GLOBAL
ENVIRONMENT
FACILITY

India

Development of High-Rate Biomethanation Processes as Means of Reducing Greenhouse Gas Emissions

Project Document
January 1994

GLOBAL ENVIRONMENT FACILITY

India

Development of High-Rate Biomethanation Processes as Means of Reducing Greenhouse Gas Emissions

Project Document

This Project Document has been edited to facilitate public dissemination.
The original is on file in the GEF Office at UNDP Headquarters in New York.

ABBREVIATIONS

APCTT	Asian and Pacific Centre for Technology Transfer
APMC	Agricultural Produce Marketing Committee
ASSOCHAM	Associated Chambers of Commerce and Industry
CII	Confederation of Indian Industries
CLRI	Central Leather Research Institute
GEF	Global Environment Facility
IISc	Indian Institute of Science (Bangalore)
IREDA	Indian Renewable Energy Development Agency
MNES	Ministry of Non-conventional Energy Sources
MOU	Memorandum of Understanding
mtoe	Million tonnes oil equivalent
NBB	National Bioenergy Board
NEERI	National Environmental Engineering Research Institute
NGO	Non-governmental organization
NPD	National Project Director
NRSE	New and renewable sources of energy
PMC	Project Management Cell
UASB	Upflow anaerobic sludge blanket
UNDP	United Nations Development Programme

CONTENTS

UNITED NATIONS DEVELOPMENT PROGRAMME

GLOBAL ENVIRONMENT FACILITY

Project of the Government of India

Title:	Development of High-Rate Biomethanation Processes as Means of Reducing Greenhouse Gas Emissions
Number:	IND/92/G32
Duration:	Three years
Project Site:	India: Ambur, Bhadrachalam, Bhilai, Bhubaneshwar, Bombay, Delhi, Madras, Nasik, Pallavaram and Pune
UNDP Sector:	Environment
Subsector:	Energy and environment
Government Counterpart Agency:	Department of Economic Affairs, Ministry of Finance
Executing Agency:	Ministry of Non-conventional Energy Sources (MNES)
UNDP Approval:	January 1994
Estimated Starting Date:	April 1994
Government Inputs:	Rupees (Rs.) 142 million (in kind) (US$ 4.5 million)[1]
GEF/UNDP Inputs:	US$ 5.5 million

Brief Description:

This project will control emissions of methane in India by applying state-of-the-art high-rate biomethanation technology to a number of waste substrates. The project will formulate a national strategy for biogas generation and utilization, demonstrate a variety of technologies through the

[1] The United Nations official exchange rate at the date of signature of this Project Document was US$ 1 = Rs. 31.50.

establishment of sixteen demonstration units, and educate policy-makers, waste generators, agricultural communities, and the public about the environmental and economic benefits of methane recovery from waste. The creation of an alternative clean fuel source will result in improvements in the quality of the environment (air and water) at the local and global levels, leading to improvements in the areas of health and sanitation. The quality of life for women in the rural sector will also be enhanced by the substitution of methane for fuelwood, which is traditionally gathered by women.

A. CONTEXT

1. Description of subsector

The Indian environment

Methane is the most abundant atmospheric hydrocarbon released as a result of the anaerobic degradation of biological systems. It is also a major component of natural gas and coal-mine gases. Estimates indicate that the level of methane in the atmosphere has increased 2.5 times over the last 100 years. Studies show global methane concentrations, presently about 1,700 parts per billion (ppb) by volume, increasing at an annual rate of approximately 1 percent (14 to 16 ppb per year). Methane emissions are associated with global warming, increases in tropospheric ozone and smog formation, as well as possible stratospheric ozone depletion.

As a greenhouse gas, methane is second only to carbon dioxide in prevalence. Methane, however, contributes eleven times more by weight to the greenhouse effect. Compared to a greenhouse effect of 60 percent for carbon dioxide, global emissions of methane are estimated to contribute 15 percent. On the other hand, methane has a shorter lifetime (8 to 12 years) than carbon dioxide (approximately 120 years). Reductions in methane emissions would thus have a short-term impact on atmospheric concentrations of greenhouse gases. Nevertheless, smaller reductions would be required to stabilize atmospheric conditions.

The increase in methane concentrations can be attributed to several natural and anthropogenic factors including biomass burning, rice cultivation, wetlands, enteric fermentation in ruminants, landfills, coal mining, and natural gas exploration and transport. Globally, more than 60 percent of methane emissions are attributable to anthropogenic sources. Of the 378 million tonnes of global methane emissions per year, India's contribution is estimated at 16 million tonnes[2] to 52 million tonnes.[3]

---

[2] A.P. Mitra, "Global Change, Greenhouse Gas Emissions in India," Draft Scientific Report, Number 1, (New Delhi: Council for Scientific and Industrial Research, 1992). Tata Energy Research Institute (TERI), 1993.

[3] D.R. Ahuja, "Estimating Regional Anthropogenic Emissions of Greenhouse Gases," Climate Change Technical Series 20P-2006 (Washington, D.C.: United States Environmental Protection Agency (USEPA), 1990).

Of the major greenhouses gases, only methane concentrations can be stabilized with modest cuts in anthropogenic emissions. Due to methane's relatively short atmospheric lifetime, a 10 to 20 percent reduction in emissions would stabilize concentrations at current levels. This order of reduction is much lower than the corresponding reductions required for other greenhouse gases: 50 to 80 percent for carbon dioxide, 80 to 85 percent for nitrous oxide, and 75 to 100 percent for chlorofluorocarbons. Recovery and the gainful utilization of methane would, therefore, offer the dual benefit of reducing greenhouse gases while providing an additional source of energy.

India generates large quantities of waste from the agricultural, municipal, industrial, and food processing sectors. Much of this waste enters the environment with little or no treatment. Once the wastes are released, their natural biodegradation releases methane into the atmosphere. Some of the treated wastes, particularly those from industrial operations, are subjected to the energy-intensive aeration process. The technique of biomethanation has been successfully used for several decades to treat such wastes to recover methane. In India, under the National Project for Biogas Development, over 1.4 million small biogas plants have been constructed using conventional biomethanation. The Ministry of Non-conventional Energy Sources (MNES) has sponsored over 700 small and medium-sized plants for treating various substrates.

With the emergence of high-rate processes, the technique of biomethanation has undergone considerable change during the last two decades. These procedures convert the biodegradable matter into methane in a relatively short time with lower capital costs, easier operation, and higher yields of methane. Biomethanation has the potential to generate 153 million giga Joules (GJ) per year of energy in the sectors selected for this project. This energy generation has the additional benefits of improving the environment, health and sanitation. Drawing upon its significant experience in this area, the MNES proposes to expand its programme to include high-rate biomethanation of additional substrates, and utilize the biogas generated to provide a cost-effective alternative to fossil fuels. The biodegradation of wastes has already attracted the attention of national and state-level institutions, making the introduction of high-rate biomethanation both timely and feasible.

Several groups in India have already attempted to develop bioenergy from waste. National and state institutes, research and development institutions, and universities that deal with microbial technologies have developed some of the skills necessary for this project. India also has a large agricultural base and growing industrial activity, both of which produce a wide range of degradable wastes. With its technological base and abundance of wastes, India is well positioned to utilize these wastes to generate methane, reduce greenhouse gas emissions, and improve health and sanitation.

Status of Indian power sector

Although the Indian economy continues to be primarily based on agriculture, the industrial sector has seen significant growth over the last four decades. Energy generation capacity has increased from 1,700 megawatts (MW) in 1950 to over 72,000 MW. The Eighth Five-Year Plan

(1992-97) and the Ninth Five-Year Plan (1997-2002) anticipate capacity increases of 30,800 MW and 60,000 MW respectively, to meet the growth in demand.

Over 70 percent of the power generated in India comes from coal. This trend is expected to continue during the eighth and ninth plans due to the limited fuel options available in the country. As a result of this reliance on coal, carbon dioxide emissions are expected to more than double from the present total of 220 million tonnes during the period of the next two plans. Compounding this problem, some 110 million tonnes oil equivalent (mtoe) of traditional fuels such as firewood and biomass are used in the household sector, particularly in rural areas where alternative fuels are not available. The use of these fuels contributes to deforestation and a concomitant loss of biodiversity.

Given its large agricultural base that provides 180 million tonnes of food grains in addition to other crops, India is rich in renewable agricultural residues. A conservative estimate places the availability of such renewable residues at 50 to 60 million tonnes per annum. In addition, the country produces substantial quantities of solid and liquid wastes from the industrial, municipal, food processing and domestic sectors. Efficiently utilized, these resources offer a viable energy option with the attendant benefits of reducing greenhouse gas emissions, avoiding deforestation, and minimizing pollution. To realize this goal, efficient technologies for biomethanation and biogas utilization must be acquired.

Role of the project

This project for developing biomethanation processes will:

- Develop the institutional framework at the national level to support a bioenergy development programme utilizing high-rate biomethanation processes
- Develop expertise in national and state institutes, research and development organizations, and universities, to assimilate and adapt technology, improve research and development in high-rate biomethanation processes, and provide technical assistance for constructing biomethanation plants
- Promote the use of biomethanation technology and biogas utilization as a cost-effective means of energy generation through national and local seminars and workshops, promotional campaigns, training, and demonstrations
- Develop a national master plan and several investment proposals to utilize this important renewable resource.

2. Host country strategy

To meet the growing energy needs of the country, the government has emphasized the utilization of new and renewable sources of energy (NRSE). MNES implements the government's policies on the development of these resources. The bioenergy development programme, started as a modest initiative under the NRSE programme a decade ago, has already assumed major importance for the MNES. The budget for the MNES has increased from Rs. 5.8 billion (US$ 184 million) in the seventh plan to Rs. 8.51 billion (US$ 270 million) in the eighth plan.

There has been a growing emphasis on protecting the environment through the use of clean technologies, recycling, utilization of wastes, and appropriate waste treatment methods to meet the requirements of the 1986 Environment (Protection) Act and other regulatory provisions. The existing legislative framework therefore provides incentives for the adoption of biomethanation processes for effluent and wastes.

India's annual US$ 6 billion in imports reflects the growing demand for petroleum products, and highlights the need for conservation. A full use of the country's renewable energy sources, along with improvements in energy efficiency, would greatly aid the country's efforts in this area.

Responding to these conditions, the government seeks to develop commercially viable demonstration biomethanation and bioenergy units in several areas. These processes are expected to be adopted for commercial use by the private and utility sectors, giving the NRSE programme a major boost.

This project includes numerous demonstration units to establish the technological and economic viability of biomethanation using various substrates (Annex 1). The sixteen specific sub-projects have been identified by availability of the substrate, availability of the technology, visits to national laboratories, and discussions and meetings with industries and other organizations on the need for biomethanation and energy utilization. Development of the project has involved all the potential stakeholders. Details were presented in two inter-departmental meetings attended by representatives from key ministries such as Environment and Forests, Science and Technology, Urban Development, Economic Affairs, and the Planning Commission. Extensive discussions were held with the proposed technology development institutions and user groups in the private, public and non-governmental sectors before the document was finalized. Similar participation is integral to the execution and implementation of this project. Development should follow a truly interactive national process, supplemented by international expertise. A detailed summary of the sub-projects is provided in Annex 1.

