Government of India
Ministry of Urban Development

National Mission On Sustainable Habitat

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1. Background

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Sustainable development concerns in the sense of enhancement of human well-being broadly conceived, are a recurring theme in India's development philosophy. The present day consensus reflect three foundational aspirations. *First that human beings should be able to enjoy a decent quality of life; second, that humanity should become capable of respecting the finiteness of the biosphere; and third, that neither the aspiration for the good life, nor the recognition of biophysical limits should preclude the search for greater justice in the world.* Sustainable habitat would mean achieving a balance between the economic and social development of human habitats together with the protection of the environment, equity in employment, shelter, basic services, social infrastructure and transportation. In the context of rapid urbanisation, there is wide awareness about the need to minimize the environmental costs of urbanisation. Environmental damage and depletion of non-renewable resources need to be addressed to meet present and future challenges such as climate change and associated vulnerabilities.

Climate change causes vulnerability of human settlements which is related to extreme weather events and such gradual changes in the climate exceed the adaptive capacity of human systems. Climate change adds to the existing stress on the sustainability of human settlements and society. Non climate sources of change like rapid urbanisation are often the main source of stress.

The concentration of urban population in a few large cities has led to tremendous pressure on civic infrastructure systems like water supply, sewerage and drainage, solid waste management, parks and open spaces, transport, etc. It has also led to deterioration in the quality of city environment. In several cities, the problems of traffic congestion, pollution, poverty, slums, crime and social unrest are assuming alarming proportions. Climate change is likely to exacerbate the existing stresses that these settlements already face. It may also impact measures that are being undertaken for sustainable development of these areas.

Human settlements are accustomed to variability in environmental conditions and are resilient to normal variations. Vulnerabilities arise out of experiences that are beyond the normal experience and due to limited adaptive capacity. Climate change is likely to affect infrastructure related to water, sanitation, energy, transportation, health-care, fire services and other forms of emergency measures. Climate change could affect water supply systems in any number of ways. It can affect the water demand for drinking and cooling systems. Where climate change leads to failure of small local water sources such as wells, it could lead to greater demand for regional water supplies. Changes in precipitation patterns could lead to reduction in water availability and fall in water tables. In coastal areas it could lead to saline intrusions in rivers and ground water. Loss of melt water could reduce river flows during critical times.

A change in water availability and supply also affects sewered sanitation and drainage systems. When water supplies reduce, sewerage systems also become vulnerable. Further, sewage treatment plants are vulnerable to floods or sea level rise, as these are often located near rivers or seas. Where the sewer outfalls are in the sea, sea-level rise will affect the functioning of such systems. Storm water drainage systems could become frequently overloaded and cause flooding if

heavy storms become more frequent due to climate change. The impact of inadequate drainage systems in cities like Mumbai are already being felt leading to flooding and huge economic losses. More frequent floods could also present a significant threat if these lead to contamination of flood waters with faecal material. Climate change may impact upon transport and other infrastructure due to extreme local climatic experiences, leading to significant economic losses. Rising sea-levels in coastal areas would increase the risk of flooding and increase the vulnerability of communities residing in these areas, especially the poor. The urban-heat island effects could get exacerbated due to increase in baseline temperatures, affecting climatic comfort of the urban populations and may consequently lead to additional costs in climate control.

The vulnerability of human populations varies with economic, social and institutional conditions. The poor and the marginalized have little capacity to adapt to changes in climate by adopting such mechanisms as air-conditioning or heating. The traditional coping mechanisms of these vulnerable communities may be over stretched due to additional stresses related to climate change. Climate change threatens the homes, livelihoods and health of the urban poor. When disasters strike, their homes may be damaged or destroyed and they may be unable to travel to work causing them to lose money for food and other basic needs. Poor people often live in informal settlements on land which is susceptible to climate change–flood plains, coastal lowlands or unstable hillsides. Drains and culverts are frequently blocked with rubbish. Slum dwellers often lack secure tenure, proper shelter, water, sanitation, electricity and other services. Most have no insurance. Climate change may add to their problems.

