Chapter II

Environmental Industry Development in Developing Asian Countries: Case of India

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Summary and Recommendations

Worldwide phenomenon of environmental degradation has affected India as well owing to the rapid increase in population and economic development. Encouraging achievements in social indicators on one hand have also been accompanied with inadequately provided basic services. Scoping of environmental issues for this study was done accordingly after a comprehensive literature review and covers key environmental issues: Air, Water, Solid waste, Green house gases and Climate change and Environmental Management. The study provides an overview to each issue and identifies critical issues facing the sector while highlighting Government policy measures & initiatives. Briefly discussing the experience of different projects and/or funding agencies, the study also brings up potential business opportunities in the sector.

Growth in road based passenger transport accompanied with an increase in number of personal vehicles is the major contributor to the problem of air pollution. Rapid strides in industrialisation and power generation capacities have further magnified the problem. Prevention-based approach, especially in the SSI, has worked to a limited extent. Mechanisms and subsidies to deliver better energy services are misdirected towards more affluent urban households and commercial sectors. Existing information base on emission loads, emission factors, traffic volumes, specific resource consumption in the industry and emissions per unit output needs to be strengthened so as to evaluate success of policy and technology. Reforms need to be initiated in the Power sector by fixing fuel prices at realistic levels, rehabilitation of existing less efficient infrastructure and putting the renewable energy sources to maximum use. Getting the price of electricity right shall also send correct signals to consumers so as to encourage them to invest in energy saving practices and technologies. Reducing vehicular emissions shall require improved vehicle technology and fuel quality,

better traffic flow, controlling the number of vehicles on the road and use of alternative fuels and vehicle technologies. Interventions to reduce indoor air pollution shall include improving ventilation in-house, using improved and eco friendly stoves and cleaner fuels and creating awareness amongst masses about health impacts of indoor air pollution. Potential business opportunities lie in design and provision of systems for reducing levels of NO_x, SO_2 and noise; clean coal technology; heat recovery systems and; better combustion and emission control technology in vehicles. R&D thrust areas have also been identified in the field of renewable energy.

Though India is rich in terms of annual rainfall and total water resources available, the uneven distribution of resource causes regional and temporal shortages. Per capita availability of renewable freshwater resources in India fell from 6000 cubic metres in 1947 to about 2300 cubic metres in 1997. Sewage generation in urban centres has increased six-fold between 1947 to 1997. Critical issues facing resource management include the widening gap between demand and supply, inequitable access to basic services, degradation in resource quality, inefficiencies in resource usage and poor pricing policies. There is a need to strengthen monitoring networks for water quality monitoring, generate information on availability of groundwater and on water consumption and effluent discharge patterns for industries. There is a need to increase resource availability through rainwater harvesting measures, preventing water run-offs and inter basin water transfer. Water management efforts should be at a river basin or sub-basin level. Appropriate tariff structure for water services will encourage wise usage of resource and generate additional support for the fund-starved service providers as well. Efforts for conservation of water need to be intensified to prevent overexploitation of scarcely available resource and reduce the quantity of wastewater generated. Sewage collection, interception and treatment efficiencies need to be enhanced further. Potential business opportunities lie in generating more resources by removal of dissolved organics in brackish water and saline water and bettering resource quality through removal systems for BOD and COD, high Ammonia wastewater, heavy metals and treatability studies for sewage and process wastewater.

Solid waste generation in the country has increased from 6 million tonnes in 1947 to 48 million tonnes in 1997 owing to urbanisation and changes in lifestyles.
India has witnessed a significant growth in industrial sectors that have a major potential for generation of hazardous waste. Production and consumption of plastic has itself increased

more than 70 times between 1960 and 1995. Inadequacies in solid waste management (SWM) system, poor waste segregation practices, absence of dedicated waste disposal facilities and inadequate infrastructure and culture for waste recycling pose problems in management of waste. Rules for waste management fail to provide any incentive for waste reduction/minimisation and do not clearly identify the role and responsibilities to be undertaken by the CPCB and SPCBs.

Studies on waste inventorisation and to explore the risks and health impacts of hazardous waste disposal need to be carried out. Technological interventions that need urgent consideration include waste collection, treatment and disposal. There is a need to set up decentralised waste treatment facilities throughout the country and demonstrate their viability through pilot-scale projects. Institutional and regulatory reforms need to be initiated in ULBs and additional support has to be mustered from the private sector. Business opportunities include design and execution of comprehensive solid waste handling, treatment technologies and disposal systems. This covers waste to energy technologies, resource recovery from wastes, waste stabilisation, soil remediation studies and technology evaluation of available options.

Given its dependence on climate-sensitive sectors as agriculture and forestry, India is also vulnerable to climate change. Main sources for the increase in atmospheric carbon dioxide being energy consumption. The Government of India's policy on climate change has been broadly based on the principle that developed countries should show a demonstrable sincerity in initiating actions to address climate change and the developed world should transfer resources and technologies at favourable terms to the developing world. Energy efficiency and increased use of renewable energy are the two main measures that can greatly reduce emissions of green house gases. The interim approval criteria drawn up by the MoEF states that CDM should be oriented towards improving the quality of life of the very poor from environmental standpoint. Data requirements for proper planning and initiation include development of GHG inventories; vulnerability assessment and; identification of strategies, options and technologies to reduce GHG emissions. It is also required to develop adaptive capacity to combat the negative impacts of climate change and build institutional capacity on operationalising CDM.

Environmental management is changing from resistant compliance to sustainable business decision-making with greater public awareness and support from judiciary. The number of

companies going in for ISO 14001 certification has also increased from a mere 1 in 1995 to 605 by the end of 2002. There is a need to bring in a change in mindsets towards judicious use of available resources. Government policies also need to shift from that of a watchdog to facilitator accompanied. This shall be have to be supplemented with better information availability in public domain, better tracking of operations and resource consumption, environmental accounting of operations and through introduction of market-based instruments that have a potential to provide cost-effective solutions to environmental problems and stimulate environment-friendly technological progress.

Based on their experience in India, the funding agencies recommend changing the mind-set of key business and government leaders with respect to environmental management. There is also a need to build awareness among the employees when dealing with environmental and occupational health and safety issues. Introducing management measures such as monitoring and reporting to sharpen management's awareness of environmental costs and benefits is also called for.

1. Introduction

1) Overview

India has been no exception to the worldwide phenomenon of environmental degradation resulting from rapid increase in population and economic development. The trends rather have been substantial and more prominent as compared to other developing economies. The economics of environmental pollution, depletion and degradation of resources has in fact been neglected as compared to the issues of growth and expansion.

The country has recorded encouraging achievements in the age-specific mortality rates, expectation of life at birth and aspects related to livelihood conditions like education, nutritional security and health. With the country's population having grown three-fold and the urban population itself quadrupling in four decades (1951-1991), the current infrastructure in most of the cases is not only over stretched but also inadequate.

The rapid expansion of cities has brought to the fore acute problems of transport congestion, atmospheric pollution and unwise water and waste management resulting in the degradation of the quality of life. The deterioration of environmental quality in Indian cities is but one aspect of the threat to the quality of life, the other perhaps more pertinent issue being that of the sustainability of growth itself. The much-needed impetus to industrial development has also resulted in huge residuals, having undesirable effects on the environment.

The study titled *Environmental Industry Project* aims to promote development of environmental industry in the Asia-Pacific Region. Looking at the current state of environmental industry development, the objective of the study is to:

1. establish the current status of environmental industry development;
2. identify major factors responsible for industry development, including government policies and contributions of multinational corporations (MNCs) and bilateral and multilateral donors;
3. analyse major constraints and issues facing the industry and;
4. recommend domestic and external policy measures to promote the industry development on the basis of their dynamic comparative advantages

2) Scope of the study

To define the scope of environmental issues for this study, comprehensive literature review has been done. Salient features of the different studies have been discussed briefly:

1) The *US Commercial Services Report* lists the following as major areas of investment in India's environmental industry: Water treatment, Biomedical waste, Industrial and Vehicular air pollution control, Recycling and sanitation, Environmental Management, Pollution testing and monitoring equipment/services, Clean and renewable energy equipment, Environmental consulting/engineering services.
   a) Water treatment- Market $1 billion, to grow at 14-15% for wastewater utilities and in highly water polluting sectors such as chemicals, petrochemicals, metal processing, ferrous and non-ferrous metals processing and food processing sectors.
   b) Biomedical waste- This sub-sector with an estimated market potential of approximately US $200 million sector is expected to double over the next three years.
   c) Industrial and vehicular air pollution control- Monitoring and testing technologies, expected to grow 15 percent annually owing to planned capacity additions in the thermal/liquid fuel/gas-based power sector, and retrofitting opportunities in the existing polluting industries like steel and petroleum refinery.

The report estimates the market for environmental business to be at US $3.2billion and forecasts an annual growth of around 15 percent.

2) The *Study on the Indian Environmental Scenario and Market* [1] by the Indo German Chamber of Commerce in Feb 2001, identifies the following areas as the most promising business opportunities in the environmental goods and services sector:
   a) Air pollution control (removal of gaseous and particulate emissions from air using process and prevention technologies)
   b) Water and wastewater treatment (includes technologies to purify drinking water, clean sewage, and remove pollutants from industrial wastewater)
   c) Waste management (collection, disposal, recycling, and treatment of domestic wastes, industrial wastes and hazardous wastes)

[1] Indo German Chamber of Commerce, February 2001

d) Contaminated land remediation (assessment and cleaning up of contaminated land)
e) Energy management (systems and technologies to make efficient use of both conventional and renewable energy)
f) Environmental monitoring (physical monitoring of environmental standards using instruments and analytical services)
g) Environmental services (consultancy and laboratory)
h) Noise and vibration control
i) Marine pollution control

3) MMCs report on *Opportunities for British Companies in the Indian Environmental sector*[2] prepared in 1998 quotes "the changing attitudes of India's large companies offer endless possibilities in practically all industries". It also estimates that market for clean up technologies shall be of the tune of US$7billion by 2010. These opportunities lie in the following sectors:
   a) Power sector
   b) Renewable Energy
   c) Water treatment
   d) Land degradation
   e) Solid waste disposal
   f) Medical waste disposal
   g) Cleaner paper production
   h) Environmental Management Systems
   i) Other areas including Aquaculture, Tourism and environmental damage, Health and Environment

4) The ADB in its study pointed that an estimated $1.1 billion of ongoing projects in India are being funded by various multilateral and bilateral donor agencies in sectors including forestry, river pollution control, institutional strengthening and capacity building, urban and rural infrastructure (sanitation and water supply), energy improvement, water resources/drainage.

[2] Prepared by MMC, India for The Department of Trade and Industry, Overseas Trade Services, England

5) An analysis of the sector-wise distribution of external assistance in India since 1989 has also been done by CII[3] (Table 1). This also reflects a major funding focus on urban management problems including urban infrastructure, industrial pollution and resource management.

Table 1 Sector-wise distribution of external assistance in India

Sector	Amount in million USD
Agriculture and Natural Resources	4529.42(45%)
Industry and Energy	1660.99(16%)
Urban Infrastructure	2747.43(27%)
General	765.36(8%)
Global issues	454.29(4%)

6) The key potential business opportunities in environmental consulting services in India as identified by *US Department of Commerce* are as Table 2[4].

Table 2 Key business opportunities in India

Opportunity	Details	Growth prospects
Pollution Prevention Studies	Covering environmental audit, waste minimisation and pollution prevention, especially in small and medium enterprises	Estimated market as in 1997 at US$ 15million and anticipated growth rate of 15% over next three years
Environmental Impact Assessment, Emergency plans , Safety audits	Prior environmental clearance mandatory for 29 project categories both for existing as well as new projects	Estimated market size of US$ 30million as in 1998 and projected to grow at 16-20% over next three years
Environmental	Increase in number of companies	Estimated market for EMS

[3] Compendium of Donor-assisted Projects in the Environmental Sector in India, May 2002, compiled by CII for the WB

[4] Unofficial estimates and extrapolations from the 1994 figures published in the Environmental Business Opportunities in India, Jan 1996, CII

Management Systems	going in for ISO 14001 certification. However, small and medium enterprises have not viewed EMS as a priority area.	consultancy in 1997 was approx. US$ 5million with an annual growth rate of 10-15%
Environmental Policy, Regulatory studies and Training	Translating the Environmental Action Plan into actual work through policy research, new regulations and enforcement strategies	Estimated market as in 1997 at US$ 5million and anticipated growth rate of 15% over next three years
Consultancy services for Biomedical and Hazardous waste management	Limited technical expertise available for treatment of hazardous wastes	Estimated market at about US$ 50million

Besides this the Indian market for process control, instrumentation, monitoring, testing and analytical equipment for pollution control amounted to US$ 72 million in 1996 and is expected to grow at an average annual growth rate of about 15-20%. The major constituents of the market and their respective shares are:

a) Process control equipment and instrumentation for
   i. Air/Gaseous pollution: 25%
   ii. Water pollution: 20%
b) Environmental measurement/monitoring systems:12%
c) Testing and Analysis equipment: 15%
d) Process control and Instrumentation systems: 28%

3) Contents of the study

Based on review of these studies, the current study proposes to cover the following environmental concerns that have emerged in the country:

1) Air
2) Water
3) Solid waste
4) GHG and Climate change
5) Environmental Management

The study also presents in Chapter 6 two interesting case studies on experience of funding agencies in the country.