The sub-projects will be implemented in two phases. In phase one, several design options will be considered for trial on a small scale. The most successful schemes will be selected for adoption on a larger scale in phase two. The two phases are expected to last approximately thirty months each.

3. Prior and ongoing assistance

There is no other direct bilateral or multilateral programme, approved or active, in this sector. The only project in a related area is the joint initiative of the United Nations Development Programme (UNDP) and the United Nations Educational, Scientific, and Cultural Organization (UNESCO) on advanced studies in Biotechnical Engineering and Biotechnology (IND/89/103).

4. Institutional framework for subsector

As the designated agency of the Government of India for the development of bioenergy, MNES will execute this project. MNES will be responsible for:

- Overall project planning and coordination
- Identification and development of the implementing agencies for technology and demonstration units
- Securing the involvement and support of the relevant government agencies, such as the Ministry of Environment and Forests, Ministry of Urban Development, Department of Biotechnology, Department of Science and Technology, Department of Power, Council of Scientific and Industrial Research, and the Planning Commission
- Securing the involvement of the private sector through consultations with organizations like the Federation of Indian Chamber of Commerce and Industry (FICCI), the Confederation of Indian Industries (CII), the Associated Chambers of Commerce and Industry (ASSOCHAM), and others on the National Bioenergy Board
- Involving non-governmental organizations (NGOs), wherever feasible, for the effective development of projects at the local level
- Using the experience available for technology commercialization in organizations such as Biotech Consortium India Limited, under the Department of Biotechnology
- Identifying national and international institutions for training, technical assistance, education, and other activities relating to the project
- Involving national laboratories in the development programme so that they become the focal points for technology development and transfer, and assist in the construction of the demonstration plants. These laboratories will include:
  - National Environmental Engineering Research Institute (NEERI)

- Central Leather Research Institute (CLRI)
- Central Pulp and Paper Research Institute (CPPRI)
- Central Food Technology Research Institute
- National Chemical Laboratory (NCL)
- Centre for Biotechnology Development (CBD), Anna University
- Indian Institute of Science (IISc), Bangalore.

B. PROJECT JUSTIFICATION

1. Problem to be addressed and the present situation

Large quantities of biodegradable wastes are generated in India by the municipal, industrial and agricultural sectors. Much of this waste is not treated at all, resulting in the natural degradation of their organic content, releasing greenhouse gases, and causing environmental pollution. Some of the wastes are treated by conventional means, such as aeration. These methods are energy intensive and expensive, and generate significant quantities of biological sludge which must be disposed.

Despite the existence of legislation regulating the treatment and disposal of such wastes for several years, the degree of compliance has been low. This failure is due to the high cost of effective treatment technologies. Biomethanation of such wastes to recover methane and other resources can make treatment financially more attractive. In addition to reducing emissions of greenhouse gases and protecting the environment, developing a viable substitute for fossil fuels makes high-rate biomethanation a technology worth adopting.

The bioenergy division of the MNES has been active in the field for many years, and has scored several successes in the agricultural and industrial sectors. Despite this, however, biomethanation technology has not been used to its full potential. The reasons for this include:

- The lack of a formal structure to promote and coordinate the development of advanced high-rate biomethanation technology at either the national or state levels
- The lack of proven technologies for dealing with the various substrates, leading to uncertainty about results
- Inadequate information on plant costs and benefits
- Limited availability of consultants and firms promoting high-rate biomethanation technology.

The institutional framework at both the national and state levels must be strengthened to develop a national strategy promoting high-rate biomethanation techniques. External technical

assistance will be required to assist national staff in developing bioenergy processes. The project must, therefore, improve both the institutional and technical support for biomethanation technology.

2. Expected end-of-project situation

This project is designed to develop an institutional framework to promote high-rate biomethanation processes to treat wastes and generate bioenergy. Using demonstration units, the programme will ensure the sustainability of the project by proving its viability to the private sector. The following achievements are expected by the end of the project:

- A national strategy, including investment proposals, for high-rate biomethanation treatment of municipal, industrial, and agricultural wastes to generate bioenergy.
- A National Bioenergy Board (NBB) with a network of national laboratories, institutes, and other agencies providing technology and designs for high-rate biomethanation, biogas utilization, training of personnel, and other services.
- Proven technologies and designs for waste treatment, proving the viability of such processes in India. These technology packages can form the basis for national environmental guidelines in the various sectors. The technology developed would also be replicable in other countries, particularly those in the developing world.
- A strategy for commercialization of technology packages through enabling provisions, incentives, and other methods to make investments attractive for private, public, municipal, and other sectors.
- Strengthened central and state-level institutions to advise and assist municipal bodies, industry, and communities in high-rate biomethanation of wastes and by-product recovery.
- Development of human resources in bioenergy and microbial technology, high-rate biomethanation processes, technology development and commercialization, and related areas. There will also be a corresponding generation of skills for users of these technologies, thereby promoting their use on a large scale.
- A network of professionals in India and abroad in bioenergy, biomethanation, microbial technology, waste management, and related areas to assist in further development in these areas.

3. Target beneficiaries

The following groups are expected to benefit from the project:

- Local communities will see reduced pollution by treating wastes and recovering methane which would otherwise have been released into the environment. The recovered methane is a valuable source of energy to generate heat and electricity.

- In the rural sector, energy from methane can replace fuelwood, thereby reducing deforestation, and relieving the burdens of women who traditionally gather wood. The sub-projects will also generate sludge which can be used as fertilizer.

- On the national level, the utilization of methane from wastes would reduce dependence on imported petroleum, improving the national economy and the trade balance.

- The seminars, workshops, training programmes, and overseas exchanges that form a part of this project will improve management skills, as well as scientific and administrative skills in technological areas. This enhanced capacity will benefit the MNES, national laboratories and institutes, research and development firms, universities, private and public sector industries, NGOs, and other interested groups. In addition, new private consultancy and engineering firms could emerge to support the development of the national bioenergy programme.

- Organizations constructing demonstration plants under the sub-projects would benefit from the assistance received from the Global Environment Facility (GEF)/UNDP and MNES. A list of institutions, companies and other groups who would benefit from the project's schemes is provided in Annex 1.

- While the project personnel of MNES and technical institutions would be immediate beneficiaries of this project, consumers of bioenergy and cleaner technology would also stand to benefit greatly in the long run. As such, large numbers of entrepreneurs, as well as the general public, would be the ultimate beneficiaries of the project.

- Reducing emissions of methane, a potent greenhouse gas, will stabilize atmospheric methane concentrations, mitigating the greenhouse effect. By utilizing methane instead of fossil fuels, greenhouse gases will be further reduced. The project will therefore have a two-fold effect on the reduction of greenhouse gas emissions.

4. Project strategy and institutional arrangements

Project strategy

A national strategy will be formulated, along with detailed investment proposals for bioenergy development based on cost-effective technology packages. To ensure that the programme reaches

its full potential, as suggested in the guidelines of the GEF's Scientific and Technical Advisory Panel (STAP), the technology will be made "right" through innovation and adaptation, the costs correct through improvements in cost-effectiveness, and the market environment supportive through the overcoming of market barriers.

Technical skills and management expertise will be developed for the demonstration plants. MNES, the NBB, and the institutions responsible for the sub-project will assess the training needs of the project, and discuss technology development and implementation of the demonstration units. (Assistance from national and international consultants will be required.) These discussions will address:

- Design and operation of the waste treatment plant, including the system for the recovery of methane
- Selection of biogas engines for generating electric power from methane with or without co-generation systems
- Trouble-shooting, and the monitoring and evaluation of technology once the demonstration plant is operational to ensure that a technical package for replication of the plant is available
- A project management and review process within the MNES/NBB to effectively monitor and coordinate the project
- A Memorandum of Understanding (MOU) between MNES and the other parties involved.

Promotional programmes will be developed to increase the interest in biomethanation processes among national, municipal, industrial, and agricultural groups. Increased support for such schemes will accelerate the installation of bioenergy units. In the rural sector, the training of NGOs or communities in biogas generation, utilization, and related environmental activities will enable them to act as promoters for the project.

A master plan and the national strategy will be developed with the full participation of all stakeholders, complying with the government's guidelines on environmental impact assessment and the Environmental Overview and Project Management Strategy (EOPMS) developed for this project.

Institutional arrangements

MNES will establish NBB as the nodal agency for the development of bioenergy in India. MNES will execute the project with policy guidance and direction from the NBB. The Secretary of the MNES will be the chairman of the NBB. For day-to-day operation of the NBB, a National

Project Director (NPD) will be appointed to serve as the member-convener of the Board. The NPD will be an officer not lower than a Joint Secretary/Advisor to the Government of India. A Project Management Cell (PMC) will be created to assist the NPD, consisting of a Chief Project Manager, a Project Manager (in the rank of a Principal Scientific Officer), and other suitable technical, scientific, administrative and support staff. Staff in the PMC will be devoted to the project on a full-time basis. In addition, NBB will have representatives from other related government ministries and departments. In order to secure wider commitment to the bioenergy programme, industry associations, national institutions, and other agencies, as well as national experts interested in the project, will also be invited to join the NBB. The functions of the NBB will be to develop a national strategy for bioenergy development and to provide guidance to the various demonstration sub-projects.

Project management

The Chief Project Manager and members of the PMC will be responsible for management of the demonstration sub-projects. The PMC will also support technology acquisition, national workshops and training programmes, preparation of promotional literature, cost-benefit analysis of the sub-projects, and other activities.

In order to expedite the demonstration sub-projects, the PMC will meet once every month (or more frequently during critical periods). The PMC will engage consultants, award sub-contracts, nominate personnel for fellowships and study tours, acquire technology, and collaborate with national and international institutions.

The demonstration sub-projects and the acquisition of technology (from overseas, where necessary) will be implemented by a national technology agency under a subcontract. This agency will be required to provide technical assistance and personnel at certain stages of implementation.

The demonstration units are being placed with organizations in the private and public corporate sectors, as well as in some municipal agencies. The technology for the demonstration projects is being acquired from selected organizations (mostly national laboratories). While the national technological agency will provide technology and design inputs, the operation and maintenance of the demonstration unit will remain the responsibility of the unit itself. In order to ensure the clear definition of responsibilities, the MNES will sign an MOU with all the groups involved before the project is initiated. The PMC will be the focal point of the MOUs.

One major responsibility of the PMC will be to conduct extensive cost-benefit analysis of each sub-project to identify commercially viable models for adoption on a larger scale. This analysis will be critical to shaping the national strategy and the master plan.