1.1 Addressing Climate Change: Mitigation and Adaptation

Dealing with climate change broadly requires two sets of actions. The first relates to mitigation and the second relates to adaptation. In a developing country like India, issues related to adaptation may be the primary concern since per capita Green House Gas (GHG) emissions are anyway only a fraction of emissions in developed countries and also significantly lower than the world average. However, there are many GHG mitigation opportunities that offer win-win possibilities i.e. mitigation along with overall reduction in costs. These opportunities need to be harnessed optimally. In this context, promoting energy efficiency in the residential and commercial sectors, improved management of water supply, sewerage and municipal solid waste and promotion of urban public transport assume great significance. Apart from mitigation, societies also need to respond to climate change by adapting to its impacts which include drought, changes in river hydrology, extreme rainfall, river and inland flooding, cyclonic storms, storm surge and coastal flooding, and sea-level rise.

1.1.1 Drought

One of the climate change risks to the Indian economy and its people, and therefore to sustainability of habitats, is the increased intensity, frequency and geographical coverage of drought. Its primary impact is on rural areas where agriculture, animal husbandry, and to a lesser extent forestry and fishing, are significantly impacted leading to cycles of seasonal and distress migration. Droughts lead to drinking water shortages and increase in food and biomass fuel prices that hurt the urban poor and middle classes and hence the city economy. It also leads to a number of other impacts like depressed demand for secondary goods and services because of depressed agricultural demand. Rural-urban migration has only contributed about 20 per cent of India's incremental urban population growth since 1971. This trend could change due to climate change related impacts that may render subsistence agriculture uneconomical in parts of semi-arid central, western and southern India.

Climate change may increase droughts in semi-arid peninsular and western India, leading to further misery for the landless and small and marginal farmers, who

are typically forced to migrate to cities. They form the most vulnerable groups in cities - having limited skills, education, capital and access to social networks that underpin much economic and social mobility in urban India. They are also more likely to live in illegal and unserviced settlements that are exposed to a wide range of environmental risks varying from flooding to fire and continual cycles of demolition and eviction by civil authorities. They are therefore, dual victims of existing natural hazards and emerging climate change– displaced from their original places of residence and occupations and challenged by urban risks at their new places of residence.

1.1.2 Changes in River Hydrology

The most serious regional impact of climate change could be changes in the river hydrology in the Indo-Gangetic plain and the Brahmaputra valley due to glacial melt and regression of the Himalayan glaciers. The sustainability of habitats in these regions would be at risk. Inter-basin transfers could be amongst the options that might need to be considered.

1.1.3 River and Inland Flooding and Extreme Rainfall Events

Climate change is also expected to increase the severity of flooding in many Indian river basins, especially of the Godavari and Mahanadi along the eastern coast. Floods are expected to increase in north-western India adjoining Pakistan, and in most coastal plains in spite of existing upstream dams and 'multi-purpose' projects. Extreme precipitation is expected to show a substantial increase in some parts of the country.

Sanitation infrastructure is the main determinant of the contamination of urban flood-water with faecal material presenting a substantial threat of enteric diseases. In addition to flood hazards, more extreme rainfall events associated with climate change will also cause hazards from landslides in many urban centres in hilly regions.

Dealing with likely increase in risks associated with storm water will require a significant revision of urban planning practices across cities in the flood affected regions. Flood and climate change mitigation and adaptation measures will have to be integrated into day-to-day urban development and service delivery systems. Due to higher precipitation in more intense events, there is a need to increase the margin of design safety to enhance the hydraulic capacity of the sections. This will result in additional investments.

1.1.4 Cyclonic Storms, Storm Surges and Coastal Flooding

Yet another important climate change induced risk is that of cyclonic storms, storm surges and accompanying coastal inundation. The high concentration of population especially on the eastern coast, has led to extremely high vulnerability in this region, leading to devastating loss of life and property. The 1999 Orissa super cyclone killed over 10,000 people, devastated buildings, lifeline infrastructure and economic assets across 10 coastal and six inland districts, which included a number of towns and cities due to a mixture of devastating storm surges, cyclonic winds and coastal flooding.

