Executive Summary

ES 1 The National Master Plan

The National Bio-energy Board (NBB), Ministry of Non-Conventional Energy Sources (MNES), is developing a National Master Plan (NMP) for waste-to-energy as one of the activities under UNDP/GEF assisted project on development of high rage biomethanation processes as a means of reducing Green House Gases Emission. The NMP provides a framework for waste-to-energy programme for the country besides a means of processing / treatment for safe disposal of waste.

The primary objective of NMP is to provide additional power generation capacity in a decentralized manner through projects for 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. The NMP 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 has been developed to formulate NMP.

- Assess the potential of the wastes to generate energy in urban and industrial sectors
- Identify priority areas in urban and industrial sectors
- Select appropriate technologies for identified priority areas
- 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 requirements

ES 1.1 Potential and Priorities

The first step is to assess the potential of the solid and liquid wastes to generate energy in the urban and industrial sectors and determine the priority areas within the sectors.

ES 1.1.1 Urban Sector

Municipal Liquid Waste (MLW)

The potential of the MLW for conversion to energy is presented in Table ES 1.

Table ES 1 Power Generation Potential from Urban Liquid Waste

Year	Sewage Generated (MLD)	Power Generation (MW)
2002	15402	287
2007	17775	332
2012	20680	386
2017	24752	462

Treatment of urban liquid wastes is principally managed by local bodies and supported financially to some extent by the Ministry of Environment and Forest (MoEF) through National River Conservation Directorate's (NRCD) River Action Plans for some identified River Basins. Since WTE projects are an integral part of the overall wastewater treatment, MNES has a limited role in the overall project being executed with NRCD support or directly by the local body.

Out of these projects, only those, which use anaerobic systems, will be amenable to energy generation. Also the amount of power generated by these plants is generally sufficient to meet about 60% (in some cases 100%) of the power needs of the plant itself thus making it a "captive generation plant."

Considering the above, although urban liquid waste has substantial potential of conversion to energy, the scope for MNES initiative is rather limited.

Municipal Solid Waste(MSW)

The potential of the MSW for conversion to energy is presented in Table ES 2.

Table ES 2 Power Generation Potential from MSW

Period	MSW Generated	Power Generation
	(TPD)	(MW)
2002	97174	1638
2007	130927	2266
2012	189986	3276
2017	265834	4566

Under the Municipal Solid Wastes (Management & Handling) Rules of December 2000, all Class I cities have to provide proper treatment and disposal facility for MSW. This translates to a very significant potential for WTE projects.

Based on the above it has been decided that, in the urban sector, focus of the NMP would be primarily on MSW with emphasis on Class I cities. However, the present policy for MLW would also be continued.

ES 1.1.2 Industrial Sector

The energy generation potential from identified industrial sectors are presented in Table ES 3

Table ES 3 Power Generation Potential in Identified Industrial Sectors

Sectors	Period		
	2007	2012	2017
Dairy (Liquid waste)	61	77	96
Distillery (Liquid waste)	503	628	785
Maize Starch	105	132	164

Sectors	Period		
	2007	2012	2017
Liquid Waste	*24*	*30*	*37*
Solid Waste	*81*	*102*	*127*
Tapioca Starch	24	30	37
Liquid Waste	*18*	*22*	*27*
Solid Waste	*6*	*8*	*10*
Poultry (Solid waste)	65	81	102
Paper (Liquid waste)	58	72	90
Slaughterhouse (Solid Waste)	94	117	146
Sugar	363	453	567
Liquid Waste	*59*	*73*	*92*
Solid Waste	*304*	*380*	*475*
Tanneries (Liquid waste)	6	8	10
Total	**1279**	**1598**	**1997**

The identified priority areas in the industrial sector are presented in Table ES 4.

Table ES 4 Prioritization of Industrial sector for WTE Projects

Sector	Grade / Priority
Distillery, Paper, Sugar (pressmud), Maize Starch	A
Dairy ,Sugar (liquid), Poultry Farms, Slaughter House, Tapioca Starch	B
Tannery	C

Source: Technical Memorandum on Shelf of Viable Projects, August 2003

The approach proposed for the industrial sector is that the focus should be on the priority sectors. For sectors where individual units do not have a potential for energy generation (e.g Poultry, Cattle Farms etc.) clusters of units would have some potential, which can be explored. A mechanism similar to the concept of CETPs can be considered to harness the energy potential.

ES 1.2 Technologies

The most significant waste-to-energy technologies are based on biological or thermal methods. It is essential that technologies identified, based on evaluation criteria consisting of technical, commercial and environmental aspects, are employed for the WTE projects.

ES 1.2.1 Urban Sector

MLW being a very dilute waste, biomethanation is the only relevant WTE technological option. Whereas for MSW, the ranking of various WTE technologies is presented in Table ES 5

Table ES 5 Ranking of Technologies

S. No.	Technology	Ranking
A. Biological Process		
1.	Biomethanation	1
2.	Landfill with Gas Recovery*	2
• **B. Thermal process**		
4.	Gasification	3
5.	Incineration	4

* *Landfill with gas recovery is excluded as a potential technology option in view of "The Municipal Solid Waste (Management & Handling) Rules, 2000. Under unavoidable circumstances or till installation of alternate facilities, landfilling shall be done following proper norms.*

ES 1.2.2 Industrial Sector

The technologies, identified for conversion of different types of industrial waste in to energy are given in Table ES 6.

Table ES 6 Identified Industrial WTE technologies

Sr. No	Type of Waste	Technology
1	Liquids	Biomethanation
2	Solids	Gasification/Pyrolysis, Incineration/Combustion
3	Semi-solids	Biomethanation, Gasification/Pyrolysis, Incineration/Combustion

Source: Technical Memorandum on Waste-to-Energy Technologies, February 2003

ES 1.3 Demonstration Projects

The present policy of supporting demonstration projects does not seem to have defined selection criteria and focused strategy. Of the 18 projects, which have received support from MNES, majorities are based on industrial wastes. Therefore, a review of present selection criteria and development of a focused strategy are needed for implementing the demonstration projects.

The approach adopted in the NMP is to cover identified priority sectors for urban and industrial WTE projects and avoid duplication. It also recommends conditions that would permit replication and access to technology by others and financial contribution by the beneficiary should be essential part of the demonstration projects.

ES 1.4 Research & Development

The NMP approach is to encourage need based R & D, promote adaptive research, integrate demonstration/pilot projects and commercialization with R & D and use technology acquisition wherever possible.

A dedicated full-fledged institutional R & D Cell is recommended for coordination of all WTE R&D activities.

ES 1.5 Finance

For funding, the NMP approach is to gradually move away from subsidy regime towards sustainable development with self-sufficiency. The NMP recommends the introduction of a credit line for financing the WTE projects.

ES 1.6 Targets and Time Frame

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, end of 12th Five Year Plan (FYP).

For the period 2004 to 2007, considering the 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:

- Interest subsidy 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 / demonstration projects, development of strategies to attract private initiatives and initiation of the process to move from subsidy regime to self sustaining regime.

For the Eleventh and Twelfth Five Year Plans the targets are based on the successful implementation of the above strategies and accelerated growth in implementation of WTE projects to achieve the final targets at the end of the Twelfth Five Year Plan.

Based on the above rationale, the targets and time frame for the period 2004 to 2017 are developed and the same is presented in Figure ES 1and ES 2 in terms of MW and percentage respectively.

Figure ES 1 Targets and Time frame for the period 2004 – 2017 (MW)

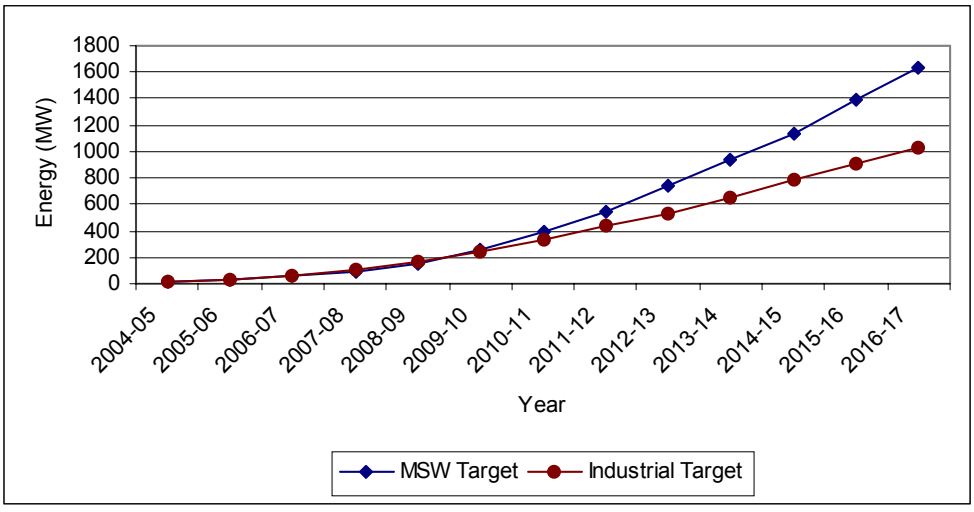
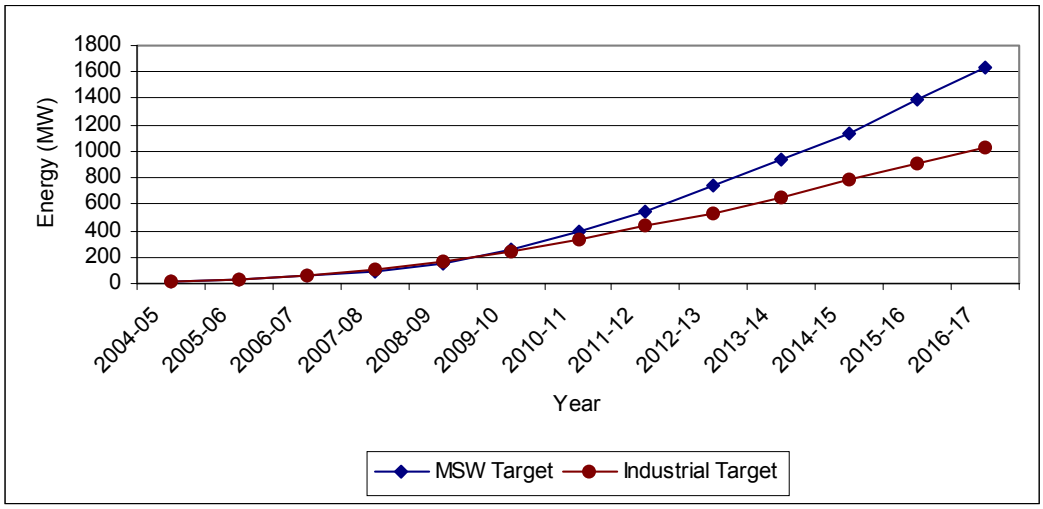


Figure ES 2 Targets and Time frame for the period 2004 – 2017 (%)



ES 1.7 Financial Analysis

- Financial analysis of WTE projects has been used to assess their commercial/financial viability based on the potential revenue generation to the investment made. A realistic criteria for such analysis consisting of capital cost, operation and maintenance costs, cost of capital, power price, price of other by- products etc. were developed.

ES 1.7.1 Urban Sector

Municipal Solid Waste

Based on these criteria the commercial viability of MSW to energy projects using biomethanation and RDF with incineration technologies for plant capacities of 150, 500 and 1000 TPD were determined. Based on the above, the following subsidies for MSW to energy projects for the period 2004 to 2007 have been recommended.

Table ES 7 Capital Subsidy Requirements (Rs Crores/MW) for Commercial Viability of MSW to Energy Project for the Period 2004-07

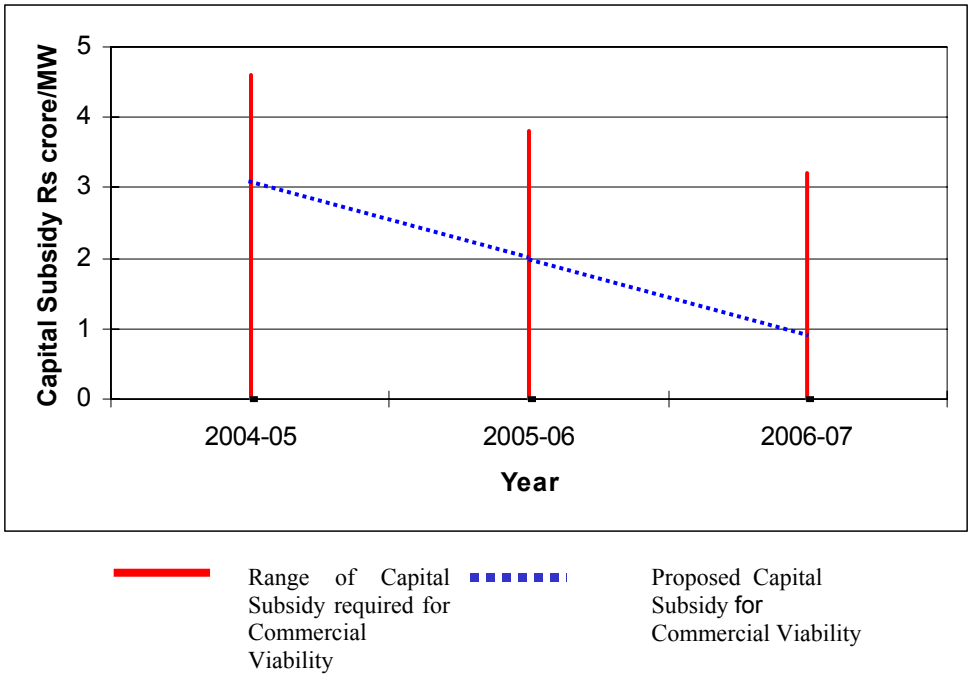
S. No	Year	Biomethanation (TPD)			RDF (TPD)		
		1000	500	150	1000	500	150
1	2004-05	Nil	3.9	4.6	Nil	Nil	1.5
2	2005-06	Nil	3.1	3.8	Nil	Nil	0.8
3	2006-07	Nil	2.4	3.2	Nil	Nil	0.1

The capital cost per MW energy generation is expected to decrease as the technologies mature with time and also due to the reducing trend of the interest rates. Based on these considerations a separate set of criteria for financial analysis for the eleventh and twelfth FYP has been developed to analyse the commercial viability

Analysis of commercial viability showed that no subsidy is required for MSW to Energy Projects during the 11th and 12th FYP. For speedy implementation of the Waste-to-Energy projects the NMP

recommends a credit line for providing a loan of 33.33 % of the project cost to the proponent at an interest rate 2 % lower than the market rate.