NBB will provide policy guidance and direction to the project team, approve workplans and budgets, and monitor project implementation. The National Project Director will be the leader of

the PMC and will ensure that effective linkages exist between the various agencies. The PMC will report on the various demonstration schemes to the NBB, which will meet quarterly. The responsibilities of the NBB will include:

- Monitoring the progress of the various schemes through the PMC, providing necessary policy decisions, guidance, and direction to the various groups
- Formulating, in consultation with GEF/UNDP and the executing agency, the workplan, budget, and other aspects of the project, as well as implementing them through the PMC
- Relieving constraints, if any, on the project through domestic inputs
- Reviewing project progress and preparing reports for the government, UNDP and other agencies
- Providing guidelines to the PMC for review and approval of Terms of Reference (TOR), MOUs, and other protocols for the various schemes and subcontracts
- Organizing training activities, including overseas study tours, domestic workshops, and seminars
- Providing advice and direction as required for the project
- Recruiting and training NGOs to educate the public, particularly in rural areas.

Planning and development

Another important function of the NBB will be to formulate national plans and strategies for the development of a bioenergy programme. The PMC will ensure that the plans and strategies are updated regularly. The PMC's tasks will include institutional development, the survey of resources, the development of investment strategies, planning, and the promotion of measures to popularize the use of bioenergy.

Financial management

MNES funds its projects through the Indian Renewable Energy Development Agency (IREDA). The proposed project can be effectively handled by IREDA, thus obviating the need for a separate financial management body. Being familiar with projects in this sector, IREDA can meet the financial control and other reporting requirements of UNDP. IREDA is also represented in the NBB.

International participation

The project, while using national resources to the maximum extent possible, will also draw on the expertise of international professionals. Study tours and fellowships will be organized for Indian professionals, while international consultants will visit India. Technology links in critical areas will be maintained with established organizations. Engineers and scientists of the technology licensors will also visit India to support the transfer of technology. An international operational network will thus be created among professionals involved in the project. The NBB/MNES will ensure that the highest quality national professionals are recruited, as required by UNDP.

Other aspects

The sub-projects have been identified in the following way:

- The 1992 GEF Participant Group identified the areas for generating sub-projects
- A list of potential technologies and institutions were tentatively identified by project participants, including industries and agencies likely to have an interest in these areas
- MNES assessed the interest and capabilities of the institutions to construct the demonstration units through visits
- Potential sources of foreign technologies were contacted for a preliminary assessment
- A list of potential technology sources and demonstration units was drawn up (see Annex 1).

To ensure that responsibilities and objectives are clearly defined, MNES will enter into an MOU with the various agencies participating in the sub-projects. Foreign technology will be imported after technical evaluations have been conducted in accordance with the required agreements, with the Asian and Pacific Centre for Technology Transfer (APCTT) in Delhi playing an important role. These procedures will make possible the timely and cost-effective execution of the demonstration sub-projects (see Annex 2).

Special assistance required during the various stages of the project will be supplied by consultants, both national and international. These consultants will be chosen in accordance with the requirements of the task, and will support the NBB and other committees during implementation. In addition, local engineering design firms and contractors will be utilized in the detailed design and construction of the demonstration units.

National and international consultants will be invited at critical stages of implementation to participate in the various deliberations and evaluations related to this project in order to reinforce the technological capabilities of the NBB and the various committees.

The project will receive support from promotional efforts undertaken by government departments in areas such as environmental protection, health, and sanitation, whose goals are consistent with those of the project. As per GEF requirements, the project is also in keeping with India's national environmental strategies and legislation.

5. Reasons for GEF assistance

Although biomethanation processes have been used in India for over two decades, the sub-projects under this programme are a major departure from the processes currently in use. High-rate biomethanation uses smaller reactor volumes and involves novel methods of treating wastes. There is, therefore, an element of uncertainty in their efficiency and reliability under Indian conditions, particularly with respect to the substrates being considered. Under such circumstances, few entrepreneurs would embark on the large-scale utilization of biomethanation. The benefits of the process would first need to be demonstrated to justify the development of such complex technologies. The purpose of this project is to fund a demonstration that will prove the value of biomethanation, and so create an interest in its replication. The project also qualifies under the GEF funding criteria for the following reasons:

- In accordance with STAP criteria, the project is one that incurs incremental costs in order to produce global benefits in addition to local ones. Its costs therefore exceed what a country would normally be willing to pay for a national development project. High-rate biomethanation involves technologies that allow cost reduction, technical improvements, and market development.

- The project will improve the local and global environment through the development of cost-effective schemes aimed at reducing greenhouse gas emissions.

- The project will generate proven designs for the treatment of a wide range of wastes, thus making replication possible both at the national and international levels. The demonstration units will offer a basis for the transfer of technology and the training of personnel.

- The project's utilization of renewable waste resources offers a sustainable source for the generation of energy, with beneficial environmental impacts.

- The biomethanation programme will improve energy generation and utilization, reducing the dependence on fossil fuels.

- Although biomethanation technology is already known in India, the project will adapt the techniques to a wide range of substrates. The demonstration will provide a model to other developing countries where similar conditions obtain.

- The sub-projects will result in an improvement in the standards of environmental sanitation, with concomitant improvements in the quality of public health, groundwater, drinking water, and so on. The project will also reduce the discharge of untreated wastes.

- The project will develop institutional capabilities and human resources in: bioenergy development, biomethanation, and other microbial processes; project management; and technology transfer and training.

- The project will demonstrate the economic, environmental, technical, and institutional sustainability of processes aimed at reducing emissions.

Because the technology involved in the sub-projects is still being developed, it is difficult to estimate the investment required for offsetting one tonne of carbon dioxide over the lifetime of the project. This analysis would be possible once the technology packages are developed, and the environmental costs and benefits are determined. It is hoped that the success of the demonstration units will create commercial possibilities for the technologies involved.

An estimate was made of the potential for the reduction of greenhouse gas emissions in India through the successful development and adaptation of technologies covered by this project. It was assumed that the biomethanation processes used in the project would result in:

- A direct reduction in the emissions of methane and carbon dioxide arising from the putrefaction of wastes

- Secondary changes in emissions of carbon dioxide through the replacement of fossil fuels with biogas.

The table below shows estimates of the potential for greenhouse gas reduction in four sectors through biomethanation. This reduction is calculated in terms of carbon dioxide equivalent (taking the radiative forcing of methane as being eleven times that of carbon dioxide by weight, as per the supplementary report of the Intergovernmental Panel on Climate Change (IPCC 1992).

Carbon dioxide equivalent reduction in four sectors through biomethanation
(in tonnes per annum)

Waste sector	*CO_2 equivalent reduction*
1. Small community sewage treatment	11,000,000
2. Treatment of leather wastes	83,000
3. Treatment of pulp and paper wastes	470,000
4. Biomethanation of biomass	15,700,000

The above estimates are based on the assumption that, in the course of this project, methane would be generated from:

- Approximately 30 percent of the sewage generated in the country from cities with a population of more than 10,000 people
- All effluent generated in the leather, and pulp and paper sectors, using high-rate biomethanation processes (as mandated by environmental regulations)
- Approximately 50 percent of agricultural wastes and residues that are subjected to biomethanation.

The national strategy for bioenergy development proposed in this document will take into account both the timeframe required for the pattern of waste utilization described above, as well the availability of resources. The situation at the end of the project could also provide opportunities to include other substrates. The effective utilization of biogas through efficient engines with co-generation could lead to further significant reductions in carbon dioxide emissions.

6. Special considerations

This project is intended to provide significant environmental benefits through the biomethanation of wastes, and from the replication that will follow this demonstration initiative. In addition to resolving some of the uncertainties inherent in technological innovation, significant design and development endeavors are anticipated to adapt high-rate biomethanation to Indian conditions. Further modifications could be required in the design of the demonstration plant before its replication could be possible in other settings. These considerations introduce an element of risk in the standardization and commercialization of the process, which would make it difficult for the project to obtain funds from the usual sources.

Private and public corporate entities have been selected for the implementation of the sub-project demonstration units in order to ensure their timely and cost-effective execution. Organizations have been selected on the basis of their experience in successfully handling such schemes, their interest in the programme, and their ability to operate and maintain such plants.

To encourage private parties to invest in the demonstration units, the project will need to consider a system whereby the cost of equipment can be shared between the Government of India, GEF, and the entity selected for the demonstration unit. The following components of the demonstration sub-projects will be funded by the GEF:

- Expenses related to the identification and evaluation of technology, assistance in the areas of design and construction, and any trouble-shooting and monitoring integral to the development of the technology.

- The cost of the biomethanation technology proposed by this project.

- Five percent of the cost of equipment for the demonstration sub-projects. This component comprises 6 percent of the total assistance from GEF. These funds will be reimbursed to the MNES after it has incurred expenditures on the demonstration sub-projects.

This approach to cost-sharing has been based on past experience of the MNES with similar technologies.

In terms of the government counterpart contribution to the sub-projects, MNES will bear a maximum of 50 percent of equipment costs for the demonstration units. Subsidies for the demonstration units will be assessed on a case-by-case basis once details of the sub-projects are available. In addition, loans will be available through IREDA for the sub-projects.

The private sector parties who will participate in the demonstration sub-projects will also benefit from government subsidies. These subsidies are justifiable in view of the following:

- The field of high-rate biomethanation is new and requires subsidies to cover the risks involved

- The private sector parties demonstrating the sub-projects will incur considerable expenses for manpower, operating costs and maintenance

- The completed demonstration unit will be in the public domain, and will be available for transfer and replication without any fees or royalties

- Active participation of the private sector will, in addition to demonstrating the unit's commercial potential, provide a channel for disseminating the project's results throughout the private sector

- The project satisfies UNDP criteria concerning environmental protection, technology transfer, human resources development, and technical cooperation among developing countries.

7. Coordination arrangements

The government ministries and departments, technology institutions, and related agencies all recognize the need for proper coordination of project activities. Experience shows that too many layers of decision-making and controls often impede the progress of a project. To achieve effective coordination, MNES, through the NBB, will act as the executing agency for the project, coordinating policy and oversight. The PMC of the NBB, which will be the implementing agency, will be responsible for day-to-day management of the sub-project demonstration units at different sites in the country. The NBB will also liaise between UNDP and the government.

8. Counterpart support capacity

The July 1990 Policy Paper of the MNES accords high priority to development of the bioenergy sector. This commitment is clear in the increase of more than Rs. 40 million (US$ 1.27 million) for bioenergy programmes from the 1992-93 to the 1993-94 budget. MNES is planning to allocate Rs. 8 billion (US$ 254 million) for non-conventional energy programmes for the period of the Eighth Five-Year Plan.

MNES has strong relationships with national and state institutes and laboratories, research and development institutions, private agencies, NGOs and industries. These agencies have considerable capabilities to support technology, project management, and other related aspects of the project. Some key national institutes will play a pivotal role in developing technology and assisting in the construction of demonstration units. The project's demonstration schemes will be built in places where there are adequate management and technical capabilities to ensure effective project implementation.