4) Structure of the study

The subsequent chapters on the listed environmental concerns provide:

1) An *overview*[5] to the issue
2) Highlight *Government policy measures & initiatives*[3]
3) Highlight the *critical issues* facing the sector, also covering *Policy gaps* and *Knowledge/Information/Data gaps*
4) *Experiences* from/of different projects and/or funding agencies
5) *Potential business opportunities* in the sector and
6) *Recommendations*

[5] Various studies at TERI: DISHA (Directions, Innovations and Strategies for Harnessing Action for Sustainable Development , TERI 2001) and State of Environment: India, UNEP 2001

2. Air

1) Overview

The rise in number of vehicles together with greater industrial expansion and inadequate enforcement has combined to produce unacceptably high levels of pollution. High SPM levels have been observed in most of the Indian cities, while some of them also recorded high levels of SO_2 and NO_x. The following summarise air pollution scenario in the country:

1) The number of motor vehicles in the country has increased from 0.3 million in 1951 to 37.2 million in 1997 with the two wheeler population increasing from 9% in 1951 to 69% in 1997 and share of buses declining from 11% to 1.3% during the same period. Of these vehicles, 32% were estimated to be concentrated in 23 metropolitan cities, with Delhi accounting for 8% of the total vehicles.
2) Road based passenger transport has recorded high growth from an estimated 44.8 billion passenger kilometres in 1951 to 2515 billion passenger kilometres in 1996. Consumption of gasoline and HSD (high speed diesel) has also increased by about 14-15% between 1980-81 to 1996-97.
3) Rapid strides in industrialisation have got India a place in the list of ten most industrialised nations in the world. Power generation in the country has also multiplied 55times over last 50 years to 93.3 thousand MW in 2000. Of this, the thermal power constitutes to about 74% of power generated.
4) Domestic pollution resulting from the use of different types of fuels like coal, fuelwood and other biomass fuels is estimated to contribute 7-8% of the total pollution load in the country's capital, Delhi.

2) Government policy measures and initiatives

The Government of India has formulated legislations, policies and programmes for control of air pollution. Brief details of these efforts are as discussed:

1) The Air (Prevention and Control of Pollution) Act, 1981
2) The Environment (Protection) Act, 1986
3) AAQ standards for SPM, RSPM, SO_2, NO_x, CO and Lead have been laid down for industrial, residential and sensitive areas. Emission standards have been prescribed for various pollutants from different industries. Stringent vehicular emission norms along

with fuel quality specifications have been laid down in 1996 and 2000. Euro I norms are applicable since 1 April 2000 and Euro II will be applicable wef 1 April 2005.

4) Environmental Impact Assessment (EIA) has been made mandatory for 29 kinds of project activities. Industries are required to submit an annual environmental statement to the respective state pollution control boards providing information on the activities undertaken, pollution caused and resources consumed.
5) Guidelines exist on siting of industries so as to benefit from the natural self-cleansing capacities of receptor media. District wise zoning atlas has also been prepared in order to guide industrial siting.
6) Status of pollution control as on 30June 2000 shows that of the 1551 industries, 1324 have provided necessary pollution control facilities, 165 have been closed and other 62 are on defaulter list. However, the small-scale sector which accounts for more than 40% of the country's total industrial output generally lacks adequate pollution control measures.
7) The Ministry of Environment and Forests (MoEF) has also undertaken carrying capacity studies for some areas in the country.
8) Various clean production and pollution prevention technologies are being developed to reduce waste generation and emission of pollutants. Beneficiated/blended coal use with ash content less than 34% has been made mandatory in ecologically sensitive areas.
9) Action plans for pollution control are being prepared and implemented in the identified problem areas and involve the concerned agencies/industries. Epidemiological studies have also been initiated in seven critically polluted areas[6].

3) Critical issues

1) Vehicular Pollution

Increase in population, urbanisation and per capita income has led to a rapid growth of about 10% in the number of vehicles as listed in Table 1.1. The trends clearly indicate a considerable decline in the share of public transport in India. Among the major reasons is the inability of public transport system to keep pace with the increasing demand and the deteriorating quality of service. Other reasons include age of the vehicle fleet, technology they run on, fuel quality, poor access to alternative fuels, inadequate traffic planning lead to

[6] Vapi(Gujarat), Angul-Talcher(Orissa), Chembur(Mumbai), Cochin(Kerala), Kanpur(Uttar Pradesh), Mandi-Gobindgarh(Punjab) and Najafgarh Drain basin(Delhi)

emissions of carcinogenic benzene, oxides of sulphur and nitrogen and fine particulate matter. Emission levels from vehicles are estimated to grow at an annual rate of 5%.

Table1.1[7]: Growth in number of vehicles over years

Category	*1975*	*1980*	*1985*	*1990*	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*
Two-wheelers	946	2,117	5,179	12,611	14,200	15,661	17,183	18,899	20,831	23,252	25,729	28,642	31,328	33,913
Cars, jeeps, and taxis	766	1,059	1,607	2,694	2,954	3,205	3,361	3,569	3,841	4,204	4,672	5,138	5,556	6,042
Buses	114	140	223	298	331	358	364	392	423	449	484	538	540	559
Goods vehicles	335	473	822	1,238	1,356	1,514	1,603	1,691	1,794	2,031	2,343	2,536	2,554	2,681
Others[b]	311	732	1,339	2,311	2,533	2,769	2,994	3,109	3,406	3,850	4,104	4,514	4,897	5,198
All vehicles	2,472	4,521	9,170	19,152	21,374	23,505	25,505	27,660	30,295	33,786	37,332	41,368	44,875	48,393

[a] includes omnibuses

[b] include tractors, trailers, three-wheelers (passenger and goods vehicles and other miscellaneous vehicles which are not separately classified)

2) Pollution from domestic and commercial sectors

Burning of unprocessed biomass for cooking in traditional inefficient devices contributes majorly to indoor air pollution. Such emissions are particularly toxic because of the poor availability of dilution air indoors resulting serious health problems from prolonged exposure to pollutants. Emissions from traditional fuels in the residential sector are estimated to decline though the levels shall remain a cause of concern.

3) Industrial Pollution

Despite that the number of air polluting industries in the country have reduced drastically, high potential still exists in bettering the energy use efficiencies. As the demand for energy increases, pollution from power generation shall remain a concern.

Studies estimate the energy saving potential to be in the tune of about 25% to 50% in the small-scale industries. Comparison of the specific energy use in select Indian industries as

[7] Motor Transport Statistics of India, Ministry of Surface Transport, 2000, New Delhi

against other developed countries, as Table 1.2, highlights this potential. Small-scale industries are another area of concern because of the poor penetration of clean technologies and end of pipe treatment in different clusters of the country.

Table 1.2[8] Comparison of specific energy use (million kcal/tonne) in selected industries

Country	Steel	Cement	Pulp and paper
India	9.50	2.00	11.13
UK	6.07	1.30	7.62
USA		0.95	9.70
Japan	4.18	1.20	-
Sweden	5.02	1.40	7.56

4) Policy gaps

1) Over reliance on command and control type of environmental management has worked to a limited extent, particularly in the small-scale industries (SSIs). This prevention-based approach needs to be strengthened by policy initiatives that promote clean technology approaches and better land use planning.
2) Lack of tools to assess effectiveness and impact of various policy measures.
3) Separate transport policies do not exist at state and national levels.
4) Lack of well-defined policy to promote private sector participation in public transport.
5) Lack of co-ordination between various agencies to improve transport services.
6) The Indoor Air Pollution issues have not been integrated into the health, energy, infrastructure and rural development programmes.
7) Mechanisms and incentives (like subsidies) to deliver better energy services are misdirected towards more affluent urban households and commercial sectors.

[8] Ministry of Science and Technology 1993

5) Knowledge/Information/Data gaps

1) Monitoring at hotspots like traffic intersections and other sensitive areas needs to be strengthened by increasing the number of stations, frequency and scope of monitoring. The results of analysis need to be linked with policy and infrastructural changes. There is not much of Private/Community participation in monitoring activities.
2) The existing information base on emission loads, emission factors, vehicles on road, traffic flow volumes, specific resource consumption in the industry and emissions per unit output calls for further strengthening so as to evaluate success of policy and technology.
3) Information base is also poor on source apportionment; epidemiological aspects of different pollutants; success of programmes and subsidies for improved and efficient stoves, better kitchen design and; effectiveness of different fuels.

Box 1: Case study on Small-scale cast iron foundries in India

The case study describes a technological upgrading initiative undertaken by TERI to improve the energy efficiency and environmental performance of small-scale foundries have very low energy efficiency and poor environmental performance. Upgrading the technology used in the melting plant lowers energy consumption, which in turn lowers the operating cost and also the emissions of pollutants at source. The reduction of pollution at source reduces the size of the pollution control system necessary to meet the statutory emission standards. Until recently, most of the foundries had conventional cupolas. The divided blast cupola offers an attractive option to reduce coke consumption at a modest investment. When the regulatory authorities enforced the emission standards, most small-scale foundry units found it extremely difficult to comply with the law primarily due to lack of availability of any ready-made gas cleaning system. Hence, a suitable flue gas cleaning system along with a divided blast cupola was designed to provide a viable solution to the small-scale foundries.

A full-scale demonstration plant consisting of the energy-efficient divided blast cupola and a high-efficiency venturi-scrubber for improving the energy and environment performance was set up by TERI at a small-scale foundry unit in Howrah. The plant, which is operating continuously since September 1998, has drastically reduced its coke consumption and emissions of suspended particulate matter and sulphur dioxide. Adoption of the demonstrated technology by foundries planning to modernise or expand their operations is a win–win option–a reduction of pollution load and also energy saving in melting operation.

Conventional cupolas consume more coke and release large amounts of suspended particulate matter and sulphur dioxide in the absence of any pollution control device. The new technology aims at reducing pollution at source through optimisation of the design and operational parameters of the melting furnace and reduction of stack emission by an appropriately designed pollution control system. To maintain a tighter control on the raw material and fuel input, the feed materials are charged into the cupola by a mechanical charging system. The exhaust gases are cleaned using a properly designed venturi- scrubber to meet the more stringent emission standards before discharge to the atmosphere. The critical components of the pollution control system are made of stainless steel to avoid corrosive wear and ensure several years of trouble-free operation.

The new design reduced coke consumption by 35% and emissions of both particulate matter and sulphur dioxide by as much as 90%, bringing the emissions well below the permissible limits. More specifically, the emissions of particulate matter came down from 1500-2500 milligrams per normal cubic metre to only 55-70 and of sulphur dioxide from 600 to 30 whereas the upper limits (for cupolas more than or equal to 3 tonnes per hour) are 150 and 300 milligrams per normal cubic metre respectively.

6) Experiences

The constraints in renewable energy sector is good case study to be looked at. Although the cost of generation of small hydro at about Rs 1.43 per kilowatt-hour is highly competitive with conventional technologies, some renewable energy technologies, such as solar photo voltaic (SPV), are far less economically attractive than conventional technologies. Even if the cost declines by 50% the SPV cost would remain incompetitive compared with that of other renewables and conventional technologies, notwithstanding the low variable costs associated with SPV technology. Other factors that constrain the use of renewable energy technologies are as follows:

1) Technological

a) Most renewable energy technologies have not achieved maturity within the country, and a large portion is imported.
b) Renewable energy sources are site-specific, and the supply may not be continuous.
c) Technical information is not easily available either for the entrepreneur or the consumer.

2) Institutional

a) A top-down centralised approach is generally adopted for this potentially highly decentralised option.
b) Little encouragement has been received from the state electricity boards.
c) There is a lack of awareness about the potential environmental benefits.
d) There is a lack of serious education and training for operation and upkeep.
e) Incentives are misused; they are related to investment rather than to performance of plants.

3) Financial and economic

a) Diesel and electricity are subsidised for use by agriculture and residential consumers.
b) Funds allocated to renewable energy sector are minimal when compared with fossil fuel and nuclear energy options.
c) In some cases, large initial investments are required.

4) Infrastructural

a) The land requirement for renewable energies could be very high.
b) Poor grid availability proves to be a major deterrent.
c) There is a lack of proper maintenance and servicing facilities at the local level.

A number of options to address the constraints exist, some of which are already at various stages of implementation:

1) collection of information; dissemination and training campaigns;
2) reorienting of the investment portfolios of power utilities to develop decentralised power options and encouragement for the utilities to ensure grid connection to private developers;
3) formulation of a policy for power purchase;
4) promotion of the financing of economically viable renewable energy technologies by developing and introducing innovative financing schemes, such as lines of credit, revolving funds, and hire-purchase plans, to the conventional loan schemes and;
5) formulation of government policy and legal and regulatory frameworks that encourage private sector participation.

7) Potential business opportunities

1) Systems for reducing levels of NO_x, SO_2 like burners, catalytic converter and technology for control of NO_x /HC/SO_2 from large stationery diesel engine
2) Noise pollution controls for equipment like compressor, pressure reducing valves etc.
3) Technology for coal washing, clean coal, fugitive emission control
4) Technologies for air pollution control and heat recovery systems in small-scale industry like foundries etc. Package scrubbing systems for small and medium scale units
5) Better combustion technology and emission control technology in vehicles like smoke traps for Diesel vehicles. Electric vehicles and alternate fuels for surface transportation. R&D thrust areas identified by the Ministry for support in the field of renewable energy are detailed below:
6) Use of Biomass for briquetting, co-generation and power generation
7) Production of gaseous fuels like producer gas, methane etc and their application in rural applications

8) Solar Energy applications like Development of Photovoltaics and other materials and improvement in solar cell/system efficiencies for Solar ponds, solar energy assessment studies.
9) Electricity generation using wind electric generators
10) Tools for building energy conservation
11) Techno-economic feasibility studies and market surveys in the areas of hydrogen and geo-thermal energy
12) Monitoring Hydrocarbon-analyser instruments both portable and continuous, on-line stack monitoring, continuous ambient air monitoring, continuous gaseous emission monitors
13) Special pollutant removal systems like fluoride removal in phosphatic fertiliser, particulate emission in control in urea prilling tower, bagasse fired boilers and small scale flue gas desulfurisation system

8) Recommendations

1) Power sector

a) Reforming and restructuring the power sector by fixing fuel prices at realistic levels: While most coal prices have been deregulated, power station grades of domestic coal are still priced below the cost of production and the true value of better grades is underestimated. Cleaner imported fuels are priced too high in comparison with domestic coal.

b) Rehabilitating power generation plants and T & D Networks
Investment needs to be made to rehabilitate transmission and distribution (T&D) networks, better the power factor, check pilferage and thefts so as to bring down the energy losses which are in the tune of 21%.

c) Energy use is currently less efficient and less cost-effective than the best available technology would allow. There is a need to manage and model energy demand by implementing policies that reduce energy consumption. Demand-side management programs could reduce total system costs and hence pollutant emissions.

d) The Ministry of Non-Conventional Energy Sources has estimated that 126 GWs of power generation capacity is available from renewable energy sources in long term. Although there is a high technical potential, the prospects for expansion in short term are limited owing to different restraints.

e) Significant benefits in pollution control shall result from improved implementation of existing standards and working through market mechanisms. It is necessary to have a suitable legislative and regulatory framework for administering the MBIs and checking the different barriers to effective implementation.
f) Clean coal technologies[9] do improve combustion efficiency and reduce SPM and SO_2 emissions to the environment. Similarly, coal washing prior to its burning needs to be practised at a larger scale.
g) The National Thermal Power Corporation's experience suggests that the use of fly ash can be encouraged by changes in plant policy. Most plants, however, do not appear motivated to pursue these policies. The current problems of ash disposal and management could in part be corrected through stronger enforcement of present environmental standards.
h) Construction of new coal-fired plants will be needed to meet future demands, it is therefore important to consider the environmental impacts attributable to plant location. Relative disadvantages and advantages of two-types of power plant sites need to be considered: locate the plant at a load center (that is, in an area where a high population of power users is concentrated) or at the pit-head (in a sparsely populated area).
i) Other reforms include:
    i. Getting the price of electricity right so as to send the correct signals to consumers to encourage them to invest in energy saving practices and technologies.
    ii. Getting the price of fuels right to "create a more level playing field" for natural gas and renewable energy sources
    iii. Increasing the commercial motivation of utilities to give them the incentives to make choices that benefit the environment, such as improving ash management and rehabilitating transmission and distribution systems
    iv. Increasing the funds available to utilities so as to make improvements by raising tariffs.

