

## 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 (GHG) 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

### 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.

#### 1.1.1 Urban Sector

##### Municipal Liquid Waste (MLW)

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

**Table 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 Waste-To-Energy (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 2.

**Table 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.

**1.1.2 Industrial Sector**

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

**Table 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
<i>Liquid Waste</i>	<i>24</i>	<i>30</i>	<i>37</i>
<i>Solid Waste</i>	<i>81</i>	<i>102</i>	<i>127</i>
Tapioca Starch	24	30	37
<i>Liquid Waste</i>	<i>18</i>	<i>22</i>	<i>27</i>
<i>Solid Waste</i>	<i>6</i>	<i>8</i>	<i>10</i>
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
<b>Total</b>	<b>1279</b>	<b>1598</b>	<b>1997</b>

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

**Table 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.

## 1.2 Technologies

The most significant WTE 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.

### 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 5.

**Table 5 : Ranking of Technologies**

S. No.	Technology	Ranking
<b>A. Biological Process</b>		
1.	Biomethanation	1
2.	Landfill with Gas Recovery*	2
• <b>B. Thermal process</b>		
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.

### 1.2.2 Industrial Sector

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

**Table 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*

### 1.3 Demonstration Projects

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.

### 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.

### 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.

### 1.6 Targets and Time Frame

The rationale for the targets and time frame for the NMP is based on achieving the total WTE Potential of urban and industrial sectors, as of 2002, by 2017, end of 12<sup>th</sup> 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 11<sup>th</sup> and 12<sup>th</sup> 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 FYP 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 FYP.

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 1 and Figure 2 in terms of MW and percentage respectively.

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

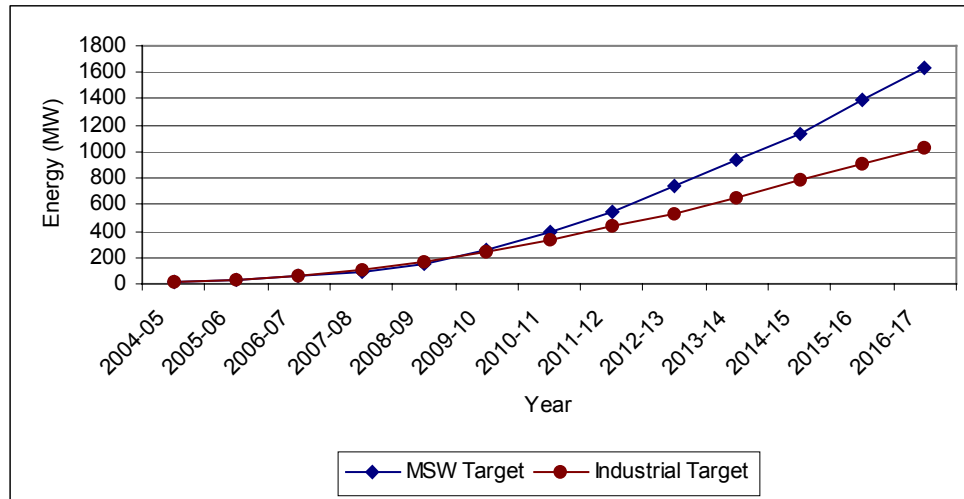
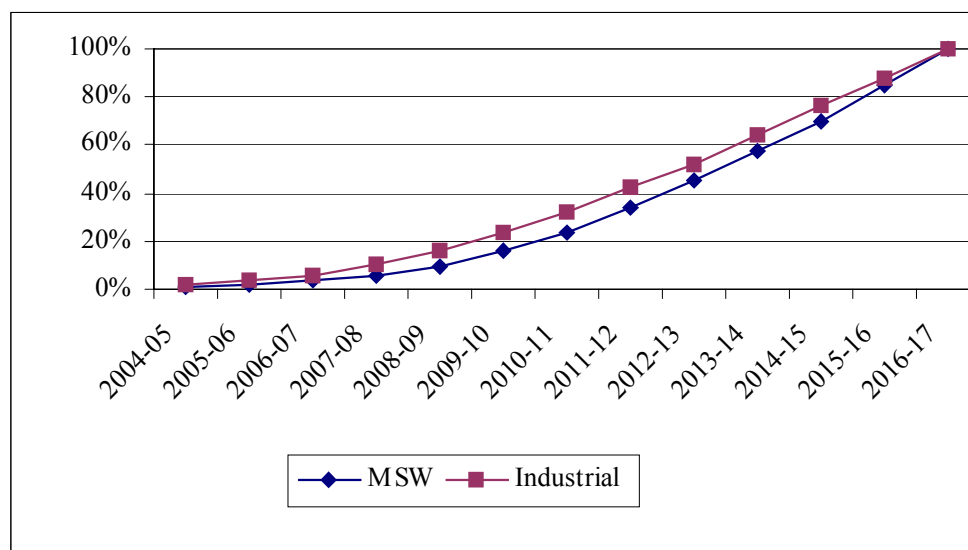