C. DEVELOPMENT OBJECTIVES

The development objective of this project is for India to contribute to environmental protection at the local and global levels by developing biogas generation facilities to convert waste to energy. This objective is consistent with the government's policies for reducing net emissions of greenhouse gases, increasing primary supplies of energy and electricity to meet India's growing needs, reducing environmental pollution, reducing dependence on imported petroleum products, and developing alternate sources of energy.

The successful implementation of the project will enable large amounts of wastes which would otherwise be discharged into the environment to be used to generate valuable energy. It will also make available the microbial technology of high-rate biomethanation, which has considerable potential to preserve environmental quality.

D. IMMEDIATE OBJECTIVES, OUTPUTS AND ACTIVITIES

IMMEDIATE OBJECTIVE 1

Develop a national master plan for bioenergy generation based on high-rate biomethanation to reduce methane emissions, generate energy, and improve environmental quality.

Achievement Indicator

Acceptance by the MNES of the master plan, including a comprehensive long-range development plan and investment strategy, produced by the twelfth month of the project. Acceptance by the MNES and the Planning Commission of the final master plan, including the results of the demonstration schemes, for inclusion in the Ninth Five-Year Plan. Acceptance by international donors of the proposals incorporated in the master plan. The final master plan will include:

- An assessment of available data, plans, and analysis of the work done
- An analysis of options for bioenergy development with reference to the substrates available in the country, technology availability, economic feasibility, environmental implications, operation and maintenance, replicability, and other issues
- An investment strategy and proposals for the master plan, including possible funding sources.

Output 1.1

A national master plan for bioenergy generation and utilization, including an investment strategy for promoting the adoption of this technology in various sectors. A draft of the plan should be available by the twelfth month from the start of implementation, and a final plan by the forty-eighth month.

Activities for Output 1.1

1.1.1 Establish NBB as the nodal agency for coordinating bioenergy development, and provide staff for the PMC.

Responsible party: MNES.

Starting date: April 1994.
Duration: 6 months.

1.1.2 Recruit experts and consultants to assist in various stages of the project.

Responsible party: NBB and national institutions.
Starting date: May 1994.
Duration: 6 months.

1.1.3 Compile information on the inventory of wastes and biodegradable material with potential for biogas generation in the various sectors through reviews, studies and surveys.

Responsible party: NBB and national institutions.
Starting date: May 1994.
Duration: 12 months.

1.1.4 Identify and evaluate the technologies available in India and abroad that are directly relevant to the national bioenergy programme.

Responsible party: NBB and national institutions.
Starting date: May 1994.
Duration: 6 months.

1.1.5 Review and assess the current programmes in national laboratories, research and development institutions, and other agencies for biomethanation and bioenergy.

Responsible party: NBB and consultants.
Starting date: May 1994.
Duration: 6 months.

1.1.6 Prepare a national master plan and investment proposals at the end of the project, with the involvement of potential donors for future investments.

Responsible party: NBB and consultants.
Starting date: April 1988.
Duration: 12 months.

1.1.7 Facilitate the formulation of a national government strategy for the energy sector which includes biomethanation processes.

Responsible party: NBB/PMC and consultants.

Starting date: June 1994.
Duration: 36 months.

1.1.8 Review the legal and policy framework on the environment to facilitate the wider adoption of biomethanation processes.

Responsible party: NBB/PMC and other departments/ministries.
Starting date: October 1994.
Duration: 24 months.

IMMEDIATE OBJECTIVE 2

To develop commercially viable technology packages for replication by the sixtieth month of the project.

Achievement Indicator

The environmental benefits of the demonstration units of the projects should have justified the costs, and high-rate biomethanation processes should have been widely adopted, with private sector participation.

Output 2.1

Operation and design packages for biomethanation of various substrates to be used for replication of the projects by the sixtieth month.

Activities for Output 2.1

2.1.1 Appoint the NBB and PMC, and assign team members to direct and implement projects.

Responsible party: MNES.
Starting date: April 1994.
Duration: 4 months.

2.1.2 Define the sub-projects' objectives, and work out the details of their economics, technology, financial cost-sharing, and roles and responsibilities. Include all these aspects in an MOU between the relevant parties.

Responsible party: MNES/NBB, national institutions, industries and IREDA.
Starting date: June 1994.
Duration: 6 months.

2.1.3 Recruit consultants for the various sub-projects and the PMC to begin implementation of the demonstration units.

Responsible party: NBB and national institutions.
Starting date: June 1994.
Duration: 6 months.

2.1.4 Identify and assess indigenous technology suitable for the demonstration units. Select and import foreign technology suited to Indian conditions, where required, through correspondence, on-site visits, and negotiations.

Responsible party: PMC/NBB, national institutions and industries.
Starting date: June 1994.
Duration: 6 months.

2.1.5 Initiate construction of the demonstration sub-projects through the following:

- The technology institutions, in consultation with the demonstration unit, will prepare the technical report, design, and cost estimates for approval by the PMC and NBB
- Once approved, the technology institution will commence design of the unit
- The demonstration unit, with the help of the technology institution, will prepare the documents for bidding
- The PMC will review and approve the quotations based on the budgets approved by the NBB
- The demonstration unit will construct the plant with expert assistance from the technology institutions during critical phases
- The demonstration sub-project will be commissioned with the help of the technology institution
- Consultants (national and international) will be recruited in keeping with the details provided in the Project Document.

Responsible party: PMC, national institutions and consultants.
Starting date: June 1994.
Duration: 40 months.

2.1.6 Performance and cost of the demonstration unit will be monitored regularly by the PMC and other interested agencies, such as IREDA. The PMC will report its findings to the NBB regularly.

Responsible party: PMC, national institutions and consultants.
Starting date: June 1994.
Duration: 56 months.

2.1.7 Evaluate and report the success of the demonstration sub-project upon completion of the trial stage. The report will include environmental effects, cost-benefit analysis, energy and resources recovery, and other technical and commercial elements.

Responsible party: NBB/PMC and consultants.
Starting date: April 1996.
Duration: 24 months.

2.1.8 A final document containing technical details necessary for replication will be prepared and publicized widely.

Responsible party: NBB/PMC, national institutions and consultants.
Starting date: April 1998.
Duration: 12 months.

2.1.9 Using the institutional capability developed in phase one, the small phase one demonstration unit will be adapted for a larger scale unit in phase two.

Responsible party: PMC, national institutions and consultants.
Starting date: April 1996.
Duration: 12 months.

2.1.10 A cost-benefit analysis will be conducted for the demonstration projects.

Responsible party: NBB/PMC and national institutions.
Starting date: June 1998.
Duration: 12 months.

Output 2.2

Well-developed institutional capabilities in India to undertake future biomethanation projects.

Activities for Output 2.2

2.2.1 Personnel in the government, national laboratories, and other institutions working in the field will be nominated for study tours and fellowship programmes overseas.

Responsible party: PMC/NBB.
Starting date: June 1994.
Duration: 6 months.

2.2.2 Opportunities will be provided for technical personnel to be exposed to foreign technology and to interact with outside experts at both the local and international levels.

Responsible party: PMC/NBB.
Starting date: June 1994.
Duration: 48 months.

2.2.3 Training programmes will be conducted to develop the necessary human resources to meet the national objectives of biogas generation and utilization.

Responsible party: PMC/NBB, national institutions and consultants.
Starting date: June 1994.
Duration: 48 months.

2.2.4 A network will be established between institutions (such as NEERI, CLRI, CII and ASSOCHAM), municipalities, industry groups, and other interested parties to promote biogas technology and the demonstration programme.

Responsible party: NBB and national institutions.
Starting date: April 1994.
Duration: 60 months.

IMMEDIATE OBJECTIVE 3

To promote biogas generation and utilization by disseminating information about these processes.

Achievement Indicator

NBB will have conducted workshops and training programmes, and disseminated literature to the parties concerned, resulting in increased utilization of biomethanation processes. An institutional framework will be in place, along with several consultants, to provide potential users

with information on technology, design, funding, and other assistance for constructing biogas plants. Public demand for high-rate biomethanation technology will have increased.

Output 3.1

Increased awareness of biomethanation processes using a wide range of substrates, and increased use of the biogas produced, among industries, municipal bodies, the rural sector, technical personnel, designers, consultants, and other parties.

Activities for Output 3.1

3.1.1 National workshops will be organized to promote application of biomethanation technology in multiple sectors.

Responsible party: NBB, national institutions and consultants.
Starting date: September 1994.
Duration: 54 months.

3.1.2 National and international experts will participate in the workshops to learn about modern technologies, and the benefits and cost-effectiveness of the biomethanation process.

Responsible party: PMC, national institutions and consultants.
Starting date: September 1994.
Duration: 54 months.

3.1.3 Training modules and promotional literature, in English and in regional languages, will be distributed through national institutions to promote awareness about the benefits of biomethanation.

Responsible party: PMC, national institutions and consultants.
Starting date: September 1994.
Duration: 12 months.

3.1.4 An aggressive print and electronic media campaign will be launched to increase public awareness of the benefits of biomethanation.

Responsible party: NBB/PMC, the Directorate of Audio-Visual Publicity (DAVP), and the Ministry of Information and Broadcasting.

Starting date: October 1994.
Duration: 54 months.

3.1.5 Training in bioenergy will be conducted for potential users such as industry, municipal agencies and rural bodies. The agenda will include programmes for NGOs who are active in the field, particularly in the rural sector.

Responsible party: PMC, NGOs and national institutions.
Starting date: September 1994.
Duration: 54 months.

Output 3.2

An improved programme on the use of biomethanation technology to promote biogas generation and utilization.

Activities for Output 3.2

3.2.1 Develop a workplan for a promotional campaign on the use and benefits of biomethanation technology.

Responsible party: PMC and consultants.
Starting date: September 1994.
Duration: 54 months.

3.2.2 Develop national schemes, available to all potential users, for biogas generation and utilization.

Responsible party: PMC, national institutions and consultants.
Starting date: September 1996.
Duration: 30 months.

3.2.3 Assess development needs for various sectors, identify the options available, and formulate promotional plans for these groups.

Responsible party: PMC/NBB.
Starting date: April 1995.
Duration: 36 months.

3.2.4 Devise financial schemes which will provide incentives for growth in bioenergy generation.

Responsible party: NBB.
Starting date: September 1996.
Duration: 30 months.

E. INPUTS

1. Government of India

Personnel

Wherever necessary, existing manpower resources from the various government agencies and consultants will be used for the project. The NBB will be staffed by government personnel. For the demonstration units, staff will be selected from the nominated national laboratories and institutes, industry, consultants, and engineering contractors for construction activities. The MNES will ensure that adequate numbers of personnel are assigned, and that these individuals have the necessary technical and management expertise for the project. The staff requirements are described below.

