FINAL REVIEW OF THE UNDP/GEF PROJECT IND/92/G32 *DEVELOPMENT OF HIGH-RATE BIOMETHANATION PROCESSES AS MEANS OF REDUCING GREENHOUSE GAS EMISSION*

FINAL VERSION
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LIST OF ABBREVIATIONS

APR-PIR	Annual Project Report – Project Implementation Report
BIMA	Biogas-induced mixing arrangement
BOD	Biological oxygen demand
CAG	Comptroller & Auditor General
CDM	Clean Development Mechanism of the Kyoto Protocol to UNFCCC
CLRI	Central Leather Research Institute
CMDA	Chennai Metropolitan Development Authority
CPPRI	Central Pulp and Paper Research Institute
CSTR	continuous stirred tank reactor
CH_4	methane
CO_2	carbon dioxide
GEF	Global Environment Facility
GHG	greenhouse gas
H_2S	hydrogen sulphide
HUSMAR	hybrid upflow sludge media anaerobic reactor
IISC	Indian Institute of Science
IREDA	Indian Renewable Energy Development Agency
IRR	internal rate of return
kWh	kilowatt-hour
NMP	National Master Plan for Development of Waste-to-Energy
MLD	million litres per day
MoEF	Ministry of Environment of Forests
MNES	Ministry of Non-Conventional Energy Sources
MSW	municipal solid waste
MW	megawatt
MWH	Montgomery Watson Harza
NBB	National Bio-energy Board
NEERI	National Environmental Engineering Research Institute
PEDA	Punjab Energy Development Agency
PMC	project management cell
RRL	Regional Research Laboratory
Rs.	Indian rupee
TEDA	Tamil Nadu Energy Development Agency
TPD	tonnes per day
TNPL	Tamil Nadu Newsprints & Paper Limited
UASB	upflow anaerobic sludge blanket
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	UN Industrial Development Organization
UNDP	UN Development Programme
US$	US dollar
WTE	waste-to-energy

Exchange rates used:
US$ 1 = Rs. 31.5 (1992)
US$ 1 = Rs. 45.5 (01/06/2004)
€ 1 = US$ 1.2185 (01/06/2004)

1 lakh = 100,000
1 crore = 10 million

EXECUTIVE SUMMARY

Methane (CH_4) is one of the important greenhouse gases causing global climate change. Large quantities of organic wastes from agricultural, municipal, industrial and food processing resources are generated in India and safe disposal is a major problem. Using high rate biomethanation processes to treat the organic waste will result in production of low-cost methane, which can be used for energy purposes.

This is the terminal Evaluation Report of the project *Developing High-Rate Biomethanation Processes as Means to Reduce Greenhouse Gas Emission* (project number IND/92/G32. It was prepared by Mr. Jan van den Akker and Mr. Vinay Deodhar. It is based upon review of the documentation developed under the project and interviews with staff of the multilateral agencies involved (UN Development Programme, UNDP and, the Indian project management (Ministry of Non-Conventional Energy Resources) and the implementing agencies of selected demonstration subprojects. The project has been funded by the Global Environment Facility (GEF), the Government of India and third-party investors with a total budget of USD 22 million. The main objective has been the reduction of methane emission by demonstrating and developing the capabilities in India to effectively capture methane-containing biogas from various sources of organic waste, such as pulp and paper, leather industry, slaughterhouses, vegetable waste, agro-processing waste and municipal sewage.

The project document was signed in 1992 and implementation started in 1994. The UNDP-GEF contribution was US$ 5.5 million and the Union Ministry of Non-conventional Energy Sources (MNES) has been the implementing agency for this project. The project has had five broad outputs: (i) national strategy for bio-energy development from various wastes; (ii) demonstrating a range of technically proven technologies for treating various wastes in 16 demonstration subprojects; and (iii) well-developed human resource capabilities in technology development and commercialization and a network of institutional and professional contacts in biomethanation and related waste management areas.

According to GEF regulations, an independent review is needed at the end of a project to assess the project implementation, project performance, the impacts and relevance of the project as well as lessons, if any, to be learned. To this end, a comprehensive Terms of Reference was drawn up and an evaluation mission was fielded to India in October 2005. This report is the outcome of this evaluation study. As part of the study, field visits were made to relevant organisations in Delhi and Mumbai and to some of the demonstration subprojects in Chennai, Salem, Karur, Surat, Dewas and Ludhiana. In addition, discussions were held with several key stakeholders, and a large amount of secondary literature and documents was gathered. The first part of the report of the evaluation team concerns the findings regarding project design and execution as well as results and impacts, and the second part presents the conclusions and recommendations.

Key accomplishments of the project have been:

- MNES is also implementing a National Programme on Energy Recovery from Urban and Industrial Wastes since 1995. The programme aims at promotion, development demonstration dissemination and adoption of environment friendly all conversion technologies for both liquid and solid wastes. The programme offers financial support for

enabling activities and investment incentives. A major thrust was given by this Project through awareness creation and by creating opportunities for undertaking several commercial scale plants on similar wastes.. A National Master Plan (NMP) for Waste-to-Energy has recently been finalised which is being used by MNES in their policy formulation regarding waste management and methane gas recovery. MNES has now formulated incentive schemes for projects on energy recovery from urban and industrial waste for the period 2005-06 that include incentives, such as a capital subsidy.

- Of the 16 subprojects, 2 studies have been carried out and out of the 14 technology demonstration projects, 13 have been completed (with 50% of the investment cost of project as support from MNES whereas 75% contribution was provided for projects based on vegetable market wastes and the balance coming from the beneficiaries). In the subprojects, a broad range of technologies have been applied, from indigenously available to imported technology, focussing on various substrates (waste from paper and pulp, leather, abattoir and agro-processing industries, as well as waste from vegetable markets and municipal sewage systems) and working with different target groups (municipalities, small industry and large industry). In terms of financial viability, some subprojects have shown to be commercial viable, while other could not have been realised without the 50% capital cost subsidy. In general the investment costs have been high, especially where the imported equipment content was high, but this ca be expected in pilot projects. In this sense, the importance of the Biomethanation project has been not only to demonstrate that biomethanation technology works, but that various cost reduction opportunities exist in indigenisation of technology and by looking carefully at the cost-effectiveness of the end use of the biogas, e.g. using biogas on-site as heat saves in investment in relatively expensive gas engine and gas cleaning equipment,
- Some 46 business meetings and workshops were organized with stakeholders from the different waste generating sectors and 9 national training programs; 71 professionals were deputed in 12 fellowship training programmes and 15 study tours were organised for 43 officials of government institutions and organisations. The project has facilitated interaction between project developers (municipalities, industry), technology institutions, national laboratories and state nodal energy agencies; although the evaluation team noticed that this institutional interaction differed from subproject to subproject. A quarterly newsletter, “Bio-Energy News”, is brought out under the aegis of this project. In short, the evaluators have the opinion that the project has had a noticeable impact regarding awareness amongst the industrial sectors that generate biodegradable waste.
- The project has had positive environmental impacts. The estimated direct annual greenhouse gas emission reduction from the 13 demonstration subprojects is an estimated 244,000 tCO_2e per year.

Regarding project execution, the evaluation team has the following major observation. This is a well-conceived and well-designed project addressing all the important areas of challenge as far as development of biomethanation sector is concerned. Nonetheless, the project document as such seems to have been hastily drafted, leaving uncertainties regarding the project institutional setup and the ‘wait-and-see approach’ of the prospected beneficiaries caused much delay in the first years. More time was apparently needed to convince private sector partners and municipalities alike to invest in technologies, such as biomethanation, that were considered mature at the time and that had not been demonstrated yet. However, once these hurdles were taken the project has been implemented in such a way that most of the envisaged results have been achieved.

Important recommendations coming out of this evaluation study are:

- Large and complex programmes require much more preparation time so that implementation modalities are clearly defined, budget resources are adequately defined. Furthemore, the time and efforts needed to involve private sector and other stakeholders to have their 'ownership' should not be underestimated. It also important that a sound monitoring and evaluation framework is formulated to be able to assess the project's outputs and impacts in a quantitative and comprehensive way.
- Biomethanation can make a significant contribution to the Government's targets of reducing greenhouse gas emissions and to have 12,000 MW of power capacity through renewable energy sources by the year 2012. However, to realise this, it is necessary to continue with creating awareness and build sector capacities and to publicise success stories and the potential of biomethanation under the Clean Development Mechanism. MNES should continue to allocate resources for such capacity building and information dissemination
- The National Bioenergy Board (NBB) was created as coordinating policy-making body, but in practice has functioned more as project monitoring committee for the UNDP/GEF Biomethanation project with MNES. Given the importance of bioenergy and the involvement of various government departments (planning, finance, energy, urban development, technology, agriculture, etc.), it should be considered to continue NBB in a coordinating role as to bring cohesiveness in the bioenergy-relevant programmes operated by the various ministries and departments.
- While the efforts of MNES to subsidise investments in biomethanation are laudable in the sense that its shows the Government's driven ness, in the longer run subvention will not be financially sustainable. The NMP suggests that subsidies will decline over time. The evaluators suggest also that difference should be made between sectors and type of waste and that the financial strength and resources of the project proponent should be taken into consideration. In any case, the MNES programme should begin to focus on involving the financial sector so that subsidy can be gradually replaced over time by credit lines from the commercial banking system.

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1. INTRODUCTION

1.1 Background

(Number 2.1 and 2.2 of Sample Outline (Annex 3) of the ToR given in Annex A)

Methane (CH_4) is a prominent greenhouse gas (GHG) along with carbon dioxide (CO_2) and chlorofluorocarbons (CFC), responsible for climate change phenomena. Methane emissions are caused by energy related activities (e.g. burning of traditional biomass); agricultural activities (e.g. rice cultivation, enteric fermentation); and anaerobic degradation of organic materials (e.g. solid waste disposal). Although the volume of methane (CH_4) contribution to the world's greenhouse gas (GHG) emissions is three times smaller than that of carbon dioxide, at the same time, methane is a particularly strong GHG, its global warming potential (GWP) is 21 times that of carbon dioxide CO_2. Methane emissions from waste are reported to be contributing about 31% of the total methane emissions in India.

India generates large quantities of wastes from the agricultural, municipal, industrial and food processing sectors. Much of these wastes find their way into the environment with little or no treatment which results in their biodegradation with consequent release of methane into the atmosphere. In addition, untreated waste disposal creates serious health and sanitation problems. Waste treatment technologies such as aeration, are highly energy intensive, directly and indirectly contributing to GHG emissions.

The production of biogas under controlled conditions is often referred to as biomethanation and also called anaerobic digestion. Biomethanation (BM) may have relevance in treating wastes from a number of sectors, including (and not restricted to) solid waste management, sewage waste water treatment and treatment of industrial wastewater (from tannery, animal manure, slaughterhouses, sugar, starch and other industries). Containing methane, the biogas produced is a potentially valuable energy resource. Methane forms a remarkably clean fuel when burnt, the combustion process of methane produces no particulates and only about half of the carbon dioxide associated with coal combustion. If not captured, the gas as valuable resource is not only lost, being a greenhouse gas, it contributes to the global warming. Biomethanation projects usually have a number of other environmental benefits. For example, the anaerobic process destroys many pathogens that are usually present in human and animal waste and manure, while the slurry that remains is nutrient-rich and can be treated further and used as fertiliser. The anaerobic treatment of the biomass in the waste and wastewater of alcohol distilleries yields nutrient-rich slurry and the water can be re-used for irrigation, while avoiding the disposal of the biomass waste into rivers and streams, which can create serious pollution problems. In general, biomethanation of urban waste reduces the amount of waste that would otherwise have ended up in landfills or incineration plants or worse, in open dumps, rivers and streams.

Biogas has range of potential energy end uses**.** Direct on-site use offers good opportunities. It requires that a suitable user already exists on the site that needs the fuel for boilers to produce steam for process and space heating or power generation. This direct use requires minimal treatment of the gas. A further treatment to remove corrosive constituents of the gas yields a medium-grade fuel, which can be used in industrial boilers, dryers, kilns or furnaces or in boilers and turbines to generate electricity (to be used on-site or sold the power grid). The production of a high-grade fuel requires the separation of methane from the gases that have no heating value, i.e., of carbon dioxide (which also causes corrosion when combined with water) and of trace gases, as well as the removal of moisture and particulates.

1.2 Project description and objectives

(*Number 3.1, 3.2 and 3.3 of Sample Outline (Annex 3) of the ToR given in Annex A*)

Indian energy demand is largely met by coal and other fossil fuels in the urban, industrial and transport sectors, and by biomass fuels in the rural areas. Continuing dependence on this energy mix to meet the ever-increasing energy demands of a rapidly growing economy is likely to lead to high GHG emissions. The UNDP/GEF project is significant in this context as it was designed to demonstrate the potential of biomethanation to contribute to the augmentation of sustainable energy supply by exploiting the vast resource of 'organic waste' from different sectors.

The UNDP/GEF biomethanation technical assistance project was approved in March 1994 and commissioned in September 1994 with an envisaged duration of 5 years. Due to a number of reasons activities relating to capacity building and awareness could progress satisfactorily while only two projects (at RRL, Bhubaneswhar and at M/s Sethia Paper Mills Ltd., Muktsar, Punjab) became operational until 1997. The remaining projects were in the planning stage only – identification of sites/ beneficiary organizations, preparation of DPRs and tender documents and selection of technology etc. The project schedule was revised on a number of occasions and project activities and the project was not operationally closed until September 2005. The development objective of this project is "to enable India to make its contributions in protecting the global and local environment by developing aggressive plans to gainfully utilize the wastes generated in municipal, industrial and agricultural sectors for energy recovery".

The emphasis of the project is put on *four objectives*:

1. Developing a National Master Plan (NMP) for the generation and utilisation of biogas based on high-rate biomethanation processes
2. Setting up 16 demonstration subprojects
3. Capacity building of organisations at national and State level
4. Promotion of dissemination of the idea of biomethanation technology and biogas utilisation through national and local level seminars

The project, with a total of US$ 22 million, has three budget components:

- GEF US$ 5.5 million
- Government US$ 5.5 million
- Private sector: US$ 11 million

1.3 Evaluation methodology and structure of the report

(*Number 2.3 and 2.4 of Sample Outline (Annex 3) of the ToR given in Annex A*)
(*Item K in the Scope of the Evaluation of the ToR*)

The project work started in early 1995, but faced some time constraints due to delay in the initiation of the targeted 16 demonstration subprojects and other reasons that will be detailed in the next chapter. In order to evaluate the progress made and to make recommendations for future action, an external review of the project's design, implementation and its relevance for biomethanation development in India, a Mid-Term Evaluation was carried out in 2000. In accordance with UNDP and GEF a regulation, a Terminal Evaluation has to be carried out under the responsibility of the implementing agency, in this case the United Nations Development Programme (UNDP) of which the results are presented in this report.

During the mission, the external evaluation mission drew up a table of contents (ToC) that covers the issues to be addressed as mentioned in its Terms of Reference (see Annex A) and follows the structure of this report:

- Introduction (project description and evaluation method)
- Findings on project progress
  - Implementation in terms of achieving objectives, inputs, activities, outputs, and impact and measurement against indicators (as set in the project document and the annual project review documents)
  - Description of project impacts
  - Evaluation team's assessment of project objectives, results and impact
- Conclusions and recommendations
  - Conclusions taken into account sustainability and replicability issues
  - Lessons learned and recommendations

A mission team, consisting of two independent evaluators, Mr. J. van den Akker and Mr. V. Deodhar was fielded to India 8-25 October 2005. During the mission's 16-day travel extensive discussions were held with representatives from UNDP India, the national counterpart Ministry of Non-Conventional Energy Sources (MNES, New Delhi), MWH (Mumbai) and from selected demonstration subprojects in Chennai, Salem and Karur (Tamil Nadu), Surat (Gujarat), Dewas (Madhya Pradesh) and Ludhiana (Punjab). An in-depth analysis was made of relevant documents (APR-PIR[1], mid-term evaluation report, budget revision sheets, project papers and consultant reports), and, where appropriate, requests for missing information were made.

The consultants have adopted the following methodology of evaluation:

i) Review of reports and documentation
   a. Project Document (1992)
   b. Mid-term Project Evaluation Report (2000)
   c. MNES website text on the Project
   d. Review of India High Rate Biomethanation Process (2004, by PriceWaterhouseCoopers)
   e. Analysis and Evaluation of CDM Prospects for Biomethanation Projects (2004, by IT Power India)
   f. CDM and Biomethanation (2003, by Winrock International India)
   g. Annual Project Reports (APR-PIR, 2001, 2002, 2003, 2004, 2005)
   h. Green Energy From Wastes (2005, MNES)
   i. National Master Plan of Waste-to-Energy in India (by MWH)
   j. UNFCCC guidelines on estimation of GHG reductions, such as the CDM Approved Methodology AM0012
   k. Miscellaneous sources, such as Methanetomarket.org, etc.

ii) Interviews with UNDP and MNES (PMC) Officers and discussions with the promoters, using a structured questionnaire

iii) Visits to six sub-projects and the agency for National Master Plan preparation

iv) Study of policy documents and general information regarding industrial and urban waste management

The report is divided into three sections. This first section provides general background of the project, purpose of evaluation, project implementation set up, partners/stakeholders and evaluation methodology. The next section dwells on findings from the reports, field visits,

[1] APR-PIR: Annual Project Report – Project Implementation Report (for UNDP-GEF projects)

interactions and responses to the questionnaire, observations during the field visits. These findings are described in the overall framework of the project. It also briefly describes the GHG mitigation potential of the projects. In the third section, Conclusions from the observations and findings are discussed in the context of project objectives. These also pertain to sustainability and replicability of project and lessons learnt. The section also provides project specific and generic recommendations, future directions and CDM potential for the sector. Additional information is provided in the Annexes.

1.4 Project set-up and project partners

(Number 3.4 and 5.3 of Sample Outline (Annex 3) of the ToR given in Annex A)
(Item F.6 in Scope of the Evaluation of the ToR)

The project is one of the initiatives to mainstream the efforts of management of waste especially, biodegradable solid and liquid waste. The management and control of these at the government level is the primary responsibility of ministries of environment and forests, and urban development. In order to make a better use of these and to recover a part of the energy contents of these substrates, energy recovery is the main intent of the project. In order to ensure a better coordination among the above, the Ministry of Non-Conventional Energy Sources (MNES) was made the implementing Ministry. The views of the other stakeholders mentioned above are taken in account through the National Bio-energy Board (NBB) specially constituted to make policies and procedures for implementation of the project. NBB is the apex body which provides policy guidelines for development of a national strategy for bio-energy and oversees implementation of the project. NBB has representatives of the following Government ministries and departments:

- Ministry of Non-Conventional Energy Sources (MNES)
- Ministry of Environment & Forests
- Ministry of Urban Development & Employment
- Department of Bio technology
- Department of Economic Affairs,
- Ministry of Finance
- Department of Science & Technology
- Department of Scientific & Industrial Research
- Planning Commission and
- UNDP

A Project Management Cell (PMC) was created in MNES for assisting NBB in implementation of the project. The PMC was headed by the Adviser (Urban, Industrial and Commercial Applications Group) as the National Project Director and assisted by Director and Scientific Officers. In addition, few Technology Institutions have been associated with NBB for providing assistance in technology related matters. Powers of executing various implementation activities are vested with the National Project Director (NPD) with due concurrence of NBB and relevant officials. Financial management for the project was entrusted to IREDA, which received a handling fee for this from the Government's rupee budget of the project. The funds were released by UNDP directly to IREDA on receipt of request for advance from the project authority in the Ministry. MNES also channelled its counterpart funds through budgetary allocation to IREDA. Payments to clients/beneficiaries were released by IREDA on the basis of Payment Release Advice of PMC. Regular auditing of funds was carried out by UNDP and the Comptroller and Auditor-General (CAG) of India.

2. FINDINGS

2.1 Implementation: outputs, activities and accomplishments

(*Number 3.5 and 6.1 of Sample Outline (Annex 3) of the ToR given in Annex A*)

For each of the four project objectives, as mentioned in paragraph 1.2, this section assesses the project's performance and implementation of the project, in terms of achieved outputs, and activities finalized.