Figure 2 : Targets and Time frame for the period 2004 – 2017 (%)



### 1.7 Financial Analysis

Financial analysis of WTE projects has been used to assess their commercial/financial viability based on the potential revenue generation and 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.

#### 1.7.1 Urban Sector

##### Municipal Solid Waste

Based on these criteria the commercial viability of MSW to energy projects using biomethanation and Refuse Derived Fuel (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.

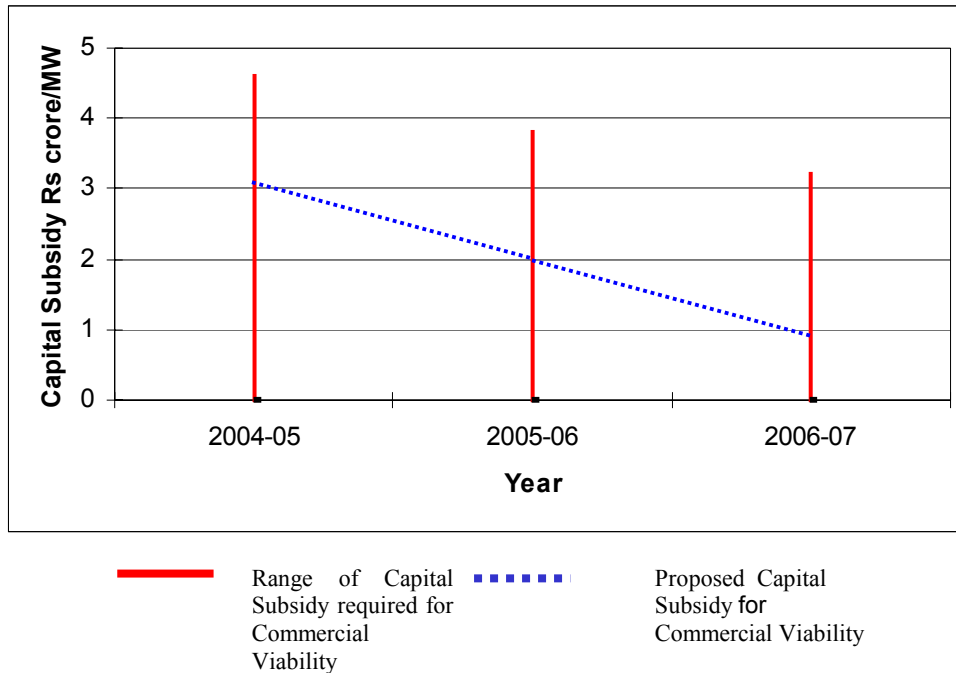
Table 7 : Capital Subsidy Requirements (Rs Crores/MW) for Commercial Viability of MSW to Energy Project for the Period 2004-07

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 11<sup>th</sup> and 12<sup>th</sup> 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 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 11<sup>th</sup> FYP.