- **Figure ES 3 Proposed Capital Subsidy (Rs Crores/MW) for MSW to Energy Projects for the Period 2004-07**



Municipal Liquid Waste

The management of MLW is included in various programmes of NRCD, MoEF. The scope of financial contribution from MNES appears to be rather limited. However, a budget of Rs. 2 Crore for the year 2004-05 and Rs. 3 and 4 Crores respectively for the subsequent years has been proposed to maintain continuity of the existing policy.

The technology for treating MLW is well proven in the country and the MoEF is also very active in this sector by providing 70 % of the project cost as subsidy. Hence the NMP recommends that MNES need not provide financial support in this sector from 11th FYP.

ES 1.7.2 Industrial Sector

To encourage the energy generation from the industrial waste, NMP recommends to create 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.

The cost to the government is based on a loan up to 33.33 % of the project cost with interest rate 2 % lower than the market rate for the Eleventh and Twelfth Five Year Plan.

ES 1.8 Cost to Government

Based on the NMP targets and timeframe and strategies emerging out of financial analysis, discussed above, the cost to the Government for implementation of WTE projects during the period 2004-07, 11th and 12th FYP for urban and industrial sectors is given in Table ES 8.

Table ES 8 Summary of Cost to the Government

S. No	Period	Net Cost to Government (Rs. Crores)		
		Urban		Industrial
		MSW	MLW	
1	2004-07	110	9	45
2	2007-12	1270	-	891
3	2012-17	1363	-	499
	Total	**2743**	**9**	**1435**

ES 1.9 Funding Options

The various options available for providing funds for credit line are:

- Other Ministries
- Multi Lateral / Bilateral Agencies

At the central level, other than the Ministry of Non-conventional Energy Sources (MNES), Ministry of Environment and Forest (MoEF) and Ministry of Urban Development (MoUD) are the nodal ministries involved in formulating the policies and programmes for the waste management in the country.

The Ninth and Tenth Five Year Plan budgets of these ministries were studied in-order to ascertain the possible funding from these ministries. The possible funding from MoEF and MoUDare given in Table ES 9

Table ES 9 Possible Funding from MoEF and MoUD

Sr. No	Ministry	Year	
		2012	2017
1	MoEF *	250	375
2	MoUD*	500	800
	Total	**750**	**1175**

** Assuming that 10% of the budget is used for Waste-to-Energy Projects*

There are several international financial institutions and agencies that also fund projects in the energy and environment sectors. A line of Credit can be obtained from these institutions through financing agreements between the Government of India and the Government of lending country.

The line of credit can be managed by any national funding institutions, which in turn can lend the funds to the project proponents at an interest rate equivalent to the market rate. The difference between the interest income earned from the project proponents can be utilized to create an Interest Differential Fund (IDF). This fund can then be utilized as a revolving fund or to pay back the credit.

ES 1.10 Implementation

Waste-to-energy projects are generally promoted /implemented either by private entrepreneurs/organizations or Urban Local Bodies (ULBs). A series of risks are perceived by them

during the course of implementation of the WTE projects and hence a critical assessment of the various risks involved and the remedial measures that could be evolved is an important phase for encouraging initiation of WTE projects.

The risk factors that could be considered by investors while analyzing WTE projects and possible mitigation measures have been discussed in Chapter 2.

ES 2 Strategic Action Plan (Road Map)

The Master Plan consists of a set of objectives, strategies and targets and time frame. The next step involved is the conversion of this Master Plan into a Strategic Action Plan or a Road Map. The Strategic Action Plan (Road Map) is prepared for the period 2004 to 2007. This action plan is detailed sufficiently and provides a framework to develop subsequent action plans for the Eleventh and Twelfth five-year plans. This will permit flexibility to develop the action plans based on the experience gained as well as performance evaluation. 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.

The Strategic Action Plan (SAP), thus 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.

ES 2.1 Policy

To discuss various policy issues and arrive at a consensus it is proposed to have a policy workshop among 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.

The financial requirements for implementing the action plan for policy initiatives is given in Table ES.11

ES 2.2 Information Dissemination

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

by a more general dissemination of information through the media also. Funding requirement for various modes of information dissemination is given in Table ES 10.

ES 2.3 Technical Assistance

The SAP proposes technical assistance to urban local bodies in developing a cluster approach for making the projects viable in the smaller cities, preparation of DPRs and training programmes for project implementation. For the Industrial sector, 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. Funding requirement for technical assistance in urban and industrial sectors is given in Table ES10.

ES 2.4 Financial Assistance

The SAP proposes to provide financial assistance for project implementation in urban and industrial sectors based on the strategies of the NMP. The funding requirement is given in Table ES10.

ES 2.5 Research and Development

The SAP proposes support for Research and Development / Technology Demonstration 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 also proposes setting up of a dedicated team as R&D cell within the MNES to co-ordinate and monitor all WTE R&D activities that are carried out in national and international institutions in the urban and/ or industrial sectors with special allocation of funds and resources. Funding requirement for carrying out various proposed R & D activities is given in Table ES10.

Besides these the SAP proposes to approach multilateral and bilateral funding agencies for a credit line for Waste-to-Energy projects and aid for technical assistance to be available for the eleventh five year plan.

The total funding requirement for the period 2004-07 is given in Table ES 10

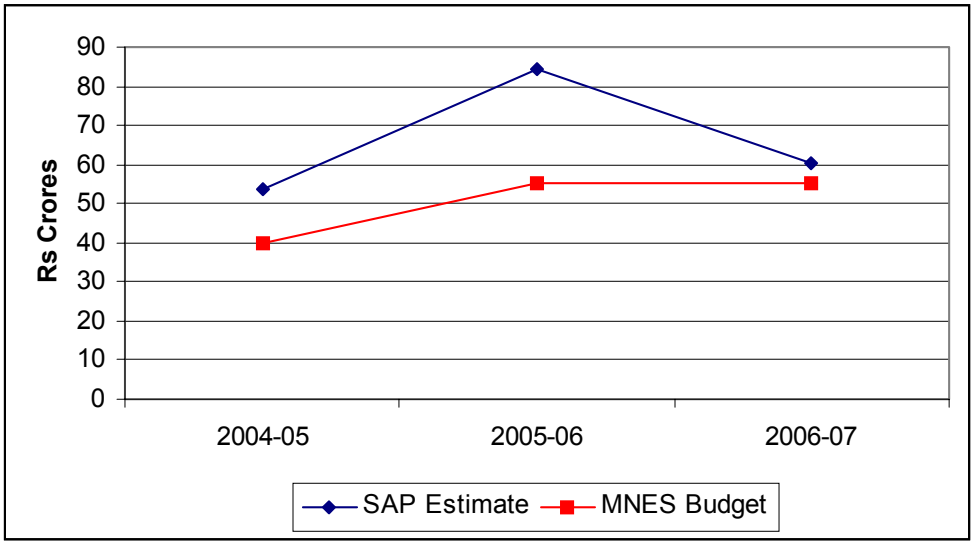
ES 10 Summary of Funding Requirement for the period 2004-07

Sr. No	Enabling Instruments	Sector	2004-05	2005-06	2006-07	Total
			Rs in Crores			
1	Policy Initiatives		**0.35**	**0.05**	**0.05**	**.45**
2	Information dissemination	Urban Sector	0.60	0.60	0.60	1.80
		Industrial Sector	0.30	0.30	0.30	0.90
		Through Media	1.0	0.5	0.5	2.00
			2.25	**1.45**	**1.45**	**5.15**
3	Technical Assistance	Urban Sector	1.55	1.05	1.55	4.15
		Industrial Sector	2.65	0.80	0.80	4.25
			4.20	**1.85**	**2.35**	**8.4**

Sr. No	Enabling Instruments	Sector	2004-05	2005-06	2006-07	Total
			Rs in Crores			
4	Financial Assistance/ Assistance for Project Implementation	Urban Sector	36	28.50	29	93.5
		Industrial Sector	05	15	25	45
			41	**43.50**	**54**	**138.5**
5	Research and Development (Across the Sectors)	Urban Sector	3.0	4.5	1.5	9.0
		Industrial Sector	0.20	0.30	-	0.5
		Advanced Emerging Technologies and	0.75	0.75	-	1.50
		Dedicated WTE R&D Cell	2.0	2.0	1.0	5.0
			5.95	**7.55**	**2.5**	**16.00**
6	Preparation for mobilizing external funding sources		0.25	-	-	0.25
	Grand Total		**53.90**	**84.4**	**60.35**	**168.50**

The comparison of the budget of MNES for the period 2004-07 with estimated budget/funding requirements of SAP is presented in Figure ES 4

Figure ES 4 Comparison of MNES Budget and Estimated SAP Funding Requirement for period 2004-07



The SAP proposes monitoring the performance of the activities 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 in 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.

1 Introduction

Waste-to-Energy projects form an integral but small part of the overall waste management strategy. Its future growth is, hence, inseparably linked with the progress made by the country in waste management. Rigorous implementation of the current Ministry of Environment & Forests' (MoEF) policies, enforcement of the Environmental Protection Legislation and Rules and implementation of current policies of MNES as well as those proposed in the National Master Plan (NMP) will thus determine the future of Waste-to-Energy projects.

At present, MNES is implementing a Programme on Energy Recovery from Urban Wastes with the following objectives:

- To harness the available potential of MSW-to-energy;
- To promote the setting up of projects for recovery of energy from urban wastes; and,
- To create a conducive environment for the development and implementation of waste-to-energy projects.

Three projects for energy recovery from Municipal Solid Wastes with an aggregate capacity of 17.6 MW have been set up at Hyderabad, Vijayawada and Lucknow. Other urban waste projects include a 1 MW project based on cattle manure at Haebowal, Ludhiana; a 0.5 MW project for generation of power from biogas at sewage treatment plant at Surat; and, a 150 kW plant for vegetable market and slaughterhouse wastes at Vijayawada. Another 300 kW project based on vegetable market waste is under commissioning at Chennai. Similarly, projects aggregating to about 27 MW have been installed in the country so far in distilleries, pulp and paper mills, slaughter houses, tanneries and starch industries. Detail of these projects are presented in Appendix A.

Waste management is the domain principally of the MoEF, which deals with both Urban and Industrial Pollution Control and Prevention. It is the ministry that is responsible for the enactment of laws, framing of rules and their enforcement. It also supports waste management projects through various programs such as River Action Plans under National River Conservation Directorate (NRCD), Common Effluent Treatment Plants etc.

Similarly the Ministry of Urban Development and Poverty Alleviation (MoUD&PA) is involved in projects related to the urban infrastructure including urban waste management, especially the Municipal Solid Waste (MSW).

Various ministries and departments involved in waste management either directly or indirectly in Waste-to-Energy projects are presented in Figure 2.5 and Figure 2.6 for Urban and Industrial Sectors respectively.

MNES, hence, has to have active co-operation with these ministries for successful implementation of Waste-to-Energy projects. The National Master Plan for Waste-to-Energy therefore has to be developed considering this perspective.

1.1 Activities Leading to development of the NMP

The preparation of the NMP is based on the following activities carried out and presented in various reports.

- Preparation of Structured Database
- Assessment of Ongoing R&D Programs

- Analysis of Technology Options
- Identification of Technology Transfer Mechanisms
- Study of Government Infrastructure
- Development of Investment and Funding Strategies
- Development of Shelf of Viable Projects

The NMP is designed to be a "stand alone" document. It incorporates key concepts developed in the various Technical Memoranda (Structured Database, Technologies, Research and Development, Technology Transfer, Government Infrastructure, Investment and Funding Strategies, Funding and Shelf of Viable Projects) earlier submitted as part of the development of the NMP.

1.2 NMP Objective

The primary objective of NMP is to provide additional power generation capacity in a decentralized manner through projects for 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. The NMP 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.

1.3 Analysis of the NMP Objective

The analysis of the NMP objectives raises the following questions which the subsequent sections attempt to deal with.

- "Maximize energy recovery from urban and industrial wastes"
  - The targets are urban liquid, urban solid, industrial liquid and industrial solids. Which is the priority?
  - How do we define "maximize"? by the Quantity of waste, or/and the number of towns/industries, or/and the energy/fuel generation or/and the money spent?
  - How do we realize this objective? Is it through financial support, technical support, & creation of awareness?
- "Cost effectiveness by using technologies that are applicable to the Indian conditions, and to support the ongoing adaptation to meet implementation needs"
  - What is the ranking of available technologies?
  - What technologies should be "demonstrated"?
  - What Research and development effort should be supported?
- "Vital solutions to environmental problems including reduction in GHG emissions"
  - Should the waste management be the primary target as it is the starting point of Waste-to-Energy projects?
- "Road map for the next 10 to 15 years"
  - What should be the basis for setting up realistic targets and time frame?

Based on the above, the approach developed for the National Master Plan (NMP) is to define and analyze the primary objective of the NMP, identify focus areas in each of the sectors to maximize returns on investments and to develop strategies to make the enabling instruments more effective. The NMP also provides targets for the period 2004 to 2017 (upto the end of twelfth five year plan). This approach and development of the NMP is presented in Chapter 2.

Chapter 3 deals with the Strategic Action Plan (Road Map) which provides details about activities to be under taken with in a time frame, agencies identified to carry out these activities and provides estimates of financial requirements for successful implementation.

Although the NMP is prepared for the period 2002 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.

2 The National Master Plan

The NMP approach is to identify potential and priorities (focus areas) in each of the sectors to maximize returns on investments, select technologies suitable for Indian conditions, to support ongoing adaptation to meet implementation needs, to setup realistic targets and time frame and to develop strategies to make the enabling instruments more effective.

Following steps are proposed for the development of NMP

- Assess the potential of the wastes to generate energy in the urban and industrial sectors
- Identify the priority areas in urban and industrial sectors
- Select appropriate technologies for priority areas
- 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

2.1 Assessment of Waste-to-Energy Potential

2.1.1 Urban Sector

2.1.1.1 Municipal Liquid Waste (MLW)

The estimated energy generation potential for the year 2002 is 287 MW. The power generation potential at the end of the year 2007, Eleventh (2007-2012) and Twelfth (2012-2017) Five Year Plan is given in Table 2.1.