It should be noted that the structure regarding project performance (in terms of objectives, outcomes and indicators) in the Annual Project Reports (APR-PIR) of the period 2001-2005 does not follow the same order as the original project document (in terms of objectives outputs and activities). The description in this paragraph tries to relate the two by giving indicators (of APR-PIR) and activities (as given in the project document) per outcome as given in the APR-PIR (termed objective in the original project document)

Outcome 1 To develop a National Master Plan (MNP) for generation and utilisation of bioenergy based on high-rate biomethanation processes

Indicators (as given in the Annual Project Reports, APR-PIR)	*Output 1.1 National Master Plan for bioenergy generation* *Activities (as given in the original 1992 document)*
Preparation of background materials: 1.1 Assessment of available data, plan and work completed 1.2 Analysis of various technological options for bio-energy development with reference to the substrates available in the country 1.3 Identification of proven biomethanation technologies, status of field-testing and standardization, techno-economic feasibility, environmental implications,	1.1.1 Establish National Bioenergy Board 1.1.2 Identify experts and consultants 1.1.3 Compile information on the inventory of wastes and biodegradable materials 1.1.4 Identify and evaluate technologies available in India and abroad 2.1.4 Identify and assess indigenous technology suitable for the demonstration units 1.1.5 Review and assess the current programmes in the various national laboratories, R&D institutions and other agencies
Preparation and approval of NMP: 1.4 Possible avenues for technology transfer and replication in the country 1.5 Evolving involvement strategy and shelf of investment proposals 1.6 Evolving national strategy in the field of waste to energy	2.1.1 Constitute NBB 1.1.6 Prepare National Master Plan and investment proposals 1.1.7 Enable the Government of India (GoI) to develop a national strategy for the energy sector taking biomethanation into account 1.1.8 Review legal and policy framework on environment to facilitate adoption of biomethanation processes
	Output 3.2 Improved programme on the use of biomethanation technology

	3.2.1 Develop work plan for promoting the use of biomethanation 3.2.2 Develop formal schemes for biogas generation 3.2.3 Assess sectoral needs 3.2.4 Devise suitable financial schemes

Indicator 1.1

The first two-and-a-half years were spent in developing partnership with various stake-holders, identifying sites for demonstration sub-projects and in developing institutional mechanism for implementation of the Project. This is one of the reasons for the delay in the initiation of project activities (which will be elaborated in more detail in paragraph 2.3.4) The NBB was set up, providing policy guidelines for development of a national strategy for bio-energy and overseeing implementation of this Project (see paragraph 1.4). However, instead of functioning as a policy-making body, the NBB has acted mostly as a Project Monitoring Committee for the UNDP-GEF project (see also paragraph 3.2).

Indicator 1.2, 1.3 and 1.4

Before the work on preparation of National Master Plan for waste-to-energy was started, a few activities were undertaken to prepare background material through following activities:

- Feasibility studies of 30 sample Class I cities and five industry sectors
- State-of-the-Art report on biomethanation of Pulp & Paper Industry effluents
- A directory on "Waste to Energy" in India.
- Evaluation of various technologies commercially available worldwide for implementation in the various subprojects.

MNES launched a National Program on Energy Recovery from municipal and industrial waste in June 1995. M/s Montgomery Watson Harza (MWH, a subsidiary of a US company, based in Mumbai) was selected (on the basis of a global bidding process) and awarded the contract for preparation of the NMP during January 2001.

The following reports and activities were undertaken by MWM during 2001 to2005 as a part of the preparation of NMP:

1. Structured database on industrial an municipal waste (accessible through the website www.indiawteplan.com)
2. Assessment of current R&D in waste-to-energy (WTE)
3. Identification and evaluation of WTE technology options
4. Development and prioritization of projects
5. Identification of technology transfer mechanisms
6. Developing investment and funding strategies
7. Study of government infrastructure and suggested changes

Based on the seven reports, the main document on National Master Plan has been finalized. A strategic action plan (road map) for the period from 2005 to 2017 for exploitation of total estimated potential of 2600 MW is also a part of the final document on NMP.

Three stakeholders' workshops for pooling of resources and for sharing the outcome of various activities were organized, the first one in June 2000, a second in July 2001 and a third one in April 2004. The above-mentioned draft reports were modified in accordance with the feedback given by the Project Team and the feedback obtained at these workshops.

The draft NMP was put on the project website: (www.indiawteplan.com), after incorporating the suggestions that emerged from the third stakeholders' workshop, for seeking comments of all the stakeholders before its finalization. A presentation on the outcome of NMP was also made by the consultant before the members of NBB in its meeting held on 16th July, 2004. Being based on the 1991 census, the final NMP document is now being further updated by incorporating a few modifications and additions based on the new census data of 200. The evaluation team has been informed by the PMC officials that the NMP would be ready by November 2005.

Outcome 2 To develop commercially viable technology packages ready for replication

Indicators (as given in the Annual Project Reports, APR-PIR)	*Output 2.1 Setting up of demonstration subprojects in seven subsectors* *Activities (as given in the original 1992 document)*
2.1 Setting up of 16 demonstration subprojects (including two evaluation studies) in seven waste sectors based on indigenous or imported technology 2.2 Absorption, modification and standardization of the cost effective technologies, preparation of technology packages for replication	2.1.2 Work out details of the various subprojects 2.1.3 Identify and induct the services of suitable consultants 2.15 Activate the setting up of demonstration subprojects 2.1.6 Monitor demonstration units through regular assessment of performance and cost data 2.17 Evaluate and report the success of the demonstration subprojects 2.1.8 Prepare a final document containing technical details

Indicator 2.1

A total of 16 demonstration projects were to be set up in various sectors that produce biodegradable waste. At the time of project formulation a list of possible projects was prepared for this purpose (Annex B). However, many of these projects could not be taken up due to a number of reasons such as the ill-preparedness and wait-and-see approach of many beneficiaries and the inability or reluctance of beneficiary organizations to commit 50% of the project cost. Mid-way through the project, however, it was decided to increase the number of demonstration projects to 29. Then after a thorough review, it was decided to limit the projects to the original number of 16.

Out of 16 sub-projects to be taken up under this Project, thirteen sub-projects have already been completed. Two projects involve assessment of technologies and equipment for biogas use. The remaining one sub-project based on slaughterhouse solid waste is currently under advance stages of completion and is expected to be fully commissioned by end of March 2006. The vegetable market wastes project at Jalandhar, planned initially, was dropped due to delay in selection of the turnkey contractor. It is understood that a project with capacity of 5 tonnes per day of segregated municipal solid waste (MSW), based on the biomethanation technology developed by Bhabha Atomic Research Centre (BARC) has recently replaced this cancelled project .

The following table 1 provides an overview of the 16 subprojects.

Table 1 Characteristics and basic data of the 16 biomethanation subprojects

	Project/Sector	Total Project Cost and NBB, UNDP/GEF & Beneficiary Contributions	Current Status
	PULP & PAPER INDUSTRY EFFLUENT		
1.	Evaluation of Pilot Biomethanation Reactor for treatment of Pulp & Paper Mills Effluent at M/s Satia Paper Mills, Muktsar, Punjab.	---	Completed
2.	Large Scale Paper Mills Effluent Treatment Plant using Rice Straw & Reed as Raw Materials at Satia Paper Mills, Muktsar, Punjab Organisation: pulp & paper industry Supporting technology institution: CPPRI (Saharanpur)	Project Cost : Rs 224.00 lakh NBB Share : Rs 112.00 lakh UNDP Share : --- Beneficiary Share: Rs 112.00 lakh Capital cost was Rs. 22.4 million. Recurring expenditures: Rs. 13.27 million /yr and fuel savings of Rs. 14 million/yr. IRR: 4-5 years (1.5-2 with the 50% subsidy. Estimated 29,950 tCO_2 reduction per year Comment: This subproject has successfully demonstrated that black liquor from paper mills based on rice straw and other similar biomass can be treated through biomethanation and it also provides a financially attractive means of achieving the discharge standards for the effluents from a paper mill. There are some 525 pulp and paper mills in India.	Commissioned in May 1997 and now completed and functioning satisfactorily. Up to 11,000 m^3 of biogas per day is being produced by treatment of 4000 m^3/day effluents (black liquor). The gas is used in the boiler as fuel, replacing about 22 tonnes of rice husks that are currently used as fuel. The process technology used is UASB (upflow anaerobic sludge blanket) and was provided by: M/s Western Paques, Pune, licensee of Paque, Netherlands
3.	Large Scale Paper Mills Effluent Treatment Plant using sugarcane bagasse as Raw Material at Tamil Nadu News Print and Papers Ltd (TNPL)., Karur. Organisation: pulp & paper industry Supporting technology institution: R&D Division of TNPL	Project Cost : Rs 384.14 lakh NBB Share : Rs 192.07 lakh UNDP Share : --- Beneficiary Share: Rs. 192.07 lakh Net annual savings = fuel savings (Rs. 92,000/day) - operational expenditure (Rs. 35,000/yr) = Rs. 188 lakh/yr. Estimated 46,800 tCO_2 reduction per year (45,400 from methane emission avoidance and 1,400 due to furnace oil savings) Comment: According to TNPL the project has been financially attractive and TNPL is planning to develop other biomethanation projects as CDM activity	Commissioned in April 2003 and operating satisfactorily Capacity: 12000 m^3/day Gas Prod: 14000-17000 m^3/day, which is being used on-site in the line mud burning kiln (meeting 50% of the heat load of the kiln, which is approximately replacing 12000 - 13000 litres of fuel oil. Process/technology: UASB (upflow anaerobic sludge blanket). Technology supplier: by M/s. GENL, Pune (licensee of Paques, Netherlands)

	LEATHER & ABATTOIR INDUSTRY WASTE		
4.	Large Scale Leather Solid Wastes / Abattoir Wastes Treatment Plant at Hind Agro Industries Ltd. (HAIL), Aligarh, U.P. Organisation: slaughterhouse Supporting technology institution: CLRI, Chennai	Project Cost : Rs 325.00 lakh + USD 656,000 NBB Share : Rs 162.50 lakh UNDP Share : USD 328,000 Beneficiary Share: Rs. 162.50 lakh + USD 328,000 Estimated 14,850 tCO_2 reduction annually	Was expected to be commissioned by December 2005 (Completion of this project has been delayed due to delay in completion of civil work of the anaerobic digester) and in supply of imported equipment) Gas Prod: 4500-5000 m^3/day per day for 0.5 MW power from about 50 TPD solid wastes
5.	Treatment of Fleshings from Tanneries and Sludge from Tannery Effluent Treatment Plant at Visharam Tanners Enviro Control Systems (VISHTEC), Mehlvisharam, Tamilnadu Organisation: company formed by local tanners Supporting technology institution: CLRI, Chennai	Project Cost : Rs 157.96 lakh NBB Share : Rs 67.47 lakh UNDP Share : Rs 27.30 lakh UNIDO Share : Rs. 27.64 lakh LTM/CLRI Share: Rs. 27.64 lakh Beneficiary Share: Rs. 7.90 lakh The plants provides savings of Rs 2 lakh/yr on their electricity bill Estimated 1,115 tCO_2 benefits Comment: the subproject has been set up for Tanners Cooperatives at Melvisharam, Tamil Nadu in collaboration with United Nations Industrial Development Organisation, Regional Programme for Pollution Control (UNIDO) RePo, Chennai, Leather Technology Mission (LTM), Govt. of India and Central Leather Research Institute (CLRI), Chennai.	Commissioned in November 2001 The plant handles 5 tonnes per day (TPD) of solid organic waste from the tanneries and can generate 320 m^3/day. The gas is being used for generation of power in a 63 kWh duel fuel engine. Technology/process: CSTR (continuously stirred tank reactor) and indigenous dual-fuel engine Technology provider: CTC (France) A study was carried by CLRI to implement certain modifications and de-bottlenecking for optimization of various processes and design parameters for maximizing energy recovery. This has also helped CLRI in standardization of technology package for subsequent replication.
6.	Leather Solids (Chrome Shavings) Treatment Plant at Tata International Ltd. (TIL), Dewas, Madhya Pradesh Organisation: tannery Supporting technology institution: CLRI, Chennai	Project Cost : Rs 86.50 lakh NBB Share : Rs 43.25 lakh UNDP Share : -- Beneficiary Share: Rs. 43.25 lakh Energy savings: Rs. 15.5 lakh per year and chrome recovery of Rs. 4.5 lakh/yr. Total savings of Rs. 20 lakh/yr. Estimated 987 tCO_2 reduction benefits annually Comment: TIL plans to expand its biomethanation activities as the technology is considered very profitable	Commissioned in September 2002. Capacity: 2 TPD of chrome-containing leather solid waste Gas Prod: 320 m^3/day and is being used as cooking fuel in TIL's canteen, replacing LPG Technology/process: indigenously modified UASB. The contract for construction was awarded to M/s. Mailhem Engineers Pvt (Pune). The Project consist of: (a) Pre-treatment of leather solid waste for removal / precipitation of chrome, (b) Biomethanation of the remaining gelatine slurry, (c) utilisation of biogas in the existing duel fuel boiler and (d) Recovery of chrome from the chrome sludge.

7.	Large Scale Leather Solid Waste/Abattoir Waste Treatment Plant at Al Kabeer Exports Ltd. (AKEL), Rudram, Medak, Andhra Pradesh Organisation: slaughterhouse Supporting technology institution: CLRI, Chennai	Project Cost : Rs 310.56 lakh + USD 173760 NBB Share : Rs 149.52 lakh UNDP Share : Rs. 5.76 lakh + USD 86880 Beneficiary Share: Rs. 155.28 lakh + USD 86680 Estimated 7,140 tCO_2 reduction per year Comment: The successful adoption of this innovative technology has encouraged M/s Al-Kabeer to set up one more biogas plant for the treatment of solid wastes, which is based on a state-of-the-art technology obtained from Austria. These biomethanation installations have shown the way to solve the problem of waste treatment and disposal in environmentally benign manner, which also appears to be financially profitable.	Commissioned in November 2001 Capacity: 60 TPD Gas Prod: 3500-4500 m^3/day of biogas having a methane content of about 65%. from solid waste resulting from slaughtering buffaloes and sheep. The gas replaces about 420 klitres of furnace oil per year for steam generation (annual saving Rs. 30 lakhs) and saves on chemicals (Rs. 30 lakh) The process/technology is BIMA (biogas-induced mixing arrangement). Technology supplier: M/s. Enkem Engineers Pvt. Ltd, Chennai, licensee of ENTEC, Austria
	VEGETABLE MARKET YARD WASTE		
8.	Vegetable Market Waste Treatment Plant at Market Committee, Jalandhar, Punjab	---	Capacity: 15 TPD Dropped due to delay in finalization of award of contract. According to MNES, this has been replaced by the Bhabha Atomic Research Centre (BARC) plant in Mumbai, which produces 5 TPD of municipal solid waste.
9.	Mixed Solid Waste Treatment Plant at Vijayawada Municipal Corporation (VMC) Vijayawada, Andhra Pradesh Organisation: Municipal Authority Supporting technology institution: CLRI, Chennai	Project Cost : Rs 303.45 lakh NBB Share : Rs 151.725 lakh UNDP Share : Rs. 75.862 lakh Beneficiary Share: Rs. 75.862 lakh. Revenue generated from biogas is about Rs. 14 lakh/yr Estimated 5,165 tCO_2 reduction benefits annually	Commissioned in February 2004. Capacity: 20 TPD of mixed waste (16 vegetable market and 4 tonnes of slaughterhouse waste). Gas production: 1615 m^3/day and 5 tonnes of organic manure. Biogas is used in 145 kW imported biogas engine and the electricity generated is sold to the state grid. Technology/process: modified UASB. Turn-key contract provided to M/s. Mailhem Engineers Pvt. Ltd. (Pune). Gas engine supplied by M/s. Cogen (India), licensee of M/s. Jenbacher (Austria)
10.	Vegetable Market Waste Treatment Plant at CMDA, Chennai Organisation: Municipal	Project Cost : Rs 325.00 lakh + USD 320000 NBB Share : Rs 250.53 lakh UNDP Share : Rs 13.47 lakh + USD 240000 CMDA Share : Rs. 61.00 lakh	Commissioned in April 2005 and operation started in August 2005. Capacity: 30 TPD of vegetable market waste.

	Authority Supporting technology institution: CLRI, Chennai	+ USD 80000 Comment: since the project is in its start-up phase it is too early to make cost-benefit estimates. Estimated 9,633 tCO_2 reduction benefits annually	Biogas generation of 2500 m^3/day and 9-10 tonnes of organic manure. The gas is used in a 230 kW imported engine and sold to the grid Technology/process: BIMA (biomass-induced mixing arrangement) with biogas engine imported from M/s Deutz, Germany.
	MUNICIPAL WASTEWATER/ SEWAGE		
11.	Small Community Sewage Treatment Plant at the Regional Research Laboratory (RRL), Bhubaneswar Organisation: research Supporting technology institution: Regional Research Laboratory (CSIR, Lab) Bhubaneshwar	Project Cost : Rs 23.41 lakh NBB Share : Rs 11.70 lakh UNDP Share : -- Beneficiary Share: - RRL : Rs. 8.60 lakh (35%) H&UD : Rs. 3.40 lakh (15%) (State Govt.) Estimated 113 tCO_2 emission reduction per year Comment: The installation of the plant has demonstrated a new and effective means of decentralized treatment of sewage with recovery of energy in the form of biogas	Subproject commissioned in 1997 and full capacity utilisation since June 1998. The produced gas is used in the canteen and /or lighting the area around the plant. Capacity: 400 m^3/day (=.4 MLD) of treatment of sewage Gas Prod: 25 m^3/day which is used as fuel in the canteen or flared Technology/process: anaerobic fixed-film reactor (FFR), indigenously developed at National Environmental Engineering Research Institute (NEERI), Nagpur
12.	Installation and Evaluation of Biogas Engines at Anjana Sewage Treatment Plant, Surat Municipal Corporation, Surat. Organisation: Municipal Authority Supporting technology institution: Sardar Vallabhhai National Institute of Technology, Surat	Project Cost : Rs 160.96 lakh + Euro 209,550 NBB Share : Rs 80.98 lakh UNDP Share : Euro 104,775 Beneficiary Share: Rs. 80.98 lakh + Euro 104775 Estimated 17,050 tCO_2 emission reduction per year	Commissioned in March 2004 and subcontracted to M/s, Chemtrols Ltd (Mumbai). The plant has three sludge digesters for total treatment capacity of 82 MLD and generates about 100-120 m^3 per hour of biogas from each digester (4500 m^3/day). The 0.5 MW engine imported from M/s Gauscor, Spain) generates electricity for the treatment plant's power requirements., resulting in net energy generation of 7700 kWh/day and corresponding savings of Rs. 10 lakh/month
	BIOGAS UTILISATION		
13.	Evaluation of biogas engines	---	An evaluation of biogas engines of 540 KW (3 engines of 180 KW each) and four dual fuel engines of 450 KW each for power generation based on biogas generated from two Sewage Treatment Plants installed at Kanpur and Varanasi by IISc, Bangalore.