National Bioenergy Board

Chairman (Secretary, MNES)
National Project Director (one)
Deputy Director (one)
Scientific Officers (three)
Office assistants (three)
Drivers/service staff (four)

Staff from other government ministries and departments will be made available at various stages of the project as required. NBB will be substantially staffed with MNES personnel. Operational expenses for the NBB, except for the Chief Project Manager (a consultant), will be met by the MNES. By the end of the project, NBB will become self-sufficient and able to manage the next phase of commercialization.

Technology agencies

For the demonstration sub-projects, the technology agencies will provide personnel for design, critical aspects of construction supervision, assistance in commissioning, trouble-shooting at the demonstration stage, and streamlining plant operations. When technology is imported for the demonstration sub-projects, the technology agencies will provide the necessary personnel to assist the MNES/NBB in assessing technology and adapting designs to Indian conditions. Acquisition of technology from foreign sources and construction of the demonstration units will be sub-contracted. These sub-contracts will include costs for all manpower, travel, specialist personnel, production of reports, and other activities. Qualified staff will be available from the large technological institutes in India. Upon successful demonstration of the sub-projects, the national institutions involved will have the necessary experience to disseminate biogas technology and train other parties to replicate the design.

Demonstration units

The units that undertake to host the demonstration sub-projects will provide the personnel required to implement the project from inception to full-scale operation. Specifically, staff will be provided for project management, and for operation and maintenance of the unit. In most cases, the project will be implemented through equipment suppliers and engineering contractors under the standard tendering procedures of the Government of India and UNDP.

Institutional development

The Government of India's counterpart budget includes costs for increasing the skills and capabilities in the various organizations to support the project. The technological institutions will require special equipment to supply the demonstration sub-projects. Although it is not possible to define specific needs at present, the GEF/UNDP budget provides for import of equipment for the institutions.

2. Global Environment Facility

GEF will provide the funding for technical assistance to the project as outlined in the attached budget. GEF payments will be made to the government every three months in accordance with the budget agreement between the two parties. MNES will ensure that a separate bank account is opened by IREDA for handling GEF funds.

Since the project is adapted to conditions unique to the host country, there are special requirements that increase the risk and additionality in terms of project costs. GEF will therefore fund the following components:

- *Technology imports.* This will cover the costs of technology assessment, overseas visits to evaluate/acquire technology, technology fees and other related expenses.

- *Design, supervision of construction, trouble-shooting, and streamlining of plant operations.* This will include the cost of national and international experts. Without demonstrating the success of these pilot initiatives, high-rate biomethanation technology plants are unlikely to be replicated.

- *National and international consultants.* In addition to national consultants supplied by the government, GEF may hire further consultants to assist with the project, as and when required.

- *Overseas training and study tours.*

- *Five percent of equipment costs for the demonstration units.* In view of the financial risks for the private sector agencies constructing these innovative units, GEF will finance up to a maximum of 5 percent of equipment costs. The Government of India will bear up to a maximum of 50 percent of hardware costs for the demonstration sub-projects. This funding will be reviewed on a case-by-case basis.

F. RISKS

The schemes under this project will require an extensive use of high-rate biomethanation for deriving biogas from several complex substrates. In some cases, the technology will have to be adapted to suit the substrate and local conditions. Although India already has considerable expertise in this area, certain technological complexities will need to be overcome to achieve the full development objectives of the project. In order to minimize risks in technology, multiple techniques will be tested during different phases of the project. In the first phase, several technologies will be tried out to assess their suitability for demonstration purposes. The more successful techniques among them will be employed for demonstration on a larger scale in the second phase. The abundant technical resources available from national institutes and laboratories, as well as the utilization of national and international consultants, will further ensure that technical difficulties are overcome. The phased approach for the demonstration schemes, the evaluation system, and the level of expertise supporting the project combine to make the risk of failure low.

The policy environment in India supports a successful outcome for the project. There is, however, some risk that biomethanation processes will not be adopted on a large scale, even after the technology has been proved. Several constraints, including the restricted availability of investments, could hinder full adoption of biomethanation processes. To reduce the risks, the existing policy framework, particularly environmental regulations, will be reviewed. In addition, MNES will create training and educational programmes to disseminate information and generate interest in this technology. The worst case scenario for this project would be a slow pace in the adoption of biomethanation technology. The project could not therefore be a complete failure. However, it is anticipated that the success of the demonstration projects will lead to the adoption of biomethanation processes on a large scale, thereby enhancing the country's development objectives.

G. PRIOR OBLIGATIONS AND PREREQUISITES

The Government of India will undertake the following obligations for the project:

- Allocate funds in the national budget as described in Section E on inputs in this document
- Provide the necessary equipment, facilities and personnel
- Establish the NBB and the other agencies described in Section E

- Nominate counterpart officials from the various ministries, departments, and agencies to undertake project activities throughout the duration of the project
- Provide appropriate facilities for the training of personnel
- Provide the necessary information relating to the project to experts and consultants
- Sign MOUs with national laboratories, research and development institutions, overseas technology sources, and the units setting up the demonstration sub-projects.

The Project Document will be signed by UNDP, and UNDP assistance will be provided subject to UNDP receiving satisfaction that the prerequisites have been, or are likely to be, fulfilled. When anticipated fulfillment of one or more prerequisites fails to materialize, UNDP may, at its discretion, either suspend or terminate assistance.

H. PROJECT REVIEW, REPORTING AND EVALUATION

The project will be subject to periodic tripartite reviews, evaluation, and performance reporting, in accordance with established UNDP policies and procedures. This monitoring will include two in-depth evaluations, in year three and year five, involving specialist agencies such as the United Nations Environment Programme (UNEP), the United Nations Center for Human Settlements (UNCHS), and the United Nations Department for Development Support and Management Services (UNDDSMS). The nature and frequency of review will be determined by the Resident Representative of the UNDP and the Government of India.

The project will be subject to tripartite review by representatives of the government (DEA), UNDP, and the executing agency at least once every twelve months from the start of project implementation. The National Project Director shall prepare and submit to each tripartite review meeting a Project Performance Evaluation Report (PPER) at least two months in advance. Additional PPERs may be requested during the project, if necessary.

A project terminal report will be prepared before the final evaluation. It shall be prepared in draft form sufficiently in advance to allow review and technical clearance by the executing agency, at least four months prior to post-project evaluation.

I. LEGAL CONTEXT

1. This document shall be the instrument referred to in the Standard Basic Assistance Agreement of the UNDP. The following types of revisions may be made in the document with the signature of the UNDP Resident Representative only, provided he or she is assured that the other signatories of the document have no objections to the proposed changes:

- Revisions in, or additions to, any of the annexes of the original Project Document

- Revisions which do not involve significant changes in the immediate objectives, outputs or activities of the project, but are caused by the rearrangement of inputs already agreed to, or by cost increases due to inflation

- Mandatory annual revisions which rephase the delivery of agreed project inputs, or cost increases due to inflation.

J. BUDGET

The budgets for the project, covering contributions from the Government of India and UNDP, are attached.

PROJECT BUDGET COVERING GOVERNMENT CONTRIBUTION (in rupees)

(Country contributions will be made in kind)

Project Title: Development of High-Rate Biomethanation Processes as Means of Reducing Greenhouse Gas Emissions

Project Number: IND/92/G32

Component	Budget Line	Project Component	TOTAL		1994		1995		1996		1997		1998		1999	
			w/m	Amount	w/m	Amount	w/m	Amount	w/m	Amount	w/m	Amount	w/m	Amount	w/m	Amount
11		Personnel (Note 1)	600	4,000,000	90	500,000	120	750,000	120	800,000	120	850,000	120	900,000	30	200,000
15		Duty Travel		5,000,000		750,000		1,000,000		1,000,000		1,000,000		1,000,000		250,000
19		Component Total		9,000,000		1,250,000		1,750,000		1,800,000		1,850,000		1,900,000		450,000
30		Training (Note 2)		10,000,000		1,500,000		2,000,000		2,000,000		2,000,000		2,000,000		500,000
39		Component Total		10,000,000		1,500,000		2,000,000		2,000,000		2,000,000		2,000,000		500,000
41		Office Equipment		4,000,000		2,000,000		2,000,000								
42		Sub-Project Contribution (Note 3)		100,000,000		6,066,900		10,407,900		16,474,900		44,717,600		16,474,900		5,857,800
49		Component Total		104,000,000		8,066,900		12,407,900		16,474,900		44,717,600		16,474,900		5,857,800
50		Miscellaneous														
51		NBB Operating Expenses (Note 4)		12,500,000		2,000,000		2,500,000		2,500,000		2,500,000		2,500,000		500,000
52		IREDA Handling Charges (Note 5)		6,500,000		394,350		676,510		1,070,870		2,906,640		1,070,870		380,760
59		Component Total		19,000,000		2,394,350		3,176,510		3,570,870		5,406,640		3,570,870		880,760
99		Total		142,000,000		13,211,250		19,334,410		23,845,770		53,974,240		23,945,770		7,638,560

Note 1: Includes salaries and related costs of 10 full-time NDB/PMC (MNES) personnel as per organisation chart including the NPD, Project Manager, 3 Scientific officers and 3 Administrative/Service staff. The salaries of the consultants will be borne by UNDP/GEF.

Note 2: This amount is ear-marked for the training of personnel and development of institutional capabilities of MNES and other Government Departments/Ministries to meet the requirements of the project.

Note 3: The total value of equipment for the sub-projects is Rs. 191,200,000. Of this, the share of equipment proposed to be borne by the MNES will be Rs. 100,000,000 which has been phased as per the attached annex. Operating costs and expenses on account of repairs and maintenance of plant and machinery will be borne by the users of the sub-projects (demonstration) units.

Note 4: NDB operating expenses includes all elements relating to the operation of the office including telephone/fax, office rental, repairs/maintenance, electricity and consumables. Travel and related expenses are separately provided for.

Note 5: IREDA handling charges have been provided @ 2% of the total project value (UNDP and counterpart budgets) for the complete financial services relating to the project.

Phasing of Cost of Plant and Machinery
(in rupee 100,000s)

Sub-Project Description	Total	1994	1995	1996	1997	1998	1999
1. NEERI Fixed Film Sewage Treatment (S 1)	40	15	20	5			
2. NEERI Sludge Based Sewage Treatment (S 2)	100			15	50	20	15
3. Large Scale Sewage Treatment (S 3)							
4. NEERI Fixed Film Leather Effluent (L 1)	20	8	12				
5. CLRI UASB Leather Effluent Treatment (L 2)	66			15	35	10	6
6. Large Scale Leather Effluent Treatment (L 3)	20	8	12				
7. Leather Solid Waste Treatment (L 4)	96			10	50	25	11
8. Large Scale Leather Solid Treatment (L 5)							
9. Western Paques Paper Effluent Treatment (P 1)	640			70	350	180	40
10. Large Scale Paper Effluent Treatment (P 2)	50	15	25	10			
11. Market Waste Mod. KVIC Technology (M 1)	100	30	50	20			
12. Market Waste Imported Technology (M 2)	420			50	250	80	40
13. Large Scale Market Waste Treatment Unit (M 3)							
14. Paques Bio-gas Engine (B 1)	120	40	80				
15. Caterpillar/KC Bio-gas Engine (B 2)	240			120	120		
16. Large Scale Bio-gas Engine Trials (B 3)							
Total	1,912	116	199	315	855	315	112

Equivalent U.S. Dollars for Plant & Machinery: 6.07 million

Note: 5 % of the above amount i.e. U.S. $ 304,000 is allocated to UNDP/GEF Funds.