Table 2-1. Power Generation Potential from MLW

Year	Sewage Generated (MLD)	Power Generation (MW)
2007	17775	332
2012	20680	386
2017	24752	462

Source: Structured Urban and Industrial Database

2.1.1.2 Municipal Solid Waste (MSW)

MSW has a high-energy generation potential. The power generation potential from MSW is given in Table 2.2

Table 2-2. Power Generation Potential from MSW

Period	MSW Generated (TPD)	Power Generation (MW)
2002	97174	1638
2007	148066	2550
2012	214865	3688
2017	303627	5192

Source: Structured Urban and Industrial Database

2.1.2 Industrial Sector

The energy generation potential from identified industrial sectors at the end of the period 2004-07, Eleventh (2007-2012) and Twelfth (2012-2017) Five Year Plan are given in Table 2.3

Table 2-3. Power Generation Potential from Industrial Sector (MW)

Sectors	Period		
	2007	2012	2017
Dairy (Liquid waste)	61	77	96
Distillery (Liquid waste)	503	628	785
Maize Starch	105	132	164
Liquid Waste	*24*	*30*	*37*
Solid Waste	*81*	*102*	*127*
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Solid Waste	*6*	*8*	*10*
Poultry (Solid waste)	65	81	102
Paper (Liquid waste)	58	72	90

Sectors	Period		
	2007	2012	2017
Slaughterhouse (Solid Waste)	94	117	146
Sugar	363	453	567
Liquid Waste	*59*	*73*	*92*
Solid Waste	*304*	*380*	*475*
Tanneries (Liquid waste)	6	8	10
Total	**1279**	**1598**	**1997**

Source: Structured Urban and Industrial Database.

The estimated energy potential for the year 2002 for MSW, MLW and Industrial are1638 MW, 287 MW and 1022 MW respectively.

2.2 Identification of Priority Areas

2.2.1 Urban Sector

2.2.1.1 Municipal Liquid Waste

The treatment of the urban liquid wastes is principally managed by Local Bodies and supported financially to some extent by the MoEF through NRCD's River Action Plans for some identified River Basins. The support is in the form of grant, which in the past was as high as 100% and is presently 70%.

In order to harness the power generation potential of MLW the issues considered for the NMP are as follows:

- Since Waste-to-Energy projects are an integral part of the wastewater treatment, MNES could only "tag on" to the overall project being executed with NRCD support or directly by the Municipality.
- Out of these projects, only those, which use anaerobic systems, will be amenable to energy generation.
- The amount of power generated by these plants is generally sufficient to meet about 60% (in some cases 100%) of the power needs of the plant itself thus making it a "captive generation plant."

Considering the above, although urban liquid waste has some potential of conversion to energy, the scope of MNES initiative is considered to be rather limited.

2.2.1.2 Municipal Solid Waste

Municipal Solid Waste (MSW) management is the primary responsibility of the Local Bodies and at present gets some financial support from the MoUD. Support from MNES is restricted to Waste-to-Energy projects only.

The issues requiring consideration for the NMP are as follows:

- Under the Municipal Solid Wastes (Management & Handling) Rules of December 2000, all Class I cities have to provide proper treatment and disposal facility for MSW by December 2003. This translates to a very significant potential for Waste-to-Energy projects.

- Emphasis so far has been on supporting large projects in Metros where most of the projects are on BOO, BOOT etc, where the support is in the form of Capital or Interest subsidy.

- There is a pressing need for technical and financial support for MSW management in smaller towns facing the deadline of the MSW Rules.

Considering the above, the NMP, in the urban sector, primarily focuses on conversion of MSW to energy.

2.2.2 Industrial Sector

A consolidated representation of the WTE assessment framework for the different industrial sectors is given in Appendix 2A. The priority rating of various industrial sectors for Waste-to-Energy projects is carried out based on Sector Power Potential (MW), Waste Availability/Collection, Emerging Clean Technology and Technology Status. The rating given to the individual evaluation criteria tend to reflect the industry's experiences in adapting novel biomethanation systems and processes during the past decade. All the industrial sectors have been re-grouped in terms of the total score to evolve a grading system.

A summary of prioritized industrial sector having WTE potential is given in Table 2.4

Table 2-4. Prioritization of Industrial sector for WTE Projects

Sector	Grade / Priority
Distillery, Paper, Sugar (pressmud), Maize Starch	A
Dairy ,Sugar (liquid), Poultry Farms, Slaughter House, Tapioca Starch	B
Tannery	C

Source: Technical Memorandum on Shelf of Viable Projects

The various issues considered by the NMP are discussed below.

2.2.2.1 Liquid Wastes

The Waste-to-Energy projects is a part of the overall waste management strategy. Financial support has been given, by MNES, to some of these industries in the form of demonstration projects.

- The Government of India policy, with respect to pollution control in large and medium scale industries, clearly specifies that it is the responsibility of the industrial unit itself under the polluter pays principle.

- The Environmental Protection Act makes it mandatory for industries to comply with pollution control requirements and achieve the disposal standards.

- The present MNES policy for industrial liquid waste gives priority to power generation as against fuel/energy generation.

- For small-scale units, a proper assessment is necessary to target the liquid waste along with the financial support required for this purpose. The NMP considers a mechanism similar to the concept of CETPs to harness the liquid Waste-to-Energy potential.

2.2.2.2 Solid Wastes

Solid waste generated by some industrial sectors; such as sugar, pulp & paper etc. have a potential for energy generation.

Again, for small-scale units, although individual units do not have a potential for energy generation, clusters of units, for example poultries, would have some potential, which can be tapped.

These wastes can possibly be targeted through technical and financial support, after a detailed assessment.

2.3 Selection of Appropriate Technologies

2.3.1 Urban Liquid Waste

MLW being a very dilute waste, biomethanation is the only relevant Waste-to-Energy technological option. Significant progress has already been achieved, by NRCD, MoEF, during the nineties for exploiting the biochemical energy potential of MLW through biomethanation processes. Several full scale plants of various capacities are in successful operation in the country.

2.3.2 Urban Solid Waste

This section of the Master plan elaborates about the various technological options and assessment of these technologies

2.3.2.1 Technological options

Several technologies are now available for energy recovery from urban and industrial wastes that are based on thermal or biological methods (Figure 3).

Sanitary Landfill

Historically, landfills have been the most economical and environmentally acceptable means for disposal of solid wastes throughout the world. Even with the initiation of concepts like waste reduction, recycling and transformation technologies, disposal of residual solid wastes in landfills remains an important component of an integrated solid waste management system.

Over the past two-three decades, engineering features have been added to address the numerous environmental concerns of atmospheric contamination by landfill gases (LFG) and contamination of ground/ surface water resources by leachates and surface run-off

The quantum of LFG generated from a landfill depends on the characteristics of the waste deposited. The amount of degradable materials in MSW is determined by the composition of waste and its exposure to moisture in the landfill.

The rate of landfill gas generation is influenced by several environmental factors. These factors determine the decomposition rate, which, in turn, affects the volatility and productive life of a landfill.

The time taken for the decomposition of half of the degradable content of MSW also varies, for example, food waste takes 1 year, garden trimmings takes 5 years whereas card board takes almost 15 years.

Generally, it takes almost two years, from the beginning of landfill, to generate maximum quantity of LFG . During this time, anaerobic digestion of most of the organic content of food wastes occurs. LFG generation continues after this time but at slowly decreasing rates. While gas generation can extend for periods of up to fifty years, in most cases, LFG release occurs within five years, because food and garden waste typically comprise a large proportion of all organic materials in MSW.

Although the gas is produced once anaerobic conditions are established within the landfill, it may take several years to produce sufficient quantity of LFG, which intrun can be used o produce power. LFG production (and also the quality of the gas) declines along with the time to the extent at which power generation is no longer economical. Generally, for a typical well-engineered and well-operated landfill, the expected period of LFG production may be as long as 50 to 100 years. However, power generation may be economically feasible only for 15 to 20 years.

The microbial process and the reactions that take place within the landfill influence the composition of landfill gas. For a landfill with gas recovery, proportion of methane present in the LFG is the concern. The methane content typically ranges between 40 to 60 %. Other compounds that are produced include carbon-di-oxide and traces of some gases.

Gas collection typically begins after a portion of a landfill (called a cell) is closed. There are two collection system configurations - vertical wells and horizontal trenches. Vertical wells are the most common type of well used for gas collection.

An important part of any LFG collection system is the condensate collection and treatment system. Condensate forms when warm gas from the landfill cools as it travels through the collection system. A compressor may be required to compress the gas before it can enter the energy recovery system. The size, type and number of compressors needed depend on the gas flow rate and the desired level of compression, which is typically determined by the energy conversion equipment.

Maximising the success of LFG exploitation in India will, however, require development of properly engineered landfills that receive a regular supply of waste with a considerable organic content. If, for example, the landfill is not properly capped or laterally confined, LFG will be lost by diffusion to the atmosphere, and concurrent ingress of atmospheric oxygen in the landfill cell will destroy the necessary anaerobic conditions for methanogenesis. Another significant requirement in landfill management is the regular compaction of the waste as it is interred. This removes trapped air within the waste and hastens the development of the requisite anaerobic conditions. This, of course, presupposes that an effective waste collection system is in place to maintain a constant supply of waste in an appropriate volume.

Neverthelessthese constraints, it is feasible for India to develop an LFG recovery and use programme from its existing and proposed landfills. It is also possible to increase its efficiency and output with time and by paying proper attention to its engineering details. Such a programme will be complementary to the other waste-to-energy technologies and will not be in competition with these waste-to-energy technologies that rely on MSW.

Landfill has been the most common and widely prevalent practice of MSW disposal in many countries. Some of the issues that now tend to limit the practice of sanitary landfilling include land availability, production of leachates and deleterious odorous gases, and public acceptability of landfill as a disposal method. Adverse public opinion has been a critical factor limiting the overall success of

refuse disposal by landfilling, even though well-engineered landfills have overcome some of the operational problems. A further issue has been the absence of a satisfactory waste collection infrastructure.

Biomethanation

Biomethanation of aqueous wastes involves hydrolysis, acidogenesis, acetogenesis and methanogenesis reactions, which generates a mixture of methane, carbon dioxide and other gases. It is essential to establish a stable heterogeneous bacterial consortium under strict anaerobic conditions and to establish process parameters that influence biomethantion rates and biogas yield for various types of organic waste.

Several designs of bioreactors were developed and commercialised during the past three decades for handling diverse industrial wastewaters and municipal sewage. These include:

- Suspended growth reactor systems
  - Completely Mixed Digesters, Contact Reactors, Anaerobic Lagoons (Covered)
  - Upflow Anaerobic Sludge Blanket (UASB) Reactors
- Attached growth reactor systems
  - Anaerobic Upflow/Downflow Filters, Fluidized Bed Bioreactors
  - Hybrid reactors.

The suspended growth reactor systems are suitable for wastewaters containing a high concentration of suspended solids and soluble biodegradable substrate.

Attached growth reactors utilize biomass grown as a film on an inert media immersed in the reactor. As the wastewater flows through the media filled reactor, in upflow or downflow mode, the attached anaerobic biomass converts both soluble and particulate organic matter in the wastewater to biogas. The attached growth reactors are well suited for wastewaters that contain primarily soluble biodegradable substrates.

In the hybrid system, the concentration and level of the sludge blanket is easily monitored and maintained. The media at the top of the reactor assists in the retention of biomass and also serves as a gas-liquid-solid separator. The hybrid processes are applied to wastewaters with intermediate levels of particulates, although their performance is usually better with soluble biodegradable substrates.

The low-solids (4-6% solids) anaerobic digesters such as standard-rate digester, two-stage digester and high-rate digester are widely used for biomethanation of sludge produced in aerobic wastewater treatment plants.

Biomethanation of solid/semi solid wastes can be carried out either with medium-solids (8-15 %) or high-solids (20-35 %) process in anaerobic digesters, using a variety of proprietary features.

The medium-solids process is suitable to generate methane gas from animal manure, poultry litter and municipal solid waste (MSW). The high-solids process is also used for energy recovery from MSW. Two important advantages of the high-solids process are less water requirements for dilution and high gas production per unit volume of the reactor.

An extensive literature review of biomethanation technology indicated that several variations of biomethanation plants, ranging from small farm digesters to large-scale waste treatment plant with biogas recovery, has been built in many countries by private, government, research and non-governmental organizations.

In India, the high rate biomethanation process for energy recovery has been successfully used for various industrial wastewaters and sewage.

Combustion / Incineration

In Incineration, a series of oxidation reactions take place in the combustion of organic waste in presence of oxygen. In this exothermic reaction, heat energy is liberated which may be utilised for different purposes. This technology is commercially well established and is fully understood in terms of maximising efficiency and obtaining optimum energy yields. A critical issue associated with incineration is the control of atmospheric emissions, to achieve stringent regulatory norms.

Two approaches are currently available for incineration of MSW, namely, Mass Burn Systems and Refuse Derived Fuel (RDF) systems.

Mass-burn incinerators burn raw waste in the same physical form as it is generated and received.

Refuse-Derived Fuel (RDF) systems refer to solid waste that has been mechanically processed to produce a storable, transportable, and more homogeneous fuel for combustion. RDF can be co-fired with fossil fuels in existing large industrial or utility boilers or used as the primary fuel in specially designed 'dedicated' boilers.

Fluidized bed combustion (FBC) is a versatile novel design and can be operated on a wide variety of fuels, including MSW, sludge, coal, and industrial wastes.

Incineration of MSW is a well established WTE Technology and widely adopted in the developed countries. The recent focus is on environmental compliance using elaborate air pollution control systems for flue gas clean-up which has made it a rather expensive option.

Gasification and Pyrolysis

Gasification or pyrolysis forms a molecularly simple and high quality gaseous fuel (producer gas) for which complete and efficient combustion is inherent. It can be combusted in a gas engine or gas turbine to generate electricity. These systems have low environmental emissions and higher energy recovery potential.

Gasification and pyrolysis processes can have a higher level of acceptability due to the advantages over incineration. Gasification technology is at a commercial uptake in developed countries and has a high potential of adaptability in India.

Emerging Technologies

Emerging technologies like plasma pyrolysis, microwave waste destruction and laser waste destruction are at various stages of commercial uptake and merit a continuing review to assess their relevance for possible application to the treatment of certain waste types under Indian conditions.