12.	Installation and Evaluation of Biogas Engines at Ugar Sugar Mills, Dist. Belgaum, Karnataka Organisation: Sugar Industry	Project Cost : Rs 139.94 lakh NBB Share : Rs 39.97 lakh UNDP Share : Rs. 30.00 lakh Beneficiary Share: Rs. 69.97 lakh Estimated 46,810 tCO_2 emission reduction per year	Commissioned in November 2001 Capacity: 1.0 MW (M/s Greaves , Pune; 4 engines of 250 KW each). Technology: H_2S scrubber developed and supplied by IISc, Bangalore and use of indigenously manufactured biogas engines
	ANIMAL / AGRO RESIDUES		
15.	1 MW Power Plant based on Biomethanation of Animal Waste at Dairy colony, Haibowal, Ludhiana Organisation: owned by PEDA (Punjab Energy Development Agency) Supporting technology institution: Indian Institute of Technology (Roorkee, U.P.)	Project Cost : Rs. 13.65 crore NBB Share : Rs. 1.30 crore UNDP Share : Rs. 5.52 crore Beneficiary Share: Rs. 6.82 crore Note: Haebowal Dairy Complex in Ludhiana, spread over an area of 50 acres, has 1490 dairies with an animal population of 1,50,000 and generates about 2475 tonnes of animal droppings. Estimated 32,900 tCO_2 emission reduction annualy	Commissioned in June 2004. Animal manure capacity: 250 TPD, producing 10,000 m^3/day Electricity production: 1 MW (the surplus energy after meeting the in house power requirement is fed to the state grid). Besides, the electrical energy, the project also produced stabilized organic manure (about 7 tonnes of 70% solids and 40 tonnes of 50% solids) per day Technology: BIMA (biogas-induced mixing arrangement) supplied by M/s Enkem Engineers (Chennai), a licensee of Entec (Austria) with biogas genset provided by M/s Cogen India (Pune), licensee of M/s Jenbacher (Austria)
	FRUIT / FOOD PROCESSING WASTE		
16.	Fruit / food Processing Industry Wastes at Varalakshmi Starch Industries Ltd., Pappireddypatti, Salem, Tamil Nadu Organisation: Starch Industry	Project Cost : Rs 359.60 lakh NBB Share : Rs 89.75 lakh UNDP Share : Rs. 89.75 lakh Beneficiary Share: Rs. 179.50 lakh Emission reduction of 26,170 tCO_2 per year Comment: according to Varalaxmi, the project is viable, but depending on the subsidy on capital cost given	Commissioned in December 2003 Liquid waste capacity: 1200 m^3/day Gas Prod: 8400 m^3/day which is used on-site to replace furnace oil. Technology: HUSMAR (hybrid upflow sludge media anaerobic reactor) with a dual-fuel engine. Technology provided by New Jersey Institute of Technology, USA

Note: 1 lakh = 100,000, 1 crore = 10 million. 1 US$ = Rs. 45.5 (June 2004)
CPPRI: Central Pulp & Paper Research Institute; CLRI: Central Leather Research Institute.
The emission reductions data are own estimates (calculated and presented in Table 2)

Indicator 2.2

Setting up of various sub-projects has given a platform for demonstration of various designs types of anaerobic digestions and energy end-uses (on-site heat, on-site electricity and electricity fed into the state grid), including both indigenously developed and imported technologies:

- UASB (Up-flow Anaerobic Sludge Blanket technology)
- Continuous Stirred Tank Reactor (CSTR)
- Hybrid Up-flow Sludge Media Anaerobic Reactor (HUSMAR)
- BIMA Technology (Biogas Induced Mixing Arrangement)
- Indigenously developed UASB and Fixed Film Technologies
- Indigenously developed biomethanation technology for chrome shavings, H_2S removal system for biogas purification and gas engines for utilisation of biogas for generation of power.

In case of very specialized type wastes, e.g. leather shavings, the technologies have emerged from the promoter companies, which have the best knowledge of the substrate. In case of substrates for which technologies are available in the common domain e.g. sewage, the plants intend to use the gas generated from existing digesters. Based on the interactions with sub projects visited and reports of other projects, it is evident that the project proponents have been able to understand and absorb the technical know-how. This is also true of the construction/erection phase, which has imparted the necessary "best practices", e.g. civil construction on a weaker land mass through process of piling at Ludhiana. Many of the promoters are confident of being able to design, detailed engineering, construction and operation of such plants in future.

One objective of the demonstration subprojects was to identify certain bottlenecks in the technology options, processes and equipment and to propose suggestions for improvements in the process, making the operation easier or for cost reduction by employing cheaper technology. Examples of such bottlenecks are given in Text Box 1 and in Annex B.2 for the projects visited by the evaluation team. In this sense, the project contributed to absorption, modification and standardization of the cost effective technologies. One main bottleneck was formed by the limited number of technologies suitable to identified substrates worldwide. The other self-imposed constraint was the non- repetition of the same technology in similar types of substrate. These limitations have led in some cases to acceptance of technologically more risky options. Finally, due to the high content of imported equipment in some of the subprojects, the capital and operation and maintenance (O&M) cost have gone up.

In terms of dissemination of technology packages for the various substrates and end use of the biogas, the publication "Green Energy from Wastes" gives technology descriptions of the various subprojects. However, the consultant team feels that these technology sheets should not only highlight the technological accomplishments, but could elaborate more on the operational and other difficulties encountered , on the economics of the plant and on the CO_2 reduction achieved and where possibilities for cost reduction exist.

Outcome 3 To promote and disseminate the idea of generation and utilisation of biogas through high-rate biomethanation processes

Indicators (as given in the Annual Project Reports, APR-PIR)	*Output 2.2* *Strengthened and well-developed institutional capabilities* *Activities (as given in the original 1992 document)*
Capacity building at national and state level: 3.1 Development in human resource capabilities in the area of bioenergy 3.2 Development of institutional network of national laboratories, institutes and other agencies Promote biomethanation through promotional events: 4.1 Organization of conferences, workshops, seminars and training programmes 4.2 Promotional campaigns and publication of publicity materials	2.2.1 Nominate personnel in government and national institutions for study tours 2.2.2 Expose the technical personnel to outside experts and technology 2.2.3 Develop human resources through training programmes 2.2.4 Establish network between institutions (NEERI, CLRI, IISc, CPRI, associations and municipalities) *Output 3.1* *Strengthened and well-developed institutional capabilities* 3.1.1 Organise and conduct national level workshops 3.1.2 Arrange for national and international experts to participate in the workshops 3.1.3 Bring out training modules and promotional literature 3.1.4 Make full use of electronic media for an awareness campaign 3.15 Conduct training programmes for various types of users (industry, municipalities, rural bodies)

Indicators 3.1-3.2

The following activities have been carried out:

- *Fellowship training programme:* As part of this Project, a total of 71 Indian fellows working in the field of waste to energy in different organisations were deputed, in twelve Fellowship training programmes, in The Netherlands, USA, UK, Sweden, Austria, Denmark and Germany.
- *Study tours:* Fifteen study tours have also been organized for a total of 43 representatives of various Technology Institutions and Government organisations to visit biomethanation installations, research & development and training institutions, manufacturers and consultancy organisations in various countries, viz. Australia, Austria, Canada, Cuba, Denmark, Germany, France, Italy, New Zealand, Mexico, The Netherlands, Sweden, Switzerland, UK and USA.

Indicators 4.1-4.2

The following activities have been carried out:

- *Conferences/workshops and training programmes*: With a view to generate awareness and also to share the experiences of various experts, 46 conferences/workshops / business meets and 9 in-service training programmes have been organized so far. A third stakeholders' workshop to discuss find draft on National Master Plan on Development of Waste to Energy in India was organised in New Delhi on 29th April 2004. The mission team believes that the results of the conferences, workshops and training programmes should have been made available in the form of conference and workshop proceedings and study tour reports to the public at large by means of publications (apart from seminar summaries in the BioEnergy News) or on the website of MNES (www.mnes.nic.in).

- *Publication of a newsletter:* A quarterly newsletter "Bio Energy News" (BEN) is being published on regular basis with the first issue being published in September 1996. The Newsletter focuses on developments taking place in the field of waste processing and treatment technologies, waste management practices, bio-energy, etc. A total number of thirty-two issues have been published so far (up to June 2005). The BEN is also now available on the website of MNES as well as the UNDP website.

2.2 Project implementation: impacts of biomethanation project

(Number 6.1 of Sample Outline (Annex 3) of the ToR given in Annex A)
(Item G.1 in Scope of the Evaluation of the ToR)

This paragraph provides an overview of the project impacts. With the completion of the project and valuable experience generated through subprojects, the thrust of the newsletter and programs should change to dissemination and on catalysing market promotion of biomethanation projects. Overall, it can be concluded that the project has contributed to the creation of a conducive climate in which new projects can be formulated by industry on their inherent strengths, with support from MNES, but increasingly based on commercial financial instruments (as the subsidy on capital cost will decline over the years to come).

2.2.1 Reduction of technology cost trajectories

(Number 6.1 of Sample Outline (Annex 3) of the ToR given in Annex A)
(Item G.2 in Scope of the Evaluation of the ToR)

Almost all the demonstration sub-projects set up under UNDP/GEF assisted Project are among the first projects of their kind and therefore the cost of energy generation as well as equipment is high, due to a large content of imported and proprietary equipment and also due to the risks associated with the new technologies. The project cost per MW is in the range of $ 1.3 to $ 2.8 million, depending on a number of factors such as size of the plant (economics of scale) and type of waste used. The issue of cost-effectiveness is discussed in more detail in paragraph 2.2.5.

However this cost is expected to come down with absorption of technology and indigenization of the technology, and with the setting up of more such projects. One issue noted by the consultant team is the use of biogas for heat as opposed to electricity, which can have a significant impact on the cost of project development. The main reason for this is the reduced cost for expensive generating equipment and the H_2S scrubber (to remove the sulphur in the biogas before it reaches the engine), especially when this equipment has to be imported from abroad. A 1 MW generator can cost as much as US$ 0.75-1 million. This in the end has to be recovered either by energy sales to the grid or by on-site use. Here, one issue mentioned by respondents in the grid-connected subprojects visited by the consultant team was the unfavourable tariff at which power to the state grids have to be sold.

Another major problem with imported equipment, observed was non-availability of spares and skilled labour for maintenance of this equipment, e.g. a two-week plant shutdown at the Haebowal Dairy plant in Ludhiana due to failure of the turbocharger. However, it is encouraging to note that indigenous developments are taking place in critical imported items like gas engines and biogas holders. Cummins India is understood to have brought out an

indigenous gas engine of medium capacity up to 220 KW on their 'lean-burn' technology. So also few diesel engine manufacturers are experimenting on dedicated gas engines built on the same frame. Similarly, the neoprene gas holders are also becoming available in India. These developments will bring down the cost per MW or m^3 of gas of the biomethanation plants.

The biodegradable waste can be classified in few major categories. It is thus, possible to prepare technology packages to suit these categories based on the most suitable technology option, size and best use of the generated biogas. This standardization will help in cutting down the initial cost of project, and determining the gestation period with higher certainty. The operation and maintenance procedures can also then be standardized.

Thus the cost of biomethanation technologies is coming down. This is especially true of indigenously developed technologies that work at relatively lower capacities of 30 - 50 tonnes per day (TPD) of biodegradable waste, such as municipal soild waste (MSW). Even when MSW is to be treated, when segregation of waste at the source as mandated by MSW (M&H) Rules 2000 is implemented (see also paragraph 2.2.3), the maximum size of treatment facility is expected to be in this range. The power or gas generated at this scale is not very high, hence the end use is ideally for smaller users which could use the power grid of the local utilities by paying wheeling charges as permissible under the Electricity Act 2003. Such deals are taking shape in various states in the WTE sector. The indigenization of various components/equipment like the low capacity (100 - 500 kW) the storage balloons made of neoprene and the control system is an additional factor. MNES may take the direction from NMP and promote this as a package nationwide. The focus could be on using the waste from specific sources like vegetable markets (CMDA project), animal/night soil residues, slaughterhouses, fruit/food processing industries and even hotels/restaurants. Also, the low hanging fruits like sewage plants set up under Yamuna and Ganga Action Plans based on UASB process where biogas is simply flared could be the first few candidates.

2.2.2 Expansion of business and support services for waste-to-energy

(Number 6.1 of Sample Outline (Annex 3) of the ToR given in Annex A)
(Item G.5 in Scope of the Evaluation of the ToR)

The project has promoted cooperation and networking between national laboratories and institutions on the development, modification and standardization of cost effective waste-to-energy technologies. Also, suppliers of indigenously developed technologies, foreign technology suppliers and consultancy organizations have developed ties with counterpart Indian engineering or consultancy companies as a result of the project.

The project has stimulated cooperation between the promoter and a technology institution (TI) selected based on strengths, proximity etc. Some of the TIs associated with subprojects are Central Leather Research Institute (CLRI), Central Pulp & Paper Research Institute (CPPRI), National Environmental Engineering Research Institute (NEERI) and IIT Roorkee. Besides these some of the projects were also facilitated by nodal agencies viz. Tamil Nadu Energy Development Agency (TEDA) and Punjab Energy Development Agency (PEDA). The TIs and nodal agencies helped the promoters in understanding and assimilating the technology, design, construction, supervision commissioning, trouble shooting monitoring and evaluating the projects at demonstration stage. They were also part of the selection committee for technology and associated activities, in preparing the tender documents,

deciding the selection criteria and managing the process of selection and implementation of the project.. These institutions have benefited both on account of the experience in technology demonstration but on project management as well.

The consultant team noted that the interaction between TIs and beneficiary was dependent on the beneficiary's need. In this respect, large companies, such as Tata, are clearly capable of raising their own technological (and financial) resources, while small companies and municipalities have more need for technical backstopping (and investment support).

2.2.3 Development of sectoral policies and regulations on waste-to-energy

(Number 6.1 of Sample Outline (Annex 3) of the ToR given in Annex A)
(Item G.3 in Scope of the Evaluation of the ToR)

The project has initiated a supportive policy environment for waste-to-energy. The Ministry of Non-Conventional Energy Sources (MNES) launched a National Programme on Energy Recovery from Urban, Municipal and Industrial Wastes during the year 1995. This programme aims at promotion, development, demonstration, dissemination and adoption of environment friendly conversion technologies for both liquid and solid wastes, thereby reducing the quantity of wastes and the emission of greenhouse gases in the environment, besides producing renewable energy. The programme offers an attractive package of financial incentives to the industries, urban local bodies and project promoters to encourage their active participation. The project also supported preparation of a National Master Plan for Waste-to-Energy, under which the potential of waste to energy projects in various industries and from city waste was estimated for a period up to 2017. This involved study of waste generation in over 300 cities and 9 major industry sectors that generate biodegradable waste. The NMP also facilitated policy formulation, institutional networking and outreach.

Waste-to-energy (WTE) projects especially those generating power for export purposes are subject to regulation from state electricity regulatory commissions (SERC). The Electricity Act 2003[2] and the National Electricity policy provide encouragement for renewables in general including WTE projects. It is worth noting that some of the SERCs have issued orders fixing tariff of power purchase from WTE projects, e.g. the Maharashtra Electricity Regulatory Commission order in April 2004. These orders will allow private sector agencies promoting the WTE projects and enable selling the power to electric utilities under commercial contracts.

In addition to this, the Ministry of Environment and Forest has notified the Municipal Solid Waste (MSW) management and Handling Rules 2000,according to which every Municipal Authority shall be responsible for implementation of any infrastructure development for collection, storage, segregation, transportation, processing and disposal of MSW and have to set up waste processing and disposal facilities. MNES has also formulated schemes for the Accelerated Programme on Energy Recovery from Urban and Industrial Wastes for the year 2005-06 to provide incentives including capital subsidy.

[2] Electricity Act 2003 allows for generation of power by any project developer including from renewable energy sources and sell it to third parties through grid of transmission and distribution utilities. There will be a three way wheeling agreement and the charges to be paid to the grid owner will be decided by the state Electricity Regulatory Commission. The states are required to announce the policy in this regard

Box 1 Performance of subprojects visited by the evaluation team

(Number 6.1 of Sample Outline (Annex 3) of the ToR given in Annex A)
(Items G.2 and G.8 in Scope of the Evaluation of the ToR)

Sr. No.	Project Promoter, Location	Project Output	Status	Gas generation M^3/day	Remarks
1	CMDA, Chennai	Power 250 KW	Commissioned in Sept. 2005	2500	Grab failure
2	Varalakshmi Starch, Salem	Power 500 KW	Running since 2002	4500 –5000	Power generation not remunerative due to diesel price increase. Gas used for boiler fuel
3	TNPL, Karur	Lime Kiln Heat	Running since 2003	15000	
4	Surat Municipal Corpn., Surat	Power	Running since 2003	4500	
5	Tata International, Dewas	Cooking fuel	Running since 2002	280	
6	PEDA, Haebowal Dairy, Ludhiana	Power, 1000 KW	Commissioned in October 2004	10000	Engine Turbocharger failure

The evaluation team visited a total of six sub-projects that covered a wide variety of technologies and substrates. A structured questionnaire (Annex D) was prepared to judge the experience of the project promoters. Some major observations based on the interviews and field visits are as follows:

- Private sector participation for implementing these projects especially for waste generation due to urban activities like market yard is essential. This will save tax payers resources and will also ensure speedy implementation and efficient operation.
- Continuous study of the process may be necessary for improvements in the plant, e.g. improving the methane content of the biogas. The technology provider must therefore be engaged for a longer period along with the operator, responsible for operation and maintenance.
- Two of the plants visited were non-functional due to failure of some critical equipment. Standard operating procedures, including the levels of essential spare inventory etc., need to be prepared and adhered to. Also the process of indigenization of the imported equipment and spares should be hastened. This will help in reducing the down-time.
- In case of one of the subprojects, the biogas was to be used in a dual-fuel engine for power generation along with diesel. During the time that elapsed between the project conceptualization and actual operation, the diesel price shot up from Rs. 11/litre to over Rs. 30/litre. This made dual-fuel power generation highly expensive. In case where the plants export a part of the power generated to grid under a Power Purchase Agreement, this could lead to heavy losses, as usually the tariff for power supply is lower than the tariff at which the plant operator has to buy electricity. In view of this a careful design of project and mechanisms to provide necessary flexibility are essential.
- The above is also true for situations where the organic substrate depends on a source, which might become scarce in future. In such cases, alternative organic wastes of similar characteristics may have to be identified.
- A majority of the promoters felt that subsidy for meeting a part of capital cost is essential due to still high cost of the plant. The extent of subsidy can however be reduced progressively, as more experience is gained which would bring down the capital costs.
- Some of the promoters expressed desire to transfer the know-how gained to other players in the country. They also evinced interest in setting up projects under different project finance mechanisms like BOOT, BOO etc.

The MNP, elaborated under the Project, has provided valuable inputs for this Programme. Together with the provisions of the Electricity Act 2003, this policy framework would provide an atmosphere conducive to commercialization of biomethanation technologies. Such policy initiatives will pave way for large-scale utilization of waste, which are presently being discharged without treatment, for the recovery of heat and/or power.

Prior to the Project, biomethanation projects were not being financed through conventional financing mechanisms. This was primarily due to high capital costs, technology uncertainties and risks. *The project has helped in removing the uncertainties by demonstrating a range of biomethanation technologies.* However, the above-mentioned financial support mechanisms will need some more time before establishing and it is suggested that the experience of the technology demonstration under the UNDP-GEF projects should be disseminated more and among a wider section stakeholders, especially including banks and financial institutions.

2.2.4 Improvement of awareness and understanding of technologies among producers and users

(Number 6.1 of Sample Outline (Annex 3) of the ToR given in Annex A)
(Item G.3 in Scope of the Evaluation of the ToR)

The Biomethanation project has addressed a variety of substrates and wide range of biomethanation technology options. The technologies once selected for a type of substrate was excluded while selecting technology for subsequent projects in that category. This has enabled utilizing the available funds in a diversified manner and provided experience on large selection of technologies. The project has enabled the participation of a large number of officials of national and state level organizations in fellowship training and study tours abroad. Many of these officials continue to be engaged in promotion of the biomethanation technologies, according to the PMC officers interviewed by the evaluation team. This "*train-the-trainers*" activity has thus resulted in a multiplier effect. In addition to the overseas programmes, large number of conferences / workshops / business meets and in-service training programmes were organized in the initial period that created large scale awareness among the concerned industries.

The project also funded publication of a quarterly newsletter "Bio-Energy News" on a regular basis. The same is proposed to be continued by MNES even after the completion of the project. The newsletter maintained the quality of articles published and also provided information on latest developments on the topic worldwide. Over 3000 copies of the "Bio Energy News" are mailed to different organizations/ individuals involved in promotion of energy recovery from waste.

According to the PMC officers interviewed, the High-Rate Biomethanation project has had a noticeable impact especially among the industrial sectors generating biodegradable waste in terms of improved awareness about biomethanation processes in general and about the relative advantages with respect to different substrates. However this claim is difficult to quantify, because no real monitoring and evaluation system set up. For example, the mission team believes that the results of the conferences, workshops and training programmes should have been made available in the form of conference and workshop proceedings and study tour reports to the public at large by means of publications or on the website. While we were

informed of the availability on files, the experiences from a large number of tour reports may not be available in structured manner. Also, undertaking follow-up surveys among workshop or study tour participants or, for example by surveys among existing and prospective beneficiaries could have shed more light on the effectiveness of the information and awareness raising component of the Biomethanation Project.

2.2.5 *Environmental impacts and greenhouse gas emission reduction; cost effectiveness*

(Number 6.1 of Sample Outline (Annex 3) of the ToR given in Annex A)
(Items G.4 and G.6-7 in Scope of the Evaluation of the ToR)

Direct and indirect greenhouse gas emission reduction

The project has had a positive environmental impact by abating methane a potent greenhouse gas (GHG). We estimated the direct annual GHG reduction from the 13 projects is 244,000 tCO2e annually, as indicated in Table 2.