PROJECT BUDGET COVERING UNDP CONTRIBUTION

Project Title: Development of High-Rate Biomethanation Processes as Means of Reducing Greenhouse Gas Emissions
Project Number: IND/92/G32

Component	Budget Line	Project Component	TOTAL		1994		1995		1996		1997		1998		1999	
			w/m	Amount	w/m	Amount	w/m	Amount	w/m	Amount	w/m	Amount	w/m	Amount	w/m	Amount
10		Project Personnel														
	11-50	International Consultants														
	11-51	Consultants NBB (Note 1)	15.0	330,000	2.0	40,000	3.0	62,000	3.0	65,000	3.0	68,000	3.0	71,000	1.0	24,000
	11-52	Consultants - Workshop (Note 2)	7.5	220,000	1.0	25,000	1.5	40,000	1.5	44,000	1.5	46,000	1.5	47,000	0.5	18,000
	11-53	Consultants - Short Term (Note 3)	10.0	225,000	1.0	20,000	2.0	42,000	2.0	44,000	2.0	46,000	2.0	48,000	1.0	25,000
	11-99	Sub-total	32.5	775,000	4.0	85,000	6.5	144,000	6.5	153,000	6.5	160,000	6.5	166,000	2.5	67,000
15		Duty Travel														
	15-01	Travel in India (Note 4)		169,400		25,000		36,700		35,000		32,700		30,000		10,000
	15-99	Sub-total		169,400		25,000		36,700		35,000		32,700		30,000		10,000
16		Mission Costs														
	16-01	Mission Cost (Note 5)		60,000						30,000						30,000
	16-99	Sub total		60,000						30,000						30,000

Comp onent	Budget Line	Project Component	TOTAL		1994		1995		1996		1997		1998		1999	
			w/m	Amount	w/m	Amount	w/m	Amount	w/m	Amount	w/m	Amount	w/m	Amount	w/m	Amount
17	National Professionals															
	17-01	Chief Project Manager, NDB	60.0	80,000	9.0	10,000	12.0	15,000	12.0	16,000	12.0	17,000	12.0	18,000	3.0	4,000
	17-02	Unspecified, NDB (Note 6)	20.0	28,400	3.0	3,600	4.0	5,200	4.0	5,500	4.0	6,000	4.0	6,500	1.0	1,600
	17-03	Unspecified Workshops (Note 7)	25.0	38,700	3.0	4,200	5.0	7,500	5.0	7,500	5.0	8,000	5.0	8,000	2.0	3,500
	17-99	Sub-total	105.0	147,100	15.0	17,800	21.0	27,700	21.0	29,000	21.0	31,000	21.0	32,500	6.0	9,100
19		Component Total	137.5	1,151,500	19.0	127,800	27.5	208,400	27.5	247,000	27.5	223,700	27.5	228,500	8.5	116,100
20	Sub contract (Note 8)															
	21-01	Sewage Technology (S1)		266,400		100,000		166,400		-		-		-		-
	21-02	Leather Technology (L1)		266,400		100,000		166,400		-		-		-		-
	21-03	MSW Technology (M2)		516,400		250,000		266,400		-		-		-		-
	22-01	NEERI (S1, S2, L1)		83,675		31,110		39,525		13,040		-		-		-
	22-02	CLRI (L2, L3)		93,600		35,460		50,140		8,000		-		-		-
	22-03	CPPRI (P1, P2)		159,100		6,500		3,000		26,000		76,000		39,200		8,400
	22-04	MGSN (M1)		25,400		8,900		14,000		2,500		-		-		-
	22-05	NCUCBD (M2)		71,400		27,000		36,400		8,000		-		-		-
	22-06	I.I.Sc. (B1, B2, B3)		38,100		8,000		8,700		8,700		9,000		3,700		-
	23-01	Phase II (S3)		74,350		-		-		20,700		27,810		17,570		8,270
	23-02	Phase II (L3)		49,450		-		-		21,000		23,450		5,000		-
	23-03	Phase II (L5)		67,150		-		-		26,050		28,580		9,520		3,000
	23-04	Phase II (M3)		138,600		-		-		28,000		71,600		30,000		9,000
29	Component Total			1,850,025		566,970		750,965		161,990		236,440		104,990		29,670
30	Training															
	31	Fellowships (Note 9)														
	31-01	Biomethanation of effluents	30.0	150,000	6.0	26,000	6.0	28,000	6.0	30,000	6.0	32,000	6.0	34,000	-	-
	31-02	Biomethanation of sewage/sludge	30.0	150,000	6.0	26,000	6.0	28,000	6.0	30,000	6.0	32,000	6.0	34,000	-	-
	31-03	Biomethanation of MSW	30.0	150,000	6.0	26,000	6.0	28,000	6.0	30,000	6.0	32,000	6.0	34,000	-	-
	31-04	Microbial Techniques	30.0	150,000	6.0	26,000	6.0	28,000	6.0	30,000	6.0	32,000	6.0	34,000	-	-
	31-05	Bioenergy Utilisation	30.0	150,000	6.0	26,000	6.0	28,000	6.0	30,000	6.0	32,000	6.0	34,000	-	-
	31-06	Plant/Process Design	30.0	150,000	6.0	26,000	6.0	28,000	6.0	30,000	6.0	32,000	6.0	34,000	-	-
		Sub total	180.0	900,000	36.0	156,000	36.0	168,000	36.0	180,000	36.0	192,000	36.0	204,000	-	-

Comp onent	Budget Line	Project Component	TOTAL		1994		1995		1996		1997		1998		1999	
			w/m	Amount	w/m	Amount	w/m	Amount	w/m	Amount	w/m	Amount	w/m	Amount	w/m	Amount
32		Study Tour/Group Training														
	32-01	Study Tour (Note 10)	20.0	180,000	4.0	32,000	4.0	34,000	4.0	36,000	4.0	38,000	4.0	40,000	-	
33		Workshops/Seminars/In-service Training														
	33-01	Training Programmes (Note 11)		237,000		35,000		51,000	-	55,000		58,000		38,000		-
	39	Component Total	200.0	1,317,000	40.0	223,000	40.0	253,000	40.0	271,000	40.0	288,000	40.0	282,000	-	-
40		Equipment														
	45-01	NBB Office Equipment		65,000		65,000										
	45-02	Sub-project Equipment (Note 12)		304,000		18,440		31,640		50,080		135,940		50,080		97,820
	46-01	Unspecified Equipment-Overseas (Note 13)		500,000		75,000		100,000		100,000		100,000		100,000		25,000
	49	Component Total		869,000		158,440		131,640		150,080		235,940		150,080		42,820
50		Miscellaneous (Note 14)														
	52	Reporting		34,600		4,000		4,000		5,000		5,000		6,000		10,000
	53	Sundries														
	53-01	Books & Periodicals		60,000		8,000		12,000		12,000		12,000		12,000		4,000
	53-02	Publications/Publicity Materials		90,000		10,000		18,000		18,000		18,000		18,000		8,000
	53-03	Repairs & Maintenance		30,000		4,000		5,000		6,000		6,000		7,000		2,000
	54	UNDP Field Office Expenses (Note 15)		100,000		15,000		20,000		20,000		20,000		20,000		5,000
59		Component Total		314,000		41,000		59,000		61,000		61,000		63,000		29,000
99		UNDP Contribution (Note 16)		5,501,525		1,117,210		1,403,005		891,070		1,015,080		828,570		216,590

Note 1: Expenses relate to visits by two consultants, twice a year for a duration of fifteen working days per visit throughout the project period to assist the NBB i its functions. This would be in the areas of biotechnology/engineering, bioenergy, environmental protection etc.

Note 2: Expenses relate to the visits by three consultants, twice a year during the project period for a duration of a week in connection with National Workshops. The consultants would be chosen based upon the theme of the workshop.

Note 3: During the implementation of the sub-projects, specialist assistance would be required by the NBB/PMC. It is not possible to define the precise nature of such consultants. A provision is being made for the time of such consultants. Area covered will be related to biotechnology/engineering, policy planning, bioenergy, environmental economics etc.

Note 4: Cost of travel and related expenses of International and National Consultants in India has been provided under this budget line. The National Consultants would be paid travelling expenses and DSA at the prevailing Government rates.

Note 5: This portion has been kept for two in-depth, independent evaluations, mid-term and terminal, in years three and five, as per UNDP procedures.

Note 6: NBB/PMC will require short term (2 - 4 week duration) specialist assistance of consultants during the execution and implementation phases. The areas of such consultants would include biotechnology, plant design, bioenergy utilisation and related fields.

Note 7: NBB will require the help of Indian consultants to successfully conduct the national workshops. While the quantum of effort involved can be estimated, th exact disciplines would depend upon the contents of the workshops. The fields in which assistance would be required are microbial technology, biotechnology and engineering, bioenergy utilisation, environmental sanitation etc.

Note 8: Technology acquisition, translation and setting up of the demonstration sub-projects is being done under sub-contracts. The project codes referred to are as defined in Annex 1. The sub-contract amount includes associated elements of travel and other components for all expenses to be incurred by the technology agencies. Budget line 21 relates to acquisition of technology from overseas in specific areas mentioned. Budget line 22 related to setting up of the sub-projects by Indian technology institutions in Phase I. Budget line 23 related to setting up of sub-projects in Phase II upon successful demonstration in Phase I. These do not include the cost of the equipment of the sub-projects. As regards equipment (including plant and machinery) for the sub-projects the text of the document explains the proposed sharing of cost between the demonstration units, the Government and UNDP/GEF. Provisions made in the UNDP/GEF budget and counterpart budget show the amount to be charged to UNDP/GEF and Government. The demonstration units have to bear the res of the cost.

Note 9: Fellowships are intended in six areas relevant to the major thrust of the project. Two fellowships of a duration of three months each are proposed per year during the project period in each of the six areas specified. The priorities for the fellowships would be determined by the NBB to meet the requirements and availability of trained personnel in the fields.

Note 10: Four study tours per year of one month duration during the project period is proposed in areas relevant to the project for personnel from the Central/State Governments, Ministries and Departments, NGOs, Demonstration units etc. The technology institutions having been provided with project related travel and study are not included in this provision. The areas of study would include environmental accounting, microbial processes, biotechnology/engineering, treatment processes relating to specific substrates, bioenergy utilisation and operational aspects.