Cyclones and storm surges could have a devastating impact on large urban centres including the mega cities of Mumbai and Chennai, the million plus cities of Vishakapatnam and Surat as well as other cities like Bharuch, Bhavnagar and Jamnagar apart from causing critical bottlenecks in important ports such as Kandla. Increased migration to the coast, powered by huge investments in coastal infrastructure, settlements and enterprises could lead to a substantial rise in losses.

1.1.5 Sea-level Rise

According to IPCC data, the rate of sea-level rise increased between the mid-19th and mid-20th centuries. Global sea level rose at an average rate of 1.7 mm/yr over the 20th century, with an increased rate of 3.1 mm/yr from 1993 to 2003. It is estimated that sea level could rise by 3.5 to 34.6 inches between 1990 and 2100, making coastal groundwater saltier, endangering wetlands, and inundating valuable land and coastal communities. The most vulnerable stretches along the Western Indian coast are Khambhat and Kachchh in Gujarat, Mumbai and parts of the Konkan coast and south Kerala. The deltas of the Ganga, Krishna, Godavari, Cauvery and Mahanadi on the east coast may be threatened, along with irrigated land and a number of urban and other settlements that are situated in them. The loss of these important economic and cultural regions could have a considerable impact in some states.

There is also a need for better emperical data regarding storm surge and tidal gauge data for better appreciation of the impact of climate change in coastal areas. Tools like micro-modelling could help in developing better understanding.

1.1.6 Inter-Governmental Panel on Climate Change (IPCC) Projections

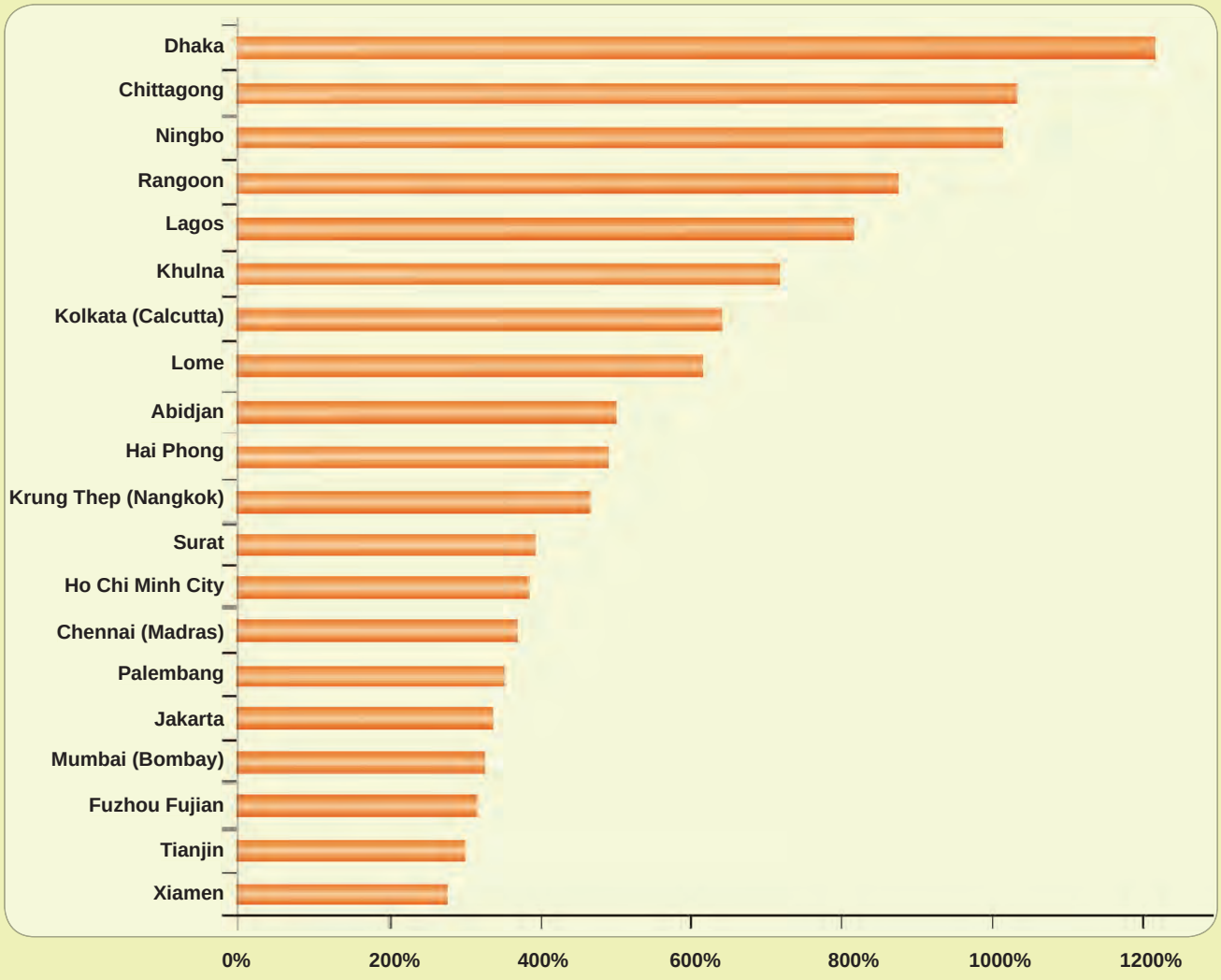
Recent assessments have indicated that the rate of sea-level rise increased between the mid-19th and mid-20th centuries. Global sea level rose at an average rate of 1.7 mm/yr over the 20th century, with an increased rate of 3.1 mm/yr from 1993 to 2003. It is projected with very high confidence that:

- Coasts will be exposed to increasing risks such as coastal erosion due to climate change and sea-level rise.
- Sea-surface temperatures will increase by about 1-3^{o} c.
- Sea level could rise by 3.5 to 34.6 inches between 1990 and 2021, making coastal groundwater saltier, endangering wetlands, and inundating valuable land and coastal communities.
- Sea water intrusion is likely to increase the habitat of brackish water fisheries but coastal inundation is likely to damage the aquaculture industry significantly. Changes in currents, water temperature, salinity, strength of upwelling and mixing layer thickness in the West Pacific and North Indian Oceans are expected due to climate change. Sea-level rise will exacerbate the already declining fish productivity in Asia.
- Flooding caused by sea-level rise is expected to affect millions of additional people every year by the end of this century, with small islands and the crowded delta regions around large Asian rivers (such as the Ganges and Brahmaputra) facing the highest risk. The IPCC has identified four deltas along the coast of India that are particularly vulnerable: Ganges-Brahmaputra (extremely vulnerable), Godavari (highly vulnerable), Krishna and Mahanadi (medium vulnerability).
- Stability of wetlands including mangroves and coral reefs around Asia is likely to be increasingly threatened.

The study undertaken by Patwardhan Narayanan, Parthasarathy and Inamdar (2004) as part of the Initial National Communication of the Government of India to the United Nations Framework Convention on Climate Change (UNFCCC), in its attempts to identify the districts most vulnerable to coastal cyclone in the last 100 years, found that there was a large variation in the extent of vulnerability in the coastal districts of India. Those districts with less infrastructure and greater demographic pressure were most vulnerable. The increase in infrastructure is outpaced by the increase in population in these areas.

1. Background

Top 20 Cities with the Highest Proportional Increase in Exposed Population by the 2070's Relative to 2005.



Ranking Port Cities with High Exposure and Vulnerability to Climate Extremes by R.J. Nicholls (1), S. Hanson (1), C. Herweijer (2), N. Patmore (2), S. Hallegatte (3), J. Corfee-Morlot (4) , J Chateau (4), R. Muir-Wood (2)

Some of the projected vulnerabilities are tabulated below: (Table 1.1)