These GHG emission reductions take place in two ways. First, on account of capture of methane- rich biogas, which if left in the open would have been released in the atmosphere. This is relative to the prevailing baseline situation or business-as-usual. For the two waste forms solids and liquid there are different baselines. For organic biodegradable waste from industry or institutions there are currently no restrictions from open dumping. Only in case of urban solid waste, the MSW (M&H) Rules 2000 prevent dumping of biodegradable waste in the open. However, it may be noted that the compliance with the rules is very poor. Hence at present and in the next five years the open dumping of waste can be taken as baseline scenario.

In case of liquid waste and sewage, there are pollution control standards for in-land disposal of waste. These regulations state a permissible level of BOD for various places of disposal. However, in both solid and liquid wastes, biomethanation is environmentally the

Table 2 Base cost and emission reduction estimates of the 13 demonstration subprojects

No.	Substrate	Proponent	Location	Baseline	Capital Rs. Lac	Capacity KW	Biogas m3/day	Methane %	Fuel LPD/TPD kWh/day	Methane tCO2e	Fuel	Total GHG tCO2e p.a.	Starting
1	Black Liq	Satia Paper	Muktsar	Rice Husk	224		11000	55.00%	-	29948		29948	May-97
2	Sewage	RRL	Bhubaneswar	LPG	23		25	75.00%	-	93	20	113	Oct-97
3	Tannery fleshing	VISHTEC	Melvisharam	Grid	158	49	320	60.00%	500	950	165	1115	Dec-99
4	Leather Fleshing	Tata Int	Dewas	Coal	87		280	60.00%	0.5	832	155	987	Mar-00
5	spent wash	Ugar Sugar	Belgaum	Grid	140	800	13500	68.00%	4144	45441	1368	46809	Dec-00
6	SHW Solids	Al Kabeer	Hyderbad	FO	348		1700	75.00%	900	6311	831	7142	Nov-01
7	Starch Eff	VSIL	Salem	FO/power	359	500	8400	55.00%	10000	22869	3300	26169	Sep-02
8	Bagasse washings	TNPL	Karur	FO	384		12500	60.00%	8000	37125	7388	44513	Mar-03
9	Sewage	SMC	Surat	Grid	210	500	4500	68.00%	5762	15147	1901	17048	Mar-04
10	Market Waste	VMC	Vijayawada	Grid	303	150	1615	55.00%	2300	4397	759	5156	Jun-04
11	Manure	PEDA	Ludhiana	Grid	1366	1000	10000	55.00%	17200	27225	5676	32901	Dec-04
12	Market Waste	CMDA	Chennai	Grid	395	250	2500	65.00%	4817	8044	1590	9633	Sep-05
13	Abattoir waste	Hind Agro	Aligarh	Grid	469	500	4000	60.00%	9000	11880	2970	14850	-
											TOTAL	236384	

Note: The current emission reduction estimation is based on baseline methodology as approved by UNFCCC CDM Executive Board. This is similar to the IPCC methodology and appropriate to use at this stage.

Table 3 Investment cost per tonne of CO_2 reduced of the 13 demo subprojects

No.	Substrate	Proponent	Location	Baseline		Capital Rs. Lac	Biogas m3/day	Investm. US$/tCO2
	Pulp and paper							
1	Black Liq	Satia Paper	Muktsar	Rice Husk	private	224	11000	1.10
8	Bagasse washings	TNPL	Karur	FO	private	384	12500	1.26
	Leather and abattoir							
13	Abattoir waste	Hind Agro	Aligarh	Grid	private	469	4000	4.63
3	Tannery fleshing	VISHTEC	Melvisharam	Grid	cooperative	158	320	20.76
4	Leather Fleshing	Tata Int	Dewas	Coal	private	87	280	12.84
6	SHW Solids	Al Kabeer	Hyderbad	FO	private	348	1700	7.14
	Vegetable market							
10	Market Waste	VMC	Vijayawada	Grid	municipal	303	1615	8.62
12	Market Waste	CMDA	Chennai	Grid	municipal	395	2500	6.01
	Sewage/wastewater							
2	Sewage	RRL	Bhubaneswar	LPG	municipal	23	25	30.35
9	Sewage	SMC	Surat	Grid	municipal	210	4500	1.80
	Animal/agro/food processing residues							
5	spent wash	Ugar Sugar	Belgaum	Grid	private	140	13500	0.44
7	Starch Eff	VSIL	Salem	FO/power	private	359	8400	2.01
	Manure							
11	Manure	PEDA	Ludhiana	Grid	state	1366	10000	6.08

Note: 1 US$ - 45.5 Rs. The cumulative CO_2 reduction is calculated over an assumed lifetime of 15 years.

safest option that also results in valuable energy recovery. In-vessel biomethanation also helps in reducing local pollution and improving health and hygiene. In addition, the biomethanation plants also generate quality organic manure that can be sold to farmers.

Besides the environmental benefits, biomethanation-based waste-to-energy projects also provide social benefits by providing additional employment directly to persons employed as well as indirectly through the energy services. Depending on the capacity of the plant, on an average the plants employ 10 – 15 persons. In addition, the transport of the raw materials, especially for solid waste, needs separate arrangement, e.g. at Ludhiana, the Haebowal dairy complex has hired contractors to collect the raw material cow dung from the member dairies daily. These social and economical benefits add further value to the Biomethanation projects.

Cost effectiveness

Table 3 provides an overview of the investment cost per tonnes of CO_2 reduced for the various subprojects per waste sector. It is difficult to compare cost-effectiveness of the 13 demonstration subprojects, given the fact that they differ in size, substrate, and end use application of the biogas generated and type of technology used (imported or indigenously available) and it is tricky to base conclusions on a few demonstration projects. However, Table 3 provides some insight:

- *Size:* The smaller projects tend to have a very high investment cost compared to the CO_2 benefits achieved; apparently economics of scale play an important role
- *Sector:* It is difficult to draw conclusions on cost-effectiveness per sector as clearly this depends on the size of the projects in each waste sector; for example, pulp and paper looks more attractive in terms of investment per tonne of CO_2 than leather and abattoirs, but the size of the projects has been larger also. One may conclude that waste sectors were projects of sufficient scale cannot be realised may not be economically attractive.

The costs are more technology-related rather than sector dependent. As the experience worldwide on the technologies is limited in general, it may be possible that these initial demo projects experience some recovery of development costs. To the extent of indigenization of major equipment, the costs have shown reducing trends, especially as far the digesters, gas engines and storage balloons is concerned.

The evaluation team did not have sufficient background material to do a detailed cost-benefit analysis for each of the subprojects. Costs include, apart from investment cost, the cost of operation and maintenance, while benefits are derived from the use of the gas (replacing fuel or electricity *in situ* or selling power to the grid) and the biogas sludge (as fertiliser).

2.3 Implementation: assessment of the evaluation team

2.3.1 Project relevance and country drivenness

(Number 4.2 of Sample Outline (Annex 3) of the ToR given in Annex A)
(Item B.1-5 in Scope of the Evaluation of the ToR)

It has been estimated that urban liquid and solid waste generation as per the 2002 figures stands at 14,000 million litres per day and 131,000 tonnes per day respectively. The potential for power generation from industrial waste is estimated at 1,300 MW. The industrial production has been growing at an average rate of 5% p.a. and is likely to continue. The decadal growth of urban population in the decade 1991-2001 was 31%. The urban population as per census 2001 was 285 million (27.8% of total population). The urban waste especially in the Class I cities (with a population of over 100,000) contains around 35–40% biodegradable organic waste. The organic waste degrades and generates methane-rich gas as well as leachate, which pollutes the ground water. Similarly, industrial waste also poses a threat to the environment. It is worth noting that the per capita waste generation in cities has been increasing during the past few decades. While there are many technology options for treating the biodegradable waste, they either need large land areas or have other detrimental effects like emissions of dangerous substances. Technically and commercially feasible technology options to treat the urban and industry waste were not available in the early nineties. In this context it is worth noting that biomethanation technology helps in capture of methane in a gainful manner. However, the experience on the biomethanation technologies was limited and the implementation mechanisms necessary for such projects had not been tested prior to the Project. That is, the reason why UNDP-GEF project has been most relevant to India.

MNES, which has the responsibility of promotion of renewable energy in the country, has also the responsibility of developing the waste-to-energy (WTE) sector, and MNES has the responsibility of policy promotion, designing and operating subsidy schemes in this sector. The MNES WTE program received a boost from the UNDP-GEF project. As a sequel to the UNDP-GEF project, MNES initiated its programmes on energy recovery from waste. Under these programmes the ministry has assisted 14 projects with a subsidy of Rs. 124 million and two projects are in the pipeline with an assistance of Rs. 22 million in the form of subsidy. The UNDP-GEF project has given several benefits to MNES, an important one being building capacity of its officials in technology evaluation and selection, project promotion. It

has also received valuable guidance from the National Master Plan which was an input for its policy in this sector. As another example of commitment, MNES also proposes to continue with the publication of Bio Energy Newsletter.

The mechanism for implementation of the project was the NBB. While the NBB may not continue to be the decision-making body, the mechanism and procedure would provide guidance to the ministry in its national program. There have been some positive developments for infrastructure financing in India. One of these was the fund allocation for urban waste management under the National Urban Renewal Mission (NURM) and 12th Finance Commission allocations. Waste management and WTE projects, being infrastructure activities, would also qualify for the viability gap funding programs. The NURM may focus on this as an effective programmatic model. However, in view of the health of the ULBs in the country, the gigantic amount of waste to be treated in over 1000 small, medium and large urban local bodies and limited resources, a menu of technology options including some non-energy options like composting will be more appropriate. .MNES would have the opportunity to propose WTE projects especially for waste from specific locations like vegetable markets, slaughterhouses and food processing industries.

2.3.2 Project conceptualisation and design

(Number 4.1 of Sample Outline (Annex 3) of the ToR given in Annex A)
(Item C.1-2 in Scope of the Evaluation of the ToR)

With respect to the project design, the evaluation team has the following comments:

- *Whether the problem that the project addressed is clearly identified and the approach soundly conceived*

  The issue of methane emission and its contribution as one of the greenhouse gases (GHG) to the global climate change has assumed high prominence in recent decades. The UNDP/GEF High-Rate Biomethanation project has been designed to target the issue of climate change through technology measures that help reduce the methane emissions over a long period of time. Moreover, the project has recognized at the outset that in order to achieve this larger goal, it was not sufficient to implement just technical solutions but also look at 'soft' issues like capacity building and national strategy formulation to ensure long-term sustainability. Thus, the identification of the problem in the project is unambiguous and focussed. The approach of the project, as enunciated in the original project document, was conceived soundly in that the outputs, viz. demonstration of different technology packages for various substrates in different sectors, capacity building and institutional networking, awareness creation and preparation of a national biomethanation master plan, were carefully identified as representing the overall requirements to develop the biomethanation sector in India.

- *Whether the target beneficiaries and end-users of the results of the project are clearly identified*

  In addition to addressing the issue of methane emission reduction through introduction of high rate biomethanation technologies in the country, this project also aimed at building

local capacities among national laboratories/institutes, entrepreneurs, NGOs and other groups. Thus, all these groups are direct beneficiaries of the project and effective partnership arrangements were established for implementation of the project with stakeholders from the government, state and local government, supporting technological institutions and private sector. The various sub-projects undertaken under the project framework seek to cover the critical sectors for waste generation and recycling such as leather, paper and pulp, sewage, vegetable waste, etc. If the national master plan envisaged under the project gets implemented in the long run, it is also expected to benefit a large number of indigenous entrepreneurs through development of a biomethanation industry by creating more awareness on recycling the organic wastes in a sustainable way. These direct and indirect beneficiaries of the project were clearly identified in the project document.

- *Whether the objectives and outputs of the project were stated explicitly and precisely in verifiable terms with observable success indicators and whether the relationship between objectives, outputs and activities are logically articulated*

  The objectives and outputs were clearly indicated in the project document but without a clear logical framework of verifiable indicators. As indicated in paragraph 2.1, the structure in terms of objectives outputs and activities as given in the project document has been changed into a different structure of outcomes, indicators and sub-indicators, as given in the Annual Project Reports (APR-PIR). The evaluation team believes that this has rationalised the table of outcomes and outputs, but is still far from the elaborated list of indicators and verifiers that are nowadays included in the UNDP/GEF project documents.

  Despite the lack of a formal logical framework, we feel that the approach of the project, as enunciated in the original project document, was conceived soundly in that the outputs, viz. demonstration of different technology packages for various substrates in different sectors, capacity building and institutional networking, awareness creation and preparation of a national biomethanation master plan, were carefully identified as representing the overall requirements to develop the biomethanation sector in India.

- *Whether the project started with a well-prepared work plan and the work plan was subsequently revised in a timely manner in the light of actual implementation of the project*

  The project did begin with a work plan with a definite timetable and detailed budget allocation for various activities listed in the project document. However, the project has not been implemented at all according to the original plan due to considerable delays, such as changes that occurred in the institutional arrangements and management personnel, and other reasons (that will be discussed in paragraph 2.3.4), This resulted in considerable delay in the implementation of the project.

2.3.3 Financial planning and delivery of counterpart inputs

(Number 5.1 of Sample Outline (Annex 3) of the ToR given in Annex A)
(Items D.1, D.6 and E.1-3 in Scope of the Evaluation of the ToR)

Table 4 provides an overview of the budget allocation per budget line and co-financier, as planned in the project document and actual spending 1994-2005. The next Table 5 provides an overview of the expenditures on the 16 subprojects (of which one was cancelled). In general, MNES has provided some 50% subsidy on the (capital) cost of each subproject, while towards the end of the project, some UNDP funds were diverted to the subprojects.

Regarding budget, we have the following observations on budget utilisation

- The total government contribution was around US$ 4.8 million, but with larger cash contribution (subsidy) to subproject cost than originally planned, as government funds were disburses usually on a 50-50% basis with the beneficiaries' contribution.
- UNDP's contribution was around US$ 5.5 million with a larger contribution to the demonstration subprojects than originally planned (consisting of subcontracts and local procurement of equipment); apparently the need for international and national consultancy was less than originally anticipated and the remaining money has been used to support the last of the demonstration subprojects. On training a bit more has been spent than was originally planned.

Table 4 Original budget allocation and actual spending during 1994-2005

	Subprojects and contributors	UNDP	NBB (government)	Investor / beneficiary	Other	Total
	Subprojects					
1	Evaluation Satia Paper Mills					
2	Satia Paper Mills, Muktsar, Punjab		246,154	246,154		*492,308*
3	TNPL, Karur, Tamil Nadu		422,132	422,132		*844,264*
4	HAIL, Aligarh, U.P.	328,000	357,143	357,143		*1,042,286*
5	Visharam, Melvisharam, T.N.	60,000	148,286	17,363	121,495	*347,143*
6	TATA Int'l, Dewas, M.P.		95,055	95,055		*190,110*
7	Al-Kabeer, Medak, A.P.	99,539	327,912	427,955		*855,406*
8	Market Committee, Jalandhar, Punjab					-
9	Vijawada Munic. Co., A.P.	166,725	333,473	166,725		*666,923*
10	CMDA. Chennai, T.N.	269,604	550,615	214,066		*1,034,286*
11	RRL, Bhubaneswar		25,714	18,901	7,473	*52,088*
12	Evaluation biogas engines					-
13	SMC, Surat, Gujarat	85,987	177,978	263,965		*441,943*
14	Ugar Sugar, Belgaum, Karnataka	65,934	87,846	394,505		*548,286*
15	PEDA, Ludhiana, Punjab	1,213,187	285,714	1,498,901		*2,997,802*
16	Varalaxmi, Salem, T.N.	197,253	197,253	394,505		*789,011*
	Technical support					-
	NEERI, Nagpur (sewage)				30,527	*30,527*
	CLRI, Chennai (wastes)				156,484	*156,484*
	CPPRI, Sarahanpur (pulp & paper)				65,121	*65,121*
	IISc, Bangalore (biogas utilisation)					-
	IIT, Roorkee (animal and agro-res.)				15,165	*15,165*
	TOTAL	**2,486,230**	**3,255,275**	**4,517,370**	**396,264**	***10,655,138***

Note: based on analysis of UNDP budget revision and delivery sheets and the annual APR-PIR reports

Table 5 Expenditures on the 16 subprojects

	UNDP budget expenditure	Planned (US$)	1994-2005 (US$)
	International consultants		
	- consultants NBB	330,000	253,655
	- consultants	225,000	52,860
	- consultants - workshops	220,000	79,012
	Travel and mission	229,400	22,603
	Nat. professionals		
	- chief project manager	80,000	41,373
	- NBB	28,400	178,107
	- workshops, other	38,700	1,876
	Subcontracts	1,850,025	627,325
	Training		
	- fellowships	900,000	1,105,027
	- study tour	180,000	304,334
	- training	237,000	141,583
	Equipment		
	- expendable	65,000	78,271
	- local procurement	804,000	2,248,605
	Miscellaneous and adjustment	314,000	348,588
	TOTAL	**5,501,525**	**5,483,219**

* *Own estimates, based on analysis of UNDP budget revision and delivery sheets*

** *Own estimates, based on APR-PIR reports*

- Both in the original budget as well as in actual spending, a substantial share of resources has gone to demonstration projects (outcome 2, see paragraph 2.1) and the fellowships and study tours component in outcome 3. In comparison, the components on awareness creation and information dissemination of outcome 3 and the policy support component (outcome 1, national master plan) seem marginal in terms of amounts spent[3]. The evaluation team feels that, in the Indian context, the design of such a budget may be understandable. The visual impact of functional project on ground is considered more significant in India and hence working plants are the best way of demonstration of the technology. While a very large number of officials were exposed to training, the continuity of trained officials is indeed an issue. It would have been preferable to have a dedicated 'train-the-trainers' programme.
- Almost all of the UNDP funds have been used, the balance unused amount of around US$ 20,000 is expected to be used for terminal workshop and dissemination of results. However, the evaluation team notices that half of the UNDP/GEF budget of the subprojects component has been spent on the PEDA subproject (Ludhiana). Here we wondered if this was caused by the urgency of using up the budget before the project's end. Being asked about this, the PMU has responded that the use of UNDP contribution in the Ludhiana has been high, because of high imported equipment content in the plant's investment (containerised engine generator set, screw press, dry-type gasholder,

[3] According to the evaluation team, this typically reflects GEF project design in the 'early stages' of GEF, when demonstration components and capacity building in the form of training abroad were core components and the PMC's spending has followed broadly this design of the budget. Nowadays in GEF project, the emphasis is more evenly spread on policy support, financial mechanisms, technology demonstration, training and awareness creation.

monitoring and gas analysis instrument). Nonetheless, given the fact that GEF funds are usually not be used for equipment, we think that part of the remaining Project funds could not have been used for other uses as well, such as additional policy support or capacity building and awareness creation.

- It should be noted that the project has leveraged much more additional resources (mostly from the beneficiaries themselves), beyond those foreseen at the time of approval. One can conclude that, although faced with initial reluctance from the private sector and municipalities, the project has ultimately achieved not only in almost realising its goal of 16 subprojects but has also managed to raise substantial co-financing of almost US$ 5 million (in comparison with the US$ 1.85 million originally anticipated) without which many subprojects could not have been realised.

2.3.4 Project performance and implementation approach

(Number 4.1 of Sample Outline (Annex 3) of the ToR given in Annex A)
(Items D.1-D.3, D.5, D.7-8 and E.1-3 in Scope of the Evaluation of the ToR)

In terms of the project's performance we try to answer the following questions:

- *Whether the project resources were adequate in terms of quantity and quality and used effectively*

The UNDP resource allocation has been more than adequate and a large part of the budget has been used towards subproject realization; apparently the need for consultancy was overestimated, or the project was designed to meet GEF requirements, rather than being based on a good analysis of what inputs (human and financial resources) are needed for what outputs (training, demo projects, information dissemination, policy support). Coming back to the project design (paragraph 2.3.2), this shows:

- The need for more detailed quantitative and qualitative estimation of the inputs (human resources, equipment, services and associated cost) in the project design phase, as needed for the various [4];
- The need for a more detailed estimation of the initial investment cost involved in setting up the demonstration projects.

Initially the UNDP financial resources were under-spent in the project, except in the case of the capacity building and training component. In the end, all funds have been used effectively to produce all the two other main results as originally formulated in the project document, i.e, the formulation of a National Master Plan (NMP) and underlying action plans as well as the formulation of 16 demonstration projects[5].