Note 11: Training programmes in the form workshops, seminars and training sessions in specific fields are proposed aimed at user groups in the Government (Central/State), Industrial, Municipal and Rural Sectors will be organised during the project period to catalyse the development of biomethanation processes. This will involve NGOs and other relevant agencies.

Note 12: As mentioned in this document, the nature of the demonstration sub-projects are such that there is an element of additional criticality. This would call for a part of the capital cost of equipment under the various sub-projects to be charged to UNDP/GEF funds. A nominal amount of 5 % has been charged for this.

Note 13: The nature of the demonstration sub-projects are such that there would be a need for testing and other specialised imported equipment during the technology translation and implementation stages. While it is not possible to specify such equipment at this stage, a provision for such equipment has been made under budget line 46 relating to international procurement. The types of equipment required would include testing and analytical equipment/instruments, special imported components for demonstration units, special equipment for microbial work etc.

Note 14: Expenses under budget line 50 relate to reporting, books & periodicals, production of promotional material required for training, workshops and to provide for repairs and maintenance of equipment provided by UNDP/GEF.

Note 15: This provision is for UNDP Field Office expenses that includes hiring of short term consultants or technical institutions for appraisal (including cost benefit analysis) of sub-projects and the regular technical monitoring of the project, as deemed appropriate by UNDP.

Note 16: The total UNDP/GEF contribution of U.S.$ 5,501,525 has been rounded off to U.S.$ 5.5 million for convenience.

Phasing of Expenditure - Technology and Design/Construction Costs

U.S.Dollars

Project Description	Total	1994	1995	1996	1997	1998	1999
1. NEERI Fixed Film Sewage Treatment (S 1)	19,050	4,760	9,520	4,770			
2. NEERI Sludge Based Sewage Treatment (S 2)	45,100 10,000	17,600 4,000	19,230 6,000	8,270			
3. Large Scale Sewage Treatment (S 3)	60,350 14,000			12,700 8,000	23,810 4,000	15,570 2,000	8,270
4. NEERI Fixed Film Leather Effluent Treatment (L 1)	9,525	4,750	4,775				
5. CLRI UASB for Leather Treatment (L 2)	23,800 4,000	9,000 3,000	12,800 1,000	2,000			
6. Large Scale Leather Effluent Treatment (L 3)	44,450 5,000			17,000 4,000	22,450 1,000	5,000	
7. Leather Solid Waste Treatment (L 4)	56,800 9,000	17,460 6,000	33,340 3,000	6,000			
8. Large Scale Leather Solid Waste Treatment (L 5)	57,150 10,000			19,050 7,000	25,580 3,000	9,520	3,000
9. Western Paques Paper Effluent Treatment)P 1)	9,500	6,500	3,000				
10. Large Scale Paper Effluent Treatment (P 2)	139,600 10,000			19,000 7,000	73,000 3,000	39,200	8,400
11. Market Waste Mod. KVIC Technology (M 1)	25,400	8,900	14,000	2,500			
12. Market Waste Imported Technology (M 2)	58,800 12,600	18,000 9,000	32,800 3,600	8,000			

13. Large Scale Market Waste Treatment Unit (M 3)	120,600 18,000			19,000 9,000	65,600 6,000	27,000 3,000	9,000
14. Paques Bio-gas Engine (B 1)	6,350	4,000	2,350				
15. Caterpillar/KC Engine Trials (B 2)	12,700	4,000	6,350	2,350			
16. Large Scale Engine Demonstration (B 3)	19,050			6,350	9,000	3,700	
17. Technology for Sewage Sludge Treatment (S 2)	266,400	100,000	166,400				
18. Technology for Leather Solids Treatment (L 2)	266,400	100,000	166,400				
19. Technology for Market Waste Treatment (M 2)	516,400	250,000	266,400				
Total	1,850,025	566,970	750,965	161,990	236,440	104,990	28,670

Note: 1: Items 1 to 16 relate to design related costs i.e. design/construction assistance, commissioning assistance, trouble shooting, monitoring and expenses relating to Indian/Foreign consultants and experts including overseas visits by Indian Parties.

Note: 2. Items 17 - 19 relate to cost of acquiring technology including the related foreign travel component.

Annex 1

SUMMARY OF ARRANGEMENTS AND COST ESTIMATES FOR DEMONSTRATION SCHEMES

The cost estimates for the various demonstration sub-projects have been calculated on the basis of information about plant capacity and relevant technological aspects. The cost in the year of implementation is based on an assumption of a 5 percent increase per annum since 1993. In working out the GEF/UNDP and government contributions to the project, these costs have been considered as subcontracts.

1. Small Community Sewage Treatment

Sub-project S1: NEERI Fixed-film Technology
Year of completion: 1994

The National Environmental Engineering Research Institute (NEERI) will be setting up a demonstration scheme for the treatment of sewage at the Regional Research Laboratory (RRL), Bhubaneshwar, based on their experience with the fixed-film technology at the Nagpur Medical College. The implementation of the scheme will commence concurrent with other demonstration sub-projects detailed in this document. Since the scheme has direct relevance to the high-rate biomethanation sub-projects, the benefits of this demonstration have also been included in the project. The allocations for technical costs are shown in the table below.

Cost estimate

Component	*Rupees*	*US$*
1. Design/construction assistance	300,000	-
2. Commissioning assistance/trouble-shooting/monitoring	200,000	-
3. Experts/consultants	100,000	-
Total	600,000	-

Sub-project S2: Sewage Sludge Treatment
Year of completion: 1994

Compared to the conventional treatment of sewage, which is generally a dilute stream, separation and treatment of sewage solids in sludge has several advantages. This technique has been practiced in developed countries for several years, and package plants are available for communities with a population

ranging from 10,000 to over 250,000. Several agencies like Thames Water, Yorkshire Water, North West Water, and similar agencies operate such plants, and would be willing to offer technological assistance for this project. Considering the importance of such processes in providing cost-effective alternatives to the energy-intensive conventional aeration process, there is considerable merit in developing this technology for Indian conditions. The steel plant of the Steel Authority of India Ltd. (SAIL) in Bhilai has expressed interest and will provide an excellent demonstration site. NEERI is considered a good agency for technology translation in view of the work already done by them on the fixed-film process. Under the proposed scheme, a demonstration unit for the treatment of sewage sludge will be set up at Bhilai to meet the requirements of some 20,000 people.

Cost estimate

Component	*Rupees*	*US$*
1. Technology assessment/negotiations	350,000	13,000
2. Technology fees	-	250,000
3. Design/development-related costs:		
• Design/construction assistance	300,000	-
• Commissioning/trouble-shooting/monitoring	200,000	-
• Experts/consultants	200,000	-
4. Visits for technology transfer		
• Overseas visits by Indian team	150,000	4,000
• Visit by overseas experts	200,000	10,000
5. Demonstration unit cost		
• Thickener	700,000	-
• Vessels/pasteurizer	100,000	-
• Heat exchangers	100,000	-
• Anaerobic digestors (3 - 360 m^3)	1,200,000	-
• Pumps and blowers	200,000	-
• Piping and valves @ 20 % of equipment cost	450,000	-
• Civil/foundation @ 15 % of equipment cost	350,000	-
• Instrument and electric @ 15 % of equipment cost	350,000	-
• Utilities and hook-up @ 15 % of equipment cost	350,000	-
• Contingency @ 10 % of equipment cost	200,000	-
Installed equipment total	4,000,000	-

Sub-project S3: Larger-Scale Sewage Treatment
Year of completion: 1997

The larger-scale demonstration will handle sewage generated by a community of 50,000 people. A preliminary cost assessment for such a unit, based on a comparison of the capital costs of NEERI's fixed-film experience at Nagpur, with the costs of the sewage sludge treatment described above, shows that the latter is likely to be more cost-effective. In view of the fact that the sludge process is a proven method, its costs have been extrapolated to calculate the cost of the scale-up. If the NEERI experience at Bhubaneshwar proves to be better, it might be possible to utilize it for the demonstration unit without exceeding the same cost allocations.

Cost estimate

The costs anticipated for the larger-scale demonstration are shown in the table below. The capital costs are based on the costs of sub-project S2, using a factorial method with an exponent value of 0.7. Escalation costs till completion in 1997 have also been factored in.

Component	*Rupee*	*US$*
1. Design-related costs		
• Design/construction assistance	600,000	-
• Commissioning assistance/trouble-shooting/monitoring	400,000	-
• Experts/consultants	500,000	-
2. Overseas visit	400,000	14,000
3. Demonstration unit cost (factorial extrapolation)	10,000,000	-

2. Treatment of Leather Effluents/Wastes

Sub-project L1: NEERI Fixed-film Technology
Year of completion: 1994

Based on their experience with fixed-film digestors, a fixed-film treatment system with a capacity of 65 m^3 per day is being set up at Amburtec in Ambur, at a nominal cost of Rs. 2.5 million (US$ 79,365). This demonstration, sponsored by the MNES, is expected to be on line in early 1994. The unit will thereafter be available for study. The project incorporates provisions for the evaluation of design through monitoring.

Cost estimate

Component	*Rupee*	*US$*
1. Commissioning assistance, trouble-shooting, monitoring	200,000	-
2. Experts/consultants	100,000	-

Sub-project L2: CLRI Upflow Anaerobic Sludge Blanket (UASB) for Leather Effluent
Year of completion: 1994

The Central Leather Research Institute (CLRI) is engaged in developing the leather sector in the country. The institute has an environmental division capable of setting up UASB systems for treating leather effluents. CLRI also has excellent connections with leather units in the country which will enable them to demonstrate the performance of the plant effectively. In order to offer a meaningful comparison between the various designs, the proposal envisages a UASB-based system with a 65 m^3/day capacity similar to sub-project L1.

Cost estimate

The UASB estimate is based on typical retention periods applicable to the designs. A chrome recovery system is not included in the scheme; non-chrome streams will be segregated for use in the trial.

Component	*Rupee*	*US$*
1. Design-related costs		
• Design/construction assistance	300,000	-
• Commissioning assistance/trouble-shooting/monitoring	200,000	-
• Experts/consultants	100,000	-
2. Overseas visits	150,000	4,000

3. Demonstration unit cost		
• Tankage	100,000	-
• UASB reactor (400 m^3)	850,000	-
• Pumps and blowers	150,000	-
• Piping and valves @ 15 % of equipment cost	150,000	-
• Civil @ 15 % of equipment cost	150,000	-
• Instrument and electric @ 10 % of equipment cost	100,000	-
• Laboratory items (lump sum)	200,000	-
• Utilities and hook-up @ 10 % of equipment cost	100,000	-
• Contingency @ 10 % of total cost	200,000	-
Equipment cost total	2,000,000	

Sub-project L3: Larger Demonstration — Leather Effluents
Year of completion: 1997

The outcome of sub-projects L1 and L2 would be used to decide on the larger demonstration unit for treating leather effluents. A demonstration unit of 200 m^3/day capacity is contemplated for this sub-project. The tannery where the unit is to be set up would be selected in consultation with NEERI or CLRI, depending on the success of sub-projects L1 and L2.