The plasma arc pyrolysis for waste destruction apparently creates no gaseous emissions and the flue gas produced and the inert solid slag can be beneficially used. The process is a totally enclosed

system that achieves waste volume reductions of the order of 200 to 1 against 10 to 1 achieved in conventional incineration processes.

Some patented processes using microwave energy are available for the destruction of hazardous, infectious or otherwise intractable wastes, without any energy recovery. However, it is clear that this technology has positive benefits for the treatment of two particularly difficult waste types namely medical wastes and tyres. The net export of energy, which is possible in the tyre processing configuration and the minimisation of emissions, are attractive factors.

The laser waste destruction technology is relatively new and has not yet been applied for waste treatment applications.

2.3.2.2 Assessment of Technological Options

Criteria for evaluation of various technologies for conversion of MSW to energy consist of technical, commercial and environmental aspects. The ranking of various Waste-to-Energy technologies for MSW is presented in Table 2.5

Table 2-5. Ranking of Technologies

Sr. No	Technology	Ranking
• **A. Biological Processes**		
1.	Biomethanation	1
2.	Landfill with Gas Recovery*	2
B. Thermal Processes		
3.	Gasification / Pyrolysis	3
4.	Incineration / Combustion	4

Source: Technical Memorandum on Waste-to-Energy Technologies,

* *Landfill with gas recovery is excluded as a potential technology option in view of "The Municipal Solid Waste (Management & Handling) Rules, 2000, Schedule II (Management of Municipal Solid Waste), Point 6 (Disposal of municipal solid wastes: Landfilling shall be restricted to non-biodegradable, inert waste and other waste that are not suitable either for recycling or for biological processing. Land filling shall also be carried out for residues of wastes processing facilities as well as pre-processing rejects from waste processing facilities. Land filling of mixed waste shall be avoided unless the same is found unsuitable for waste processing. Under unavoidable circumstances or till installation of alternate facilities, landfilling shall be done following proper norms. Landfill sites shall meet the specifications as given in Schedule – III).*

2.3.3 Industrial Sector

The technologies, identified for conversion of different types of industrial waste in to energy are given in Table 2.6.

Table 2-6. Identified Industrial WTE technologies

Sr. No	Type of Waste	Technology
1	Liquids	Biomethanation
2	Solids	Gasification/Pyrolysis, Incineration/Combustion
3	Semi-solids	Biomethanation, Gasification/Pyrolysis, Incineration/Combustion

Source: Technical Memorandum on Waste-to-Energy Technologies, February 2003

2.4 R&D and Demonstration Projects

2.4.1 Research & Development

The following approach for R & D is proposed in the NMP.

- Provide support to need based R & D
  - The support should be focussed on selected technologies in priority areas
  - R&D in advanced and emerging technologies should be supported after a careful assessment of their relevance and applicability to Indian conditions.
  - R & D should be supported to enhance the efficiency through changes in the process and reactor designs for future applications based on the operating experience of full scale operating plants
- Promote adaptive research
  - Significant cost and time can be saved by short/ medium range adaptive R&D efforts instead of any long term, sustained research for product development Hence, R & D for adaptation/incremental improvements of proven technologies should be supported.
  - Based on the feedback from the prototype installations such targeted R&D programmes will also entail significant cost reductions with better quality and competitive features. This vital activity merits special funding.
- Integrate pilot, demonstration projects and commercialization with R & D
  - Integrate R & D with demonstration projects and commercialization through proper networking from initial stages itself.
  - There is an urgent need to relate R&D efforts with market needs and to form inter-disciplinary teams consisting of MNES, R&D institutions, technology providers, and the concerned ministries focusing 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 commercialization. Suggested models are presented in Appendix 2B.
  - Commercialization of R&D processes for handling large volumes of MSW will involve fairly elaborate material handling and processing equipment to work in tandem with the main process system. The total system can be developed jointly by the technology networking team of experts.
- A dedicated full-fledged WTE R&D Cell

It is recommended that a dedicated team should be setup as an R&D cell within the MNES to provide:

- an appropriate mechanism for dissemination of information and replication of the technologies.

- co-ordination and monitoring of all WTE R&D activities and collaborative programmes carried out in national and international institutions.
- assistance in expeditious patenting of the technologies developed under the R&D activities.
- Assistance in technology acquisition, purchase or joint ventures to achieve rapid progress in WTE sector.

2.4.2 Demonstration Projects

The following approach for demonstration projects is proposed in the NMP.

- A policy should be framed for demonstration projects, which would cover identified priority sectors and selected technologies for urban and industrial Waste-to-Energy projects and avoid duplication.
- Funding should be provided for projects upto 5 MW in Capacity so that the implementation is quicker. The funding should be limited to 50% contribution from MNES as per the present policy.
- The technology should be replicable and the expertise including design criteria developed during the demonstration should be freely available to other proponents.

2.5 NMP Strategies

Based on the above approach, the following overall strategy for the Master Plan is developed.

2.5.1 Urban Sector

In the urban sector, focus would be primarily on the MSW with emphasis on Class I cities. The present policy for urban liquid waste however, would be continued. The following strategies are recommended:

- Utilize the services of institutions such as All India Institute of Local Self-Government, NGOs etc. to create awareness amongst the smaller municipalities about the MNES programmes.
- Conduct or assist in conducting training programs for ULBs on the collection, transport, treatment and disposal of MSW, which will facilitate WTE programme.
- Provide technical and financial support in the form of advice on consultancy, preparation of DPRs etc.
- Initiate need based and adaptive research programme for the already identified technologies.
- Restrict financial support to R & D and pilot/demonstration projects for selected technologies in priority areas with a specified minimum contribution to the cost by the corresponding ULB / State Government / Private Sector as per the present policy of MNES.
- Encourage clustering of smaller towns to achieve economy of scale.
- Encourage blending of urban and industrial waste, wherever possible.

- Move away from subsidy regime towards sustainable development with self-sufficiency.

2.5.2 Industrial Sector

The focus should be on identified industrial sectors for waste to fuel/energy/power projects for both liquid and solid wastes.

- Promote adaption and commercialization of proven technologies.
- Restrict financial support to R & D and pilot/demonstration projects for selected technologies in priority areas with a specified minimum contribution to the cost by the corresponding industrial unit/commercial organization as per the present policy of MNES.
- Provide technical support to industries in terms of consultancy, preparation of DPRs etc.
- Encourage clustering with similar/compatible industries and/or urban waste wherever possible.
- Promote the idea of common WTE projects on the lines of CETP concept
- Move away from subsidy regime towards sustainable development with self sufficiency.

2.6 Targets and Time Frame

The NMP has been prepared for a period starting from 2004 and ending in 2017. The rationale for the targets and time frame for the NMP is based on achieving the Waste-to-Energy potential of Urban and Industrial sectors as of 2002 by the end of the 12th Five Year Plan (2017).

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.

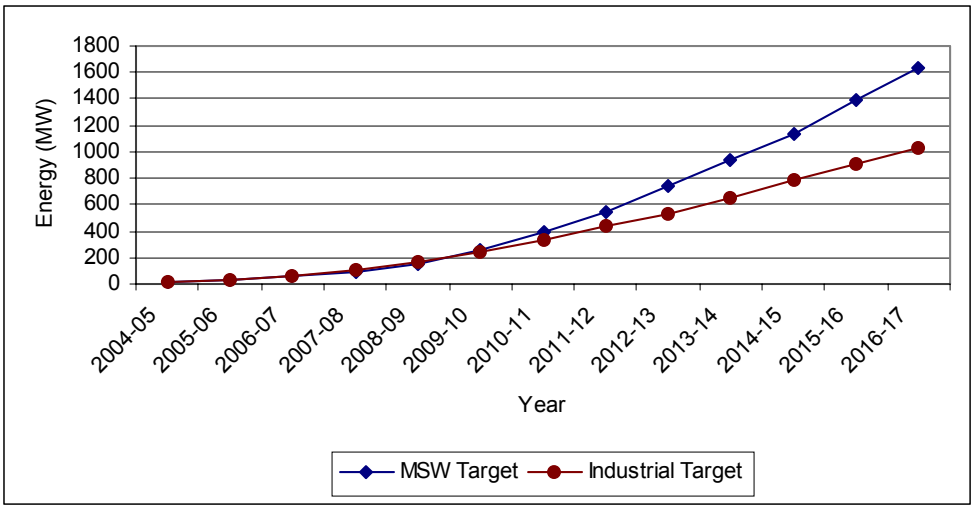
For the period 2004 to 2007, considering shorter time frame available and with the view to transform the present policies to proposed policies in a gradual manner the following approach is proposed

- Interest subsidy should be related to commercial viability of the project
- Transition from Subsidy Regime to sustainable development with self sufficiency.
- Preparation to achieve higher targets in the 11th and 12th FYP. To achieve this objectives the focus should be on :
  - Carry out policy reforms
  - Information dissemination
  - Technical assistance
  - Initiation of need based R&D and focused pilot / demonstration projects.
  - Development of strategies to attract private initiatives
  - Initiation of the process to move from subsidy regime to self sustaining regime.

For the Eleventh and Twelfth Five Year Plans the targets are based on the successful implementation of the above strategies and accelerated growth in implementation of WTE projects to achieve the final targets at the end of the Twelfth five year plan.

Based on the above rationale, the targets and time frame for the period 2004 to 2017 are developed and are presented in Figure 2.1.

Figure 2.1. Targets and Time frame for the period 2004 – 2017

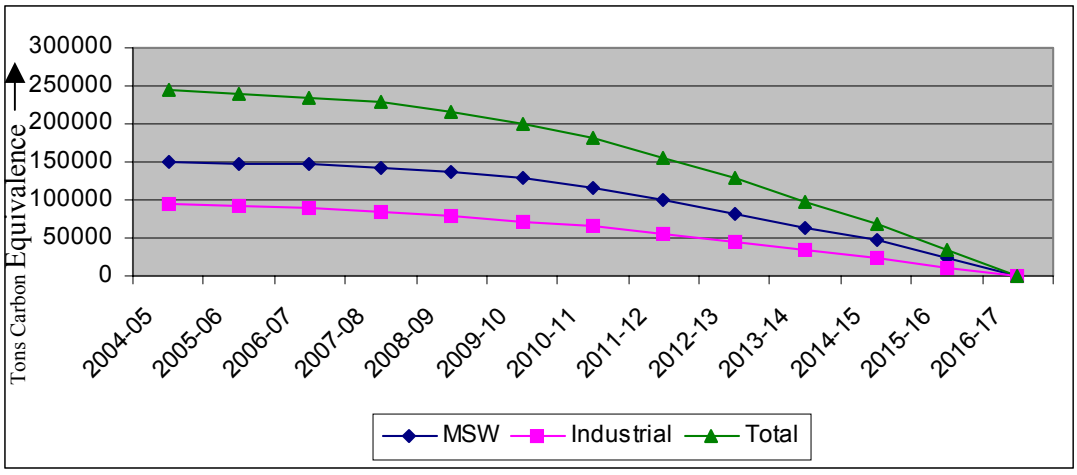


2.7 Reduction in GHG Emissions

The waste to energy plants will also reduce the emission of the GHG by capturing the gas generated and converting it into electricity. Thus accomplishing the objective of the providing vital solution to the environment.

The quantum of the GHG that will be captured while achieving the targets is illustrated through Figure 2.2. Around 228500 tons of carbon equivalence GHG will be captured before the end of the twelfth five-year plan. This quantum is based on the total estimated potential of energy generation from MSW and industrial wastes.

Figure 2.2 Quantum of GHG captured



2.8 Financial Analysis for the Period 2004 to 2007

A realistic appraisal of all WTE projects requires an analysis of all aspects of the project, positive (benefits) and negative (costs), expressed in terms of a common unit. The most convenient common unit is money and all benefits and costs of a project are measured in terms of their equivalent money value in Indian Rupees (INR).

Such a financial analysis of WTE projects can be used to assess the viability based on the potential revenue generation to the investment made. It is an important tool employed for screening various projects/technological options. It is also a statistical measure of the relationship between various variables (like capital cost, operation and maintenance cost, interest rate, subsidies, revenue income etc.). The results are generally expressed as a percentage or a quotient (like Internal Rate of Return, Debt Service Coverage Ratio etc.).

The implementation of Waste-to-Energy projects would get an impetus if the projects are financially/commercially viable. Thus return on investment becomes a critical parameter influencing the decision making process. Such viability is based on a greater degree of control over the amount and timing of cash flows. The NMP hence uses IRR as a measure to assess financial/commercial viability.

2.8.1 Urban Sector

2.8.1.1 Municipal Solid Waste

The financial analysis for the municipal solid waste is carried out based on the following criteria

1. The economic life of the project is considered as 15 years for all the technologies
2. Capital cost is considered to be borrowed from financial institutions and is considered to paid back in equated yearly installment at the interest rate of 14%
3. Operation and maintenance cost includes all money incurred for the successful operation of a WTE facility such as maintenance cost, operation costs including salaries, license fee, insurance, royalty etc. Operation and Maintenance costs are considered to increase annually at the rate of 8%, 7 % and 6 % after every five years respectively.
4. The present price of manure is taken as Rs 1000 per Tonne and is assumed to increase at the rate of 15% after every five years. The commercial value of the compost by-product in case of biomethanation is directly taken from the technology provider.
5. Project realization period is considered as equivalent to the moratorium period
6. The project is considered to be commercially viable if the IRR is 5 % more than the interest rate.
7. The capital cost of the project includes the major components of pretreatment, main process and post treatment stages. For the purpose of this analysis only direct benefits (resource recovery) are considered.
8. WTE projects also have many intangible benefits, (like better environmental condition due to the treatment and safe disposal of waste, improvement in the socio-economic conditions of the city). These are usually confined and can be considered to be specific to a particular city, region, state and technology, thus these are considered while carrying out this analysis.

The basic rationale is that there will be escalation in the energy tariff, compost price and operation and maintenance cost.

Based on the above criteria the commercial viability of bio-methanation and RDF with Incineration technologies for plant capacities of 150, 500 and 1000 TPD are determined (Table 2.7).