Table 1.1: Climate Change and Coastal Vulnerabilities

Climate Driven Phenomena	Impact/ Vulnerability	Other Processes/ Stresses	Projected Impacts/ Vulnerability	Vulnerable Zones, Groups Attached
a) Changes in Extremes				
Tropical cyclones, storm surge	Flood and wind causalities and damages; economic losses; transport, tourism, infrastructure (e.g. energy, transport), insurance.	Land use/population density in flood-prone areas; flood defences; institutional capacities.	Increased vulnerability in storm-prone coastal areas; possible effects on settlements, health, tourism, economic and transportation systems, building and infrastructure.	Coastal areas, settlements and activities; regions and populations with limited capacities and resources; fixed infrastructures; insurance sector.
Extreme rainfall, riverine floods	Erosion/landslides; flooding; settlements; transportation systems; infrastructure.	Same as in the case of tropical cyclones and storm surge, plus drainage infrastructure.	Same as in the case of tropical cyclones and drainage infrastructure.	Same as for tropical cyclones and storm surge, plus flood plains.
Heat or cold waves	Effects on human health; social stability; requirements for energy, water and other services (e.g. water or food storage), infrastructures (e.g. energy transportation.)	Building design and internal temperature control; social contexts; institutional capacities.	Increased vulnerabilities in some regions and populations; health effects; changes in energy requirements.	Mid-latitude areas; elderly, very young, ill and/or very poor populations.
Drought	Water availability; livelihoods; energy generation; migration; transportation in water bodies.	Water systems; competing water uses; energy demand; water demand constraints.	Water resource challenges in affected areas; shifts in locations of population and economic activities; additional investments in water supply.	Semi-arid and arid regions; poor areas and populations; areas with human-induced water scarcity.
b) Changes in Means				
Temperature	Energy demands and costs; urban air quality; thawing of permafrost soils; tourism and recreation; retail consumption; livelihoods; loss of melt water.	Demographic and economic changes; land-use changes; technological innovations; air pollution; institutional capacities.	Shifts in energy demand; worsening of air quality; impacts on settlements and livelihoods depending on melt water; threats to settlements/ infrastructure from thawing of permafrost soils in some regions.	Very diverse, but greater vulnerabilities in places and populations with more limited capacities and resources for adaptation.

Precipitation	Agricultural livelihood; saline intrusion; tourism; water infrastructures; energy supplies.	Competition from other regions/ sectors. Water resource allocation.	Depending on the region, vulnerabilities in some areas to effects of precipitation increases (e.g. flooding, but could be positive) and in some areas decreases (see drought above).	Poor regions and populations.
Saline Intrusion	Effects on water infrastructures.	Trends in ground water withdrawal.	Increased vulnerabilities in coastal areas.	Low-lying coastal areas, especially those with limited capacities and resources.
Sea-level Rise	Coastal land uses; flood risk, water logging; water infrastructures.	Trends in coastal development, settlement and land uses.	Long-term increases in vulnerabilities of low-lying coastal areas.	Same as for saline intrusion.
c) Abrupt Climate Change				
	Analyses of potentials.	Demographic, economic and technological changes; institutional developments.	Possible significant effects on most places and populations in the world at least for a limited time.	Most zones and groups.

Source: IPCC

Table 1.1 shows that climate change and its impacts need to be factored in the strategy to ensure sustainability of human habitats. The capacity to adapt depends on socio-economic and environmental circumstances and availability of information and technology. Adaptation to climate change involves planning of settlements and infrastructure to reduce sensitivity to extreme weather events and climate change as well as improved resilience of human systems. Proper planning and design are key elements of adaptation strategies. In case of infrastructure, new constructions that are designed for increased resilience and improved building practices provide opportunities to not only deal with rapid population growth but also with adverse consequences of climate change while simultaneously providing a cost effective option compared to later retrofitting. In certain cases, it is less costly to design and build oversized infrastructure initially than to rebuild them later to add capacity. A number of viable options exist in this regard. There is a need for vulnerability assessment at the national, state and city levels. Community design tools such as floodplain and hill-side building practices and landscape design can be used effectively to limit damage caused by climate variability and extreme weather conditions. Land-use planning, reducing heat islands through judicious use of vegetation, light coloured surfaces, reduction in motor transportation and increased use of solar devices are some tools. The planning process needs to bring together urban planners, scientists, meteorologists, hydrologists, engineers, relevant institutions and social scientists to provide inputs for designing strategies to manage ground water aquifers and ensure adequate drainage facilities to minimize inundation and water logging.

Improved water supply and sanitation as well as other basic services need to be designed to meet the additional stress. These measures are also effective in dealing with the problem of rapid urbanisation and population growth.