2) Reducing emissions from vehicles

a) Improved vehicle technology and fuel quality

Reducing vehicular emissions calls for interventions to improve both vehicle technology and fuel quality. This should be done gradually in phases by introducing

[9] Though there is only a marginal reduction in ash and CO.

cleaner technologies to allow the automobile and oil industries to make the required investments. Policy initiatives are required for in-use vehicles as well because the turnover rate of vehicles in India is low. The strategies for making in-use vehicles less polluting would revolve around mandating stricter emission standards coupled with better enforcement so that all vehicles go for periodic certifications.

b) Improved traffic flow

One major reason that improvements in vehicle technology and fuel quality have not resulted in reduction in emissions is the poor traffic flow resulting from a relatively high share of non-motorised modes on a common right of way. Improvements in traffic flow can be achieved through better traffic engineering and improved traffic management.

c) Controlling the number of vehicles on the road

The number of vehicles on the road can be achieved by measures such as an increased use of mass transit through extending its coverage, reducing waiting time and travel time, making the services more reliable, co-ordinating transfers and making available park-and-ride facilities. There is a need to introduce disincentives for use of private vehicles like increasing parking charges, surcharge on motor vehicles and fuels and fuel rationing.

d) Alternative fuels and vehicle technologies

A number of automobile technologies and alternative fuels like CNG, LPG are now available in the market. In addition, a number of such zero-emission vehicles as solar-powered vehicles and those powered by fuel cells are in the development stage. However, information on these alternative technologies is limited and needs to be explored and disseminated.

3) Interventions to reduce indoor air pollution

a) Improved ventilation

Modifying existing kitchens and designing the new rural housing units in a better way to ensure better ventilation can mitigate indoor air pollution. In this context, it is important to promote awareness of the dangers related to indoor air pollution so that people may try to adopt ways of minimising exposure through better kitchen management and infant protection.

b) Improved stoves

Improved stoves are comparatively eco-friendly as they burn less fuel and produce less smoke. Their design with provision of chimneys helps in better ventilation. User participation and improved design for higher efficiency and longer life will make these not-so-expensive stoves more popular.

c) Cleaner fuels

Use of cleaner fuels and processed biomass fuels comprise effective long-term interventions for reducing indoor air pollution. A faster transition from solid fuels to cleaner liquid or gaseous fuels requires appropriate policy interventions like checking misdirected subsidies on kerosene. Steps should therefore be taken to increase the availability of LPG and kerosene to meet the demand for cooking.

d) Dissemination and Replication of success case stories

There is a need to replicate success stories wherein IAP issues have been integrated with other projects and programmes on agriculture, forestry, nutrition, family planning and promotion of women's welfare. Government intervention shall be required in designing finance schemes that combine housing finance with improved kitchen/stove design

4) Other directions and strategies

a) Urban planning with focus on the environment

The only way to relieve highly polluted cities of the huge additional burden and pressures is to 'de-concentrate' the cities by relocating the population, industries, and economic activities in different 'priority' towns in the hinterland. Regional development plans need to be developed and implemented that incorporate policies relating to population distribution, settlement system, transport and communications, physical and social infrastructure, regional land-use, environment and eco-development, management structure for plan implementation, and counter-magnet areas for development.

b) Planing tools for air quality management

Efforts to formulate an urban air quality management strategy require information on ambient air quality and data on the emissions of pollutants, models to predict the dispersion of these pollutants, and epidemiological studies that ascertain the health effects of different ambient pollutant concentrations. Emissions inventories are also useful for planning to identify the sources and estimating the quantities of pollutants. The inventories must be kept updated to evaluate the impacts of changes in the

characteristics of emission sources and of the strategies to control air pollution on ambient air quality.

c) Air quality monitoring

The capability to monitor pollutants should be strengthened and data on air quality needs to be used to check compliance with standards; to inform the public; to trigger measures that reduce both emissions and; the public's exposure to them and to help policy-makers in formulating measures to control air pollution or to evaluate the measures that have already been implemented.

d) Epidemiological studies

Many air pollutants adversely affect people's respiratory and cardiovascular systems and, in some cases, cause premature death. An integrated study of air quality monitoring, exposure assessments, and epidemiological studies should be conducted to set more reliable air quality standards and suitable emission norms. Information on effects of certain pollutants is not available and needs to be generated and adequate mitigation strategies formulated. Air quality standards should be reviewed from time to time based on location specific carrying capacity.

e) Greater transparency

Greater transparency is needed in matters related to pollution control and sharing information with the public.

f) Increased public awareness

The most important element of strategies to mitigate air pollution shall be to bring a behavioural change by raising awareness amongst masses about health impacts of air pollutants and providing specific information on the range and effectiveness of mitigation options. This shall require facilitating involvement of all stakeholders, specifically women as part of the household energy programmes.

3. Water

1) Overview

India is considered rich in terms of annual rainfall and total water resources available at the national level, however the uneven distribution of the resource causes regional and temporal shortages. India's average annual rainfall equivalent of about 4000 billion cubic metres (BCM) is unevenly distributed both spatially as well as temporally. Annual per capita utilisable resource availability in the country also varies from 18,417 cubic metres in the Brahmaputra valley to as low as 180 cum in the Sabarmati basin (Chitale, 1992). Levels of precipitation vary from 100 mm annually in western Rajasthan to over 9 000 mm in the north-eastern state of Meghalaya (Engleman and Roy, 1993). With 75% of the rainfall occurring over the four monsoon months and the other 1000 BCM spread over the remaining eight months. The following provide an overview on the water scenario in India:

1) The per capita availability of renewable freshwater resources in India fell from 6000 cubic metres in 1947 to about 2300 cubic metres in 1997.
2) Groundwater is being increasingly overexploited; surface water is being used either inadequately or inefficiently and; the traditional water-harvesting mechanisms have also declined.
3) Sewage generation in urban centres has increased six-fold to 30 billion-litres/day between 1947-1997. Of this, only 10% is treated.
4) The average value of the total coliform count in Indian rivers rose steeply between 1979 and 1991. Groundwater aquifers in isolated pockets have also been contaminated with pollutants.

2) Government Policy measures and initiatives

Water has been included in India's Constitution as Entry 17 of the state list. The current institutional arrangement for managing the water resources in India involves various government agencies[10]. Major policies and legislations guiding the management of water resources and its quality and initiatives taken have been discussed.

[10] Central Pollution Control Board, Central Water Commission; State Pollution Control Boards; Central Ground Water Board, Ministry of Agriculture, Ministry of Power, Ministry of Urban Development, Ministry of Rural Development, Ministry of Environment and Forests, Municipal Authorities

1) The Government of India formulated the National Water Policy in 1987 and 2002. This accords top priority to drinking water supply in the allocation of water resources for various beneficial uses. The policy also addresses issues like need for well-developed information system for better resource planning, maximising water availability, planning of water resource development projects, financial and physical sustainability of projects, participatory approach, private sector participation, water quality, water zoning, water conservation, flood and drought management, performance improvement.
2) The government explicitly enacted the *Water (Prevention and Control of Pollution) Act, 1974* under which it formed the Central Pollution Control Board (CPCB) and the State Pollution Control Boards (SPCBs) for implementation. The Water Act empowers the state pollution control boards to lay down and maintain location and source specific standards for discharge of wastewater.
3) *The Environment Protection Act, 1986* is an umbrella act providing for the protection and improvement of environment and for matters connected therewith. It authorises the central government to intervene directly in order to protect the environment and also allows public interest litigation for the same purpose.
4) The government has also introduced, as a supplementary measure, major economic incentives for pollution abatement, besides the 'command and control' regulatory mechanism. The *Water Cess Act*, introduced in 1977, empowers the SPCBs to levy a cess on local authorities supplying water to consumers and on consumption of water for certain specified activities. The Act also provides for a rebate on the cess payable if the local authority or industry concerned installs a plant to treat sewage or trade effluent. To encourage conservation and reduced discharge of wastewater, the cess rates were increased three fold in February 1992. A rebate of 25% on the cess payable has been provided to those industries whose wastewater discharge does not exceed the quantity declared by them and the quality of discharge complies with the prescribed effluent standards.
5) Under the 1994 EIA notification, an *Environmental Impact Assessment* (EIA) has been made mandatory for 30 categories of development activities involving investments of more than Rs 500 million and above and environmental clearance for activities is given by the MoEF.
6) Under the *National River Action Plan (NRAP)*, stretches of major rivers with high or intermediate levels of pollution were identified by the CPCB. Sewage collection and treatment works have/are being created to reduce the pollution load to these rivers

through schemes for better sewage interception and diversion, construction of STPs, provisions for low cost sanitation and other schemes. In the first phase, as the GAP (Ganga action plan), 29 towns were selected along the river and 261 schemes of pollution abatement sanctioned. At present 156 towns are being considered under the NRAP, out of which about 74 towns are located on river Ganga, 21 on river Yamuna, 12 on Damodar, 6 on Godavari, 9 on Cauvery, 4 each on Tungbhadra and Satlej, 3 each on Subarnrekha, Betwa, Wainganga, Brahmini, Chambal, Gomti, 2 on Krishna and one each on Sabarmati, Khan, Kshipra, Narmada, and Mahanadi (MoEF 1999).

7) To focus on the urban lakes subjected to anthropogenic pressures, the *National Lake Conservation Plan (NLCP), 1993* was prepared. Bhoj Lake of Madhya Pradesh is already getting assistance under funds provided by OECF, Japan.
8) Under the World Bank aided Industrial Pollution Control project there is a provision of loan and grant assistance to proposals for construction of Common Effluent Treatment Plants (CETP) in clusters of small-scale industries.
9) The Central Ground Water Board (CGWB) constituted the Central Ground Water Authority (CGWA) for regulating the development and management of groundwater resources. To this end it has notified and banned fresh bores in areas affected by groundwater depletion. The Authority is also promoting rainwater harvesting and artificial recharge and has circulated guidelines for implementing artificial recharge projects
10) The CPCB is monitoring water quality of national aquatic resources in collaboration with the concerned state pollution control boards (SPCBs) at 507 locations. The Central Water Commission (CWC) also has a network to measure flow and monitor water quality at about 369 field stations. The CGWB monitors groundwater quality at 15355 locations. In an effort to assess the health of a water body, the CPCB has also initiated a bio-monitoring project under the Indo-Dutch Collaboration Programme on Environment and selected 215 locations for the introduction of bio-monitoring based on the interpretation of physico-chemical data at different locations.

3) Critical issues

1) Resource demand and Sectoral pressures

The rapid increase in the country’s population, from about 343 million at the time of Independence to over 1 000 million in 2000, accompanied by growth of agriculture, rapid

urbanisation, economic growth and improved access to basic services has resulted in an increase in the demand for water.

a) The agricultural sector accounts for over 95% of the total water consumption. The sector enjoys subsidised or free supply of power and water resulting in over-exploitation and inefficient use of water in the sector. Degradation of land, soil and water has resulted from unbalanced and excessive use of chemical fertilisers and pesticides.
b) The domestic sector accounts for approximately 4% of the total water consumption. With only 70%of the population in Class-I cities[11] having access to basic sanitation services and wastewater treatment efficiency at about 30%, huge proportion of untreated sewage finds its way into water bodies, making the water unfit for all useful purposes.
c) The manufacturing sector accounts for a mere 0.3% of the total water demand but industrial wastewater generation has increased from about 70 million litres a day in 1947 to 3000 million litres a day in 1997. About 45% of the total pollutant load generated in the industry is derived from the processing of industrial chemicals.
d) Water in the power sector is required for both steam generation and disposal of fly ash. High ash content (of the tune of about 40%) in Indian coal requires a high percentage of water is required for wet collection besides leading to contamination of groundwater on account of percolation of hazardous elements from the ash ponds.

Current requirement levels of 629 BCM (approximately agriculture: 95%; domestic: 4%; industry and power: 1%) against the availability of 1122 BCM indicate an overall surplus at the national level. However spatial and temporal variations in availability give rise to shortages in some regions like the Western plains. Under the BAU scenario, the country's total water requirement is projected to grow to 1060 BCM by the year 2047. Such widening gap between demand and supply shall lead to over exploitation of surface and groundwater resources and also threaten the quality of available water sources because of inadequate provisions for the treatment of wastewater.