Table 2-7. Capital Subsidy Requirements(Rs Crores/MW) for Commercial Viability of MSW to Energy Project for the Period 2004-07

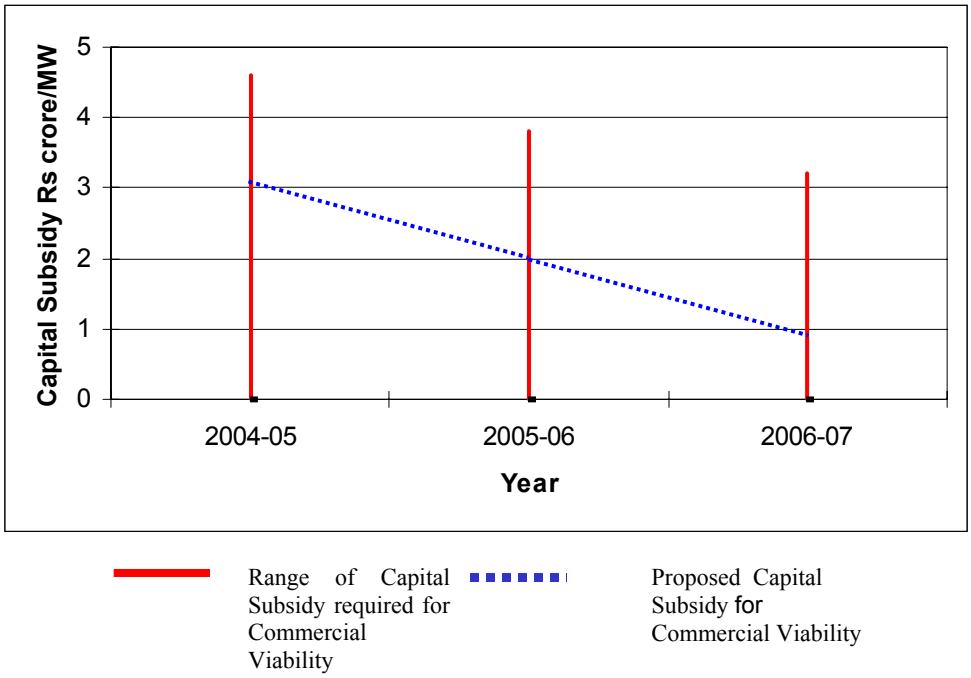
S. No	Year	Biomethanation (TPD)			RDF (TPD)			Gasification (TPD)		
		1000	500	150	1000	500	150	1000	500	150
1	2004-05	Nil	3.9	4.6	Nil	Nil	1.5	5.1	7.6	>12.5
2	2005-06	Nil	3.1	3.8	Nil	Nil	0.8	4.5	7.0	>11.9
3	2006-07	Nil	2.4	3.2	Nil	Nil	0.1	3.8	6.4	>11.4

The financial analysis shows that the capital subsidy requirement goes down over the time period (2004 – 2007) because of the anticipated increase in the power price.

The NMP recommendations for capital subsidy based on the above financial analysis for MSW projects to make them commercially viable are presented in Table 2.8 and Figure 2.3. As the capital subsidy requirement for gasification technologies are high during the period 2004 to 2007, this technology is not considered while proposing the capital subsidy.

Table 2-8. Proposed Capital Subsidy (Rs Crores/MW) for MSW to Energy Projects for the Period 2004-07

S. No	Year	Range of Capital Subsidy Required for Commercial Viability	Proposed Capital Subsidy / MW	Maximum/ Project
2	2004-05	0-4.6	3	15
3	2005-06	0-3.8	2	10
4	2006-07	0-3.2	1	5



- **Figure 2. 3 Proposed Capital Subsidy (Rs Crores/MW) for MSW to Energy Projects for the Period 2004-07**

It is seen from the above analysis that the capital subsidy is technology specific with a lower requirement of capital subsidy for RDF-Incineration / combustion based projects than biomethnation. The NMP recommends a maximum capital subsidy to be given per unit power and per project where needed, irrespective of the technology.

It should be recognized that this reduction in subsidy over the period 2004 to 2007 is recommended on the basis of rational criteria with specific parameters and hence is only indicative. It is essential that a review of these parameters and criteria should be undertaken every year to determine the actual need and quantum of subsidy required.

-
- **Cost to the Government**

With the above strategy as basis, the cost to the Government for supporting MSW to Energy Project Implementation for the Period 2004 –07 is given in the Table 2.9.

Table 2-9. Cost to Government for Supporting MSW to Energy Project Implementation for the Period 2004 -07

S. No	Year	Target (MW)	Project Cost (Rs. in Crores)	Cost to Government (Rs. in Crores)	Other Sources (Rs. in Crores)
1	2004-05	17	170	51	119
2	2005-06	17	170	34	136
3	2006-07	25	250	25	225
	Total	59	590	110	480

2.8.1.2 Municipal Liquid Waste

The management of MLW is included in various programmes of NRCD of MoEF, the scope of financial contribution from MNES appears to be rather limited. However, a budget of Rs. 2 Crore for the year 2004-05 and Rs. 3 and 4 Crores respectively for the subsequent years has been proposed to maintain continuity with the existing policy.

2.8.2 Industrial Sector

The Financial Support from the Government is based on an interest subsidy to reduce the interest rate to 6 % on the debt component for the period 2004 –07.

It is presumed that the debt component will be 2/3rd of the project cost and it will be borrowed at the rate of 14 %. Thus, the cost to the government is calculated for providing an interest subsidy of 8 % (14 – 6 = 8 %). The total cost to the government for supporting the industrial projects during the period 2004-07 is as give in Table 2.10.

Table 2-10. Cost to Government for Supporting Project Implementation in the Industrial Sector for the period 2004-07

S. No	Year	Target (MW)	Project Cost (Rs. in Crores)	"Cost to Government (Rs. in Crores)"
1	2004-05	12	90	5
2	2005-06	24	180	15
3	2006-07	26	193	25
	Total	62	163	45

2.8.3 Summary

The summary of cost by government to support implementation of WTE projects for the period 2004 to 2007 is presented in Table 2.11.

Table 2-11. Cost to Government for Supporting Project Implementation for the period 2004-07

S. No	Sector	"Cost to Government (Rs. Crores)"
1	Urban	
	MSW	110
	MLW	9
2	Industrial	45
	Total	164

2.9 Financial Analysis for 11th & 12th Plans

2.9.1 Urban Sector

2.9.1.1 Municipal Solid Waste

The capital cost per MW energy generation tend to decrease as the technologies mature with time and due to the reducing trend of the interest rates. Based on the reduced capital cost a financial analysis has been carried out to determine the subsidy requirement at the beginning of the Eleventh Five-Year plan. The financial analysis for the MSW is based on the following criteria.

1. The economic life of the project is considered as 15 years for all the technologies
2. Capital cost is considered to be borrowed from financial institutions and is considered to paid back in equated yearly installment at the interest rate of 11%
3. Operation and maintenance cost includes all money incurred for the successful operation of a WTE facility such as maintenance cost, operation costs including salaries, license fee, insurance, royalty etc. Operation and Maintenance costs is considered to increase annually at the rate of 8%, 7 % and 6 % after every five years respectively.
4. The present price of manure is taken as Rs 1150 per Tonne and is assumed to increase at the rate of 15% after every five years. The commercial value of the compost by-product in case of biomethanation is directly taken from the technology provider.
5. Project realization period is considered as equivalent to the moratorium period
6. The project is considered to be commercially viable if the IRR is 5 % more than the interest rate.
7. The capital cost of the project includes the major components of pretreatment, main process and post treatment stages. For the purpose of this analysis only direct benefits (resource recovery) are considered.
8. WTE projects also have many intangible benefits, (like better environmental condition due to the treatment and safe disposal of waste, improvement in the socio-economic conditions of the city). These are usually confined and can be considered to be specific to a particular city, region, state and technology, thus these are considered while carrying out this analysis.

The commercial viability of Bio-methanation and RDF based on Incineration technologies for plant capacities of 150, 500 and 1000 TPD are determined. Based on these computations the capital / interest subsidy required to make the project commercially viable are determined. Capital Subsidy Requirements (Rs Crores/MW) for Commercial Viability of MSW to Energy Project for the Period 2004-07 is given in Table 2.12.

Table 2-12. Capital Subsidy to make the projects commercially viable

S. No	Period	Biomethanation (TPD)			RDF (TPD)			Gasification (TPD)		
		1000	500	150	1000	500	150	1000	500	150
1	2007-12	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	3.11
2	2012-17	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	3.11

From the analysis of Commercial Viability, it is evident that no subsidy is required for MSW to Energy Projects during the 11th and 12th FYP. The role of the Government in form of financial support is hence not required. Since however these projects are environmentally necessary and socially relevant the NMP provides for funds at a reasonable interest rate through a credit line to encourage speedy implementation of such projects.

As mentioned above, it should be recognized that this conclusion about the commercial viability without subsidy over the eleventh and twelfth five-year plan period (2007 to 2017) is based on criteria with specific parameters and hence is only indicative. It is essential that a review of the criteria be undertaken every year to determine the actual need and quantum of subsidy required.

Cost to the Government

Based on the above recommendation the cost to the government to financially support the waste to energy projects are calculated and presented in Table 2.13. The net cost to the government is equivalent to the gross cost minus the revenue income generated through the interest and the repayment of the capital. Revenue from interest is based on the net accrual of 7 % interest, considering 2 % for the financial intermediary and 2 % incentive for the project proponent.

Table 2-13. Cost to the Government

S.No.	Year	Target	Project Cost	Gross Cost to Government	Return of Capital and Interest*	Net Cost to Government	Other Sources
	Unit	MW	Rs. In Crores				
1	2007-08	33	330	110	0	110	220
2	2008-09	66	660	220	0	220	440
3	2009-10	100	1000	333	21	311	666
4	2010-11	130	1300	433	63	370	867
5	2011-12	162	1620	540	126	414	1080
6	2012-13	196	1960	653	204	449	1307
7	2013-14	196	1960	653	300	353	1307
8	2014-15	196	1960	653	413	240	1307
9	2015-16	250	2500	833	520	313	1667
10	2016-17	250	2500	833	608	225	1667
	Total	**1579**	**15790**	**5261**	**2255**	**3005**	**10528**

* Revenue from interest is based on the net accrual of 7 % interest, considering 2 % for the financial intermediary.

2.9.1.2 Municipal Liquid Waste

The technology for treating the Municipal Liquid waste is well proven in the country and the MoEF is also very active in this sector by providing 70 % of the project cost as subsidy, hence NMP recommends that MNES need not financial support in this sector from 11th FYP

2.9.2 Industrial Sector

To encourage the energy generation from the industrial waste, NMP has provided a credit line with interest rate lower than the market rate for financing Industrial Waste-to-Energy projects.

Cost to the Government

The cost to the government is calculated based on a loan up to 33.3 % of the project cost from the credit line with interest rate 2 % lower than the rate of 11% considered for the Eleventh and Twelfth Five Year Plan. The net cost to the government is equivalent to the gross cost minus the revenue income generated through the interest and the repayment of the capital. Revenue from interest is based on the net accrual of 7 % interest, considering 2 % for the financial intermediary and 2 % incentive for the project proponent. The cost to the government for supporting the industrial sector is presented in Table 2.14.

Table 2-14. Cost to the Government for Industrial in the 11th and 12th FYP

Sr. No.	Year	Target	Project Cost	Gross Cost to Government	Return of Capital and Interest*	Net Cost to Government	Other Sources
	Unit	MW	Rs.In Crores				
1	2007-08	41	308	127	0	127	181
2	2008-09	62	462	179	0	179	283
3	2009-10	82	616	230	20	210	386
4	2010-11	82	616	230	49	181	386
5	2011-12	103	770	281	87	194	489
6	2012-13	103	770	281	123	158	489
7	2013-14	123	924	331	167	163	593
8	2014-15	123	924	327	209	117	597
9	2015-16	123	924	318	259	59	606
10	2016-17	123	924	308	306	2	616
	Total	**965**	**7238**	**2612**	**1220**	**1390**	**4626**

*Revenue from interest is based on the net accrual of 7 % interest, considering 2 % for the financial intermediary

2.9.3 Summary of cost

The summary of cost by Government required for the 11th and 12th five-year Plan is presented in Table 2.15

2-15. Summary of cost to the Government during 11th and 12th FYP

S. No.	Sector	Target	Cost to Government (Rs. In Crores)	
		• MW	Gross	Net
A. Eleventh Five Year Plan				
1	Urban*	491	1636	1425
2	Industrial	370	1047	891
Sub - Total		**861**	**2684**	**2317**
B. Twelfth Five Year Plan				
3	Urban*	1088	3625	1580
4	Industrial	596	1047	501
Sub - Total		**1684**	**4672**	**2081**
• **Total**		**2545**	**7356**	**4398**

* Includes only for MSW

2.10 Funding for the 11th & 12th Plans

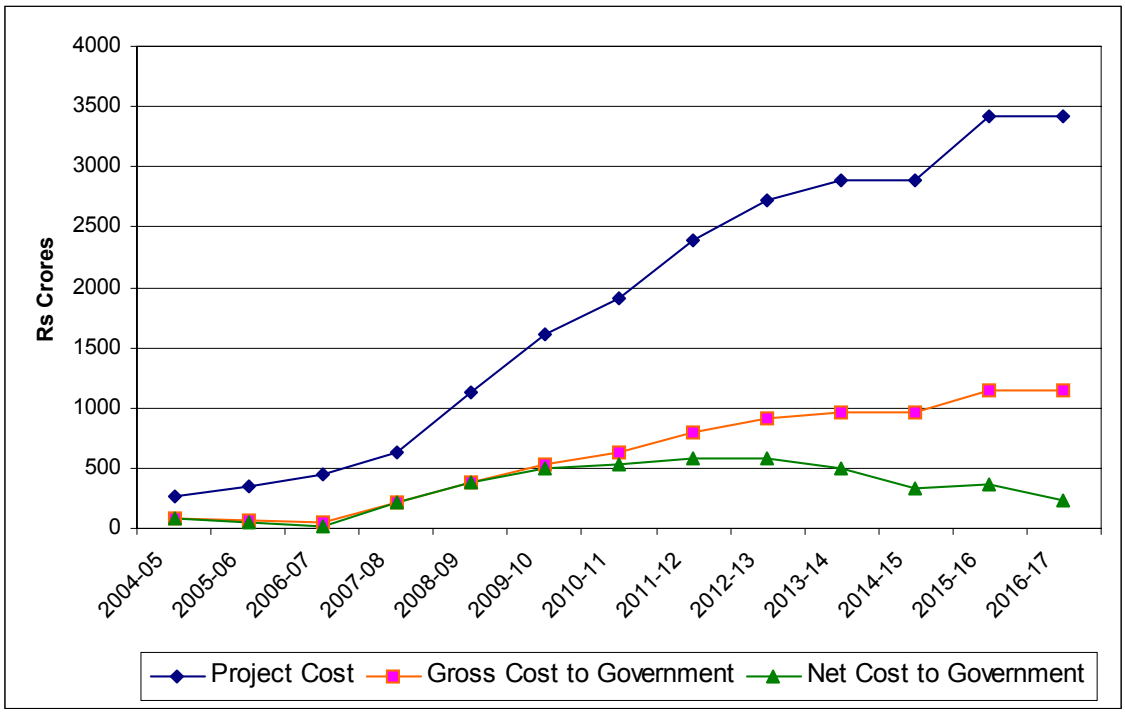
2.10.1 Funding Requirement

The total funding requirement for the Credit Line is presented in Table 2.16 and Figure 2.4.