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4 Nowadays, it is common to apply for PDF B just to look in project design issues. In this case, if PDF B would have been available, this could have been used to look in more detail into the participation of beneficiaries (private sector and municipalities) in terms of their willingness to invest in the demo subprojects and to have a more exact estimation of the subproject costs.

5 As elaborated on in paragraph 2.3.3, we do ask ourselves whether spending the amount of US$ 1.2 million on the PEDA Ludhiana subproject towards the end of the project was justified and whether part of this amount should not have been used to beef up the policy support (e.g., implementation of the NMP rather than its formulation only), training (e.g., local officials) or the information dissemination components (e.g., a comparative cost-benefit analysis of biomethanation projects supported by MNES in general and awareness creation in the form of sectoral seminars)

- *Whether management arrangements were appropriate and responsiveness of the project management to significant changes*

We discussed the institutional set-up and arrangements in paragraph 1.4. One cause of initial delay of the project's initiation has been that in the beginning institutional arrangements were not smooth.

The main issues in the time delay have been the following:

- Delays in the initiation of the subprojects. By 1997, only the biogas engines evaluation study and only 3 demo subprojects were being completed (namely at the Paper Mill in Punjab, Abattoir waste in Hyderabad, Sewage waste in Bhubaneswar). It has been taken much more time than anticipated to convince beneficiaries (private sector and municipalities) to participate, despite the relative high amount of subsidy offered (50%). Of the original list of beneficiaries in the project document, only one has participated in the end (RRL Bhubaneshwar); at least one beneficiary had gone ahead with its own activities anyway, while other may have adopted a 'wait-and-see-approach. The stakeholders' willingness for financial backup should have been thoroughly reviewed at the project's formulation stage. In some subprojects, delays in the technology selection process and procurement of equipment have occurred; in some cases, up to one or two years were lost by having to go through subsequent rounds of re-tendering. While some of this delay can be attributed to the procedural system which had to be followed, another factor is the nascent character of biomethanation technology, which is still evolving, implying that not always the same standards can be applied as for mature technologies.
- Delays caused by administrative procedures. According to the mid-term evaluation report, various changes occurred in the in the institutional arrangements and project management personnel. With the involvement of various officials in the project's procedures and the need for clearance slowed down decision making, e.g. in terms of time required for approval of financial outlays in the various subproject proposals. Originally the Project Management cell (PMC) was set up in HUDCO (Housing and Urban Development Corporation), but was transferred to MNES in January 1996 and was staffed by the Ministry's own personnel[6]. According to the mid-term evaluation report (Apparently, the housing the PMC within MNES gave more credibility to the project and helped to generate more interest.

- *Whether effective partnerships with stakeholders were established (project's collaboration with stakeholders; partnership strategy)*

A few national research institutions[7] and nodal agencies[8] have also been associated with the Project for providing assistance in various technology related matters like design, analysis of critical aspects of construction, supervision, commissioning, trouble shooting, monitoring and evaluating projects at the demonstration stage. These technology institutions also assisted the

6 The evaluation team did not find any documents that explain why the PMC could not function under HUDCO, but noted that activities picked up after 1996

7 Central Leather Research Institute (CLRI, Chennai), Central Pulp & Paper Research Institute (CPPRI, Saharanpur), Indian Institute of Technology (IIT, Roorkee), Natural Environmental Engineering Research Institute (NEERI, Nagpur), Regional Research Laboratory (CSIR, Bhubaneshwar), Sardar Vallabhhai National Institute of Technology (Surat), Indian Institute of Science (IISc, Bangalore)

8 Punjab Energy Development Agency (PEDA), Tamil Nadu Energy Development Agency (TEDA), Gujarat Energy Development Agency (GEDA)

NBB in technology assessment, technology absorption and adaptation of designs to Indian conditions. In addition to this, the beneficiary organisations are also contributing 50% of the total demonstration Sub-project cost, apart from the GOI contribution reflected in the budget. They are also responsible for operation and maintenance of the units on a long-term basis. The contribution of the beneficiary and other participating organisations in the 16 sub-projects commissioned is given in Table 2 in paragraph 2.2.5.

- *Whether project activities were properly monitored and success indicators used*

As mentioned earlier, the project document has lacked a logical framework of verifiable indicators, although the annual progress reports (APR-PIRs) present a list of indicators (see paragraph 2.1). A lot of documentation exists on the individual results various subprojects. Nonetheless, little is documented about the impacts of the subprojects as a whole, e.g. in terms of cost-effectiveness, technology packages developed and used, of the longer-term sustainability of the subprojects and of the lessons learned. One reason is that no formal monitoring and evaluation for the project was designed, as this was not a requirement for GEF projects in the 'early' years of GEF; consequently no effort has been undertaken to really monitor project results and impacts. Since MNES provides a subsidy scheme for biomethanation, some evaluation system should be developed at MNES to monitor the results and impacts of the projects it supports through its subsidy programme in general and that of the subproject supported under the UNDP-GEF project in particular. .

While the APRs mention the number of professionals that benefited from the capacity building activities (study tour, fellowship), no information exists how they are currently using their knowledge. While most of them are presumably still working in the same field, compilation of their experiences with the capacity building and how they apply their enhanced skills would have been very useful.

In general, one can conclude that the lack of a monitoring and evaluation framework makes it difficult to assess the project's impacts. Nonetheless, in this paragraph 2.2, we have attempted to make some assessment of the project's impacts, based on the APR-PIRs and on the information gathered during the mission.

- *The role of project implementing organizations in backstopping the project*

With hindsight one can conclude, that, although being a large and complex project, the project was apparently conceived in a hasty manner, without going through a solid preparation phase. Nowadays, most GEF projects go through a preparatory phase (supported with GEF PDF B funds) that takes one year or longer. As one the 'earlier' GEF project phase, the project design and work plan were not developed in a separate project preparation phase, as is now customary in full-sized GEF projects. Some of the delays which were dependent on other organizations were beyond the control of implementing agency. We note, however, that the process of identifying technology suppliers could have been simplified had a financial institution been included in the PMU. The programme was implemented mainly as a technology promotion scheme. Regarding the subprojects, there could be a lack of project management expertise with some of the subproject implementing organizations.. However, in subprojects where the implementing organizations had proven project management skills, .the backstopping was comparatively better. This could be one of the recommendations that would help effective and speedy implementation of the project.

Once in place, a dedicated core staff (PMU) has facilitated the implementation of the activities, as originally planned in the original document, although with a delay in real initiation of a couple of years.. Since then, also the various technical meetings and workshops held with the various stakeholders have also helped in receiving feedback on different activities and issues of the project. From the frequency regular meetings and production of annual progress reports (APR-PIR), it can be concluded the monitoring of project performance and backstopping for the project has been adequate, once the problems of delay in the initial phase were overcome, both from UNDP and the Government (MNES and IREDA).

3. CONCLUSIONS AND RECOMMENDATIONS

3.1 Conclusions

(*Numbers 6.1 of Sample Outline (Annex 3) of the ToR given in Annex A*)
(*Item I in the Scope of the Evaluation of the ToR)*

The following summarises the findings of the evaluation. Each of the points identified is discussed in more detail in the preceding chapter 2.

3.1.1 Project design and execution

(*Number 6.1 of Sample Outline (Annex 3) of the ToR given in Annex A*)

On project execution, we ask: "Has the project been well implemented?"

We notice that project has not been without problems. Initially, for a couple of years progress in implementation of activities was slow , due to a number of reasons:

- Delays in project initiation, due to changes of institutional arrangements of the project as a whole, e.g. requiring relocation of the Project Management Cell, and due to forced re-tendering in some of the subprojects
- Reluctance on the part of the beneficiaries to commit 50% of the project cost as their contribution. Since many biomethanation technologies are often perceived to be in the pilot stage, these are often seen as risky ventures in which private sector and municipalities are reluctant to invest.

Despite the in initial delay, we feel that project execution by MNES has been relatively well-managed as in the end the project has accomplished most of its goals:

- A National Master Plan has been elaborated (detailed in Annex C.1) and has provided inputs in the current policy formulation regarding waste management and financial incentives for waste-to-energy projects (see Annex C.2)
- All 16 subprojects have been commissioned during the project and are now in operation, using different biomethanation technologies, in different waste sectors (vegetable, animal waste, sewage, leather, pulp and paper, agroresidues), targeting different beneficiaries (municipalities, large and small private industry) in different parts of the country;
- Regarding capacity building, a large number of officials and professionals were trained (study tours, fellowships and in-house training programmes);
- A quarterly 'Bio-Energy News' has been brought out under the project and various meetings and workshops have been held to disseminate information.

On project design, we ask: "Was the project appropriately designed for the perceived needs?"

As such, the conceptualisation of the programme as captured in the project document proves to be appropriate, as the basic design of outputs and activities still holds with some modifications. Its objectives, to control greenhouse gas emissions by demonstrating the technical and economic viability of biomethanation and building technical capabilities among the project participants, are valid and relevant to the waste and energy sectors in India.

What has clearly been lacking in the beginning is a clear institutional setup and approval procedures for disbursement of financing. This should have been more defined in the project document. Also, budget expenditures have been quite different from the original budget. In addition, the project document has been lacking a good logical framework with outputs and indicators, let alone, a good monitoring and evaluation system making monitoring and evaluation of the project as a whole and of the individual subprojects difficult. The project has been without a proper PDF project preparation, as is now customary for GEF projects of this size. A number of problems could have been addressed in such a PDF-B phase, such as the project institutional setup, budgeting of activities in close correspondence with the actual need for budget in outputs, and the need for raising support and 'ownership' amongst the beneficiaries, before embarking on the project.

3.1.2 Project impacts

(Numbers 6.2 and 6.3 of Sample Outline (Annex 3) of the ToR given in Annex A)
(Items A.1 and A.2 in the Scope of the Evaluation of the ToR)

On project sustainability, we ask "how effective has the project been to contribute to market transformation?"

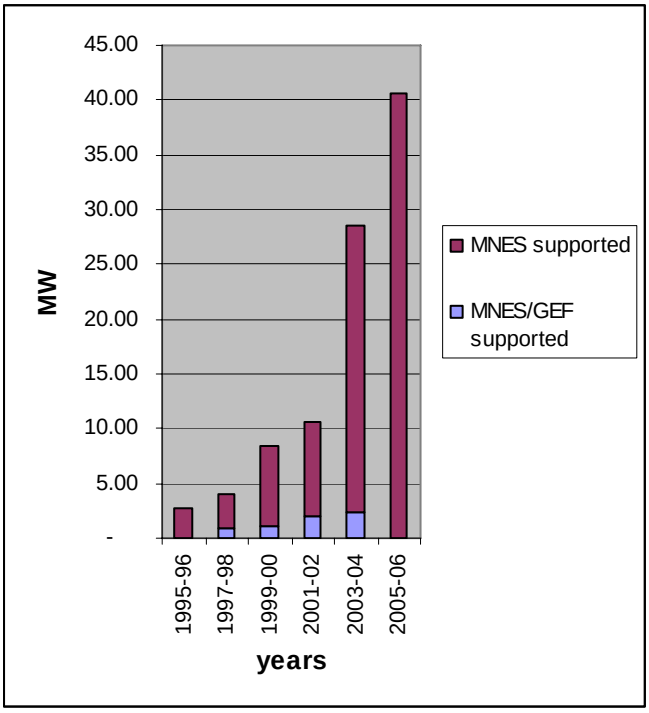
In the end, we feel that the project has contributed significantly to:

- The absorption, modification and standardization of the cost effective technologies and based on the most suitable technology option, size and best use of the generated biogas. The cost is expected to come down as the technology diffuses due to higher indigenization of the technology and with the setting up of more such projects.
- The formulation of a supportive legislative environment. The National Programme on Energy Recovery from Urban, Municipal and Industrial Wastes, the 2000 Municipal Solid Waste Management and Handling Rules and the Electricity Act of 2003 provide an atmosphere conducive to commercialization of biomethanation technologies. MNES has formulated incentives in terms of capital subsidy for the promoters of urban and industrial waste-to-energy projects as well as financial assistance for promotional activities, resource assessments and R&D activities by state nodal agencies, institutions and other organizations. The UNDP-GEF project indirectly helped in enabling this policy regime through demonstration of technologies and implementation mechanisms and directly by the formulation of the National Master Plan on Waste-to-Energy.
- Building a technology support system, by promoting the cooperation and networking between technology institutions, beneficiaries and foreign technology providers on the development, modification and standardization of cost effective waste-to-energy technologies.
- The High Rate Biomethanation project has had a noticeable impact especially among the industries generating the biodegradable waste. Information dissemination and awareness, e.g. by means of the quarterly "Bio Energy Newsletter" and the participation of a large number of officials and professionals of national and state level organizations in fellowship training, workshops, meetings and in-house trainings.

On project replication, we ask "what was the contribution to replication and scaling up of innovative practices?"

Regarding the commercial viability, the cost range for installation of 1MW of BM potential indicated as a result of the UNDP/GEF programme is in the order of US$1.3-2.8M. It is noted that these costs are potentially higher than would be expected under normal commercial BM project conditions. However, the Project has given valuable insight in how the cost per MW can be reduced. For example, the cost-effectiveness of projects can be increased by relying less on sourcing expensive technology from overseas by local development of biomethanation and gas end-use technology and by investing in project that are sufficiently large (to achieve sufficient economic of scale). On the longer term, the cost per MW installed is expected to fall as the technology diffuses and domestic production of equipment expands.

The technical replication potential expected up to 2017, under the strategic action plan arising from the National Master Plan sponsored by the Indian UNDP/GEF programme, is anticipated to be in the region of 2,600 MW installed capacity (see Annex C) Regarding the interest from other developers, some 17 subprojects with an aggregate capacity of more than 45 MW have been installed with MNES support in India (besides the 13 subprojects of the UNDP-GEF project) and two projects of capacity over 10 MW are currently under installation. An overview of the installed capacities per year by the MNES-supported projects (subprojects supported by the UNDP-GEF Project and other MNES-supported ones) is given in the figure, based on details given in Annex C.3. It should be noted that in reality the installed biomethanation capacity is even larger as the private sector is also implementing projects without requesting MNES support.



The graph shows that bioemethanation has been picking up rapidly in the decade 1995-2005. The evaluation team believes that the UNDP/GEF Prokject has been instrumental by serving as seed money for MNES in policy formulation, demonstration of technology and information dissemination, although in the absence of any monitoring and impact evaluation system in the Project, the claim may be difficult to quantify.

Every municipal authority is now responsible to follow policies on infrastructure development for collection, storage, segregation, transportation, processing and disposal of Municipal Solid Waste. As a follow up to these guidelines, ten states have already announced policies conducive for setting up waste-to-energy projects. Further incentives such as interest subsidy for commercial projects and capital subsidy for demonstration projects based on urban and industrial wastes have been established.

A number of recent reports (IT Power, Winrock, PriceWaterhouseCoopers) have assessed the Clean Development Mechanism prospects for biomethanation projects in India. These reports suggests that a technical potential exists for emissions reductions, and hence CDM finance, resulting from biomethanation projects in the municipal solid (primarily) and liquid waste management sectors in India. Despite the recent uptake of biomethanation projects in India, a number of technical, institutional, financial and other barriers perpetuate. Consequently, it is highly likely that any project utilising biomethanation technologies would be considered additional under the CDM. The IT Power report concludes that emissions reductions that could be considered additional under the CDM could amount to some 1.85 billion tonnes of CO_2e per annum. This assumes that projects will be additional up to the point a 50% diffusion rate has been achieved in the relevant sector. This would represent an enormous potential flow of capital to India under the CDM of some US$ 9 billion per annum to support improved waste management. The current rapid pace of institutional capacity building to manage the CDM in India is of vital importance in realising this potential, indeed, the rate of capacity development is such that India has currently one of the most favourable environments to develop a CDM project at the moment.

3.2 Lessons learned and recommendations

(Numbers 8.7 and 8.8 of Sample Outline (Annex 3) of the ToR given in Annex A)
(Items H and J in the Scope of the Evaluation of the ToR)

The progress and results of this project till now reinforces some of the well-tested lessons to be learnt from experiences in promoting new and renewable sources of energy. Some of the lessons are at a general programmatic level, while the others are more specific to Project.

Lessons learned and recommendations for UNDP

Large and complex technology transfer projects need to be designed properly, based on a thorough review of the issues and options. Outputs need to be based on on-the-ground realities and activities need to be designed in such a way that they can deliver the outputs within a reasonable timeframe using realistically estimated inputs, in terms of human and financial resources, while an appropriate project institutional mechanism is needed to ensure effective implementation. Sufficient time is also needed to convince the private sector to participate in 'risky investments'. In this case, perceptions about biomethanation technologies being not yet commercial are highly prevalent among stakeholders.

Unlike a decade ago, it is now common for large GEF projects to have an extended preparatory phase, supported by GEF's PDF A and PDF B funding, and the initial delays in the India Biomethanation project (that did not have such preparation support) only underlines the rationale for good project preparation.

The Project has lacked a proper monitoring and evaluation tool and consequently it has been different to monitor the Project's impact, because such monitoring activities have not been built implicitly into the project. To give an example, on the capacity building component, a survey could have been conducted among the sector professionals who have participated in national and international training programs and fellowships to ascertain the usefulness of these capacity building activities and their manifestations in the sector development, while the results should have been properly documented more in workshop proceedings and

fellowship/study tour reports. Such reports would have provided provide useful information on the effectiveness of the capacity building component and this on it turn would have provided valuable feedback for the design future of future UNDP-GEF programmes.

Recommendations:

- A good project design warrants extensive stakeholder consultations with government, private sector and beneficiaries. Adequate attention should be given to proper budgeting in the project design phase, in which the inputs needed to achieve the required project outputs are carefully assessed.
- A monitoring and evaluation tool to measure project results and impacts should be made an integral part of the project (based on the logical framework as given in the project document) and formulated at the beginning of the project so that the individual activities can be monitored and evaluated.
- The implementation mechanism should be effective but at the same time as be kept as simple as possible and some degree of flexibility in the programme design is essential.

Lessons learned and recommendations for MNES

Absence of private entrepreneurs, financial constraints of governmental institutions like municipal corporations act as major barriers, due to which the sector is not yet ready for commercialization. The failure in developing sub-projects and inability on the part of host institutions to provide 50% cost in the early stages of the project illustrates this clearly. On the other hand, some subprojects have showed commercial viability, especially when using indigenously available technology, depending on the end use of the gas (on-site heat and power or supply to the State grids, which determines the revenue stream) and, importantly, when the projects had sufficient size to achieve a profitable economics. In short, the technical potential for biomethanation in the municipal solid (primarily) and liquid waste management sectors in India is high and environmental benefits are substantial and project will be commercial, especially when advantage is taken form additional financial streams in the form of MNES's subvention and of CDM carbon credits.

MNES has set a target of 12,000 MW of power generation capacity through renewable energy sources to be achieved by the year 2012, representing 10% of the new capacity addition in the power sector. Biomethanation could make a significant contribution to this ambitious target. However, in order for this to be realized, it is necessary to not only create broad awareness, and build sector capacities but also to publicize the success stories widely so as to attract new stakeholders. Therefore, capacity building and awareness creation must be an integral part of the efforts to promote new technologies in potential sectors.

While deciding the best use of limited funds available to finance a subsidy program several factors have to be taken into account. The most effective use of subsidy would be to prop up market forces in the long term. The ultimate aim of this is to eventually withdraw subsidy completely (as is also recommended in the NMP) and allow the biomethanation activities to happen on their own as pure business propositions through available financing mechanisms.

The MNES should:

- Continue to allocate resources to for capacity building, information dissemination and awareness creation, especially targeting high-potential waste sectors and stakeholders that have less commercial muscle, such as municipalities and small entrepreneurs. In order to realize the huge business opportunities offered by biomethanation under CDM, it is necessary to expose the stakeholders to developments in global climate change area, and

impart to them the methods to develop biomethanation projects that could qualify under the CDM;

- Involve the professional financial institutions in its incentives programme; on the long run subvention is not sustainable and should be replaced by loans from the commercial banking system as the biomethanation technologies become mature;
- Support an indigenization programme for reducing the cost of technology;
- A greater networking with programmes of the Government and other bi/multilateral programmes would help to effectively use available funds and enable greater knowledge sharing, thus ensuring continuity and avoiding duplication in efforts.