2) Inequitable access to basic services

Huge disparities exist in the provision of basic services with only:

a) 77 of the 299 Class-I cities have 100% piped water supply coverage
b) 203 of the 345 Class-II towns have low per capita supply of less than 100 lpcd

[11] Those with a population of 100 000 or more

c) Per capita water supply ranges from as low as 9 lpcd in Tuticorin to as high as 584 lpcd in Triuvannamalai
d) Underprivileged have poor access to basic services

Besides the inequitable distribution of basic services, the quality of services is not upto the acceptable levels.

3) Ground water depletion

Shortages in water supply for domestic and industrial consumption, is resulting in over-exploitation of groundwater beyond its recharge capacity. The share of groundwater in net irrigated areas has also increased considerably from a third in 1965/66 to over half at present. Groundwater overdraft beyond recharge capacity is posing serious threats, in the form of a long term decline in water levels, with associated adverse consequences such as land subsidence, deterioration of water quality in aquifers, and ingress of saline water in coastal aquifers.

4) Resource quality

Indian rivers have witnessed a considerable degradation in their water quality, not only because domestic wastewater is collected inadequately and treated inefficiently in Class-I cities but also because highly complex waste from industries is discharged into water bodies. Indicators of this deterioration include depletion of oxygen, excessive presence of pathogens, settling of suspended material when the flow is lean, and bad odour. Groundwater sources too, are undergoing severe degradation due to chemical contamination, mainly from fertilisers, industrial waste, and municipal solid waste as well as biological contamination, particularly in the form of human waste in dug wells. The current degraded state of major Indian rivers is beyond its self-cleansing capacity.

5) Inefficiency in resource use/management

Government policies have provided little incentive to encourage efficient use of water. High percentage of evapotranspiration losses , excessive distribution losses of treated water in municipal water supply systems, high seepage losses in irrigation and water losses in agriculture due to water over application and low levels of Industrial output per unit of water withdrawal highlight poor resource usage practices. Inefficiencies also persist at the service providers end–in the form of overstaffing, high administrative costs, and time and cost overruns in the execution of projects.

6) Pricing policies

Water tariff structure varies from state to state, it being a state subject. Typically, water rates for agriculture and domestic use do not cover even the O&M expenses, let alone capital costs. In the irrigation and urban sectors, the percentage recovery of working expenses through gross receipts in recent years is only about 10% and 30%, respectively. The subsidy regime has on the one hand encouraged inefficient use of the resource and on the other, led to poor financial health of the sector, resulting in poor services and user dissatisfaction.

7) Institutional set-up and legal framework

In the current institutional set-up involving various government agencies, there is a separation of responsibilities on the basis of water quality and quantity. As many as eight agencies are involved in collecting the water related data as quality of surface water, ground water quality, monitoring of drinking water quality, sanitation and drinking water supply. With a number of organisations involved in water management, there is a duplication and ambiguity of functions. Implementation of environmental laws in general remains weak, mainly on account of inadequate financial resources and capacity of the pollution control boards.

4) Policy gaps

1) The current fragmentary approach, both at the central and state levels, results in duplication and ambiguity of functions and discourages unitary analysis of this scarce resource. Water being a state subject, the states are empowered to enact laws or frame policies related to water. Even then, only some of the states have set up organisations for planning and allocating water for various purposes. The existing monitoring network of different agencies also needs to be used optimally.
2) A proper legal framework for regulating withdrawals of groundwater is not in place. Though efforts have been made to check the overexploitation of groundwater through licensing, credit or electricity restrictions, these restrictions are directed only at the creation of wells. Even the licenses do not monitor or regulate the quantum of water extracted.
3) Water cess in industries, though is potentially an effective instrument for inducing abatement, the rates of raw water are so low that the rebate has not served as much of an incentive so far. Market based instruments to encourage resource conservation mainly in the agriculture and domestic sector have not been tried much.
4) It was realised during the later stages of implementation of the Ganga Action Plan, that the local authorities are not able to operate and maintain these assets due to inadequate resources and skills with them. The level of commitment required from the state agencies was also missing. The pollution was also from a number of diffused sources either urban or rural.

5) Knowledge/Information/Data gaps

1) Water quality monitoring by CPCB is presently being done at 507 locations, as against 77 stations in 1977. Reporting is done in terms of maximum, minimum and mean value of the parameter and the percentage violations for select parameters. However, specific information is not available for water quality in these water bodies for seasons with lean flow. The frequency of monitoring and number of monitoring stations also is not representative of the quality of water body specifically in the non-monsoon period.
2) Information on availability of groundwater and its quality is limited. Though groundwater availability maps have been prepared for certain locations, extraction rates have not been defined.

3) Much of information- quantitative as well as qualitative on water supplied, coverage of population, quality of service and sanitation both in the urban and rural areas is not available. Besides information gaps on water consumption and effluent discharge patterns for industries also exist.

6) Experiences

1) World Bank

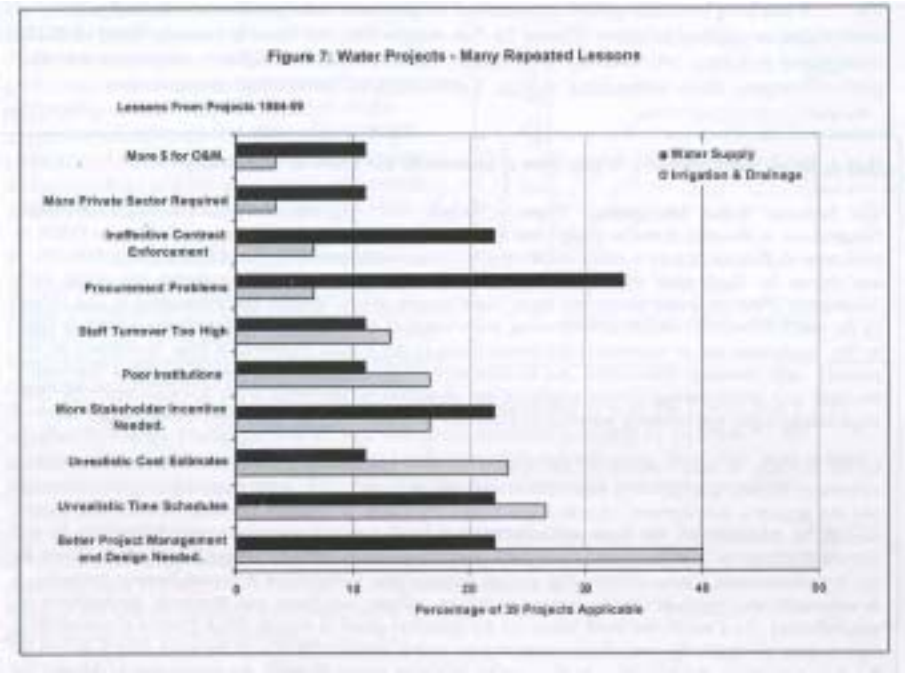
Of the World Bank's total lending in 1995-98 for the water sector, 16.9% of the lending was focussed in India. Foreign investment in irrigation by WB in India is 72%. The World Bank evaluated its water strategy in India with objectives like:

a) Whether the Bank implemented its strategy in India
b) How it implemented the strategy
c) Whether that implementation was relevant to the country context and the Banks assistance strategy
d) The degree to which the implementation was effective in meeting the country's needs and policy goals and
e) Whether the policy remains relevant

The study highlighted that water as a resource was under stress with institutional and organisational problems, too many actors and little of the policy dialogue reaching the multiplicity of water management institutions. From the national perspective, there is little transparency and community participation is negligible. Looking at how the Bank performed in India:

a) Satisfactory project outcomes have been declining, projects have become less sustainable, their institutional impact has diminished and the Bank's own performance at appraisal and supervision has deteriorated.
b) A closer look at the performance subsectors in India shows that Hydro and Rural Water Supply Schemes had the poorest performance on outcomes with none of the projects performing satisfactorily.
c) Bank projects have not met the test of efficacy- the power to produce effect i.e. sustainable institutions, water management and reforms.

The figure below summarises the project-related problems based on lessons from projects funded between 1984-99.



The findings conclude:

a) Focus has to be on the underlying organisational and institutional issues rather than fiscal reforms
b) Focus should change from supply to demand management
c) Current water sector operations have moved away from new construction and are focussing on making existing infrastructure work efficiently
d) Pay more attention to political will and commitment as political economy is at the root of many problems
e) Serious monitoring and evaluation of projects implemented required

2) JBIC

JBIC's ODA program in India was launched in 1958, India being the first country to receive ODA loans. Japan .is the largest bilateral donor country to India since 1986 and JBIC funded projects in over 13 states and across all sectors. The most prominent include – Delhi Metro, Afforestation in five states, Ajanta Ellora Conservation, Lake Bhopal conservation, Bangalore Water & Sewerage.

The Yamuna Action Plan (YAP) comprised following components in 15 towns spread over Delhi, Haryana & UP:

a) Sewerage component: Interception & Drainage works, pumping stations, treatment plants, etc.
b) Non-sewerage component : community toilets, crematoria, bathing ghats, afforestation, etc
c) Public Participation & Awareness component : rallies, street play, radio spots, hoardings, film shows, painting competition / eco-club for school children etc

The shortcomings & challenges as identified for future programs include:

a) Systematic analysis of inventory of pollution load to identify source-wise & town-wise contributors to pollution; prioritise & phase-out investments
b) YAP has mainly addressed pollution from domestic sewage. Future programs may need to look at other components like solid waste, industrial waste, slum improvement, etc.
c) Consultation & involvement of Urban Local Bodies right from planning stage is required for Sewerage component
d) Participatory approach is required for planning & construction of community assets (non-sewerage component)
e) A multi-pronged municipal reform needs to be initiated in YAP towns to build municipal capacity for ensuring sustainable O & M

3) UNICEF

India's water and sanitation program, strongly supported by UNICEF for nearly three decades has provided not only services but also long term training and technical support. The program has encouraged technological innovation and international experience while at the same time strengthening input from the community and local private sector. The Water and Environmental Sanitation (WES) program in India yields following lessons that could be useful:

a) External agencies have greater freedom than the government to test new approaches
b) It is crucial to develop technologies suited to local conditions, especially where water is scarce. Local realities must be taken into consideration in implementing policies made by the central government.
c) A balance must be maintained between technology and the social and behavioural aspects of water and environmental sanitation services

d) Gender and poverty need attention when the program is planned, implemented and monitored
e) Cost data are needed for comprehensive and effective analyses
f) Health, Education, Nutrition, Water and Environmental Sanitation have to be linked
g) Going to scale too quick has adverse repercussions
h) Long term commitment and partnerships produce results
i) Partnerships can maximise results, but they must be closely co-ordinated and mutually advantageous for each participant

Box 2 highlights technical operational problems in running of CETPs and STPs based on performance evaluation studies.

Box 2: Operational problems of CETPs & STPs

Performance evaluation exercises have been carried out for CETPs and STPs and suggest the following:
Plants usually require concerted efforts for optimising the performance as characteristics of treated effluent in general exceed prescribed norms, at times leading to high content of BOD, COD and heavy metals.

- The CETP management should stress on good maintenance of primary treatment provision at member units and also optimise the effluent conveyance to CETP. A rational distribution of member units is also required.
- Infrastructural facilities to analyse and keep a strict watch on various critical parameters like MLSS, VSS, DO besides conventional parameters like BOD, COD in treatment system are required at CETP itself.
- Excessive use of cow dung should be discouraged, as this material being rich in cellulose has a deleterious effect on population of aerobic bacteria.
- The conveyance system from member units to the plants should have adequate counter measures to check the possible inflow of surface run-off, especially during monsoons.
- Adequate arrangements should be made for at the site storage of hazardous sludge waste from treatment and for its final disposal.
- Performance of pre treatment units at the individual discharging units need serious efforts to ensure better and uniform quality of influent waste.
- Down time repairs of the equipment s should be observed regularly to avoid shut down. Besides possibilities should be explored to run the plant partially so as to improve the quality of effluent discharged in cases of plant shut down.

7) Potential business opportunities

1) Reverse Osmosis for removal of dissolved organics in brackish water and saline water for conversion of drinking water in coastal areas where fresh water is scarce and TDS removal systems like Membrane technology

2) BOD and COD removal systems: Low energy anaerobic biological systems, physico-chemical systems e.g. adsorption, advanced biological reactors, chemical oxidation, ozonation and ultrafiltration
3) Special Pollutant removal like Nitrification/Denitrification removal systems for high Ammonia wastewater, removal and recovery of heavy metals
4) Treatability studies
5) Ground water analysis
6) Process industries like paints, dyes, paper, tannery, in-house small scale electroplating industry
7) Combined industrial effluent treatment plant

8) Recommendations

1) River basin approach

Instead of the present approach wherein water-related matters are restricted to political boundaries only, water management efforts should be at a river basin or sub-basin level. This would ensure that aspects such as water allocation, pollution control, protection of water resources, and mobilisation of financial resources are not dealt in an isolation and decisions for the overall development process and land-use planning flow from this.

2) Increasing resource availability

The need is to develop surface irrigation sources and take measures for rainwater harvesting and preventing water run-offs. With the rivers of the country carrying about 80% of the flow during the monsoon months of June-September and generally in excess of 90% during the period of June-November, the run-off can be tapped by building appropriate water harvesting structures in the lower reaches to trap the water. Inter basin water transfer is another option to be considered and evaluated.

3) Plug weaknesses in the current policy and legal framework

State-specific water policies need to be prepared for all issues concerning a state. Various individual development projects and proposals, water allocation priorities and guidelines for resource management need to be area-specific and formulated by the states within the framework of such an overall plan. It is important to assess the effectiveness of the various legislative acts and work out measures that improve their applicability and outcomes.

Incentives under the Water Cess Act, for instance, have to be made more attractive to make the industries undertake pollution control measures.

