conserve Brazil's rain forests.

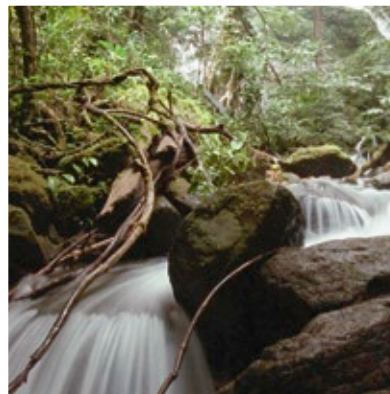
Experiences gathered in the PP-G7 are used in the Amazonian Protected Areas Project (ARPA) which has the aim to create and consolidate conservation areas of at least 50 million ha until 2012.

The **COMIFAC** (Commission Forestière de l'Afrique Central), created in 1999, is an initiative of ten Central African Congo Basin countries, with support by international donors, including WWF, the World Conservation Union, FAO, the World Bank, the European Commission and Germany. Its lines of action are:

- Resource inventory and valorization of forest resources
- Ecosystem management, reforestation and biodiversity conservation
- Employment alternatives and poverty reduction
- Regional cooperation and partnerships, capacity building, research and development
- Development of financing mechanisms and harmonization of forest and fiscal policies.

COMIFAC may in future constitute an example for REDD that even avoids international leakage.

Due to different regional coverage and advancement of the efforts described, no judgement can be ventured at this time as to which approach is most promising. Challenging pilot projects, supported by Germany and specifically designed for REDD activities, are under preparation in Madagascar and Cameroon.



## Impact

Today, a sector-wide approach on REDD is being discussed, whereby a country as a whole voluntarily commits itself to limit its forest carbon emissions.

Costs of REDD are extremely region-specific. Estimates found in literature indicate that annual payments in the range of USD 10 billion would enable deforestation emissions in developing countries to be reduced by half. This amount of money corresponds to 0.02% of 2005 world GDP and 13% of total official development assistance. However, traditional or voluntary funding mechanisms will hardly be able to provide the finance needed for effective REDD.

Carbon incentives for responsible forest management in developing countries will preserve valuable carbon and biodiversity pools. At the same time, protected forests deliver significant co-benefits for local and regional development, potentially including adaptation to inevitable climate change for the local population. REDD therefore fulfils important development goals.

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