To sum up, the actions to be taken for adaptation would be as follows:

Planning and Design – The objectives would be to develop sources of water supply, reorient land-use planning, following better building codes to limit impact of extreme events, reduce resource use, use soft and hard measures to reduce risk of floods such as reconstruction of harbour facilities and infrastructure, flood barriers, managed retreat (acquisition of properties, fiscal and financial incentives), hazard mapping, ocean storm surges and tsunami damage prevention facilities, use of community design tools such as floodplain and hillside building practices, public transportation, improved sanitation, water supply, electric power distribution systems and design practices to prevent fire damage (development densities and / or lot sizes, setbacks, etc). There is also a need to develop designs, building materials and technologies that moderate temperature extremes indoors, improve infrastructure and services, including water and sanitation, storm and surface drainage, solid waste collection and disposal. Building and planning regulations and incentives that encourage building measures to limit development of 'heat islands' also need to be supported.

Management – The strategies would be to increase environmental education, improve landscape management, institute emergency preparedness and improve neighborhood response systems. In respect of coastal, riverine and hill settlements, steps would have to be taken to provide for warning systems and evacuation plans, salvage and emergency services, insurance and flood relief, better implementation / enforcement of existing building codes, and special measures to promote adaptation and disaster preparedness in sites or cities at high risk from such events. The effort should be to build institutional capacity in environmental management and create partnerships between all responsible parties (government, private sector, educational institutions, NGOs, individuals).

1.2 National Mission on Sustainable Habitat

Given the above context, the National Mission on Sustainable Habitat which is a component of the National Action Plan for Climate Change will broadly cover the following aspects:

- **Extension of the Energy Conservation Building Code**, which addresses the design of new and large commercial buildings to optimize their energy

Table 1.2: Top 10 Countries by Population Currently Exposed to a 1:100 Extreme Event

Number of Cities	Exposed Population (000s)	Country
15	8,154	China
17	6,538	United States of America
6	**5,412**	**India**
6	3,683	Japan
2	2,725	Vietnam
2	1,591	Netherlands
3	1,540	Bangladesh
1	1,330	Egypt
1	907	Thailand
4	700	Indonesia

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demand. Incentives will be provided for re-tooling existing building stock.

- **Better Urban Planning and Modal Shift to Public Transport**. Making long term transport plans to facilitate the growth of medium and small cities in such a way that ensures efficient and convenient public transport.
- **Recycling of Material and Urban Waste Management**. A special area of focus will be development of technology for producing power from waste. The National Mission will include a major R&D programme, focusing on bio-chemical conversion, waste water use, sewage utilization and recycling options, plasma conversion of waste of biological origin to liquid fuels that can substitute for petroleum based fuels wherever possible.

Apart from the above, the Mission would also facilitate adaptation to vulnerabilities arising out of climate change like adverse impacts on water resources, increased frequencies of extreme weather like droughts, floods, cyclones, storm water surges, rise in sea levels and human health.

1.3 Promotion of Energy Efficiency in the Residential and Commercial Sector

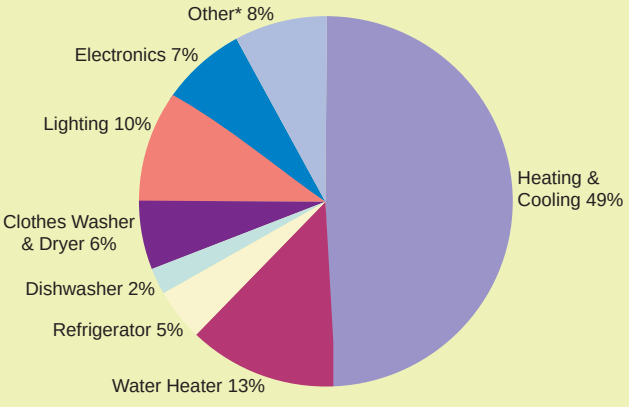
Buildings can be broadly classified under two categories namely residential and commercial. Energy end-use in these buildings varies largely across income groups, building construction typology, climate and several other factors. With a near consistent eight per cent rise in annual energy consumption in the residential and commercial sectors, building energy consumption has seen an increase from a low 14 per cent in the 1970s to nearly 33 per cent in 2004-2005.