4) Pricing of the resource

Poorly targeted subsidies send wrong signals to the users causing wasteful use of resources and suboptimal choices by consumers. Appropriate tariff structure for water services will encourage wise usage of the resource and generate additional support for the fund-starved service providers as well.

5) Resource conservation

Along with the measures towards pollution abatement it is imperative to further intensify efforts for conservation of water to prevent overexploitation of scarcely available resource and reduce the quantity of wastewater generated. There is a need to develop and implement cost-effective water appliances such as low-flow cisterns and faucets and formulate citizen forum groups to encourage and raise awareness on water conservation. Efforts have to be made to introduce and implement the Zero discharge concepts, which would enhance recycle and reuse of effluent discharge.

6) Resource degradation

In order to enhance effective treatment of wastewater, there is a need for better collection and interception of sewage. Application of many low-cost and effective technologies for wastewater treatment, e.g. UASB, duckweed ponds, and horizontal filters have been to a limited extent. There is a need to explore the advantages associated with these in terms of the negligible amount of energy required, beneficial uses of by-products (sludge as manure and biogas), lower operation and maintenance costs, etc. Adoption of cleaner technologies by the industry would go a long way in safeguarding the quality scarce resources.

7) Plugging information gaps

Baseline information on quantity as well as quality needs to be collected for water supply and sanitation both in the urban and rural areas and then used for formulating strategies and prioritising the action plan. Exercises like performance measurement of the service provider, specifically in the urban areas need to be undertaken to benchmark operational efficiencies related to water treatment and distribution. Water Zoning Atlas needs to be developed to guide decisions related to siting of industries and other economic activities.

8) Community management

Community management is the key to successful overall performance of the water sector and pollution control. It has been amply demonstrated that projects with community inputs are more successful in terms of reaching the greatest number of affected people with long lasting services. Other benefits include lower costs, greater acceptance of the technology, and better maintenance of the facilities by the users.

4. Solid Waste

1) Overview

Increasing urbanisation and changes in lifestyles have led to quantum increase in the solid waste generated in the country from 6 million tonnes in 1947 to 48 million tonnes in 1997. Collection of waste, its transportation and disposal are posing tremendous environmental challenge to planners, engineers and policy managers as shall be evident from the following:

1) More than one-fourth of the municipal solid waste is not collected at all, and the landfills to dispose of the waste are either poorly equipped or managed inefficiently
2) The production and consumption of plastic has itself increased more than 70 times between 1960 and 1995
3) During the last 30 years, there has been a significant growth in industrial sectors such as pesticides, drugs and pharmaceuticals, textiles, dyes, fertilisers, tanneries, paint, chloralkali etc which have a major potential for generation of hazardous waste.
4) Directorate General of Health Services has estimated total infectious biomedical waste generated from different states of India at 54 404 tonnes per annum as on 1 January 1993 [12]. Of this, about 85% of the waste is non-infectious, 10% infectious but non-hazardous and 5% hazardous as per a WHO study. Owing to a lack of awareness on bio medical waste management, most of the waste is getting disposed at MSW dumpsites.

Different studies have been done in Indian cities to assess per capita MSW generation and its typical characteristics. Per capita waste generation is estimated to be around 450gms/day and 250 gms/day in Class I and Class II cities respectively. Table 3.1 highlights the physico-chemical characteristics of MSW in Indian conditions.

[12] Manual on Hospital Waste Management, Central Pollution Control Board, Delhi

Table 3.1[13] Physico-chemical characteristics of MSW

Component	% of wet weight	
	1971-73 [a] (40 cities)	1995 [b] (23 cities)
Paper	4.14	5.78
Plastics	0.69	3.90
Metals	0.50	1.90
Glass	0.40	2.10
Rags	3.83	3.50
Ash and fine earth	49.20	40.30
Total compostable matter	41.24	41.80
Calorific value (kcal/kg)	800-1100	<1500
Carbon-nitrogen ratio	20-30	25-40

[a] Bhide and Sundaresan 1983; [b] EPTRI 1995

Hazardous waste generation in the country is around 7.2 million tonnes of which it is estimated that 1.4 million tonnes is recyclable, 0.1 million tonnes is incinerable and 5.2 million tonnes is destined for disposal on land[14] (MoEF 2000). Of the 323 hazardous waste recycling units in India, 303 units use indigenous raw material and 20 depend on imported recyclable wastes which mainly includes battery scrap, lead and zinc dross, ash, skimmings and residues and galvanised zinc. Table 3.1 highlights the sources and quantum of waste generated from major industrial sources.

Table 3.2 Sources and quantum of waste generated from major industrial sources

Waste	Quantities MTPA		Source/origin
	1990	1999	
Steel and blast furnace slag	35.0	7.5	Conversion of pig iron to steel and manufacture of iron

[13] Solid Waste Management in Developing Countries, Bhide A D and Sundaresan B B. 1983, Indian National Scientific Documentation Centre, New Delhi

[14] Draft on Status of Implementation of the Hazardous Waste Rules, Ministry of Environment and Forests, 2000

Brine mud	0.02	-	Caustic soda industry
Copper slag	0.02	-	By-product from smelting of copper
Fly ash	30.0	58.0	Coal based thermal power plants
Kiln dust	1.6	-	Cement plants
Lime sludge	3.0	4.8	Sugar, paper, fertiliser, tanneries, soda ash, calcium carbide
Phosphogypsum	4.5	11.0	Phosphoric acid plant, ammonium phosphate
Red mud/bauxite	3.0	4.0-4.5	Mining and extraction of alumina from bauxite
Lime stone	-	50.0	-
Iron tailings	-	11.25	-
Total	77.14	147.05	

Source. National Waste Management Council - Ministry of Environment and Forests

2) Government policy measures & initiatives

1) Municipal solid wastes

The responsibility of dealing with MSW at the Central Government level lies with the Ministry of Urban Development and Poverty Alleviation. The other ministries involved are MoEF and MNES (Ministry of Non-conventional Energy Sources). The responsibilities of waste management at local level however lie with the urban local bodies (ULBs) which ensure collection, transportation and disposal of waste.

a) The MoEF, GoI has issued the Municipal Solid Wastes (Management and Handling) Rules 2000. These rules identify CPCB as agency that will monitor the implementation of these rules and municipalities will be required to submit annual reports regarding municipal waste management in their areas to the CPCB.
b) MoEF has also notified Bio-Medical Waste (Management and Handling) Rules in 1998 for management of biomedical waste.
c) National Waste Management Council has also been constituted in 1990 and is presently engaged in survey of 22 municipalities to estimate the quantity of recyclable waste and its fate during waste collection, transportation and disposal.
d) A national plastic waste management task force has also been set up to suggest measures to minimise the adverse environmental and health impacts arising out of plastic recycling.
e) The MNES offers various fiscal and financial incentives for energy recovery from wastes.

2) Industrial and hazardous waste

The MoEF, Government of India is the nodal agency at the central level for planning, promoting and co-ordinating environmental programmes, apart from policy formulation. However, executive responsibilities for industrial pollution prevention, and control, are primarily executed by the CPCB at the central level. At the state level, execution is mainly handled by the SPCBs. The Hazardous Waste Management (HWM) Rules, 1989 provide for control of generation, collection, treatment, transport, import, storage and disposal of wastes. Besides these rules, the MoEF has also issued Guidelines for Management and Handling of Hazardous Wastes in 1991 that also includes mechanisms for the development of a reporting system for the movement of hazardous waste etc.

As part of other initiatives, state governments are in the process of identifying hazardous waste disposal sites based on EIA of the potential sites. It has been decided to impose ban on import of hazardous wastes containing beryllium, selenium, chromium (hexavalent), thallium, pesticides, herbicides and their intermediates/residues based on recommendations by an Expert Committee. Similarly cyanide wastes and mercury- and arsenic-bearing wastes have been prohibited for export and import from December 1996 in order to control movement of Basel Wastes.

The Honourable Supreme Court has ordered the closure/shifting of non-conforming industrial units using hazardous processes and hazardous chemicals from Delhi region. In addition, SC has ordered closure of 200 tanneries in Tamil Nadu, and 35 foundries in Bengal.

3) Critical issues

1) Inadequacies in solid waste management (SWM) system

Inefficient collection efficiencies of 50-90% in major metros and about 50% in smaller cities; inadequate transportation facilities in more than 70% of the cities and; inadequate disposal highlight the need to make service delivery more efficient and accountable. SWM in fact constitutes 30-50 percent of the total municipal staff and the expenditure on these services is between 20-50%[15]. Lack of adequate financial resources is cited as the most common reason

[15] Upgrading municipal services: norms and financial implications, 1989, National Institute of Urban Affairs, New Delhi

for a municipal body's non-performance, there being no tax recovery to provide/ run the related services. Private sector participation (PSP) in SWM has not been very far reaching because of weak government policies.

The country has 116 hazardous waste incinerators and 11 engineered landfills in operation but all of them are located in Gujarat. Though 74 sites have been identified in other states to set up disposal facilities, only 14 of these have been notified. In absence of adequate number of treatment and disposal facilities, the industries continue to store the hazardous waste in their premises in improperly designed storages or dispose the waste illegally at abandoned sites.

In absence of proper segregation of waste at source, waste treatment alternatives like recycling, waste-to-energy projects and/or composting become uneconomical to operate. Most of infectious biomedical waste, though segregated at the generation point, gets disposed at municipal waste dumpsites. This is because of the absence of dedicated waste disposal facilities for biomedical waste generators.

2) Emerging trends in waste generation and its impacts

Studies at TERI point that the total waste generated in 2047 will exceed 260 million tonnes more than five times the present level. With technical difficulties in treating and disposing this waste scientifically, cumulative land requirement for waste disposal will increase to about 1385 square kilometres by 2047 as against the current requirement of nearly 10 square kilometres. The landfill gas, which is 50% to 60% methane, contributes significantly to global warming and is estimated to increase from the current 7 million tonnes to 39 million tonnes by 2047 under a BAU scenario.

4) Policy gaps

1) The HWM rules promulgated by the MoEF in the year 2000 fail to provide any incentive for waste reduction/minimisation efforts. Industries are therefore reluctant to adopt such measures.
2) In absence of standards for clean up of the sites contaminated earlier and limits for disposal of waste on land, the errant industries are not legally bound to clean the site unless ordered by judicial intervention.

3) Rules for the management of municipal waste and biomedical waste management do not clearly identify the role and responsibilities to be undertaken by the CPCB and SPCBs.
4) Enforcement on part of the regulatory agencies has been feeble partly due to inadequate infrastructure including staff in different SPCBs assigned for hazardous waste management in the state.

5) Knowledge/Information/Data gaps

1) Hazardous waste inventory carried out by various States is usually a one-time exercise. But with the industrial growth being very dynamic, there is a need to constantly update the waste inventories and design appropriate waste management strategies.
2) There has been less work to explore the risks and health impacts of hazardous waste disposal on surrounding ecosystem and communities.
3) Although some attempts have been made at the city level to identify and quantify municipal waste and biomedical waste, there are no state/nation-wide waste inventories available in both the cases.

6) Experiences

A lot of debate has been going on the potential of waste to energy projects in India. The proposed options include generating power from waste or converting it to fuel pellets. There has been some support from government agencies like MNES, MoEF and different ULBs for such projects but without much of success. Some of the experts quote their opinion as *solving a problem by burning it and hiding the ash under the carpet*. The associated reasons include:

1) Calorific value of the Indian waste ranges between 800-1050 kilocalories per kilogram as against a desired level of about 1500 kilocalories per kilogram for energy generation. To make the waste more fit for processing and producing power, it is usually recommended to add fuel to the waste that implies an additional incurring cost.
2) Cost of power generation through incineration is estimated to be between Rs 8-12 crore per MW to process 100-150 tons of waste per day which is 4-5 times as compared to the traditional thermal power plants. Similarly fuel pellet plants cost about Rs 2.33 crore to handle same amount of waste as against a compost plant that requires about Rs 1-1.5 crores. These economics raise the basic question of investing taxpayer money in such unproven technologies without undertaking any pilot scale studies.

3) Health effects of these burn technologies also ask for a mindful approach to address the problem of waste disposal. The Indian culture of disposing unsegregated waste poses health hazards resulting from carcinogenic dioxins, furans and heavy metals like arsenic, lead, cadmium and mercury.

Some of the notable cases that need to be looked at include:

1) Timarpur Incinerator

Timarpur in Delhi was the first MSW power plant project with incineration technology. Jointly funded by the Danish government and MNES in 1989/90, the plant was designed to use 300 tons of waste per day and produce 3.5 MW power. Put into trial operation in March 1987, and operated for 8–10 hours per day during this shake-out phase, the plant was reported to be running without commercial viability, probably due to some design problem and was therefore finally closed. The most serious cause was that the waste that was available for the plant was very different in composition: being inert and with moisture and energy content different than test results. This resulted in a waste stream with a density of 500–1,000 kg/m3, which is far above the design parameters. The energy content of the old Delhi waste was only 2,559 kJ/kg (1,100 BTU/lb), much less than originally planned.

2) Other waste to energy projects

A ray of hope came from the private investors/promoters who offered to take up the waste-to-energy projects with their own investment on BOO basis during 1993/94. As per proposals agreed to, the municipal corporation was expected to provide land and garbage free of cost while the promoter would run the plant commercially. Only a few agreements appear to have been converted into real projects. The status of projects in India is as follows:

a) An MSW project with 500 TPD capacity has been installed at Hyderabad Municipal Corporation by Selco International Ltd wherein the waste is converted into energy-rich fuel pellets. The energy plant installed with the help of the MNES and the APTDC (Andhra Pradesh Technology Development & Promotion Centre) is expected to expand further to treat 1500 TPD of waste to produce 20 MW power.
b) Nagpur Municipal Corporation signed an agreement with ENBEE Infrastructure Limited, Bhopal, for installation of a 500 TPD, 4 MW waste-to-power project using biogas technology with foreign collaboration. The construction work started at the site after the project received the sanction of subsidy from the MNES and loan from IREDA (Indian

Renew-able Energy Development Agency Ltd) and HUDCO (Housing and Urban Development Corporation Ltd).