Table 2-16. Summary of Cost to the Government during 11th and 12th FYP

S. No.	FYP	11 th	12 th
		(Rs. In Crores)	
1	Total Project Cost	7683	15347
2	33% Loan from Credit Line	2535	5065
3	Revenue	367	2591
4	Net Cost	2317	2081
5	Other Sources	5148	10282

Figure 2.4 Summary of Cost to the Government during 11th and 12th FYP



2.10.2 Funding Options

The various funding options available for providing funds for credit line are:

- Other Ministries
- Multi Lateral / Bilateral Agencies

2.10.2.1 Other Relevant Ministries

The various ministries involved in the urban and industrial waste-to-energy programmes is shown in Figure 2.5 and Figure 2.6 respectively. At the central level, other than the Ministry of Non-conventional Energy Sources (MNES), Ministry of Environment and Forest (MoEF) and Ministry of Urban Development and Poverty Alleviation (MoUD & PA) are the nodal ministries involved in formulating the policies and programmes for the waste management in the country.

The Ministry of Environment and Forests (MoEF) is the nodal agency for planning, promotion, co-ordination and overseeing the various environmental protection and forest conservation programmes. This ministry has a major role in terms of the administration of effective implementation of waste management programmes through its various central level divisions, including the Central Pollution Control Board. The ministry is also dependent on its state level divisions such as the state departments of environment and forests and state pollution control boards for implementing its programmes and the regulatory regime.

The Ministry of Urban Development and Poverty Alleviation (MoUD & PA) is the apex authority at the central level to formulate policies, sponsor and support programmes, co-ordinate the activities of various ministries, state governments and other nodal authorities in urban development and poverty

alleviation sectors. The ministry is responsible for monitoring the programmes concerning urban waste management in the country.

The Ninth and Tenth Five Year Plan budgets of these ministries are studied in-order to ascertain the possible funding from these ministries. The possible funding from MoEF and MoUD & PA are given in Table 2.17 and 2.18 respectively.

Table 2-17. Possible Funding from Ministry of Environment and Forest

Ministry of Environment and Forest	2002	2007	2012 (Estimate)	2017 (Estimate)
Total Outlay of the Ministry	3013	5945	10000	15000
Funds used for Urban and Industrial Pollution Control	787	1705	2500	3750
% Of Total Outlay	26.11	28.68	25	25
Funds available if 10 % of the budget is used for MSW to energy projects			250	375

Table 2-18. Possible funding from MoUD&PA

Department of Urban Development, MoUD&PA	2002	2007	2012 (Estimate)	2017 (Estimate)
MoUD – Infrastructure schemes	871.01	2653.85	5000	8000
MSW	1.01	99	500	800
% of Infrastructure Outlay	0.1	3.7	10	10

Figure 2.5 Relevant Ministries in Urban sector

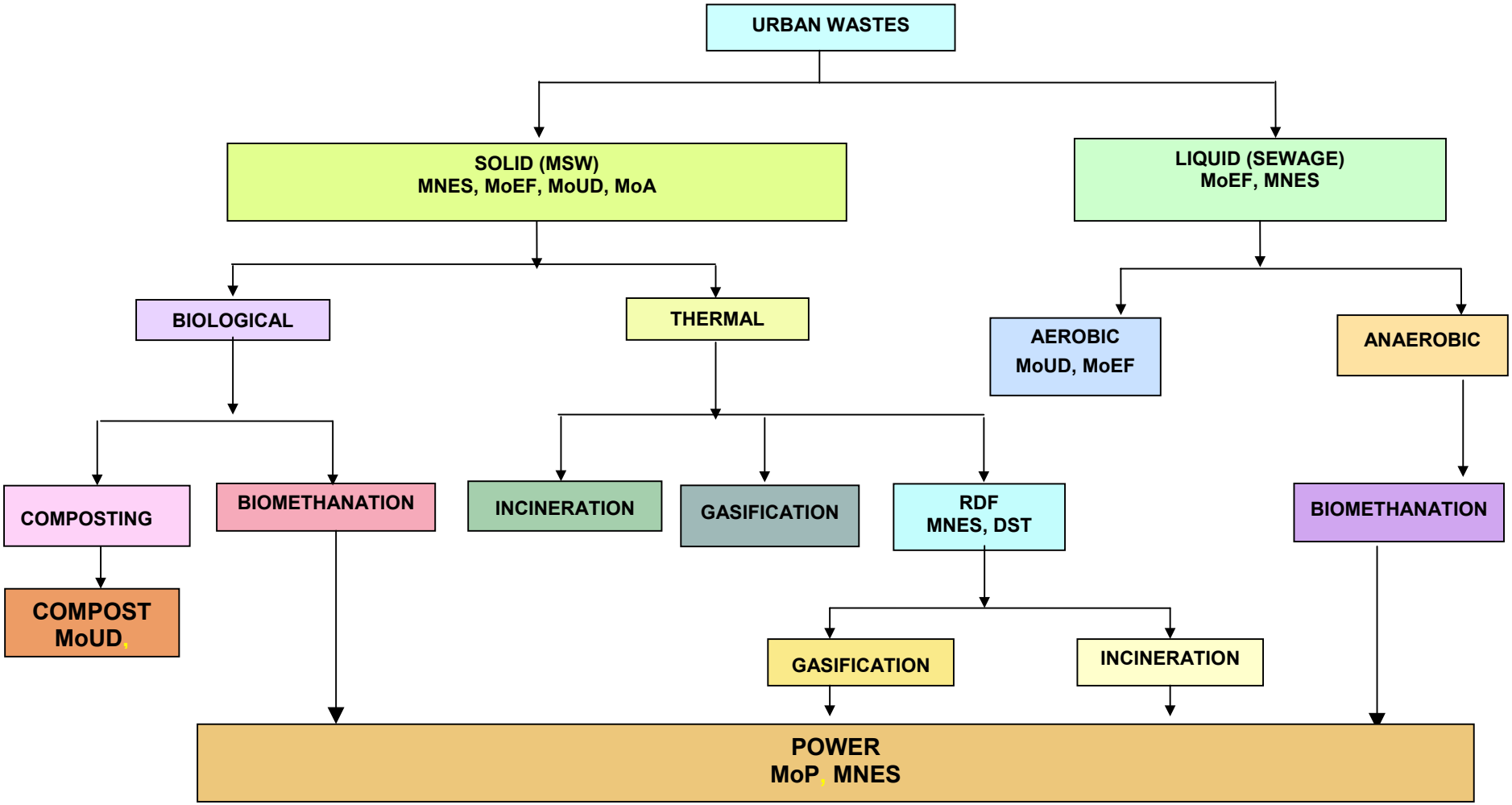
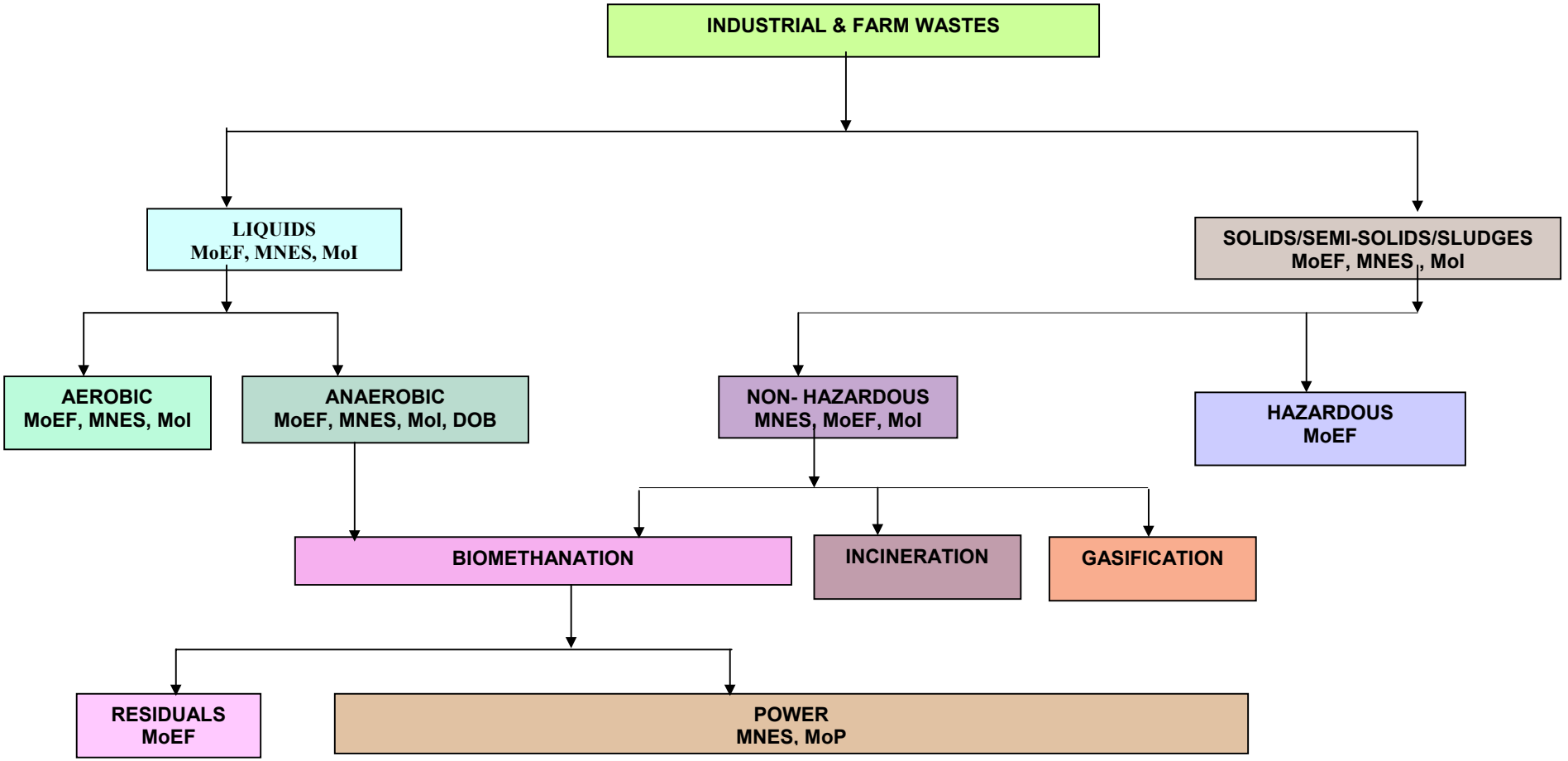


Figure 2.6 Relevant Ministries in Industrial sector



2.10.2.2Multilateral / Bilateral Agencies

There are several international financial institutions and agencies that also fund projects in the energy and environment sectors. A line of Credit can be obtained from these institutions through financing agreements between Governments of India and the Government of lending country.

The line of credit can be managed by any national funding institutions, which in turn lends the funds to the project proponents at an interest rate equivalent to the market rate. The difference between the interest income earned from the project proponents can be utilized to create a Interest Differential Fund (IDF). This fund can then be utilized as a revolving fund or to pay back the credit.

2.11 Summary of Funding

The summary of the funding requirement for project implementation is shown in the below Table 2.19

2-19. Summary of Funding Requirement for Project Implementation

S. No.	FYP		2004-07	11th	12th
1	Potential (as on 2002)	MW	2665		
2	Target	MW	121(5%)	861(32 %)	1684 (63%)
3	Total project Cost	Rs Crores	1053	7683	15347
4	33 % Loan through Credit Line	Rs Crores	Nil	2535	5065
5	Revenue	Rs Crores	Nil	367	2591
6	Net Cost	Rs Crores	143	2317	2081
7	Funding Other Sources	Rs Crores	494	5148	10282

This funding requirement for the period 2004 to 2017 is based on phasing out of subsidy and creating a regime of self-sustainability. The time period for reduction in the quantum of subsidy and complete phasing out of the subsidy will, however, depend upon the accuracy of the various parameter considered in the criteria of evaluation.

It is imperative that this transition from subsidy to self-sustainability regime is carefully monitored and applied after a comprehensive review of the parameters involved.

2.12 Implementation

Waste-to-energy projects are generally promoted /implemented either by private entrepreneurs/organizations or Urban Local Bodies (ULBs). A series of risks are perceived by them during the course of implementation of the WTE projects and hence a critical assessment of the various risks and involved the remedial measures that could be evolved is an important phase for encouraging initiation of WTE projects.

Waste-to-energy projects offer a complex basket for the bankers/investors and promoters. The industrial sectors generally offer good investment opportunities unlike urban sector with greater inherent risks. The industrial waste-to-energy projects offer a conducive investment scenario because of four main reasons.

- The industrial projects offer a commercially attractive return on capital employed.
- The risk factor is backed up by credit rating of the promoter increasing the degree of comfort for the investor.
- The investor enjoys the option of escrowing the entire receivables of the industrial unit to ensure repayment.
- The investor has assured security for the assistance.

On the other hand, urban waste-to-energy projects are relatively new and appropriate/adequate risk mitigating measures are not fully developed. Although, as mentioned earlier, commercial viability is one of the major factors affecting investment in WTE projects, this section attempts to identify some of the other potential risks as perceived by investors and possible mitigation measures.