Recommendations for follow-up of the Biomethanation Project

In the short run, it is recommended that:

- The remaining UNDP funds for biomethanation project should be used for printing of the booklet "Green Energy from Wastes" and for organization of a workshop to disseminate the results of the Biomethanation project
- A study or specific sector case studies are made on the cost and benefits of biomethanation and its potential under CDM which objectively outlines the essential factors for sustainability of biomethanation projects[9], providing realistic and detailed examples of what will work in India (based on the experience with over 30 biomethanation projects in India) and of baseline methodologies that are approved or under discussion by the CDM Executive Board.
- It is further recommended that such a study is disseminated through newsletters, international conferences, national workshops organized per sector (pulp and paper, starch, leather and abattoir waste, fruit and vegetable waste, municipal solid waste and sewage) or per target group (large industry, small industry, municipalities) and by means of involving sectoral bodies (e.g., National Dairy Board, APMC, industry associations) in the dissemination of information on investment opportunities in waste-to-energy activities.
- A small grant from UNDP and MNES may be made available for further detailed monitoring and evaluation of the projects and also for dissemination of information in the country.

The National Bioenergy Board (NBB) was created to act as the supreme body for making policies, giving directions for program implementation and approvals for selection of technology providers as well as contractors. Bioenergy is vastly growing field and is all the more relevant in the prevailing situation of large energy demand supply gaps, damaging environmental impacts of the fossil based power in the country. Bioenergy could broadly include energy from biomass in various forms such as agro waste, bio ethanol, biodiesel, industrial/urban biodegradable waste etc. The programmes like MNES national bioenergy programme are essential for realizing the potential of energy from these sources. However, instead of functioning as a policy-making body, the NBB has acted mostly as a Project Monitoring Committee for the UNDP-GEF project. In view of the above considerations after the completion of the project, it is still relevant. The Consultants have the following suggestions for continuation of NBB.

[9] Criteria include (a) the proven capacity of technology packages to treat waste and capture methane gas, (b) financial viability with or without MNES capital grants, (c) ability to generate other revenue streams (e.g., manure sales, heat and/or power generation, certified carbon emission reductions), (d) potential cost of non-compliance with environment protection and waste handling legislation

NBB would be reorganised with representatives from

- MNES (Ministry of Non-Conventional Energy Sources)
- Planning Commission
- MOP (Ministry of Power)
- MOPNG (Ministry of Petroleum & Natural Gas)
- MOUD (Ministry of Urban Development)
- MOEF (Ministry of Environment & Forests)
- Ministry of Rural Development
- DST (Department of Science & Technology)
- Experts from relevant institutes (e.g., Forest Research Institute, ICAR etc).

NBB would coordinate all the major programmes operated by various ministries and departments so as to bring cohesiveness. It should have a programme budget to fund research studies, demonstration projects and awareness creation and capacity building programmes. It should meet regularly to consider and approve proposals in the fields of Bioenergy through various programmes of constituent ministries. NBB should also coordinate with other authorities such as State and Central Electricity Regulatory Commission, Bureau of Energy Conservation, CDM National Authority, Central Electricity Authority etc., e.g., on the issue of tariff setting for grid-connected waste-to-energy projects.

ANNEX A. THE EVALUATION MISSION'S TERMS OF REFERENCE

TERMINAL EVALUATION

UNDP/GEF project IND/92/G32 – Development of High Rate Biomethanation Processes as Means of Reducing Green House Gases Emission

PROJECT BACKGROUND:

Methane is the most abundant atmospheric hydrocarbon released as a result of anaerobic degradation of biological systems. It also occurs as a major component of natural gas and coal mine gases. Estimate of methane level in the atmosphere shows that there has been an increase in the methane level by about 2.5 times during the last 100 years.

India generates large quantities of wastes from the agricultural, municipal, industrial and food processing sectors. Much of these wastes find their way into the environment with little or no treatment which results in their natural biodegradation with consequent release of methane into the atmosphere. Some of the wastes, particularly those from industrial operations, which are treated are, in most cases, subjected to the energy intensive aeration process. The technique of biomethanation has been successfully used for several decades to treat such wastes with the recovery of methane.

Power generation in India is substantially based on coal and this trend is expected to continue during the next decade due to the fuel options available to the country. As a result, the carbon dioxide emission from the power sector would be more than double from the present figure of around 220 million tones during the next one decade. In addition to the above, some 110 MTOE of traditional fuels such as firewood, bio-mass etc. are used in the household sector, particularly in the rural areas, where alternate fuels are not available. This additionally contributes to deforestation and concomitant loss of bio-diversity.

The UNDP/GEF Biomethanation Processes project has considerable significance in the national context, particularly in the industrial and municipal sectors, as means of augmenting the energy requirements of the nation using renewable recourses in a cost effective manner.

The development objective of this project is to enable India to make its contributions in protecting the global and local environment by developing aggressive plans to gainfully utilize the wastes generated in municipal, industrial and agricultural sectors for energy recovery. This objective is consistent with the stated policies of the Government to reduce net emission of greenhouse gases, increase primary supply of energy and electricity to meet India's growing needs, and add to reduced dependence on imported petroleum products, through efficient use and exploitation of alternate sources of energy.

This project, approved on 15 March 1994, commenced operations from September 1994 with the establishment of a Project Management Cell. The project activities were completed on 31 December 2004. The two sub-projects at Hind Agro, Aligarh and CMDA, Chennai are at

advanced stages of completion and the available information relating to these projects based on their installed capacity/present status is to be included.

The project has UNDP/GEF inputs of US $5.5 million with a matching contribution of Rs.142 million (equivalent to US $4.5 million @ 1994 exchange rate of Rs.31.50 to US $1) from the Ministry of Non-Conventional Energy Sources, Government of India. The project is executed by MNES.

PROJECT IMMEDIATE OBJECTIVES:

- Develop institutional framework at the national level to generate necessary awareness and capabilities to provide impetus to the bio-energy development programme utilizing high rate biomethanation processes;

- Develop requisite expertise and capabilities in the national and state level institutes, R&D organizations and universities to assimilate and adapt the technology, improve technical know-how and assistance in setting up plants using the biomethanation processes;

- Promote the use of biomethanation technology and bio-gas utilization as cost effective means of energy generation through demonstration sub-projects and national and local level seminars and workshops, promotional campaigns, training and demonstration; and

- Develop a national master plan and a shelf of investment proposals to utilize this important renewable resource through commercialization processes.

INSTITUTIONAL ARRANGEMENT OF THE PROJECT:

A National Bio-Energy Board (NBB) has been set up in MNES as an apex body under the Chairmanship of Secretary-MNES, to develop bio-energy in the country and also to execute the project by providing policy guidance and directions. NBB is represented by Planning Commission, Departments of Bio-Technology, Economic Affairs, Scientific & Industrial Research, Science & Technology, Ministry of Urban Affairs and Employment, Ministry of Environment & Forests, UNDP, Industry Associations, technology institutions and other agencies.

The functions of the NBB are two-fold, to develop a national strategy for bio-energy development for long range planning purposes and to provide guidance and directions to implement various demonstration sub-projects and other activities under the project.

A Project Management Cell with full-time National Project Director (Advisor-MNES), and National Project Coordinator (Director-MNES) supported by a team of scientific officers and other suitable administrative/supporting staff has been set up.

Technology for the demonstration sub-projects is being organized through technology institutions, which provide assistance for design, critical aspects of construction, supervision, commissioning, trouble-shooting, monitoring and evaluation of projects at demonstration stage. In the case of technology imports for the demonstration sub-projects, the technology institutions also assist the MNES/NBB in technology assessment, technology absorption and translation of designs to Indian conditions.

Five technology institutions are associated to assist the project to set up 16 sub-projects in municipal liquid wastes/sewage, leather industry effluent/solid wastes, pulp & paper industry effluent, vegetable market wastes/MSW and utilization of bio-gas for power generation.

TERMINAL EVALUATION

INTRODUCTION:

The Monitoring and Evaluation (M&E) policy at the project level in UNDP/GEF has four objectives: (i) to monitor and evaluate results and impacts; (ii) to provide a basis for decision making on necessary amendments and improvements; (iii) to promote accountability for resource use; and (iv) to document, provide feedback on, and disseminate lessons learned. A mix of tools is used to ensure effective project M&E. These might be applied continuously throughout the lifetime of the project – e.g. periodic monitoring of indicators, or as specific time-bound exercises such as mid-term reviews, audit reports and terminal evaluations.

OBJECTIVES OF THE TERMINAL EVALUATION:

In accordance with UNDP/GEF M&E policies and procedures, all regular and medium-sized projects supported by the GEF should undergo a terminal evaluation upon completion of implementation.

Terminal evaluations are intended to assess the relevance, efficiency and effectiveness of the project in relation to its objectives. It looks at early signs of potential impact and sustainability of results, including the contribution to capacity development and the achievement of global environmental goals. It will also identify/document lessons learned and make recommendations that might improve design and implementation of other UNDP/GEF projects.

The mid-term evaluation of the project was done in April 2000.

SCOPE OF THE EVALUATION:

The evaluation will focus on three main areas:

a) Assessment of outcomes and achievement of objectives;
b) Sustainability; and
c) M&E systems.

On the outcomes, in particular the evaluation will assess the following when relevant to project objectives:

A. 1) How effective has the project been to contribute to market transformation outcomes in terms of:
   a) Enabling policy environments?
   b) Availability of finance?
   c) Business enterprise support?
   d) Information dissemination and awareness

A.2) What is the project contribution to replication or scaling up of innovative practices or mechanisms that support the project objectives with particular reference to:

a) evincing interest from other developers, especially the private sector who can play a major role, with details of adoption and potential of various demonstrated technologies;
b) To elaborate on commercial viability and replicability potential of each sub-project. What barriers exist to the pilot activities being replicated on a large scale through private sector investment. How is the gas/power produced from existing sub-projects linked to consumption and how much is the revenue (direct and indirect) generated/saved.
c) GOI/State policies and the relevance of the National Master Plan for replication. Any other details of GOI policies linked to the investment strategies and the funding mechanism to support replication.
d) potential of replicable projects to be taken under Clean Development Mechanism bringing a compound impact.
e) potential interest of any funding/donor organizations by way of commitment of funds in each participating State for the project replications. The details on long term sustainable funding and short-term subsidies from Central/State Governments.
f) adoption of replication strategies in State policies or GOI's Five Year Plan.

The terminal evaluation will include ratings on the following three aspects: (1) Outcome/Achievement of objectives (the extent to which the project's environmental and development objectives were achieved; (2) Sustainability; and (3) Quality of M&E Systems. The ratings will be: Highly Satisfactory-HS, Satisfactory-S, Moderately Satisfactory-MS, Moderately Unsatisfactory-MS, Unsatisfactory-U, and Highly Unsatisfactory-HU.

The evaluators will assess and elaborate the following issues as they pertain to the three main focus of the evaluation:

B. <u>Project Conceptualization/Design:</u>

B.1 Whether the problem the project addressed is clearly identified and the approach soundly conceived.

B.2 Whether the target beneficiaries and end-users of the results of the project are clearly identified.

B.3 Whether the objectives and outputs of the project were stated explicitly and precisely in verifiable terms with observable success indicators.

B.4 Whether the relationship between objectives, outputs, activities and inputs of the project are logically articulated.

B.5 Whether the project started with a well-prepared work-plan and reasons, if any, for deviations.

C. <u>Project Relevance:</u>

C.1 Whether the project is relevant to the development priorities of the country.

C.2 Given the objectives of the project, whether appropriate institutions have been assisted.

D. Project Implementation:

The evaluation team will examine the quality and timeliness in regard to:

D.1 The delivery of inputs specified in the project document, including selection of sub-projects, technology selection, fund sanctioning, institutional arrangements, interest of beneficiaries, the scheduling and actual implementation.

D.2 The fulfilling of the success criteria as outlined in the project document.

D.3 The responsiveness of the project management to significant changes in the environment in which the project functions (both facilitating or impeding project implementation).

D.4 Lessons from other relevant projects (same focal area) if incorporated in the project implementation.

D.5 The monitoring and backstopping of the project as expected by the Government and UNDP.

D.6 The delivery of Government counterpart inputs in terms of personnel, premises and indigenous equipment.

D.7 Project's collaboration with industry associations, if any.

D.8 What major issues and problems affected the implementation of the project and what factors could have resolved them.

E. Financial Planning:

E.1 To provide activity-wise actual project cost, financial management (by addressing disbursement issues, if any), and details of co-financing, as per Annex 2 enclosed.

E.2 To include major findings, if any, of financial audit.

E.3 Assess the achievement of the environmental and developmental objectives as well as the project's outputs in relation to the inputs, costs and implementation time and examine the project's compliance with the application of the incremental cost concept.

F. Project Performance:

F.1 Whether the management arrangements of the project were appropriate.

F.2 Whether the project resources (financial, physical and manpower) were adequate in terms of both quantity and quality.

F.3 Whether the project resources are used effectively to produce planned results.

F.4 Whether the project is cost-effective compared to similar interventions.

F.5 Whether the technologies selected (any innovations adopted, if any) were suitable.

F.6 Te role of IREDA and its impact (positive and negative) on the functioning of the project.

G. Specific Project Impact:

The overall outputs and their meaning are as defined in the project document (copy enclosed) that should form the main basis for this evaluation. The mission may also make use of the Mid-term Evaluation Report, Report of 3-Country Study and the Study on CDM and Biomethanation conducted on the above project. The details of the specific project impact to be provided, in addition to general outputs, is as under:

What are the potential areas for project's success? Please explain in detail in terms of impact, sustainability of results and contribution to capacity development.

G.1 What is the performance of sub-projects already put in operation. This is to be done after visiting the sites of sub-projects as per the enclosed itinerary (Annex 4). The itinerary prepared includes all the waste sectors covered in the project.

G.2 Impact of awareness raising, information sharing, training & workshops, study tours and fellowship programmes on the institutional capacity enhancement and project replication activities.

G.3 Net Greenhouse Gases Emission reduction done (in terms of tonnes of carbon) under each sub-project and the potential for the life of each project. The GHG emission during the plant operation process is to be accounted for. The baselines for each sub-project need to be established based on the studies done by reputed institutions/existing practices. The base-line calculation mechanism may be discussed with UNDP/MNES before taking up the evaluation. The assistance of MNES can be availed in obtaining production data of each sub-project and assessment of GHG emission in certain sub-projects.

G.4 Level of institutional networking achieved and capacity development of key partners, if done in a structured manner at different stages – from inception to sub-project operations.

G.5 Environmental impact (positive and negative) and remedial action taken at each sub-project site.

G.6 Social impacts, including impact on the lives of women at each sub-project site.

G.7 Any underlying factors, beyond control, that influenced the outcome of each sub-project.

H. LESSONS LEARNT:

Significant lessons that can be drawn concerning best and worst practices in producing results, in particular anything that worked well and that can be applied to other sub-projects and anything that has not worked so well and should be avoided in future.

Any corrective actions required, if any, for the design, implementation, monitoring and evaluation of similar projects.

I. CONCLUSIONS:

After findings have been analyzed the evaluation should present its conclusions.

J. RECOMMENDATIONS:

Evaluators should provide recommendations for future improvement of similar projects based on findings and conclusions.

K. METHODOLOGY/EVALUATION APPROACH:

The evaluation methodology will include the following tools:

- Documentation review (desk study) based on – (i) sectoral Government of India policies; (ii) GEF guidelines on CO_2 emission reduction calculations; (iii) GEF guidelines on incremental cost calculations; (iv) other documents to be reviewed are listed in the first paragraph under the heading "Specific Project Impact" on Page 7; and (v) any other document the evaluators feel necessary to facilitate their work.
- Interviews;
- Field visits;
- Questionnaires, if any;
- Participatory techniques and approaches for gathering and analysis of data; and
- Participation of stakeholders and/or partners.

EXPLANATION ON TERMINOLOGY:

An explanation on the terminology used in the TORs is enclosed (Annex 1), for reference.

EVALUATION TEAM:

The mission will comprise of two members – (1) an independent UNDP/GEF international consultant; and (ii) a national consultant (not associated in any way with the project and not a serving Government official). The team leader will be the UNDP/GEF international consultant. The National Project Director and his staff as well as UNDP/GEF, New Delhi, will facilitate the work of the mission.

The expected qualifications and work experience of the international and national consultants will be as under:

International Consultant: Post-graduate, preferably Ph.D. with a minimum of ten years of experience, and:

a) good exposure to climate change/renewable energy related areas, including biomethanation processes and clean development mechanism;
b) knowledge of GEF operations, GEF project development and incremental cost calculations;
c) Monitoring & Evaluation methods and approaches (including quantitative, qualitative and participatory); and
d) Information analysis and report writing.

National Consultant: Post-graduate, with a minimum of eight years of experience, and:

a) knowledge of Government of India policies on environment and renewable energy;
b) good knowledge of renewable energy technologies and clean development mechanism;
c)
d) knowledge of project development and risk analysis;
e) monitoring and evaluation methods and approaches; and
f) information analysis and report writing.

TIME TABLE AND ITINERARY:

The evaluation will be of a duration of 20 working days and will start towards second week of October 2005 with the following tentative schedule:

4 days Initial briefing with UNDP/GEF and MNES/NPD and desk review of all the relevant documents and reports.

11 days Visit the sub-project sites (programme enclosed) and hold discussions with technical institutions, beneficiary organizations and other stakeholders, including validation of preliminary findings with stakeholders through circulation of initial reports, if any, for comments, meetings and other types of feedback mechanisms. The list of visits to projects is tentative and may be altered after preliminary discussions with the consultants.

5 days Concluding discussions, report drafting, presentation and debriefing.

CONSULTATIONS:

The consultants are open to consult all reports, files, manuals, guidelines and resource people they feel necessary, to make the most effective findings, conclusions and recommendations.

The mission will maintain close liaison with the UNDP Resident Representative in India, with the concerned officials and agencies in UNDP and the Government of India, and the counterpart staff assigned to the project.

Although the mission should feel free to discuss with the authorities in India anything relevant to the assignment, under the terms of reference, it is not authorized to make any commitments on behalf of UNDP/GEF or the Government of India.

REPORTING:

While the mission is free to include any detailed method of reporting, a sample outline giving minimum GEF requirements is enclosed for preparing the Report (Annex 3).

The mission will prepare and submit its draft report of the evaluation to UNDP. A presentation and debriefing of the report to UNDP, the project authorities, MoEF and DEA will be made in New Delhi. Based on the discussions during the meeting, the mission will finalize the report. The mission members must submit the final version of the report (in six copies) to UNDP, New Delhi within two weeks for distribution to all parties.

In case of major disagreements from any project stakeholder about evaluation findings, conclusions and/or recommendations, these should be included as an Annex to the evaluation.

Annex 1. Explanation on Terminology

Implementation Approach includes an analysis of the project's logical framework, adaptation to changing conditions (adaptive management), partnerships in implementation arrangements, changes in project design, and overall project management.

Some elements of an effective implementation approach may include:

- The logical framework used during implementation as a management and M&E tool
- Effective partnerships arrangements established for implementation of the project with relevant stakeholders involved in the country/region
- Lessons from other relevant projects (e.g., same focal area) incorporated into project implementation
- Feedback from M&E activities used for adaptive management.

Country Ownership/Driveness is the relevance of the project to national development and environmental agendas, recipient country commitment, and regional and international agreements where applicable.

Some elements of effective country ownership/driveness may include:

- Project Concept has its origin within the national sectoral and development plans
- Outcomes (or potential outcomes) from the project have been incorporated into the national sectoral and development plans
- Relevant country representatives (e.g., governmental official, civil society, etc.) are actively involved in project identification, planning and/or implementation
- The recipient government has maintained financial commitment to the project
- The government has approved policies and/or modified regulatory frameworks in line with the project's objectives

For projects whose main focus and actors are in the private-sector rather than public-sector (e.g., IFC projects), elements of effective country ownership/driveness that demonstrate the interest and commitment of the local private sector to the project may include:

- The number of companies that participated in the project by: receiving technical assistance, applying for financing, attending dissemination events, adopting environmental standards promoted by the project, etc.

- Amount contributed by participating companies to achieve the environmental benefits promoted by the project, including: equity invested, guarantees provided, co-funding of project activities, in-kind contributions, etc.
- Project's collaboration with industry associations

Stakeholder Participation/Public Involvement consists of three related, and often overlapping processes: information dissemination, consultation, and "stakeholder" participation. Stakeholders are the individuals, groups, institutions, or other bodies that have an interest or stake in the outcome of the GEF-financed project. The term also applies to those potentially adversely affected by a project.