The other municipal corporations who are in the process of signing agreements with private promoters are in cities of Mumbai – 1000 TPD (10 MW); Pune – 450 TPD (4 MW); Solapur 300 TPD(3 MW); and Kalyan – 600 TPD (6 MW).

3) Anaerobic digestion projects

In India, the focus has been mainly on the creation of large, centralized community-scale digesters, which provide gas for lighting and cooking for a number of households and community centers, power for machines such as flour mills, and electricity to community buildings and for individual households. Most of the Indian community-scale anaerobic digesters operate on a mix of human night soil and cattle manure, are quite labor-intensive, and deliver the resulting biogas via pipeline to nearby households, small businesses, and community centers. Recurring problems that confront community-scale systems include the labour intensive work of ensuring a steady supply of manure to the plant and the issue of long-term operation and maintenance of the system.

4) Emerging PSP arrangements in solidwaste management (FIRE (D))[16]

Different kinds of PSP arrangements experimented by the ULBs in India include:

- Contracting for Vehicular fleet maintenance and repair, leasing vehicles
- Service contracts for waste collection and transportation
- Long term concessions on resource recovery projects
- Community contracting to complement service provision by the ULB

a) The Chennai Municipal Corporation privatised waste collection and transportation in three of its zones that represents about 35% of the total area and manages 1000 tons of waste per day. The private operator selected for the assignment is responsible for sweeping, collection, storage and transportation of the waste and for creating public awareness. The rate fixed for the first year was Rs 648 per ton, which is much lower than the Corporations own estimated cost of Rs 1050 per ton.
b) The Kolhapur Municipal Corporation(KMC) conceptualised a BOOT solid waste composting project under which the Corporation provides 4 hectares of land on a long

[16] www.dec.org

term lease to the private operator for a facility that handles 160 tons of waste per day. The responsibility of supply of waste lies with KMC.

5) Landfill projects

A German Technical Co-operation Project (GTZ) for assisting Karnataka State in development of Hazardous Waste Management Infrastructure has been initiated in 1995 at an estimated cost of DM 3 million for creation of hazardous waste disposal facility and DM 3 million for technical co-operation. In this project, the work completed include hazardous waste inventory, status of existing disposal system, and evaluation of waste disposal alternatives with focus on incineration and landfilling. The study has recommended setting up one single centralised landfill and development of one cement kiln in the state to incinerator status.

Box 3: Naroda Industries Association

Established in the year 1967 is the first of the industrial estates in the country. Located in the north-eastern part of Ahmedabad, the estate has an area of 357 Hectare and 689 plots. The estate has 554 industries representing thirty-one different industrial sectors (primarily chemical, plastic and ceramic and pottery units). The industries are predominantly small and medium scale in nature, in terms of initial investments. Several multinational corporations are also represented in the estate. A few large industrial houses of India are also present. The total turnover of goods manufactured amounts to nearly US$ 300 Million per annum. The goods are by and large sold overseas.

The first comprehensive exercise at the estate level of organization was carried out during the years 1998-2000. The principles of eco-industrial networking (EIN) were employed in interpreting the diversity of production systems, related waste streams and opportunities for value addition. The exercise was carried out under the guidance of the University of Kaiserslautern, Department of Economics & Economic policy (Dr. Martin Z. Wilderer & Prof. Dr. Michael Von Hauft) and with significant leadership inputs from Shri Rayjibhai Patel (Former President of NIA). Nineteen waste streams, from more than 450 firms, were identified and classified based on their commercial. Waste exchange and resource optimisation in production were proposed mainly for the biologically degradable waste component. Other significant waste streams included spent acid, gypsum, iron sludge, boiler ash and ceramic wastes. Further work is in progress on defining the quantitative and qualitative correlates between production systems and waste generation in order to identify at-source reduction and value addition options. This project has laid the foundation for sectoral analyses and reinforced the process of examining gaps in infrastructure and ambient monitoring programmes.

The waste to energy initiative is the first important output based on the EIN project. One ton of biologically degradable waste every day will serve as the energy source at the biogas plant located in the premises of the NEPL. This is the first of its kind in India wherein biologically degradable wastes of industrial origin are used for generation of biogas. The source of the wastes includes industries engaged in food and agro processing. 85 cu-m of gas per day is expected to be generated from the anaerobic digestion process and will be used to generate 13KW of power everyday to illuminate the NEPL premises at night. Additionally the slurry generated will be useful as manure. Two important cleaner production demonstration projects at NIE provided substantial impetus for dissemination of the concepts of waste minimization, cleaner production & significant process enhancement.

The vision of this effort is to work for Integrated industrial production and environmental protection at the individual firm level and the collective estate level. The endeavor recognises the need for Capacity building, development of an enabling action framework and implementation schedule integrating cleaner production and other preventive environmental management approaches towards synergising industrial production and environmental protection initiatives.

7) Potential business opportunities in solid waste management

Design and execution of comprehensive solid waste handling, treatment technologies and disposal systems:

1) Waste to energy technologies like exploring potential of waste incineration for power generation
2) Technologies for resource recovery from wastes
3) Aerobic/Anaerobic, Bio-filtration/oxidation technologies or other treatment technologies for municipal solid wastes; Biomethanation of semi-solid organic residues.
4) Technologies / pollution control equipment for sludge treatment
5) Waste pre-treatment, incineration or other appropriate technologies for waste disposal in a scientific manner
6) Appropriate technologies to improve industrial waste management practice particularly for fly ash, blast furnace slag, lime slag, phosphogypsum and red mud in the country
7) Incineration / pyrolysis technologies for pesticides petroleum, paints and chemical industry
8) Stabilisation of hazardous waste Hazardous waste treatment technologies for cyanide waste, zinc wastes, lead, copper wastes, phenolic waste and tarry wastes and land fill management
9) Hospital waste assessment and management including Design, operation and maintenance of hazardous / hospital care waste disposal systems
10) Production of solid, liquid or gaseous fuels (producer gases, methane etc.) from municipal, urban and industrial biomass wastes and organic effluents as replacements for petroleum fuels (LPG) etc

Other promising areas of environmental consultancy include soil remediation studies, technology evaluation of different available technologies and developing models for private public partnerships.

8) Recommendations

Satisfactory, efficient and sustainable solid waste management system shall require proper planning, implementation and management systems to be incorporated in the national policy

for solid waste management. The present and future ways to manage solid waste need consideration of the following aspects:

1) Setting targets for waste reduction by introducing collection and disposal fees and tax incentives, better implementation of the mandatory standards and regulation and creating awareness on voluntary compliance with policies by business and consumers.
2) Technological interventions that need urgent consideration include waste collection and waste treatment and disposal. Waste collection can be improvised through provision of community waste bins at convenient followed by the separation of waste at source into biodegradable and non-biodegradable components. Infectious waste from health care facilities and industrial waste should be transported strictly in separate covered vehicles. Treatment and disposal should follow suggested segregation practices to generate better options for scientific disposal of waste.
3) Setting up decentralised waste treatment facilities (composting, vermi-composting, and anaerobic digestion) throughout the country and demonstration of their viability through pilot-scale projects and their replication on a mass scale.
4) Institutional and regulatory reforms in ULBs: To upgrade the existing infrastructure and improve efficiency of the ULBs, the government has to generate and provide additional resources. Staffing plans need to be worked out for better utilisation of available manpower.

   Additional support has to be mustered from the private sector. To attract PSP, ULBs need to generate more financial resources by introducing user charges. Private sector involvement in door-to-door waste collection can improve better collection as well as financial performance.

   ULBs also need to build their own capacity so as to better monitor private sector operations and own functions, since the overall responsibility of ensuring proper service delivery and standard compliance has to remain with the ULB. Solid waste management should be assigned to a separate cell, preferably headed by an engineer and proper staffing pattern for planning, design, specification of technical systems; performance monitoring and; rationalisation of operations. Developing policy guidance for user charges, cost recovery mechanisms and ULB institutional changes
5) Developing solid waste management plans on a regular basis, both at macro and micro levels: Non-governmental organisations and community resident welfare associations (RWAs) need to be proactive in organising programmes to build awareness and environmental consciousness. Such programmes will need technical know-how and

regular information on best waste management practices and techniques from research and academic institutions in addition to financial support from the local or state governments. Bilateral and multilateral agencies should support such capacity-building initiatives if funds are inadequate.

6) Private sector can play an important role along with NGOs in waste management at the micro level. With the technical and managerial capabilities and the much-required capital support of the private sector for decentralised collection and treatment, the targets for waste minimisation and scientific management can be effectively achieved and enforced. The government needs to provide fiscal incentives to promote private sector participation.

5. Green House Gases and Climate Change
1) Overview

India, given its dependence on climate-sensitive sectors as agriculture and forestry and low technical and financial adaptive capacity, is vulnerable to climate change. Climate models indicate that India's climate could become warmer (Lonergan 1998) and heavy rainfall events are likely to be more frequent in South and South-East Asia (IPCC 1998).

Main sources for the increase in atmospheric carbon dioxide is energy consumption from the combustion of fossil fuels, some industrial processes (e.g. cement manufacture), and the changing land-use patterns. Methane emissions come from livestock, animal waste, coal-bed releases, production and transport of oil and gas, wet cultivation of rice, burning biomass, and landfills and other human waste. Sources of oxides of nitrogen are fertilizer, combustion of fossil fuel, and manufacture of nylon.

Emissions from different countries vary considerably in terms of absolute and per capita amounts (Table 4.1). Although India figures among the top ten contributors to GHG emissions, its per capita emissions is only one-thirteenth of the OECD average, estimated to be 0.86 tonne of carbon dioxide per annum in 1995. Impacts of climate change on different sectors is as discussed:

1) Agriculture

Kumar and Parikh (1998) estimate a loss of 9% to 25% in farm revenue for a temperature rise of 2–3.5 °C. Agriculture in the coastal regions of Gujarat, Maharashtra, and Karnataka is likely to be affected the most, whereas West Bengal, Orissa, and Andhra Pradesh stand to benefit to a small extent (Sanghi et al. 1998).

2) Forests

Increased temperature and rainfall will increase the productivity of tropical forests in India but for teak plantations in moist deciduous forests, higher temperatures will reduce soil moisture, resulting in a decline in productivity (Achanta and Kanetkar 1996).

3) Coastal areas

India with a low-lying, densely populated, and fertile coastline, is among the 27 countries identified as vulnerable to a rise in sea level (UNEP 1998). Coastal infrastructure, tourism, and other economic activities such as oil exploration are also at risk.

4) Health

Higher temperatures will increase the extent, incidence and distribution of diseases like malaria, dengue, bilharzia, leishmaniasis, and schistosomiasis—as it is, 70% of the epidemics in India relate to water-borne or water-related diseases. The additional impacts of climate change on the existing conditions could seriously exacerbate health problems (IPCC 1998).

5) Other impacts

Other direct impacts of higher temperatures include an increase in energy demand for space cooling and increased water demand for irrigation. Higher temperatures and increased seasonal variability of precipitation will affect snow-fed rivers accompanied by increases in peak flow, sediment yields, and run-off, which will have major impacts on hydropower generation, urban water supply, agriculture, and human settlements (IPCC 1998).

Table 4.1 Total and per capita emissions of CO2 from fossil fuel combustion and CO2 intensity (1995)

Region/ Country	**Total emissions (million tonnes)**	**Per capita emissions (tonnes)**	**Co_2 intensity (Kg Co_2/1990 US $ purchasing power parity)**
World	22150	3.92	0.75
Total OECD	11091	11.08	0.65
European Union	3180	8.55	0.51
US	5229	19.88	0.85
Japan	1151	9.17	0.46
Germany	884	10.83	0.63
China	3007	2.51	0.92
India	803	0.86	0.73
Brazil	288	1.81	0.33

2) Government Policy measures and initiatives

The Government of India's policy on climate change has been based on following three broad principles:

1) The primary responsibility of reducing GHG (greenhouse gas) emissions is that of developed countries and they should show a demonstrable sincerity in initiating actions to address climate change.
2) The development needs of developing countries are of prime importance.
3) The developed world should transfer resources and technologies at favourable terms to the developing world, thereby facilitating developing countries to move towards a sustainable development path.

In August 2002, the Government of India acceded to the Kyoto Protocol. The MoEF also made public interim criteria for the approval of CDM project activities. It endorsed eleven projects under CERUPT (the Certified Emission Reduction Unit Procurement Tender) of the Government of Netherlands, of which six were shortlisted.

1) 7.5 MW biomass power project in Maharashtra
2) Three 7.5 MW biomass power projects in Rajasthan
3) 15 MW wind-biomass project in Tamil Nadu
4) 14.45 MW wind power project in Tamil Nadu
5) 15 MW wind power project in Tamil Nadu
6) 15 MW wind power project in Karnataka

The Ministry of Non-conventional Energy Sources and the Ministry of Power are also encouraging the identification and development of CDM options. These have given positive signals to potential project developers.

Corporate and NGO initiatives

Research organisations and industry associations in the country are active in creating awareness about CDM opportunities. The last year has been marked by a discernible shift towards project development activities, particularly following the CERUPT call.

1) TERI has been involved with the CDM concept since its inception, and has been undertaking research related to the economic, political, and quantitative aspects of the mechanism, along with information dissemination and project development activities. It has analysed a range of CDM projects in the Indian power sector for the Ministry of

Power, and formulated baselines for key renewable energy projects in India for the MNES.

2) The thrust of Development Alternatives is social objectivity and utilisation of the traditional knowledge base with focus on renewable energy and applicability of projects in rural environmental settings.
3) CIIs Climate Change Centre works to spread awareness on climate change issues within the Indian industry; promote consensus on climate change mechanisms; build local capacity to develop climate change mitigation projects; facilitate dialogue between Indian and US businesses for collaborations on climate change mitigation projects.
4) FICCI, in collaboration with ICICI had initiated the Environmental Information Centre to promote and facilitate industry actions for environmental improvement and management; compile and disseminate information relevant to business on global climate change, energy efficiency, clean and climate friendly technologies, and other environmental issues.