Each bank, financial institution and other participants like venture capitalist, private investors have their own system of rating a project on the risk matrix. The risk factors that would be considered by investor while analyzing waste-to-energy projects and possible mitigation measures (in italics) are discussed below :

- The unreasonably long time taken for completing all the formalities /documentation to get the project started.
  Reducing the time required for completing all documentation towards the project by a single window approach for approvals.
- Lack of confidence about the technology performance and/or uncertainty about its adaptability
  Information dissemination about available and appropriate technologies
  Monetary participation in the project by vendor
- The absence of any operating unit for "waste-to-energy" in the urban sector to assess the track record.
  Support for R & D and pilot/demonstration projects
- Liability due to presence of Hazardous / Hospital waste and Residential development around the project site
  Strict implementation of MSW (Management & Handling) Rules 2000 and other relevant rules and regulations
- Uncertainty about the availability of raw material (quantity and quality of solid waste) on a consistent and sustained basis
  Execution of a proper agreement for supply of waste with provision of penalty relating to guaranteed quantity and quality of waste.

3 Strategic Action Plan (Road Map)

A Master Plan consists of a set of objectives, strategies and targets with a time frame. The next step involved is the conversion of this Master Plan into a Strategic Action Plan (Road Map).

The Strategic Action Plan defines what needs to be done and goes on to describe how it is to be done, who will do it and when so as to achieve the set objectives and targets within the time frame. This leads to definitions of various actions to be undertaken to make the instruments more effective in achieving the set objective.

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), lays down a detailed plan, evolved on the basis of relevant instruments identified, and listed below, with various activities under each of the identified instrument to achieve the NMP objectives. The SAP, thus provides details of activities to be under taken with in a time frame, identifies agencies to carry out these activities and provides estimates of financial requirements for their successful implementation.

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

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.

3.1 Policy

A number of policy issues that need to be addressed to promote Waste-to-Energy projects, actions to be taken and respective budgetary requirements are presented in this section.

Inter Ministerial Co-operation

There are various ministries involved in waste management either, directly or indirectly. In order to address the policy issues and to achieve optimum utilization of resources co-ordination amongst the ministries is essential. The ministries involved in Waste to Energy (WTE) projects are presented in Chapter 2 (Figure 2.5 and 2.6).

Power Pricing and Selling

Since the rates of power purchase for WTE projects are, at present, not attractive in India, a policy framework for power purchase rates providing reasonable and assured returns on investment is necessary to attract the project proponents.
There is also a need for a uniform policy framework across the country to offset the negative externalities of fossil fuels and to promote avenues for wheeling, banking and third party sale(s) of

power from Waste-to-Energy projects. To discuss various policy issues 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 resources.
The financial requirements for implementing the action plan for policy initiatives are as follows.

3.1.1 Policy Workshop

To initiate a dialogue and achieve consensus between all the stakeholders it is recommended that a national workshop should be organised by MNES.

- Budget: Rs 30 lakhs (Rs 10000 per person which includes travel, incidental, venue, staying, workshop materials and fees for the resource person)
- Target: Relevant Ministries, State Government organisation, SEBs, ERCs, Private Power producers and/or distributors, FIs, Industrial Associations, Professional Associations, ULBs, Private/Public Infrastructure Developers
- Resource Groups: MNES and relevant Ministries, RNAs, SNAs, Consultants and Management Institutes like IIMs, successful projects promoters.
- Duration: Two Days
- To be completed before 31st March 2005.

3.1.2 Inter Ministerial Round Table

A round table is proposed to be held every year to look into the budget allocation of various ministries and departments for waste management/Waste-to-Energy to optimize the utilization of resources .

- Budget: Rs 7.5 lakhs
- Target: MNES, MoEF, MoUD and other ministries and departments involved directly or indirectly in waste management or Waste-to-Energy or both
- Duration: One Day (every year)
- To be completed before finalizing the annual budgetary allocations of each ministry.

A summary of the financial requirement for policy initiatives is presented in Table 3.1

Table 3-1. Summary of Financial Requirement for Policy Initiatives

Sr. No	Activity	2004-05	2005-06	2006-07	Total
		Rs in Crores			
1	Policy Workshop	0.30	-	-	0.30
2	Inter-Ministerial Round Table	0.05	0.05	0.05	0.15
	Total	0.35	0.05	0.05	0.45

3.2 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.

3.2.1 Urban Sector

For urban sector SAP proposes a three pronged approach for information dissemination.

- At the level of the ULBS
- Within the ULBS
- For the Public

3.2.1.1 Regional Workshops for the ULBs

It is proposed to hold four workshops, one in each zone, every year. The details of these Workshops are given below.

- 4 workshops per year (one in each of the 4 zones) during the entire Tenth FYP starting from the year 2004-05
- Budget: Rs 30 lakhs/year (Rs 10000 per person which includes travel, incidental, venue, staying, workshop materials and fees for the resource person)
- Target: ULBs from all cities (relevant technical Person, elected representatives and administrative officer)
- Resource Groups: MNES, RNAs, SNAs, Consultants, NGOs and Institutes like AIILSG, IITs, Technology Providers and successful projects promoters.
- Workshop objective:
- Disseminate information about MNES programmes such as financial assistance, technical assistance, DPR preparation procedures.
- Duration: Two Days
- To be completed before 31st March every year.

3.2.1.2 Support To ULB's for internal Awareness

Above stated regional workshops for ULBs should be followed by another set of workshops/training programmes to disseminate information within the ULBs. These will be conducted on "as needed" basis and would be in response to a request by the ULB.

- Workshops to disseminate information gathered in regional workshop further within each ULB

- 80 % subsidy, upto maximum of Rs 50000, for conducting the training.
- Budget: Rs 15 lakhs per year (assuming 30 such internal awareness programmes)
- Target: All officers and elected representatives of the ULB
- Resource Groups: Participant of the regional workshop from the respective ULB
- Workshop objective:
- Disseminate information gathered during the regional workshop about MNES programmes such as financial assistance, technical assistance, DPR preparation procedures.
- Duration: Half Day
- To be completed before 31st March every year

3.2.1.3 Support To ULB's for Public Awareness and Participation

These Workshops should be conducted after a DPR is prepared and approved, to create awareness amongst the general public about the project and motivate them to support the project. These workshops would also be need based and would be in response to a specific request from the ULBs.

- Workshops to disseminate information about the project to the general public.
- 80 % Subsidized up to a maximum of Rs 50000
- Budget: Rs 15 lakhs per year (assuming 30 such awareness programs)
- Target: Interested public, NGOs, Media
- Resource Groups: to be selected by the ULBs
- Workshop objective:
- Disseminate information about the project to educate and motivate the public and NGOs about the project and increase their participation.
- Duration: Half Day
- To be completed before 31st March every year

The total funding requirement for this activity of information dissemination for the urban sector is presented in Table 3.2

Table 3-2. Funding Requirements for Information Dissemination for the Urban Sector.

S.No	Activity	2004-05	2005-06	2006-07	Total
		Rs. In Crores			
1	Workshops for the ULBs	0.30	0.30	0.30	0.9
2	Support to ULBs for internal awareness	0.15	0.15	0.15	0.45
3	Support to ULBs for Public awareness and participation	0.15	0.15	0.15	0.45
	Total Requirement	**0.60**	**0.60**	**0.60**	**1.80**

3.2.2 Industrial Sector

As in the urban sector, the information dissemination would be through a series of workshops as described below.

- 10 workshops in each year (one for each specific sector)
- Budget: Rs 30 lakhs (Rs 3 lakhs per workshop which includes venue, workshop materials, fees for the resource person)
- Target: Industrial units from the relevant industrial sector
- Resource Groups: MNES, RNAs, SNAs, Consultants, Industrial Association and Institutes like IITs, Technology Providers and successful projects promoters.
- Workshop objective:
- Primary objective would be to motivate industries to implement WTE projects and ensure their participation in R&D and demonstration projects.
- Disseminate information about MNES programmes such as financial assistance, technical assistance, DPR preparation procedures.
- Disseminate information about technologies R&D / demonstration project needs
- Duration: One Day
- To be completed before 31st March every year

The funding requirements for information dissemination for the Industrial sector are summarized in Table 3.3

Table 3-3. Summary of funding requirements for information dissemination for the Industrial sector

S.No	Activity	2004-05	2005-06	2006-07	Total
		Rs. In Crores			
1	Industrial workshops	0.30	0.30	0.30	0.90

3.2.3 Information dissemination Through Media

The above-targeted effort should be supported by a more general and wider dissemination of information through the media. The effort would consist of the following:

- Publication of workshops materials
- Publication of quarterly news letter (which will include success stories)
- Advertisements on television, in the newspapers and leading magazines
- Updation and wide publicity of MNES and other relevant websites
- Production and dissemination of audio and video presentations focusing on Waste-to-Energy sector
- Production and dissemination of a documentary film on Waste-to-Energy spot lighting success stories.
- Budget: Rs 1 Crore for 2004-05 and Rs. 0.33 Crore per year for the remaining period of the tenth five year plan.

The funding requirements for information dissemination through media are summarized in Table 3.4

Table 3-4. Summary of funding requirements for information dissemination through media

S.No	Activity	2004-05	2005-06	2006-07	Total
		Rs in Crores			
1	Through Media	1.0	0.5	0.5	2

3.3 Technical Assistance

Technical assistance would be provided to support R&D, pilot / demonstration projects, preparation of DPRs and training programmes.

3.3.1 Urban Sector

The SAP proposes the following technical assistance to the ULBs.

3.3.1.1 Clustering Concept

Clustering approach should be considered for making the projects viable for the smaller cities.

- Initiate a study to investigate the possibility of clustering of urban areas and /or small- scale industries in each zone. The study should include technical feasibility, financial viability, cost sharing mechanism, institutional and managerial aspects and willingness of beneficiaries for implementing the project.
- Budget: Rs 1 Crore (Rs.25 Lakhs per Zone)

- Duration of the study: 6 months
- To be completed before 31st March 2005.

3.3.1.2 Support to ULBs for DPR preparation

- Extend necessary technical and financial support to prepare DPR for cities with population less than 500000. (As requested by ULBs)
- 100 % Subsidy up to maximum of Rs 5lakhs
- Budget: For 2004-05 Rs 50 lakhs (assuming 10 such requests)

  For 2005-06 Rs 1 crore (assuming 20 such requests)
  For 2006-07 Rs 1.5 crores (assuming 30 such requests)

3.3.1.3 Support to ULBs for Training Programme

- Offered to ULBs proceeding with the implementation of the project.
- Budget : Rs 5 lakhs per year (assuming 5 such training programmes)
- Target : implementing department of the ULB
- Resource Groups: MNES, SNA, Consultant
- Training objective:
- To train the appropriate staff in collection, transportation treatment and disposal of MSW and main aspects of WTE programme.
- Duration : Two Day

The funding requirements for Technical Assistance for Urban Sector are summarized in Table 3.5.

Table 3-5. Funding Requirements for Technical Assistance for Urban Sector.

S.No	Activity	2004-05	2005-06	2006-07	Total
		Rs. In Crores			
1	Clustering Study	1.00			1.00
2	Support to ULBs for DPR preparation	0.50	1.00	1.50	3.00
3	Support to ULBs for training programme	0.05	0.05	0.05	0.15
	Total Requirement	**1.55**	**1.05**	**1.55**	**4.15**

3.3.2 Industrial Sector

Technical assistance should be provided for activities required to be taken up before commercialization of a technology and for preparation of DPRs and Training Programmes. These activities would be based on the detailed study of the identified sectors.

The needs of identified industrial sectors for WTE projects are presented in Table 3.6

Table 3-6. Needs for identified sectors

Sr. No	Priority Sector	Activity before commercilization
1	Distillery	Nil
2	Sugar	
	Pressmud	Prototype development
	Liquid	System integration
3	Paper	Nil
4	Maize Starch	
	Liquid	System integration
	Solid	System integration
5	Dairy	Sectoral Study
		System integration
6	Poultry	Sectoral Study
		System integration
		Prototype development
7	Tapioca Starch	Sectoral Study
		System integration
8	Slaughterhouse	Sectoral Study
9	Cattle farm	Sectoral Study

3.3.2.1 Conduct Sectoral Study

- Conduct sectoral studies in Dairy, Poultry, Tapioca starch, slaughter house and cattle farm sectors for waste characterization and assessment of energy recovery potential.
- Budget: Rs 10 lakhs for Dairy Sector and Rs. 40 Lakhs for rest of the sectors
- Duration of the study: 6 months
- Should be completed before 31st March 2005

3.3.2.2 System integration

- Identify engineering requirements for system integration in identified sectors :
- Sugar (liquid), dairy and maize starch (liquid and solid).
  - Budget: Rs 40 lakhs
- Tapioca starch and poultry.
  - Budget: Rs 20 lakhs

Duration of the study: 6 months

Should be completed before 31st March 2005

3.3.2.3 Clustering Concept

- Initiate a study to investigate the possibility of clustering of small scale industries. The study should include technical feasibility, financial viability, cost sharing mechanism, institutional and managerial aspects and willingness of beneficiaries for implementing the project.
- Budget: Rs 1 Crore (for 10 studies at Rs.10 Lakhs per study)

- Duration of the study: 6 months
- To be completed before 31st March 2005.

3.3.2.4 Support for DPR preparation

- Extend necessary technical and financial support to prepare DPR for WTE projects as requested by the industrial unit.
- 100 % Subsidy upto maximum of Rs 5 lakhs
- Budget: Rs 50 lakhs in the year 2004-05 (assuming 10 such requests)

  Rs 75 lakhs per year (assuming 15 such requests per year)

3.3.2.5 Support for Training Programme

- Training programme should be offered to industrial units implementing WTE project.
- Budget : Rs 5 lakhs per year (assuming 5 such training programmes)
- Resource Groups: MNES, SNAs, Technology providers, funding institutions, Consultant(s)
- Training objective:
- To train the appropriate staff in implementation, operation and maintenance of WTE project.
- Duration : Two Day

The funding requirements for the Industrial Sector for Technical Assistance are summarized in Table 3.7.