Examples of effective public involvement include:

Information dissemination

- Implementation of appropriate outreach/public awareness campaigns

Consultation and stakeholder participation

- Consulting and making use of the skills, experiences and knowledge of NGOs, community and local groups, the private and public sectors, and academic institutions in the design, implementation, and evaluation of project activities

Stakeholder participation

- Project institutional networks well placed within the overall national or community organizational structures, for example, by building on the local decision making structures, incorporating local knowledge, and devolving project management responsibilities to the local organizations or communities as the project approaches closure
- Building partnerships among different project stakeholders
- Fulfillment of commitments to local stakeholders and stakeholders considered to be adequately involved.

Sustainability measures the extent to which benefits continue, within or outside the project domain, from a particular project or program after GEF assistance/external assistance has come to an end. Relevant factors to improve the sustainability of project outcomes include:

- Development and implementation of a sustainability strategy
- Establishment of the financial and economic instruments and mechanisms to ensure the ongoing flow of benefits once the GEF assistance ends (from the public and private sectors, income generating activities, and market transformations to promote the project's objectives).
- Development of suitable organizational arrangements by public and/or private sector
- Development of policy and regulatory frameworks that further the project objectives
- Incorporation of environmental and ecological factors affecting future flow of benefits.
- Development of appropriate institutional capacity (systems, structures, staff, expertise, etc.)
- Identification and involvement of champions (i.e. individuals in government and civil society who can promote sustainability of project outcomes)
- Achieving social sustainability, for example, by mainstreaming project activities into the economy or community production activities
- Achieving stakeholders consensus regarding courses of action on project activities.

Replication approach, in the context of GEF projects, is defined as lessons and experiences coming out of the project that are replicated or scaled up in the design and implementation of other projects. Replication can have two aspects, replication proper (lessons and experiences are replicated in different geographic area) or scaling up (lessons and experiences are replicated within the same geographic area but funded by other sources). Examples of replication approaches include:

- Knowledge transfer (i.e., dissemination of lessons through project result documents, training workshops, information exchange, a national and regional forum, etc).
- Expansion of demonstration projects.
- Capacity building and training of individuals, and institutions to expand the project's achievements in the country or other regions.
- Use of project-trained individuals, institutions or companies to replicate the project's outcomes in other regions.

Financial Planning includes actual project cost by activity, financial management (including disbursement issues), and co-financing (see Annex 2 for further discussion on co-financing). If a financial audit has been conducted the major findings should be presented in the TE.

Effective financial plans include:

- Identification of potential sources of co-financing as well as leveraged and associated financing[10].
- Strong financial controls, including reporting, and planning that allow the project management to make informed decisions regarding the budget at any time, allows for a proper and timely flow of funds, and for the payment of satisfactory project deliverables
- Due diligence due diligence in the management of funds and financial audits.

Cost-effectiveness assesses the achievement of the environmental and developmental objectives as well as the project's outputs in relation to the inputs, costs, and implementing time. It also examines the project's compliance with the application of the incremental cost concept. Cost-effective factors include:

- Compliance with the incremental cost criteria (e.g. GEF funds are used to finance a component of a project that would not have taken place without GEF funding.) and securing co-funding and associated funding.
- The project completed the planned activities and met or exceeded the expected outcomes in terms of achievement of Global Environmental and Development Objectives according to schedule, and as cost-effective as initially planned.
- The project used either a benchmark approach or a comparison approach (did not exceed the costs levels of similar projects in similar contexts). A benchmark approach in climate change and ozone projects measures cost-effectiveness using internationally accepted threshold such as 10$/ton of carbon equivalent reduced, and thresholds for the phase out of specific ozone depleting substances measured in terms of dollars spent per kg ($/kg) of each type of ODS reduced.

Monitoring & Evaluation. Monitoring is the periodic oversight of a process, or the implementation of an activity, which seeks to establish the extent to which inputs, work schedules, other required actions and outputs are proceeding according to plan, so that timely action can be taken to correct the deficiencies detected. Evaluation is a process by which program inputs, activities and results are analyzed and judged explicitly against benchmarks or baseline conditions using performance indicators. This will allow project managers and

[10] Please refer to Council documents on co-financing for definitions, such as GEF/C.20/6. Annex 2 presents a table to be used for reporting co-financing.

planners to make decisions based on the evidence of information on the project implementation stage, performance indicators, level of funding still available, etc, building on the project's logical framework.

Monitoring and Evaluation includes activities to measure the project's achievements such as identification of performance indicators, measurement procedures, and determination of baseline conditions. Projects are required to implement plans for monitoring and evaluation with adequate funding and appropriate staff and include activities such as description of data sources and methods for data collection, collection of baseline data, and stakeholder participation. Given the long-term nature of many GEF projects, projects are also encouraged to include long-term monitoring plans that are sustainable after project completion.

Any issues related to the quality of backstopping and quality assurance and control of project deliverables listed in the project document should be addressed in this section.

Annex 2. Financial Planning

Cofinancing

* Other is referred to contributions mobilized for the project from other multilateral agencies, bilateral development cooperation agencies, NGOs, the private sector and beneficiaries.

Leveraged Resources

Leveraged resources are additional resources—beyond those committed to the project itself at the time of approval—that are mobilized later as a direct result of the project. Leveraged resources can be financial or in-kind and they may be from other donors, NGO's, foundations, governments, communities or the private sector. Please briefly describe the resources the project has leveraged since inception and indicate how these resources are contributing to the project's ultimate objective.

Co financing (Type/Source)	IA own Financing (mill US$)		Government (mill US$)		Other* (mill US$)		Total (mill US$)		Total Disbursement (mill US$)	
		Actual	Planned	Actual	Planned	Actual	Planned	Actual	Planned	
– Grants										
– Loans/Concessional (compared to market rate)										
– Credits										
– Equity investments										
– In-kind support										
– Other (*)										
Totals										

Annex 3: Evaluation Report: Sample Outline

(Designed for adaptation to specific project circumstances. Minimum GEF requirements are underlined).

Executive Summary

- Brief description of project
- Context and purpose of the evaluation
- Main conclusions, recommendations and lessons learned.

Introduction

- Purpose of the evaluation
- Key issues addressed
- Methodology of the evaluation
- Structure of the evaluation

The project and its development context

- Project start and its duration
- Problems that the project seeks to address
- Immediate and development objectives of the project
- Main stakeholders
- Results expected
-

Findings and Conclusions

- *Project formulation*

  Implementation approach
  Country ownership/Driveness
  Stakeholder participaton
  Replication approach
  Cost effectiveness
  UNDP comparative advantage
  Linkages between project and other interventions within the sector
  Indicators
  Management arrangements.

- *Implementation*

  Financial Planning
  Monitoring and evaluation
  Execution and implementation modalities
  Management by the UNDP country office
  Coordination and operational issues

- *Results*

  Attainment of objectives
  Sustainability
  Contribution to upgrading skills of the national staff

Recommendations

- Corrective actions for the design, implementation, monitoring and evaluation of the project.
- Actions to follow up or reinforce initial benefits from the project
- Proposals for future directions underlining main objectives.

Lessons Learned

- Best and worst practices in addressing issues relating to relevance, performance and success.

Annexes

- TOR
- Itinerary
- List of persons interviewed
- Summary of field visits
- List of documents reviewed
- Questionnaire used, if any, and summary of results.

Annex. 4 - Details of Proposed Site Visits

1) Chennai, Salem and Karur (4 days)

- Vegetable Market Waste Treatment Plant at Chennai Metropolitan Development Agency + visits to (i) Central Leather Research Institute; and (ii) Tamil Nadu Energy Development Agency.
- Biomethanation of Starch Industry Effluent Plant at Varalakshmi Starch Industries, Salem (Tamil Nadu).
- Biomethanation of Pulp & Paper Mill effluent plant at Tamil Nadu News Print and Paper Ltd, Karur (Tamil Nadu).

2) Ludhiana (2 days)

- Power generation through biomethanation of animal waste at Haebowal Dairy Complex, Ludhiana (Punjab).

3) Surat, Mumbai and (2 days)

- Power generation from biogas generated at Sewage Treatment Plant, Surat (Gujarat State).
- Presentation/briefing on National Master Plan by M/s. Montgomery Watson at Mumbai (Maharashtra State).

4) Dewas (2 days)

- Biomethanation for treatment of Leather Solid Waste at Tata International Ltd., Dewas (Madhya Pradesh State)

ANNEX B. ITINERARY OF THE EVALUATION MISSION AND PROJECTS VISITED

B.1 Itinerary

October 10,11	• Meetings with UNDP, MNES
October 12	• Travel to Chennai and planning
October 13	• Visit to CMDA project, Meetings with CLRI and TEDA Travel to Salem
October 14	• Visit and meeting with Varalakshmi Starch Project Travel to Karur, Visit/Meeting with TNPL
October 15	• Travel to Mumbai via Coimbatore
October 16	• Report writing
October 17	• Meeting/Presentation on NMP by MWH Travel to Surat
October 18	• Visit /meeting with SMC Travel back to Mumbai
October 19	• Travel to Dewas. Meeting/Visit to TIL plant. Travel to New Delhi
October 20	• Discussions and Preparation of report
October 21	• Travel to Ludhiana. Meeting/Visit to Haebowal Dairy project. Travel to Delhi
October 22 – 23	• Report preparation
October 24	• Presentation to MNES/UNDP. Preparation of draft report
October 25	• Meeting with Government of India GEF focal point at MOEF. Depart to Mumbai/Netherlands
October 26-29	• Finalization of draft report

B.2 Description of subprojects visited

Name of the Project	**Power plant based on vegetable market waste**
Promoter	Chennai Metropolitan Development Authority (CMDA)
Date of Visit	October 13, 2005
Persons met	CMDA: E.V.K.S. Mathivanan, N. V. Rakhunath, M Balamurugan, M Nagarajan, N Elango, L Sundararaj
	CLRI: S. Rajamani, R A Ramanujam,
	Enkem: P. Subramani
	MNES: V. K. Jain
Substrate	Vegetable and fruit waste from market
Technology and Supplier	BIMA technology from Entec Austria
Technology Institution	CLRI, Chennai
Performance status	Plant was commissioned in September 2005.
Observations	Plant was not in operation at the time of visit due to failure of the grab which lifts the waste and charges it in the input hopper. The plant was commissioned on September 5, 2005 and has generated around 20,000 kWh power in the period and exported 14,500 kWh to the TNEB grid. The performance of the plant was under stabilization. However, all the equipment is reported to be functioning well. At present the plant treats only 30 TPD of waste out of 100 TPD waste generated in the vegetable market. The promoters are planning to set up similar plant for remaining waste.

Name of the Project	**Biogas generation from tapioca industry wastewater**
Promoter	Varalakshmi Starch Industries Ltd. (VSIL)
Date of Visit	October 14, 2005
Persons met	VSIL: V Anbalagan, Chairman
	MNES: V. K. Jain
Substrate	Tapioca liquid effluent
Technology and Supplier	HUSMAR technology from New Jersey Institute of Technology, USA
Implementing Agency	TEDA
Performance status	Plant was commissioned in September 2002.
Observations	The plant has been working satisfactorily and generating biogas. The plant has been designed with a high degree of sophisticated control system. However, the promoter expressed that operation of some of the systems require pH maintenance with costly chemicals like caustic soda. This advanced control system does not generate commensurate benefits. Hence the system has been bypassed. Moreover, the plant has a power generation system using dual fuel engine, diesel being the other fuel. The price of diesel has risen from Rs. 11/lit in 1999 to over Rs. 36/lit in 2005. as a result, the cost of generation from the engine has risen from Rs. 1.25/kWh to over Rs. 6/kWh, making it unviable use. VSIL has therefore shifted from power generation to boiler fuel replacement, which is economically attractive. It is thus necessary to conduct sensitivity analysis while developing the project so as to provide necessary flexibility.

Name of the Project	**Bagasse wash wastewater based biogas generation plant**
Promoter	Tamil Nadu Newsprint & Paper Ltd. (TNPL)
Date of Visit	October 14, 2005
Persons met	TNPL: S Udaya Sankar, S J Varadarajan, S. Chinnaraj
	MNES: V. K. Jain
Substrate	Bagasse wash water
Technology and Supplier	UASB
Implementing Agency	TEDA
Performance status	Plant was commissioned in March 2003.
Observations	The plant has been working satisfactorily and generating biogas. The gas volume is lesser than expectation but the gas composition

Name of the Project	**Power plant based on biogas at sewage treatment plant at Surat**
Promoter	Surat Municipal Corporation (SMC)
Date of Visit	October 18, 2005
Persons met	SMC: Prakash Joshi, Commissioner, Jatin Shah, Executive Engr, V D. Patel, E H Pathan, Ranawat, Ketan Desai,
	Chemtrols: K R Haridasan, Khozem Misri
Substrate	Municipal sewage
Technology and Supplier	CSTR anaerobic digester
Technology Institution	S V National Institute of Technology, Surat
Performance status	Plant was commissioned in March 2004.
Observations	The project involves setting up imported biogas engines for producing power using biogas generated in existing digesters. The plant is working satisfactorily.

Name of the Project	**Biomethanation of leather shavings from tannery**
Promoter	Tata International Ltd. (TIL)
Date of Visit	October 19, 2005
Persons met	TIL: O K Kaul, Rajiv Bhirud
	Mailhem: Samir Rege
Substrate	Leather shavings
Technology and Supplier	Modified UASB process jointly developed by TIL and Mailhem
Implementing Agency	CLRI
Performance status	Plant was commissioned in March 2000.
Observations	The plant has been working satisfactorily and generating biogas. The technology developer, TIL is carrying out studies with a view to optimizing the process further so as to reduce consumption of resources.

Name of the Project	**Power generation from animal manure**
Promoter	Punjab Energy Development Agency (PEDA)
Date of Visit	October 21, 2005
Persons met	PEDA: Balour Singh, Anupam Nanda, Devender Singh, Anupam Nanda
	IIT Roorkee: Surendra Kumar
Substrate	Cow dung
Technology and Supplier	BIMA technology from Entec, Austria, Gas engine from Janbacher
Technology Institution	IIT Roorkee
Performance status	Plant was commissioned in December 2004.
Observations	The plant has been commissioned about a year back and is still being optimised. During the visit, the power generation was not in operation due to failure of turbocharger shaft. Promoters have reported the gas contains 55% methane as against 65% in design. Promoters have gained experience during construction of the plant as well as operation and are in a position to design the next plant themselves using CSTR technology. Promoters have noticed higher lignin content affects methane generation.

B.3 List of people met (other than the subprojects)

Sr. No	Organization	Name of the Person
1	UNDP	Anil Arora
2	UNDP	Jo Scheuer
3	MNES	Ajit Gupta
4	MNES	Anil Dhussa
5	MNES	V. K. Jain
6	CLRI	S. Rajamani
7	CMDA	N. V. Rakhunath
8	Enkem Engineers	P. Subramani
9	CLRI	T Ramasami
10	TEDA	K. Allaudin
11	CLRI	S Ramanujam
12	Anna University	R Sethumadhavan
13	Anna University	S Renganarayanan
14	TEDA	K Kulothungan
15	TEDA	M Amarnath
16	MWH	Sharad Bhagwat
17	MWH	Vidyadhar Sontakke
18	MWH	S Ramanathan
19	Consulting Engineer	Deepak Kantawala
20	Consultant	S. Veeramani
21	MOEF	Sudhir Mittal
22	MOEF	S. K. Joshi
23	UNDP	Neera Burra

ANNEX C. SUMMARY OF NATIONAL POLICY ON WASTE-TO-ENERGY PROJECTS

C.1 National Master Plan

The National programme on Energy Recovery from Urban and Industrial Wastes addresses the waste management issues in Urban and Industrial sectors in India and provides a framework for Waste-to-Energy programmes. To achieve this objective, the NBB has developed a National Master Plan (NMP) for waste-to Energy with MWH India Private Limited as consultants. The NMP is an integral part of the UNDP/GEF assisted Biomethanation project and is expected to promote setting up of several waste-to-energy projects in the country.

The primary objective of the NMP is to "Supplement the power needs by maximizing energy recovery from urban and industrial wastes in a cost effective and proven manner using technologies that are applicable to the Indian community, conditions, and support ongoing adaptation to meet implementation needs and also provide vital solutions to the environmental problems including reduction in GHG emissions". It is expected to also serve as a road map to cost-effectively implement, in a phased manner, projects for the next 15 years in the urban and industrial sectors.

Based on this primary objective and its analysis the following approach for the NMP was developed:

- Assess the potential of the wastes to generate energy in the urban and industrial sectors
- Identify the priority areas in urban and industrial sectors
- Focus R&D efforts and Demonstration Projects on selected technologies
- Set Targets and Time-frames for project implementation
- Develop a Strategic Action Plan (Road Map) consisting of activities to achieve the above targets and estimate the funding requirement

WTE potential in India

To assess the potential of energy from urban and industrial wastes, structured database was prepared for 299 class I cities, 36 selected (based on the criteria of population, regional distribution and the local characteristics) class II cities and ten identified potential industrial sectors. The industrial sectors were identified based on the production capacities, quantum of wastewater generation and organic load from the industrial sector. A structured database can be found at the project web site www.indiawteplan.com).

Potential in the urban and industrial sectors

The potential for conversion of waste to energy is estimated as:

- Municipal liquid waste: 14,151 million litres per day (MLD) in 2007 and 19,542 MLD in 2017 (with energy generation potentials of 264 and 365 MW respectively)
- Municipal solid waste: 130,927 tonnes per day (TPD) in 2007 and 265,834 in 2017 (with energy generation potentials of 2266 and 3276 MW respectively)
- Industrial waste[11]: energy generation potential of 1279 MW in 2007 and 1997 MW in 2017

The waste- to-energy plants will also reduce the emission of the GHG to atmosphere by capturing the gas generated and converting it into electricity. The quantum of the GHG emissions that will be captured while achieving the targets is around 228,500 tonnes of carbon equivalents of GHG.

[11] Distilleries, sugar, maize and tapioca starch, poultry, pulp and paper, dairy, tanneries

R&D needs and technology transfer; demonstration projects

There is an urgent need to relate R&D efforts with market needs and to form inter-disciplinary product teams focussing on prototype development. Technology networking involving research consortia, institutes, government, equipment manufacturers, consultants/ experts, project engineering, manufacturing and marketing personnel will enable an expeditious transfer of R&D/Technology output for commercialisation. Technology licensing, acquisition, purchase or joint ventures can also achieve rapid progress of R&D programmes.

The NMP approach is, hence, to provide for need based R & D, promote adaptive research, integrate demonstration/pilot projects and commercialization with R & D and use technology acquisition wherever possible. The NMP proposes financial contributions to the beneficiaries of urban and industrial Waste-to-Energy projects.

Targets and timeframe

The rationale for the targets and time frame for the NMP is based on achieving the total Waste-to-Energy Potential of urban and industrial sectors as of 2002 by 2017, the end of the 12th Five Year Plan (FYP). It is proposed that a review of the NMP strategies for the Eleventh and Twelfth Five Year Plans should be undertaken before the end of the pervious Five Year Plan.

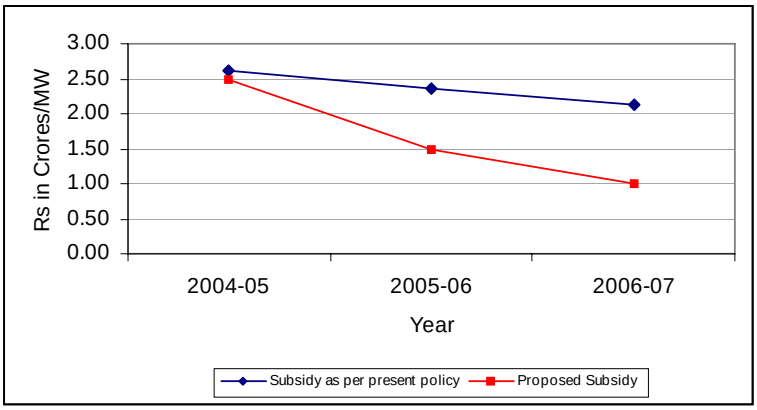
For the period 2004 to 2007, considering shorter time frame available and with the view to transit from the present policies to proposed policies in a gradual manner, following strategies are proposed:

- Financial incentives should be related to commercial viability of the project
- Gradual transition from subsidy regime to self sustaining regime.
- Preparation to achieve higher targets in the 11th and 12th FYP by carrying out policy reforms, Information dissemination, technical assistance, need based R&D and focused pilot and demonstration projects, development of strategies to attract private initiatives and initiation of the process to move from subsidy regime to self sustaining regime.