Other organisations such as Winrock International India, the Infrastructure Development Finance Company (IDFC), and Indira Gandhi Institute of Development Research (IGIDR) are also working on this issue. While IGIDR focuses on academic research on CDM potential and modalities, Winrock and IDFC are more oriented towards project development activities. The Indian branches of international consulting and certification agencies such as Pricewaterhouse Coopers and Det Norske Veritas have also become active in this field.

3) Potential business opportunities

India is currently in the process of developing a detailed GHG inventory as part of its first National Communication to the UNFCCC. This inventory is being developed for the base year 1994 using country-specific emission factors, and will cover sectors like energy, industrial processes, agriculture, land use, land use change, forestry, and waste. So far, the most comprehensive national GHG inventory available is the one prepared under the GoI-endorsed ALGAS (Asia Least-cost Greenhouse gas Abatement Strategy) project (ADB 1999).

1) Sectoral mitigation options

The inventory as Table 4.2 shows that major increase in emissions over the next 20 years would be related to energy consumption in the economy. Energy efficiency and increasing use of renewable energy (or a move towards low carbon options) are the two main measures that can greatly reduce emissions of green house gases. Power generation has a great potential for mitigation. Transmission and distribution losses are the other major source of energy losses and, hence, emissions.

Options such as bagasse-based cogeneration, combined cycle plants and renewables are already profitable and generate fewer emissions per kilowatt-hour of electricity than conventional generation. Alternative low carbon fuel options to current energy sources are another major mitigation option. Small hydro-, wind- and biomass-based power provide significant abatement opportunities. Renewable sources are also a reliable energy option for irrigation.

Table 4.2 Sectoral emissions (Gg)

Sector	1989/90	1994/95	CAGR (%)
Power Generation	175126	262932.60	8.47
Industry	207878	261483.00	4.70
Transport	86226	103659	3.75
Residential	30256	35713	3.37
Commercial	6646	6912	0.79
Agriculture	1797	2756	8.92
Total	507,932	673,457	5.80

CAGR is *compounded annual growth rate*

Source: ADB-GEF-UNDP (1998)

Energy consumption in industrial processes is another area where substantial reductions can be achieved. These include bettering process efficiency and other demand-side management options. Typically, these options lead to an improvement in energy efficiency and resource conservation and introduce advanced technologies, thus laying the foundation for long-term sustainable development. Table 4.3 lists the carbon mitigation potential in power generation and industry.

Table 4.3 Carbon mitigation potential in power generation and industry*

	Size of mitigation opportunity	Investment potential (billion US$)	Expected carbon reduction (million tonnes per year)
Coal washing	5000-6000 MW	1.8	11
Fuel switching	3800 MW	3.1	4
Conventional efficiency	6500 MW	0.15	4
Integrated gasification combined cycle	1000 MW	10	5
Renewable energy	35000 MW annually	25	60
Conversion of mercury cell process to membrane cell process in caustic soda production	0.9 Mt of capacity	8.4	0.12
Upgradation from wet to dry process in cement production	45 Mt of capacity	4	1.1
Upgradation to Hall-Herault process in aluminium production	BALCO and INDAL plants	8.4	NA

Source: Raghuraman (2002)

*** Some of the listed options may not be relevant in the present day context**

2) Priority CDM projects

The interim approval criteria drawn up by the MoEF states that the CDM should be oriented towards improving the quality of life of the very poor from environmental standpoint. The Ministry has identified the following considerations in designing CDM project activities:

a) Social well-being: Alleviation of poverty by generating additional employment, removing social disparities, and contributing to the provision of basic amenities leading to improvement in their quality of life.
b) Economic well-being: Additional investment consistent with the needs of the people.
c) Environmental well-being: Assessing impact of the project activity on resource sustainability and resource degradation, if any; biodiversity-friendliness; impact on human health; reduction of levels of pollution in general.
d) Technological well-being: Transfer of environmentally safe and sound technologies with priority to the renewables sector or energy efficiency projects.

Table 4.4 lists the various energy efficiency options.

Table 4.4 Supply-side and demand-side energy sector options

Energy efficiency options		
Power sector	Industrial sector	Domestic sector
Combined cycle plants	Diesel cogeneration	Efficient refrigerators
		Efficient air
	Iron and steel	
	Basic oxygen furnace	Conditioners
	Ultra-high-power electric arc furnace	
Inter-cooled stream injected gas turbine (ISTIG)	Continuous casting	Efficient lighting
	Dry quenching route	(including the commercial sector)
Pressurized fluidised bed combustion (PFBC)	Paper	
	Continuous digesters in paper industry	
Pulverized coal super-critical boilers		
Industrial cogeneration	Caustic soda	
	Membrane process	
Amorphous core transformers	Soda ash dual process and	
	Akzo lime process	
	Waste heat recovery	
	High efficiency burners (low excess air)	
	Heat pump	
	High efficiency motors	
	Efficient lighting	
Renewable energy options		
Power generation	Agriculture sector	Domestic sector
Biomass-fired power generation	PV water pumps	Improved biomass
	Wind pumps	Cookstoves
Solar (PV) photovoltaic power	Biomass gasifiers	Biogas plants
		Solar cookers
Solar thermal water heating		PV home systems
		PV lanterns
Wind farms		
Small hydropower		

4) Recommendations

India's immediate national priorities are focused more on local environmental issues, there are several opportunities for India to further national development priorities through participation, collaboration and contribution to international agreements. Developments and agreements in the area of climate change may provide supplemental resources for mitigation of greenhouse gases and adapting to the impacts of climate change. For instance, in the long term, the allocation of emissions rights based on equity criteria will provide additional resources through the trade of surplus emissions allocation for developing countries.

1) Data requirements

Adequate and reliable information is the minimum basic requirement for proper planning and initiation of any positive action and to effectively combat climate change. Broadly, the data requirements include:

a) Development of GHG inventories
b) Information on the impacts of climate change
c) Assessment of the vulnerability of different socio-economic segments to these impacts
d) Identification of strategies to reduce vulnerability to climate change
e) Identification of options and technologies to reduce GHG emissions leading to a definition of a project portfolio for potential investors
f) Assessment of financial resources required to achieve mitigation of GHG emissions
g) Better the capacity to adapt to adverse impacts of climate change

National capacity has to be developed to address the following areas:

a) Identification of research needs for the country including identification of knowledge gaps on inventory building, impacts of climate change, and technology requirements.
b) Building awareness on the funding opportunities and potential mitigation options. It is also required to develop domestic institutional capacity on operationalising CDM.
c) Developing adaptive capacity to combat the negative impacts of climate change

The government needs to initiate and coordinate a programme to address the above capacity-building requirements and may also require making capacity-building plan so as to provide direction to existing institutions.

2) Short- and medium-term strategy

The potential to increase energy utilisation efficiency has not been exploited because of the scarce capital resources or subsidised energy prices. Steps are already under way to address the issue of subsidised energy prices. However, resources available under initiatives to mitigate GHGs can be used to meet the additional costs of environmentally sustainable technologies that shall assist in moving towards a clean energy path by improving the level of penetration of such technologies. The country strategy on CDM has to ensure that these resources are invested in appropriate projects that meet national priorities and also help in attracting additional resources by instituting transparent guidelines and procedures.

In order to address the national priorities, the appropriate ministries and departments should identify the technologies that require additional support and can be obtained under the CDM. Accurate identification of such technologies requires the government to either undertake or commission research and analysis of various alternatives available. In addition to initiatives required for any investment (e.g. streamlining of investment procedures), the government should prioritise the type of projects it is willing to consider as potential CDM projects and:

a) clearly define rules for exclusion or inclusion of certain types of projects as CDM proposals
b) clearly list transparent evaluation criteria to establish how a potential project meets these sustainable development conditions
c) provide easy access to information to facilitate the flow of resources by potential investors
d) identify and develop an institutional structure that assists in the evaluation, implementation, and monitoring of CDM projects.

3) Long-term strategy for mitigation

India should institute policies that provide incentives and direct different sectors to improve the performance standards of their processes, products, and services. Such policies include correcting market distortions and promoting efficient processes and devices. In addition to direct savings of energy and other resources, a higher level of efficiency will generate a greater surplus of emissions allocations for trading in the international market thereby providing additional financial resources for development.

This shall also require a system for allocation of responsibilities domestically. Part of the reduction could be achieved through macro policies such as taxes and providing incentives

for early action to control GHG emissions. Mechanisms have to be built to facilitate development of national as well as international emissions trading system. Also, the government could consider instituting emissions trading market domestically for local pollutants prior to the commencement of an international trading regime. This will not only address the problem of local pollution but will also develop capacity for operating in an international environmental market and internalise the external cost of pollution.

4) Adaptation strategy

Assistance and resources for adaptation to climate change can be used to design and plan more efficient systems that reduce vulnerability not only to climate-change-induced impacts but also improve overall planning and development. For example, resources available for adaptation can be invested in designing, planning, and constructing an improved sanitation system that will reduce the probability of water-borne diseases. Likewise, constructing a more effective and efficient storm water drainage systems will prevent flooding in cities.

Generating awareness among the general public will equip people to better combat the negative impacts of climate change by building their adaptive capacity as well as face other environmental and developmental challenges on a firmer footing. Resources for adaptation and for reducing vulnerability could be used to design a better public health system, which will reduce the existing high level of exposure to diseases as well as reduce the vulnerability to higher probability of such diseases with a change in climate.

6. Environmental Management

1) Overview

The society's awareness of environmental issues and change in its expectations of business have shifted the trend from resistant compliance to sustainable business decision-making. Concern about the environment is rising, one tangible manifestation of this being the growing environmental activism. The number of environment and development-oriented NGOs in India has risen sharply in the last 10–15 years, from about 600 in the mid-1980s to about 12 000 by 1997. Supported by judicial activism, the frequency of public protests and public interest litigation has also risen. There has been a surge in the scope as well as stringency of environmental regulation alongwith a growth in regulations running form about 60 pages in the early 1970s to about 2900 pages today. The following provide an overview on the emerging trends in India:

1) The Government of India enactment the following environmental legislation in 1990s:
   a) The Public Liability Insurance Act (1991)
   b) The Environment Audit Notification (1992)
   c) National Environmental Tribunal Act (1995)
   d) Amendment to EIA Notification (1997)
   e) National Environment Appellate Authority Act (1997)
   f) Policy statement on the abatement of pollution (1992)
2) Judicial intervention related to environmental impact of industries has risen as seen from the:
   a) Ganga pollution case (1988) wherein the Supreme Court ordered some 350 units to close down; 5000 others in the Ganges basin were required to install ETPs
   b) Vellore case (1996) wherein 900 tanneries were issued closure notices
   c) Taj Trapezium ruling (1997): About 6300 small-scale industries and several large units including the Mathura Refinery were affected
   d) Supreme Court ruling on Delhi industries (1996) wherein 168 industries in Delhi were ordered to close and relocate and later 1560 more faced the same order
3) The number of companies going in for EMS ISO 14001 and getting them certified has also increased from 1 in Dec 1995 to 605 by the end of Dec 2002.

   India has however lagged in adopting other environmental management system approaches and introducing market-based instruments (MBIs) for pollution abatement in

India. Environmental policy in India has been dominated primarily by a command-and-control (CAC) regime even though MBIs for pollution control were introduced in India long back with the Water (Prevention and Control of Pollution) Cess Act, 1977. However, the purpose of this cess was not so much to control pollution as to generate revenue for the state pollution control boards. Moreover, the cess rate was so low that it neither generated sufficient revenue nor encouraged the efficient use of water.

2) Critical issues

1) Environmental policy in India has been primarily dominated by a command-and-control regime with the product, process and/or emission standards being the major instruments for management.
2) The Government's policy of control and protectionism over the years has infact resulted in myopic business decision-making and, in general, made entrepreneurs complacent to change.
3) Most Indian organisations have strong hierarchical and centralised decision structures that are dictated by habit and personal attitudes. These at times also lack depth and vision with focus only on parameters like production and costs and do not realise the significance of training, process control and quality.
4) There have been question marks on the quality of EIAs, EMS and environmental audits executed by poorly trained consultants and using poor quality data. Such efforts are usually guided by the sole objective of getting requisite approvals or certifications. Most of the times follow up on recommendations of these exercises like preparation and implementation of Environmental Management Plans (EMP) is also not carried defeating the purpose of carrying such studies.
5) Environmental performance of Indian corporates, particularly SMEs, is restricted to compliance aspects only with limited focus on resource-intensity, quality of discharges and quality of work environment. Level of commitment on issues like genuine monitoring and resource allocations for the same; 3rd part auditing and benchmarking and; information disclosure is generally low.
6) Comparative information on different products and processes is not available with the consumers/users. As a result, it is the product/process infrastructure cost and not its eco-friendliness that becomes the sole guiding criterion for selection. Life Cycle

Analysis (LCA) for product evaluation is yet to gain currency in India, the failure of the MoEF-sponsored Ecomark scheme is an excellent case in point.

Box 4 highlights the findings of a survey of Environmental Management practices in Indian corporates carried by TERI along with Business Today.