**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 WTE 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 FYPs.

**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, 11<sup>th</sup> and 12<sup>th</sup> FYP for urban and industrial sectors is given in Table 8.

Table 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
	<b>Total</b>	<b>2743</b>	<b>9</b>	<b>1435</b>

### 1.9 Funding Options

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

- Other Ministries
- Multi-lateral / Bi-lateral Agencies

At the central level, other than MNES, MoEF and MoUD are the nodal ministries involved in formulating the policies and programmes for the waste management in the country.

The Ninth and Tenth FYP budgets of these ministries were studied in-order to ascertain the possible funding from these ministries. The possible funding from MoEF and MoUD are given in Table 9.

Table 9 : Possible Funding from MoEF and MoUD

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

\* 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 on interest rate. 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.

### 1.10 Implementation

Waste-to-energy projects are generally promoted /implemented either by private entrepreneurs/organizations or local bodies. 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.

## **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 FYPs. 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 subsequent FYPs should be undertaken before the end of the previous FYP.

The Strategic Action Plan (SAP), thus provides details of activities to be undertaken within 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, Technical, Finance and R&D to each relevant sector respectively.

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

### **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 10

### **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 10.

### **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 10.

#### 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 10.

#### 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 which would lead to demonstration and commercialization of these technologies. SAP also proposes setting up of a dedicated team as R&D cell within the MNES to coordinate 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 10.

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 made available during the eleventh five year plan.

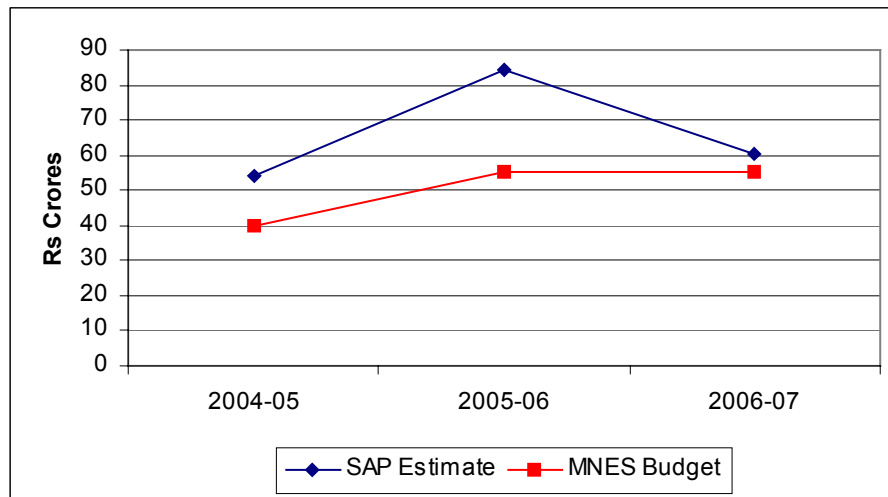
**Table 10 : Summary of Funding Requirement for the period 2004-07**

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
			<b>2.25</b>	<b>1.45</b>	<b>1.45</b>	<b>5.15</b>

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
			<b>4.20</b>	<b>1.85</b>	<b>2.35</b>	<b>8.4</b>
4	Financial Assistance/ Assistance for Project Implementation	Urban Sector	36	28.50	29	93.5
		Industrial Sector	05	15	25	45
			<b>41</b>	<b>43.50</b>	<b>54</b>	<b>138.5</b>
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
			<b>5.95</b>	<b>7.55</b>	<b>2.5</b>	<b>16.00</b>
6	Preparation for mobilizing external funding sources		0.25	-	-	0.25
	<b>Grand Total</b>		<b>53.90</b>	<b>84.4</b>	<b>60.35</b>	<b>168.50</b>

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

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



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 (1<sup>st</sup> July, 1<sup>st</sup> October and 1<sup>st</sup> January) besides a comprehensive review of the performance for the entire financial year to be taken up on the 1<sup>st</sup> of April to permit modifications in the strategic plan for the ensuing financial year.

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