Financial requirements

Financial analysis of WTE projects was used to assess their viability based on the potential revenue generation to the investment made. Realistic criteria for such analysis consisting of capital cost, operation and maintenance costs, cost of capital, price of other by- products etc. was developed for the period 2004-2007. A project is considered to be commercially viable if the IRR 5% more than the cost of capital.

Based on these criteria and power price Rs 4.24 / kwh, the analysis of commercial viability showed that no subsidy is required for *municipal solid waste* to energy projects during the 11th and 12th Five-Year Plans. To encourage the energy generation from the industrial waste for the period 2007 to 2017, NMP recommends creating a credit line for financing the industrial Waste-to-Energy projects. The same credit line created for MSW to energy projects could be used for this purpose also. To encourage the energy generation from the *industrial waste* for the period 2007 to 2017, NMP recommends creating a credit line for financing the industrial Waste-to-Energy projects. The capital cost per MW energy generation tends to decrease as the technologies mature with time and due to the reducing trend of the interest rates. Based on these considerations, the NMP recommends that the capital subsidy declines correspondingly (see the figure below).



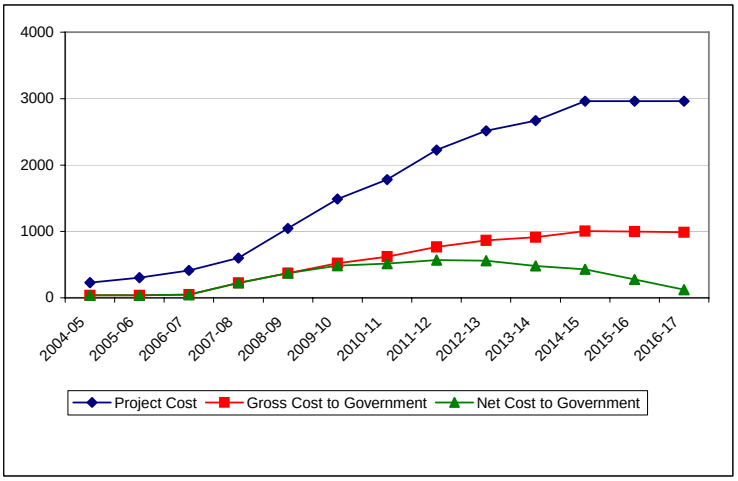
Capital subsidy for industrial WTE projects (as per present policy and proposed)

The financial requirements for urban and industrial waste to energy projects for the period 2004 to 2017 are summarized in the table and figure below:

2004 to 2017

S. No.	FYP		10th	11th	12th
	Potential (as on 2002)	MW	2717		
	Target	MW	121 (4%)	806 (30%)	1557 (57%)
	Cumulative		121 (4%)	959 (34%)	1557 (91%)
	Total project Cost	Rs Crores	1053	7137	14069
	Capital Subsidy	Rs Crores	211	5	5
	33 % Loan through Credit Line	Rs Crores	Nil	2502	4765
	Revenue	Rs Crores	Nil	341	2901
	Total Net Cost	Rs Crores	211	2166	1869

Financial requirements for urban and industrial waste to energy projects



Strategic action plan (road map)

Although the NMP is prepared for the period 2004 to 2017 it was decided that it would be more useful to develop the Strategic Action Plan for the period 2004-2007. This would provide the necessary framework to develop similar action plans for the remaining period, based on the experience gained in the period 2004-2007 as well as performance evaluation.

The Strategic Action Plan (SAP) provides details of activities to be under taken with in a time frame, identify agencies to carry out these activities and provide estimates of financial requirements for their successful implementation. The relevant instruments to achieve the objectives are

- Policy
- Information Dissemination
- Technical Assistance
- Financial Assistance
- Research and Development

Out of these various enabling instruments, policy is all encompassing and applies to all sectors. The other instruments however, are sector specific. The strategic action plan hence applies the instruments of Information, Technology, R&D and Finance to each relevant sector respectively.

Based on the strategies developed in the NMP the following strategic action plan is proposed.

Policy
To discuss various policy issues such as differential power pricing, tipping fee etc and arrive at a consensus it is proposed to have a policy workshop involving all the stakeholders (relevant ministries, project implementing agencies, project proponents, NGOs, etc.,).

It is also proposed to have a round table of relevant ministries every year before they finalize respective budgetary allocations to permit optimum utilization of resource.

Information Dissemination
The first step in achieving the targets is to create awareness about the Waste-to-Energy programs of the MNES through information dissemination. For urban and industrial sectors SAP proposes information dissemination through a series of workshops and training programmes. This targeted effort would be supported by a more general dissemination of information through the media also.

Technical Assistance
The SAP proposes the technical assistance to the urban local bodies in developing a clustering approach for making the projects viable for the smaller cities, preparation of DPRs and training programmes for project implementation. For Industrial sector the SAP proposes technical assistance for activities required before commercialization of a technology (like sectoral studies, system integration and clustering concept) and for preparation of DPRs and Training Programmes.

Research and Development
The SAP proposes support for Research and Development / Technology Demonstration / equipment development and scale up in urban and industrial sectors. A study and R&D programme on the advanced and emerging technologies in the Indian context is also proposed leading to demonstration and commercialization of the technologies for Waste-to-Energy. SAP proposes setting up of a dedicated team as an R&D cell within the MNES to co-ordinate and monitor all WTE R&D activities being carried out in national and international institutions in the urban and/or industrial sectors with special allocation of funds and resources.

Performance Monitoring
The SAP proposes performance evaluation of the existing projects supported by MNES from technical and financial aspects (technical and financial audit).

Similarly, a performance monitoring of the proposed activities of the SAP should be undertaken to assess achievements against targets and budget and to update work plan so as to achieve the set targets before the end of the financial year. It proposes monitoring thrice a year (1st July, 1st October and 1st January) besides a comprehensive review of the performance for the entire financial to be taken up on the 1st of April to permit modifications in the strategic plan for the ensuing financial year.

A separate budget of Rs 50 lakhs per year is provided for this activity.

Financial Requirement for the Period 2004 to 2007

The SAP proposes to provide financial assistance for activities to promote WTE projects and financial assistance for project implementation in urban and industrial sectors based on the strategies emerging from the NMP.

The financial requirements for all the various activities, including project implementation, are summarized in the table below

Sr. No	Enabling Instruments	2004-05	2005-06	2006-07	Total
		Rs in Crores			
1	Policy Initiatives	0.35	0.05	0.05	0.45
2	Information dissemination	1.37	1.87	1.37	4.61
3	Technical Assistance	4.70	1.85	2.35	7.90
4	Financial Assistance/ Assistance for Project Implementation	58.00	52.00	55.00	165.00
5	Research and Development (Across the Sectors)	5.65	9.85	5.75	21.25
6	Preparation for mobilizing external funding sources	0.25	-	-	0.25
7	Performance Evaluation and Monitoring	0.5	0.5	0.5	1.5
	Grand Total	70.82	66.12	65.02	200.96

Summary of Financial Requirements for the SAP activities 2004 to 2007

C.2 Accelerated Programme for the recovery of energy/power generation from industrial and commercial wastes and effluents for implementation in 2005-06

Objectives

The main objectives of the Accelerated Programme for recovery of energy power generation from industrial wastes are given below:

- To assess and upgrade various conversion technologies;
- To accelerate the installation of energy recovery projects from industrial wastes with a view to harness the available potential by 2017
- To create a conducive environment for the development of the sector in the country.

Scope

The scheme provides for Central Financial Assistance in the form of capital subsidy and Grants-in-Aid in respect of the following activities:

- Industrial waste to biogas
- Power generation from biogas
- Power generation from solid industrial waste.
- Promotional activities.
- R&D, Resource assessment, technology upgradation and performance evaluation, etc.

Eligibility of projects for Central Financial Assistance Criteria based on type of wastes

The eligibility criteria for type of 'wastes will be

- iProjects based on any bio-waste from industrial/agro-industrial sector (excluding rice husk and bagasse) that requires pre-processing before utilization for energy recovery,
- Projects for co-generation I power generation from available biogas.
- Mixing of other wastes of renewable nature, including rice husk, bagasse, sewage; cow-dung, other biomass and industrial effluents, including distillery effluents; up to a aximum of 25% will be permissible.
- Projects based on distillery effluents for generation of biogas, wastes from fossil fuels and waste heat (flue gases) shall not be supported,

Criteria based on technologies

The eligibility criteria for technologies will be :

- Projects based on waste-to-energy conversion technologies, namely, biomethanation, combustion, or a combination thereof,
- Projects for generation of power, from biogas through 100% biogas engines or steam turbines with a minimum steam pressure of 42 bar.
- There will be no minimum / maximum limit of project capacity

Assistance (CFA)

Central Financial Assistance to different` categories of projects would be given in the form of capital subsidy to the promoters and in the form of Grants-in-Aid for other activities, as given below:

Capital subsidy to promoters

Industrial waste to Biogas: • Biomethanation of low energy density and difficult industrial wastes (i.e. dairy, tannery, slaughter house, sugar (liquid), bagasse wash, textile (liquid), paper (liquid) and pharmaceutical industry • Biomethanation of other industrial wastes.	Rs. 1.0 crore/MW_{eq} (12,000 m^3 biogas per day) Rs. 0.5 crore/MW_{eq} (12,000 m^3 biogas per day)
Power Generation from Biogas • Boiler + Steam Turbine Configuration • Biogas Engine / Turbine Configuration	 Rs. 0.8 crore/MW Rs. 1.0 crore/MW
Power Generation from Solid Industrial Waste (Boiler + Steam Turbine Configuration)	Rs. 1.0 crore/MW

The amount of capital subsidy would be calculated on the basis of installed capacity.

- Total capital subsidy would be limited to Rs. 5.00 crore per project
- Subsidy amount will be restricted to 20% of the project cost.
- In case of Special Category States (NE Region, Sikkim, J&K, Himanchal Pradesh and Uttranchal), the capital subsidy would be 20% higher than that for General States. This provision will also be applicable to items (ii & iii) above.
- In case of ongoing projects 'sanctioned by the Ministry under, the existing interest subsidy scheme, the promoters would be given an option to get the undisbursed CFA amount adjusted against the loan as one-time support from.. the Ministry after successful commissioning of the. project. The total CFA amount will be equivalent to the original sanctioned interest subsidy amount, taking the appropriate discount factor used in the case of releasing the funds to IREDA/ other Fls/ banks, with the proviso that this should not lead to any additional outgo of funds from the Ministry.
- The projects already agreed to `in principle' by the Ministry, but could not be sanctioned so far, would be considered on merit under this programme.

Incentives to State Nodal Agencies

State Nodal Agencies would be provided an incentive / service charge @ 1% of MNES subsidy restricted to Rs. 5.00 lakh per project,. in order to facilitate development of projects and their monitoring during implementation / post commissioning.

Financial assistance for promotional activities

Financial assistance would be provided for organizing training courses, business meets, seminars I workshops, and publicity I awareness on case-to-case basis, subject to a maximum of Rs. 3.0 lakhs per event /activity.

Financial support to R&D projects

Financial support would be provided to R&D and Applied R&D projects including studies on resource assessment, technology upgradation, performance evaluation, etc. to institutions / industries. This will be governed by the procedures guidelines being issued by the R&D Division of MNES separately.

Financial support for preparation of DPR

50% of the cost,of DPR preparation, limited to Rs. 1.00 lakh/project, will be reimbursed to the promoters at the time of sanction of project.

Implementation Arrangements

The scheme will be implemented by private and public sector enterprises and organizations, as well as NGOs. IREDA; -other financial institutions or commercial-banks, shall forward the Detailed Project Reports, received from the promoters to file Ministry alongwith their Appraisal Note indicating the tech no-economic viability of the projects, taking into account the eligible capital subsidy. The promoters would be required to also submit an advance copy of their proposal to the Ministry directly.

For projects to be implemented without debt financing 1 loans from domestic. Fis / Banks, the proposals should be directly submitted to the Ministry for financial support. After receipt of DPR from the promoters, Appraisal Note and copy of loan sanction order from IREDA /.lead bank / FI, and other requisite information / documents from the promoters,. the proposal will be examined in the Ministry, and sanction will be issued for providing capital subsidy in accordance with the provisions of scheme.

Release of Central Financial Assistance (CFA)
The entire capital subsidy amount would be released directly to the lead bank / lending financial institution for the purpose of offsetting the loan amount only after successful commissioning of project as per DPR norms and receipt of copies of statutory clearances and requisite project relating information / documents. The condition of successful commissioning of the project would, inter-alias imply operation of the project for three months, including at least 72 hours continous operation at minimum 80% of rated capacity.

The incentives to State Nodal Agencies would be released after successful commissioning of the project.

In case the project is set up by the developer through his own resources, the CFA would be released directly to the developer after successful commissioning (as per item 7.1 above) of the project.

Monitoring Mechanisms

The concerned State Nodal Agencies will closely monitor the execution of the on-doing projects and provide guidance for their timely completion. They would also submit periodic progress reports to.MNES.

MNES will also monitor the progress of implementation of the projects as well as their performance regularly through a Monitoring Committee consisting of representatives from MNES, financial institution (s) / banks and State Nodal Agencies.

C.3 Waste-to-energy project installed or under commission, supported by MNES

The following projects have been supported by MNES under the National Programme on Energy from Urban and Industrial wastes.

Sr. No.	Name of the Project	Capacity	Year of commissioning
1.	Rice husk based power generation project at Gowthami Oil Solvents Ltd., Tanuku, A.P.	2.75 MW	1996-97
2.	Biogas based power project at K.M. Sugar Mills at Faizabad, U.P.	1.00 MW	1997-98
3.	Biogas based power project at Kanoria Chemicals & Industries Ltd., Ankleshwar, Gujarat	2.00 MW	1998-99
4.	Biogas based power project at Som Distilleries Ltd., Raisen, M.P.	2.7 0MW	1999-2000
5.	Biogas plant based on Starch Industry Wastes at Vensa Biotek, Samalkot, A.P.	8000 cum. biogas per day (0.70MWeq)	1999-2000
6.	MSW based pelletisation project by SELCO, Hyderabad (Phase I)	100 tpd (4.00 MWeq)	1999-2000
7.	Biogas based Power Generation Project at M/s Brihan Sugar Syndicate Ltd., Sheerpur, Dist. Solapur, Maharashtra	1.00 MW	2000-2001
8.	Biomethanation plant based on starch industry waste at M/s. Anil Starch, Ahmedabad, Gujarat.	0.45 MW	2001-2002
9.	Biomethanation Plant based on Sago Industry Waste at M/s Varalakshmi , Tamil Nadu	0.20 MW	2001-2002
10.	MSW based pelletisation project by SELCO, Hyderabad (Phase II)	100 tpd (4.00 MWeq)	2001-2002
11.	Biogas based power generation project by M/s Universal Starch-Chem Ltd., Dhule, Maharashtra	10,000 cum biogas per day (0.90 MWeq)	2001-2002
12.	Biogas based power generation project by M/s Saraya Distillary, Gorakhpur, U.P.	2.0 MW	2002-2003

During 2004-2005:

S.No.	Project	Capacity
1.	Biomethanation-cum-Power Generation project from Poultry droppings by M/s. G.K. Bio-Energy Pvt. Ltd., Namakal, Tamil Nadu	1.5 MW
2.	Biomethanation-cum-power generation project from MSW of Lucknow city by M/s Asia Bio-energy Pvt. Ltd. Chennai	5.00 MW
3.	Power generation project from Starch Industry Solid Waste by M/s Vensa Biotek, Samalkot, A.P.	4.0 MW

4.	Power Generation project from Palm Oil Industry Waste by M/s MPR Power Projects Pvt. Ltd., Hyderabad	3.0 MW
5.	MSW based power project at Vijaywada by M/s Sriram Energy Systems Pvt. Ltd.,	6.0 MW
6.	MSW based power project at Vijaywada by M/s Selco International	6.60 MW

Under development (2004-2005)

S.N.	Name of Project	Capacity (MW)
1.	Sugar Cane pressmud based Biomethanation cum power generation project at M/s St John Sangam Trust, Perambalur, Tamil Nadu.	2.0
2.	Power project based on poultry waste by M/s Kakatiya Allies Pvt. Ltd., Rangareddy Distt., A.P.	6.0
3.	Furfural Industry waste based power project by M/s. Delta Agro Chemicals Ltd., Krishna Distt., A.P.	2.0
4.	Poultry Waste based Biomethanation-cum-power generation project by M/s Ramaprasad Pvt. Ltd., Tanaku, A.P.	3.0
5.	M/s Rajabhaskar poultry waste based Biomethanation-cum-power generation project at Mundargi Vill., Billary Dist. Karnataka.	7.5
6.	Poultry waste based power generation project by M/s Raus Power Pvt. Ltd., Anaparthy Vill., East Godavari Dist. A.P.	3.6
7.	MSW based power generation project by M/s MSW Power India Ltd. at Navi Mumbai	12.0
8.	Starch Industry Liquid Waste based project by M/s Sahyadari Starch & Industry Ltd., Sangli, Maharashtra.	0.5 MWeq.
9.	Starch Industry Liquid waste based power generation project by M/s Devicorn Pvt. Ltd., East Godavari, A.P.	1.5
10.	Poultry Waste based power generation by M/s Sareen Poultry Farm, Raipur, Chhattisgarh.	54 kW
11.	Poultry Waste based power generation by M/s EGG Industries, Raipur, Chhattisgarh	54kW
12.	Poultry Waste based power generation by M/s Jayashree Poultry Farm, Raipur, Chhattisgarh	45kW
13.	Poultry Waste based power generation by M/s Kakku Poultry Farm, Mohandi, Dist. Rajnandgaon, Chhattisgarh	60kW
14.	Biogas generation plant based on Starch Industry Liquid Waste by M/s Rajaram Maiz Products, Rajnandgaon, Chhattisgarh.	1875cum. biogas/day (0.15 MW)
15.	Power Generation from Fruit Processing Industry Wastes by M/s Laxminaarayanaa Green Energy Pvt. Ltd., Chennai	2.25 MW

ANNEX D. QUESTIONNAIRE

UNDP / GEF Development of High Rate Biomethanation Process as means of Reducing GHG Emissions projects in India

Terminal Evaluation October 2005

Questionnaire for Subproject Interviews

A Basic Project Details

1. Project Title:
2. Promoter:
3. Organization type:
4. Management Reasons for participation in the project:

5. Substrate:
6. Baseline situation:
7. Capital Cost:

B Choice of Technology

1. Reasons for selection of Biomethanation:
2. Process of Selection:
3. Alternatives Considered:
4. Strengths/ Weaknesses of technology:

C Experiences

a) Project Formulation:
   i) Internal decision making process:
   ii) Investment Criteria:
   iii) Assistance received in formulation:
   iv) Stakeholder Consultations
   - Were they held among affected parties, within and outside of the implementing company?
   - Were there any significant suggestions/modifications?
   - Did the project design, structure or other parameters undergo any changes as a result?

b) Project Promoter Selection:
   i) Project process followed:
   ii) Model followed:
   iii) Criteria for Selection:
   iv) UNDP / GEF project assistance:

c) Construction:
   i) Time Line Planned Vs. Actual:

d) Commissioning and Commercial Operation:
   i) Process of testing / Commissioning:
   ii) Time required for commissioning / stabilization

e) Operation:
   i) Performance statistics since commissioning
   ii) Design Vs. Actual Performance:
   iii) Problems encountered and solutions

f) Overall Experience
   i) Training/ Capacity building:
   ii) Manpower trained:
   iii) Jobs created:

D Feedback Loop

1. Have the expectations been met?
2. Given choice would you still adopt biomethanation
3. Any additional similar project under planning:
4. Experience about UNDP/GEF process: Usefulness about subsidy (For only first demo project):
5. Experience about Implementing agency
6. Experience about research institution:

E Miscellaneous

1. Capacity Building on general concepts:
2. Did you participate in a study tour/fellowship program?
3. Exposure to worldwide experience:

Thank you for your valuable time and inputs!