Table 3-7. Funding requirements for Technical Assistance for Industrial Sector

S.No	Activity	2004-05	2005-06	2006-07	Total
		Rs. in crores			
1	Sectoral Studies in Dairy	0.50	-	-	0.50
2	System integration for Sugar (liquid), Dairy, Maize Starch (liquid and solid), Tapioca starch and poultry sectors.	0.60	-	-	0.60
3	Clustering Concept	1.00	-	-	1.00
4	Support for DPR preparation	0.50	0.75	0.75	2.00
5	Training Programme	0.05	0.05	0.05	0.15
	Total	**2.65**	**0.80**	**0.80**	**4.25**

3.4 Financial Assistance

3.4.1 Urban Sector

It is proposed to provide financial assistance for Project Implementation

3.4.1.1 Municipal Solid Waste (MSW)

As discussed in detail in Chapter 2, the financial assistance for implementation of projects is in the form of capital subsidy upto a maximum of Rs 2 Crores/MW with a ceiling of Rs. 10 Crores per

project, for the years 2004-05. This will be reduced to a capital subsidy of maximum of Rs 1.5 Crores / MW with a ceiling of Rs 7.5 Crores per project for the year 2005-06. It will be further reduced to subsidy of maximum of Rs. 1 crore / MW with a ceiling of Rs 5 Crores per project for the year 2006-07.

Based on these premise, the summary of funding requirements for Financial assistance for MSW for the period 2004-07 are presented in Table 3.8

3.4.1.2 Municipal Liquid Waste

Although this sector has a high WTE potential, it is not considered as a focus area as other ministries / agencies are more involved in this sector by providing technical and financial assistance. This is reflected in the fact that MNES has not been able to convert significant amount of this potential in to actual energy.

However, a budget of Rs. 2 Crore for the year 2004-05 and Rs. 3 and 4 Crores respectively for the subsequent years have been proposed to continue support as per the existing policy.

Table 3-8. Summary of Financial assistance for Project Implementation in Urban Sector

S.No	Activity	2004-05	2005-06	2006-07	Total
1	Support for MSW	34	25.50	25	84.50
2	Support for MLW	2	3	4	9.00
	Total	**36**	**28.50**	**29**	**93.5**

3.4.2 Industrial Sector

The financial assistance for implementation of projects is based on an interest subsidy to reduce the interest rate to 6 % for the period 2004 –07. The present interest rate is considered as 14 %.

Budget thus works out to Rs 5 Crores for 2004-05 and Rs 15,25 Crores respectively per year for the subsequent years.

The funding requirements for project implementation in Industrial sector are presented in Table 3.9.

Table 3-9. Funding requirements for project implementation in Industrial sector

S.No	Activity	2004-05	2005-06	2006-07	Total
		Rs. In Crores			
1	Financial Assistance for project implementation	05	15	25	45

3.5 Research and Development (Across the Sectors)

3.5.1 Urban Sector

Support for Research and Development / Technology Demonstration in urban sector is discussed here. The objective of the R&D and demonstration project is to develop basic design criteria and/or promote replicability. The R&D and demonstration project budget should include adaptation costs of technology, technology transfer, capital cost of the plant and O&M for six months. Based on the detailed assessment of technologies, the SAP proposes following budget for biomethanation and gasification, which are preferred options

- **Biomethanation**

- 1 demonstration project, of 25 TPD capacity.
- Budget: Rs 4 Crores (with additional contribution of 20 % by the ULB)

  Rs 1.5 Crores in 2004-05 and 2.5 Crores in 2005-06
- To be completed before 31st March 2006.

- **Gasification**

- 1 demonstration project, of 25 TPD capacity.
- Budget: Rs 5 Crores (with additional contribution of 20 % by the ULB)

  Rs 1.5 Crores in 2004-05, Rs 2 Crores in 2005-06 and Rs. 1.5 Crores in 2006-07
- To be completed before 31st March 2007.

Table 3-10. Funding requirements for Support for Research and Development / Technology Demonstration in Urban Sector

S.No	Activity	2004-05	2005-06	2006-07	Total
		Rs. In Crores			
1	Support for Research and Development / Technology Demonstration	3.00	4.50	1.50	9.00

3.5.2 Industrial Sector

Support for Research and Development / Technology Demonstration in industrial sector is discussed here

- Adaptive research and development leading to demonstration and commercialization of technology for conversion of waste in to energy in sugar sector.
- Budget: Rs 25 lakhs (with matching contribution from the industry, technology providers or commercial organizations)

  Rs 10 lakhs for the year 2004-05 and Rs.15 lakhs for the year 2005-06
- Adaptive research and development leading to demonstration and commercialization of technology for poultry, tapioca starch (thippi – solid waste) in to energy.
- Budget: Rs 25 lakhs (with additional 20 % contribution from the industry, technology providers or commercial organizations)

  Rs 10 lakhs for the year 2004-05 and Rs.15 lakhs for the year 2005-06 for each sector
- To be completed before 31st March 2006

Table 3.11. Funding requirements for Support of Research and Development / Technology Demonstration in Industrial Sector

S.No	Activity	2004-05	2005-06	2006-07	Total
		Rs. In Crores			
1.	Support for Adaptive Research and Development / demonstration projects in Sugar, poultry, Tapioca Starch Sector	0.20	0.30	-	0.50
	Total	**0.20**	**0.30-**	**-**	**0.50**

3.5.3 Advanced and Emerging Technologies

To benefit under the Clean Development Mechanisms (Kyoto Protocol 1997), advanced thermal processes such as pyrolysis and emerging technologies like plasma pyrolysis, laser waste destruction and microwave waste destruction could be considered as candidate technologies for energy recovery from urban and industrial wastes for India.

However, emerging technologies such as plasma pyrolysis, microwave waste destruction, laser waste destruction and hybrid systems are relatively new and in the nascent stages of their development and are yet to be demonstrated on a commercially scale in the countries of their origin.

3.5.3.1 Technology Feasibility Assessment

- A study of advanced and emerging technologies in the Indian context should be carried out.
- Budget: Rs. 25 Lakhs
- Duration 6 months
- Should be completed before 31st March 2005

3.5.3.2 Research and Development of Advanced and Emerging Technologies

- Based on the above study R&D programme should be initiated leading to demonstration and commercialization of the technologies for Waste-to-Energy.
- The programme should be initiated after setting up a network as presented in Appendix 2B
- Budget: Rs. 0.5 Crores and Rs 0.75 Crore in 2004-05 and 2005-06, respectively
- Duration 2 years

Table 3-12. Funding requirements for Support of Research and Development of Advanced and Emerging Technologies

S.No	Activity	2004-05	2005-06	2006-07	Total
		Rs. In Crores			
1.	Research and Development of Advanced and Emerging Technologies	0.75	0.75	-	1.5
	Total	**0.75**	**0.75**	**-**	**1.5**

3.5.4 Dedicated WTE R&D Cell

A dedicated team should be setup 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.

- Budget: Rs. 5 Crores

  Rs 2.0 Crore in 2004-05
  Rs 2.0 Crore in 2005-06
  Rs 1.0 Crore in 2006-07
- To be established before the end of Tenth Five Year Plan

Table 3-13. Funding requirements for Dedicated WTE R & D Cell

S.No	Activity	2004-05	2005-06	2006-07	Total
		Rs. In Crores			
1.	Dedicated WTE R&D Cell	2.0	2.0	1.0	5.00
	Total	**2.0**	**2.0**	**1.0**	**5.00**

3.6 External Funding Sources

A proposal has to be prepared to approach multilateral and bilateral funding agencies for a credit line for Waste-to-Energy projects and aid for technical assistance to be available for the eleventh five year plan.

The activity is to be started by October 2004, so that the credit line is available before the eleventh five year plan.

Budget : Rs 25 lakhs

3.7 Summary of Action Plan

In the above sections we have discussed various enabling instruments and corresponding activities to optimize the utilization of Waste-to-Energy potential. These activities include Policy Workshop, Interministerial Roundtable, Workshops for the ULBs and Industries, Support to ULBs for Internal Awareness, Support to ULBs for Public Awareness and Participation Programs, Publicity through media, Support to ULBs and industries for DPR preparation, Support to ULBs for Training Programme, Supporting Clustering Concept, Sectoral Studies, Assistance for Project Implementation, Research & Development and Pilot/Demonstration Projects and Preparation for Mobilizing External Funding Sources. These activities form the action plan. A detailed action plan depicting various activities with time frame is presented in Figure 3.1.

3.8 Summary of Funding Requirement

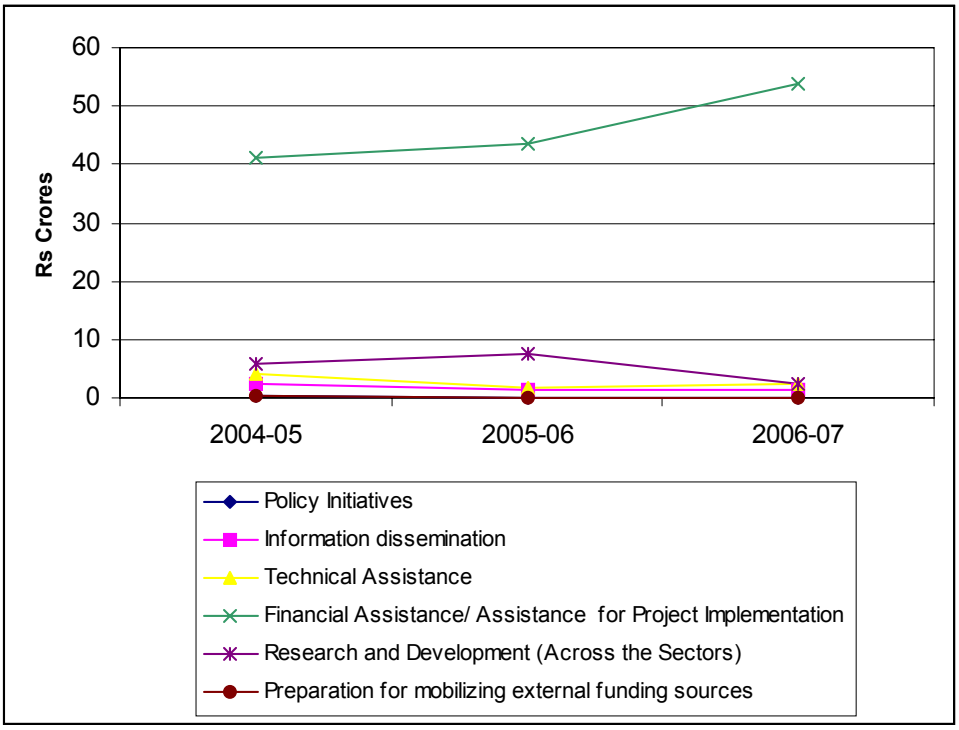
The total funding requirement for the period 2004-07 to carry out various activities under each identified instrument is given in Table 3-14 and graphically represented in Figure 3.2

Table 3.14 Summary of Funding Requirement for the period 2004-07

Sr. No	Enabling Instruments	Sector	2004-05	2005-06	2006-07	Total
			Rs in Crores			
1	Policy Initiatives		**0.35**	**0.05**	**0.05**	**.45**
2	Information dissemination	Urban Sector	0.60	0.60	0.60	1.80
		Industrial Sector	0.30	0.30	0.30	0.90
		Through Media	1.0	0.5	0.5	2.00
			2.25	**1.45**	**1.45**	**5.15**

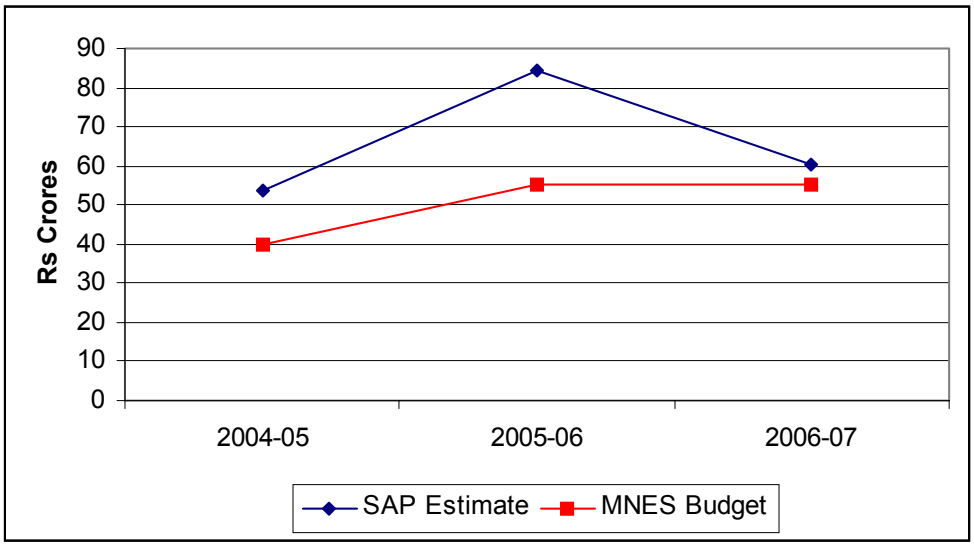
Sr. No	Enabling Instruments	Sector	2004-05	2005-06	2006-07	Total
			Rs in Crores			
3	Technical Assistance	Urban Sector	1.55	1.05	1.55	4.15
		Industrial Sector	2.65	0.80	0.80	4.25
			4.20	**1.85**	**2.35**	**8.4**
4	Financial Assistance/ Assistance for Project Implementation	Urban Sector	36	28.50	29	93.5
		Industrial Sector	05	15	25	45
			41	**43.50**	**54**	**138.5**
5	Research and Development (Across the Sectors)	Urban Sector	3.0	4.5	1.5	9.0
		Industrial Sector	0.20	0.30	-	0.5
		Advanced Emerging Technologies and	0.75	0.75	-	1.50
		Dedicated WTE R&D Cell	2.0	2.0	1.0	5.0
			5.95	**7.55**	**2.5**	**16.00**
6	Preparation for mobilizing external funding sources		0.25	-	-	0.25
	Grand Total		**53.90**	**84.4**	**60.35**	**168.50**

Figure 3-2. Total Funding Requirement for the period 2004-07



The comparison of the budget of MNES for the period 2004-07 with estimated budget/funding requirements of SAP is presented in Figure 3.3

Figure 3-3. Comparison of MNES Budget and Estimated SAP Funding Requirement for period 2004-07



3.9 Performance Monitoring

Performance should be monitored thrice a year (1st July, 1st October and 1st January) 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. A comprehensive review of the performance for the entire

financial year should be taken up on the 1st of April to allow modifications in the strategic plan for the ensuing financial year.

A format for performance monitoring and evaluation is presented in Appendix 3 A.