Cost estimate

The cost estimate is based on a factorial method using an exponent value of 0.7. Since the project will come into operation only in 1997, inflation (at the rate of 5 percent per annum) has been been taken into consideration.

Component	*Rupee*	*US$*
1. Design/construction assistance	600,000	-
2. Commissioning assistance/trouble-shooting/monitoring	350,000	-
3. Experts/consultants	250,000	-
4. Overseas visit	200,000	5,000
5. Demonstration unit cost (factorial method)	6,600,000	-

Sub-project L4: Treatment of Leather Solids
Year of completion: 1994

Leather solids and other wastes of animal origin are another class of substrates which are important in India. While no Indian institutions have the capacity for treating these wastes, CTC of France, and certain organizations in Italy and Turkey, are reported to have the necessary technology. Preliminary enquiries show that CTC's technology in this area could be worthy of adoption. CLRI, by virtue of its presence in the leather sector in the country and its past links with CTC, is well suited to undertake this demonstration scheme. Successful demonstration of the scheme could lead to an extension of the concept to the wastes produced in the meat-processing sector. Given the difficult nature of the substrate, the proposed demonstration unit will handle 1 tpd of wet solids.

Cost estimate

The cost estimate is based on the reported operation of such plants and the likely configuration reported in the literature. At the time of preparing this document, no figure for technology fees was available from CTC. Fees have therefore been assumed at US$ 250,000, based on the technology content in similar projects.

Component	*Rupee*	*US$*
1. Technology assessment/negotiations	450,000	11,000
2. Technology fees	-	250,000
3. Design/development-related costs		
• Design/construction assistance	500,000	-
• Commissioning assistance/trouble-shooting/monitoring	300,000	-
• Experts/consultants	200,000	-
4. Visits for technology transfer		
• Overseas visit by Indian team	150,000	4,000
• Visit by overseas expert	200,000	10,000

5. Demonstration unit cost		
• Tanks and vessels	150,000	-
• Shredder	80,000	-
• CSTR (250 m^3)	800,000	-
• Gas holder	60,000	-
• Pumps/blowers	140,000	-
• Piping and valves @ 15 % of the equipment cost	180,000	-
• Civil @ 10 % of the equipment cost	120,000	-
• Electric/instruments @ 10 % of the equipment cost	120,000	-
• Utilities and hook-up @ 10 % of the equipment cost	120,000	-
• Laboratory items (lump sum)	100,000	-
• Contingencies @ 10 % of equipment cost	130,000	
Equipment cost total	2,000,000	-

Sub-project L5: Treatment of Abattoir Wastes
Year of completion: 1997

The successful implementation of sub-project L4 will provide the basis for setting up a demonstration unit for treating abattoir wastes. Deonar Abattoir at Bombay has been chosen for the demonstration. CLRI will undertake the design and development of technology. Linkages with CTC will continue to be maintained during this phase for any possible support in scale-up. The nominal size of the plant will be 10 tpd wet solids.

Cost estimate

The cost estimate is based on factorial extrapolation, using an exponent value of 0.7. An inflation rate of 5 percent per annum, based on 1993 costs, has been taken into consideration.

Component	*Rupee*	*US$*
1. Design/construction assistance	600,000	-
2. Commissioning assistance/trouble-shooting/monitoring	400,000	-
3. Experts/consultants	400,000	-
4. Overseas visit	400,000	10,000
5. Demonstration unit cost (factorial method)	9,600,000	-

3. Pulp and Paper Waste Treatment

Sub-project P1: Western Paques Scheme at Warna
Year of completion: 1994

Western Paques is constructing a UASB scheme for the treatment of effluents from a 30 tpd paper mill at Warna, Maharashtra. This unit is expected to come on line in 1994. Western Paques are interested in propagating the UASB technology for various substrates relevant to India, and in sharing information on the performance of the Warna plant. The capabilities of the UASB technology of Western Paques will be assessed by the Central Pulp and Paper Research Institute (CPPRI).

Cost estimate

Since the capital costs for the plant will be borne by the demonstration unit, the cost requirements for this scheme are for monitoring and assessing the suitability of the Warna plant for replication, with or without modifications.

Component	*Rupee*	*US$*
1. Data collection and monitoring	200,000	-
2. Experts/consultants	100,000	-

Sub-project P2: Larger Demonstration — Pulp and Paper Wastes
Year of completion: 1997

A larger demonstration unit with a nominal capacity of 200 tpd will be set up in a paper mill in phase two. CPPRI, already involved in monitoring the performance of the Warna unit, will also participate in the design of this sub-project.

Cost estimate

The cost estimate is based on a factorial extrapolation of Warna unit costs, using an exponent factor of 0.7. Inflation at the rate of 5 percent per annum has been assumed.

Component	*Rupee*	*US$*
1. Design/construction assistance	2,500,000	-
2. Commissioning assistance/trouble-shooting/monitoring	1,000,000	-
3. Experts/consultants	500,000	-
4. Overseas visit	400,000	10,000
5. Demonstration plant cost (factorial method)	64,000,000	-

4. Treatment of Vegetable Wastes/MSW

Sub-project M1: Treatment of Vegetable Wastes
Year of completion: 1994

Maharashtra Gandhi Smarak Nidhi (MGSN), a public service organization in Pune, runs a demonstration unit funded by MNES. This unit has an anaerobic digestion capacity of 1 tpd of vegetable market wastes, which it receives from the wholesale vegetable market of the Agricultural Produce Marketing Committee (APMC). The unit, which is based on a modified KVIC design, supplies the biogas to restaurants in the complex. Dr. M. V. Mapuskar, the driving force behind this project, has several similar achievements to his credit. MGSN has been working on extending the capacity of the plant to 10 tpd through the use of bi-phasic degradation, which would yield advantages in retention time. The module of MGSN, though based on conventional biomethanation processes, has proved its operability under Indian conditions. Extension of such designs could provide a basis for smaller and less sophisticated applications. A demonstration unit of 10 tpd capacity at Pune is proposed. It is understood that APMC in Nasik is also interested in a similar unit.

Cost estimate

The cost for the scheme is estimated on the basis of the cost of the existing unit, with additional costs for the mechanization required to increase capacity.

Component	*Rupee*	*US$*
1. Design/construction assistance	400,000	-
2. Commissioning assistance/trouble-shooting/monitoring	200,000	-
3. Experts/consultants	200,000	-
4. Demonstration unit cost		
• Digestors	2,800,000	-
• Conveying system	300,000	-
• Shredder	100,000	-
• Gas holder	100,000	-
• Piping and valves @ 15 % of equipment cost	500,000	-
• Civil @ 15 % of equipment cost	500,000	-
• Electric/instruments @ 10 % of equipment cost	330,000	-
• Contingency @ 10 % of equipment cost	370,000	-
Equipment cost total	5,000,000	

Sub-project M2: High-rate Treatment of Market Wastes
Year of completion: 1994

In conjunction with the demonstration scheme using KVIC technology for the biodegradation of market wastes, advanced technologies being used in the industrialized world are being considered for larger-scale applications. There are several sources for such technology, including the Ref-Com in U.S.A., Biotechnische Abfallverwertung in Germany, and Organic Waste Systems in Belgium. These units can treat vegetable wastes and MSW with short retention spans, making them cost-effective for larger plants. A demonstration unit of 30 tpd using this technology is proposed at the Agricultural Produce Marketing Committee (APMC) in Madras (Koyambedu), with technological support from the National Chemical Laboratory in Pune, and the Centre for Biotechnology Development in Madras.

Cost estimate

The cost estimate for the scheme is based on a conceptual flow diagram for the Ref-Com technology. Preliminary technology fees of US$ 500,000 for the complete treatment process are used in the calculations.

Component	*Rupee*	*US$*
1. Technology assessment/negotiations	450,000	11,000
2. Technology fees	-	500,000
3. Design/development-related costs		
• Design/construction assistance	400,000	-
• Commissioning assistance/trouble-shooting/monitoring	200,000	-
• Experts/consultants	200,000	-
4. Overseas visit		
• Overseas visit by Indian team	400,000	8,000
• Visits by overseas experts	200,000	10,000

5. Demonstration unit cost		
• Shredder	150,000	-
• CSTR reactors (2 - 70 m^3)	6,500,000	-
• Pumps and blowers	300,000	-
• Conveyers/handling equipment	100,000	-
• Gas holder	100,000	-
• Separation equipment	250,000	-
• Piping and valve @ 10 % of equipment cost	740,000	-
• Civil @ 10 % of equipment cost	740,000	-
• Instrument/electric @ 5 % of equipment cost	370,000	-
• Contingency @ 10 % of equipment cost	740,000	-
	9,990,000	

Sub-project M3: Large Demonstration of Vegetable/MS Wastes
Year of completion: 1997

A large-scale demonstration with the vegetable market wastes/putrescible portion of MSW will follow the successful trials for scheme M2. The scale of operation proposed is 150 tpd nominal. The project will be set up at APMC Delhi, using the same technology institutions as for sub-project M2. In view of the large size of the plant, provision has been made to provide a mechanical handling system.

Cost estimate

The factorial method has been used to estimate the cost of the 100 tpd demonstration unit, using an exponent value of 0.7. Since the unit will come on line only in 1997, an annual inflation rate of 5 percent (based on 1994 costs) has been included in the estimate.

Component	*Rupee*	*US$*
1. Design/construction assistance	2,500,000	-
2. Commissioning assistance/trouble-shooting/monitoring	500,000	-
3. Experts/consultants	400,000	-
4. Overseas visit	400,000	18,000
5. Demonstration unit cost (factorial method)	42,000,000	-

5. Biogas Utilization

Biogas schemes will utilize the biogas generated in suitable gas engines, with and without co-generation. The schemes will be undertaken in two phases:

Phase I: The projects undertaken by Western Paques to generate power using 2 MW dual fuel engines of Wartsila and Jensbacher will be evaluated (scheme B1). Rs. 200,000 (US$ 6,349) will be provided for this purpose. Provision has also been made for the evaluation of smaller engines that are locally available from Kirloskar-Cummins and Caterpillar. Three capacities will be demonstrated during 1994 to 1996; Rs. 12 million (US$ 380,952) has been allocated for capital costs for engines, and Rs. 400,000 (US$ 12,698) for monitoring and evaluation.

Phase II: Four other sizes of engines will be evaluated, based on the experience in phase I. These will be demonstrated, with and without co-generation, at suitable locations with biogas availability. Rs. 24 million (US$ 761,905) has been allocated for capital costs, and Rs. 600,000 (US$19,408) for monitoring and evaluation.

Annex 2

TIMEFRAME FOR IMPLEMENTATION OF DEMONSTRATION SCHEMES