Box 4: BT-TERI Survey of Environmental Management Practices in Indian Corporates

TERI began with the first ever survey of environmental management practices in Indian Corporates, in March 2000. Of the 450 corporates approached for the survey, in different manufacturing sectors, 48 corporates responded.
The exercise aimed at:

- Identifying the Top 10 corporates in terms of the maturity of environmental systems and practices adopted by them
- Analysing the key trends and dominant environmental practices currently observed in Indian corporates, in general and for different categories of corporates (categorisation based on sale turnover, exports, sectors represented and parentage)

The broad findings of the survey are:

- With a response from 48 corporates i.e. 10.62%, it seems that transparency and information sharing, in Indian corporates, on sensitive issues like Environment is not upto the desired levels. Corporate's apprehensions against responding to the poll varied as:
  1. Information sharing on issues could result in more stringent standards
  2. Responding on environmental issues is not a priority job
  3. Response on such questions already a part of the corporates reply to different enforcement agencies.
- 60% of the corporates had an ISO certification in either of their facilities. But the number of facilities with such certification or certification process in progress is a mere 24% implying that Indian corporates are still to realise the benefits and potential of getting their environmental management systems accredited
- System of filling the legally mandatory environment statement (Form V audits) and comprehensive audits was popular with only 55% of the corporates. This raises a concern that corporates are merely abiding by the regulatory requirements and usually do not have adequate systems in place to measure our performance
- Though target setting vis a vis resource conservation and improvement in environmental performance is in place in most of the corporates, benchmarking is primarily wrt own facilities (63%). Only 21% of the corporates benchmark against Indian industry leaders
- As only 61% of the corporates had a separate department looking after their environmental functions, the concern is if environmental responsibilities are co-ordinated in an organised manner

Comparison of the performance of Top 10 with other respondents reflected:

- Getting their environmental management systems recognised was more customary with the Top 10 corporates
- The leaders additionally had environmental policies at both corporate and facility level; separate environmental departments; better system of auditing and reporting performance levels
- Target setting was also better with mixed benchmarking against own facilities, Indian leaders and counterparts

3) Potential business opportunities

Promising business opportunities in this sector primarily include Consultancy services for establishing EMS in industrial facilities, ISO 14001 Accreditation agencies, Environmental auditing and impact assessments, Corporate Reporting on Environment and Social responsibility. Upcoming areas with high potential include life cycle assessment of products and processes, performance evaluation and benchmarking, product design and labeling.

4) Recommendations

The performance of businesses is being watched even more closely with the increase in:

1) scope and stringency of regulatory mechanisms
2) international pressures of quality and trade
3) gap between resource demand and its supply
4) stakeholder calls for more transparency and accountability on account of greater awareness
5) competition in domestic as well as international markets

The need is to have change in mindsets towards judicious use of the available resources in accordance with the definition of sustainable development. This has to come from the top through a greater management commitment both in terms of purpose as well as resource allocation. Government policies also need to shift from that of a watchdog to facilitator. A changing paradigm shall encompass following efforts:

1) Better information availability in public domain: This calls for generating more user-friendly information through life cycle studies and voluntary dissemination of such information. Dissemination of easy replicable best practices can save resources on reinventing the wheel.
2) Better tracking of operations and resource consumption by developing indicators for all and benchmarking with pre set targets. This shall also include monitoring waste streams before and after treatment to establish their efficacy, auditing consumption of resources like water and packing material, examining in plant exposure levels etc.
3) There is a need to realise the potential of a successful EMS, which in turn calls for better understanding and awareness of the multi-disciplinary subject. Rather than viewing ISO

certification as an image building exercise, concerted efforts need to go in to reap benefits out of this through a greater level of employee involvement and commitment.

4) Operations that have detrimental effect on environment need to replace their conventional accounting systems with *environmental accounting* that additionally books intangible or contingent environmental costs (e.g. future compliance and remediation costs, legal expenses etc) and benefits resulting from eco-friendly approaches. Such an accounting system can result in more sound decisions and ultimately in a more competitive company.
5) Government needs to lead from the front by integrating sustainable development into its policies and day to day activities.
    a) Urban local bodies and Public sector enterprises should opt for EMS for their operations, greater public disclosure and accountability.
    b) Government procurement practices have a notable impact upon the National Economy and the type of goods and services available. Measures such as purchasing environmentally friendly office products and supplies, paper products and alternative fuels are examples of initiatives to advance sound environmental management for government operations. This shall then be replicated by other businesses in the private sector.
    c) There is a need to move from the present rigid and poorly enforced command and control approach to market-based instruments that have a potential to provide cost-effective solutions to environmental problems and stimulate environment-friendly technological progress. This calls for strengthening the networks for better information generation, change in the current legal and institutional structures and to enhance the capacities to deal with market-based instruments.

7. Experience of Funding Agencies

1) USAID[17]

USAID has funded many projects in India over the last ten years, following India's leap into industrialisation. These urban and industrial pollution programs supported interventions in one or more of these five areas: economic policy reform, environmental regulations and standards, education and awareness campaigns, institution building and technological change. The programs under which the funding were allocated are discussed.

1) Trade in Environmental Services and Technologies (TEST)
Designed as a major industrial pollution project, this 5 -year project aimed to develop US India business linkages that would lead to increased trade opportunities for American companies and to improve environmental conditions in India. By the end of 1997, the project had provided technical assistance to 92 Indian enterprises authorising about $25 million over five years (1992-97). The prospective success of TEST was based on assumptions of a growing market demand; US having the capability to provide some of the technologies; shortage of financing options for transfer of commercial environmental technology and; presence of strong regulatory and market incentives to invest in pollution control technologies. Unfortunately, some of these assumptions, critical to project's success, proved invalid.

2) Clean Technology Initiative (CTI)
Designed as follow-on project of TEST and aiming to promote industrial environmental management and adaptation and transfer of cleaner technologies.

- The first component focused on providing US technical assistance to promote improved environmental management through four market-based initiatives: ISO14001 certification, greening the supply chain, benchmarking techniques and industrial extension services to deliver information on environmental technologies and best practices. Total authorised funding was increased from $25 million to $29.95 million; the project assistance completion date was extended by five years to September 2002.

[17] Impact Evaluation, REDUCING URBAN AND INDUSTRIAL POLLUTION
IN INDIA, USAID, August 2001 and USAID Program and Operations Assessment Report No. 30, October 2002

- The second, trade-oriented component of CTI, like TEST, offers financing to Indian companies to procure cleaner process and energy-efficient technologies from the United States that help reduce greenhouse gas emissions. Unlike TEST, though, which worked with individual companies, it uses the "wholesale" approach (working with trade associations of the strategically targeted industries) to facilitate knowledge transfer.

3) Financial Institutions Reform and Expansion (FIRE)

Unlike TEST and CTI, both designed to address industrial pollution, FIRE addresses urban pollution. It has two components: FIRE-R for "regulatory" covers government regulation of the stock market; FIRE-D for "debt" covers the debt market. The original FIRE project was implemented over five years (1994-98) but has been extended for another five years with an ending date of September 2003.

The FIRE-D project addresses issues of mechanisms to finance urban environmental infrastructure and actual delivery of infrastructure to benefit the urban poor. The FIRE project is supported by up to $125 million in loans from USAID's Environment Credit Program and seeks to finance urban environmental infrastructure, including water supply, sanitation, solid-waste management, and area development.

Program impacts and performance

USAID funded urban and industrial pollution prevention programs had effects in the spheres of economics, environment and health. The sale of air and water pollution control equipment totalled US $33.33 million by one of the US-Indian joint ventures in the period between 1992-99. American exports of environmental equipment to India increased by 29% per year during 1992-95. As of early 1996, the United States had the largest share of environmental joint ventures with Indian enterprises at 40%. In 1991, American suppliers were exporting about $6 million of environmental equipment to India annually, or about 4percent of the total market estimated at $135 million. In 2000, they were exporting $150 million of pollution control equipment and services, 6% of the much larger $2.5 billion Indian market.

However, due to lack of solid baseline data the environmental and health impacts that resulted due to implementation of these projects could not be quantified. However an assumption can be drawn, that the installation of pollution control technologies in the industries and provision of basic services such as potable water and trash pick-up and of environmental infrastructure in low-income areas is bound to improve human health.

Program performance is normally assessed in terms of its effectiveness, whether benefits were sustained after donor funding ended, and the extent to which activities were replicated beyond the project. Following lessons have been learnt from the experience of these USAID supported bilateral urban and industrial pollution programs in India:

1) Changing the mind-set of key business and government leaders with respect to environmental management takes considerable time, but is essential if pollution control technologies, environmental management systems, and urban development are to be widely adopted.
2) Financial benefits: Companies will not invest in pollution control technologies or environmental management systems unless they perceive it in their business interest to do so.
3) Regulation: Companies are more likely to acquire pollution control technologies if there is strict enforcement of environmental standards and regulations.
4) Trade: Both supply-side and demand-side barriers hamper U.S.–India trade in environmental services and technologies.
5) Credit: Lack of financing is typically not a constraint for large Indian firms that want to procure pollution reduction technology. However, it does often hinder individual small and medium-size firms and municipalities that want to finance environmental infrastructure.
6) Replication: A key to replicating technology transfer projects is careful targeting with an eye to sharing and spreading successful results.
7) Baseline data: Baseline data are needed to assess any program's impact.

2) Industrialisation Fund for Developing Countries(IFU)[18]

The study *Environmental review of 89 investments in India and Poland* is based on investigations by independent environmental consultant's during 1998-1999 of projects, each one co-financed by one or two of four investment funds:

1) Industrialisation Fund for Developing Countries (IFU)
2) Investment Fund for Central and Eastern Europe (Iϕ)
3) Nordic Environmental Finance Corporation (NEFCO) and
4) Environmental Investment Facility for Central and Eastern Europe (MIϕ)

[18] FOREIGN DIRECT INVESTMENT AND THE ENVIRONMENT, Summary Report, IFU IØ MIØ NEFCO

This review looked at 25 projects in India financed by IFU for promotion of economic activity in collaboration with Danish trade and industry. The consultants visited the projects and collected information through interviews and questionnaires. The conclusions and recommendations of the Environmental Panel are as under:

1) 20% of project managers in India reported that they faced major environmental challenges in one or more specific areas.
2) Project managers in both India and Poland reported that the environmental challenges were primarily related to occupational health and safety.
3) 44% of the projects in India were in compliance with Danish standards.
4) The investment funds influenced the projects indirectly through the Nordic partners by propagating their environmental policies and by requesting annual reports on environmental improvements. Small and medium-sized enterprises appeared to be especially influenced by the funds' environmental policies and procedures.
5) The major barriers to environmental improvements, as seen from the perspective of project managers, were identified to be the following:
    a) Lack of awareness and motivation among the employees when dealing with environmental and occupational health and safety issues
    b) Financial constraints, especially in the largest projects
    c) Lack of environmental infrastructure such as wastewater treatment plants and facilities for controlled waste treatment
    d) Lack of clear national regulations and enforcement
6) The Environmental Panel recommended the companies continuously to strive to identify areas in which it is financially and technically feasible to bring environmental performances up to international standards so as to:
    a) improve productivity and efficiency
    b) capture the growing green markets and improve the access to export markets
    c) keep them ahead of future legal requirements and satisfy stakeholders

- All project companies should establish EMS appropriate to their size and activity
- Poor training and motivation of the work force is a main barrier to improve environmental performance. This can be mitigated through effective environmental management measures and training programmes.
- Environmental management measures such as monitoring and reporting will sharpen the management's awareness of environmental costs and benefits.

The study made following recommendations to the Investment funds and their owners:

1) The funds should further develop their environmental appraisal procedures with the objective of ensuring that project promoters carefully consider potential environmental challenges and risks.
2) The funds should use their representation on the Boards of the project companies to motivate the companies for compliance with local requirements and for further improvements.
3) The funds should extend their network of environmental advisers in host countries and facilitate their involvement in project preparation and implementation.
4) The funds should help the partner companies to ensure that clear and manageable environmental performance targets and indicators are defined and continuously monitored as the basis for regular environmental stocktaking and reporting.
5) Investment officers and other relevant fund staff must continuously receive updated training in appraising environmental aspects of projects.
6) The funds should ensure adequate and reliable reporting from the project companies, as this will help them stay up to date on their environmental performance and provide a tool for dialogue.
7) The funds should use their influence in host countries to increase awareness of the importance of environment and occupational health and safety issues.
8) The Panel advised the investment funds to improve transparency and accountability in environmental matters and regularly report on the environmental status and progress of their investments.

List of abbreviations

AAQ ..... Ambient Air Quality
ADB ..... Asian Development Bank
BAU ..... Business As Usual
BCM ..... Billion Cubic Metres
BOD ..... Biochemical Oxygen Demand
BOO ..... Build-Own-Operate
BOOT ..... Build-Own-Operate-Transfer
BTU ..... British Thermal Units
CAC ..... Command-And-Control
CDM ..... Clean Development Mechanism
CETP ..... Common Effluent Treatment Plant
CII ..... Confederation of Indian Industries
CNG ..... Compressed Natural Gas
CO ..... Carbon mono Oxide
CO2 ..... Carbon di oxide
COD ..... Chemical Oxygen Demand
CPCB ..... Central Pollution Control Board
DO ..... Dissolved Oxygen
EIA ..... Environmental Impact Assessment
EMP ..... Environmental Management Plan
EMS ..... Environmental Management System
GAP ..... Ganga Action Plan
GHG ..... Green House Gas
GoI ..... Government of India
HC ..... Hydrocarbons
HWM ..... Hazardous Waste Management
IAP ..... Indoor Air Pollution
IPCC ..... Inter-governmental Panel on Climate Change
ISO ..... International Standards Organisation
LCA ..... Life Cycle Analysis
LPG ..... Liquified Petroleum Gas
MBI ..... Market Based Instruments
MNES ..... Ministry of Non-conventional Energy Sources
MoEF ..... Ministry of Environment and Forests
MSW ..... Municipal Solid Waste
MTPA ..... Million Tonnes Per Annum
MW ..... Mega watt
NGO ..... Non Governmental Organisation
NLCP ..... National Lake Conservation Plan
NOx ..... Oxides of Nitrogen
NRAP ..... National River Action Plan
O&M ..... Operation and Maintenance
ODA ..... Overseas Development Assistance
PSP ..... Private Sector Participation
RSPM ..... Respirable Suspended Particulate Matter

RWA.....Resident Welfare Association
SME .....Small and Medium scale Enterprises
SO2 .....Sulphur dioxide
SPCB .....State Pollution Control Board
SPM ..... Suspended Particulate Matter
SSI .....Small Scale Industries
STP ..... Sewage Treatment Plant
SWM..... Solid Waste Management
T&D .....Transmission and Distribution
TDS .....Total Dissolved Solids
TPD .....Tonnes Per Day
ULB .....Urban Local Body
WHO.....World Health Organization