1.3.1 Residential Energy Consumption

Residential energy consumption can be broadly divided into six categories: lighting, cooking, space conditioning, refrigeration, water heating and others. In India, the residential sector accounts for 13.3 per cent of total commercial energy use (TERI 2004). The average annual growth rate of electricity consumption has been 8.25 per cent. Electricity use in residential buildings is primarily for lighting, space conditioning, appliances and water heating. In a study done by TERI in the city of Delhi, it was found that in summer months, air conditioners and refrigerators account for 28 per cent (each) of the electricity consumption. In winter months consumption is dominated by heaters and geysers. **Lighting accounts for about 8.14 per cent of electricity consumption in Delhi households. Thus, space conditioning (heating and cooling), refrigerators, geysers and lighting need maximum attention in the residential sector for adoption of efficiency measures.**

1.3.2 Commercial Energy Consumption

The commercial sector comprises various institutional and industrial establishments such as banks, hotels, restaurants, shopping complexes, offices and public departments supplying basic utilities. Most commercial energy is used in buildings or structures for the purpose of space heating, water heating, lighting, cooking and cooling. In India, commercial energy demand estimation and projection are beset with numerous data gaps, particularly with respect to the reporting of the number of commercial establishments/ consumers, their energy consumption patterns, degree of usage of energy for different end-use energy consuming activities and penetration of appliances and other end-use devices in the sector. However, the bifurcation of electricity consumption amongst various electricity consuming activities such as lighting, space conditioning, and refrigeration is based on electricity usage norms. Based on the President's address at the Conference of the Central Public Works Department (CPWD) in 2004, it can be stated that 60 per cent of the total electricity is consumed for lighting, 32 per cent for space conditioning and 8 per cent for refrigeration in the commercial sector. However, end-use consumption varies largely with space conditioning needs. For



Source: Residential Energy Consumption Survey, 2001

example, in a fully air-conditioned office building, about 60 per cent of the total electricity consumption is accounted for by air conditioning followed by 20 per cent for lighting. On the other hand, in a non air-conditioned building, the break-up of end uses would be significantly different.

Lighting, space-conditioning, water heating and refrigerators account for maximum electricity consumption in the commercial and residential building sector. With a 10 per cent increase in the net built up area in the residential and commercial sector annually and a large existing stock of buildings, there is a need to integrate energy efficiency in the commonly accepted construction and renovation practices in the country. Using appropriate architectural design, materials, building components along with renewable energy, it is possible to reduce electrical energy consumption in buildings appreciably. Some Indian architecture traditions are examples of human settlements designed in harmony with the habitat which can be considered to be the first step to conserve energy in buildings.

The Energy Conservation Act enables the government to prescribe an Energy Conservation Building Code (ECBC) that sets minimum performance standards for buildings. A majority of buildings, particularly those which do not take into consideration time honoured practices, have proved to be very inefficient. Their average energy consumption, measured in terms of units/annum/square metre, is around 200, while in comparison, energy efficient buildings should not consume more than 120-160 units/annum/ square metre thus having a potential saving of around 30-35 per cent. ECBC was launched by the Ministry of Power in May 2007 on a voluntary basis. The major components of the building which are being addressed through ECBC are walls, roofs and windows; lighting systems; air-conditioning systems; electrical distribution systems; and water heating and pumping systems. New buildings can save up to 50 per cent energy by appropriate design interventions in building envelope, lighting and air-conditioning systems. While the envelope does not directly use energy, its design features strongly affect the visual and thermal comfort of the occupants, as well as energy consumption in the building. A well-designed building envelope not only helps in complying with the ECBC but can also result in cost saving by taking advantage of day lighting and correct Heating Ventilation Air Conditioning (HVAC) system sizing. **Mandatory application of ECBC could help reduce energy consumption by about 1.7 billion units of electricity per year.**

National Building Code (NBC) 2005 has been developed by the Bureau of Indian Standards as a guiding code to be followed by municipalities and development authorities in formulation and adoption of Building By Laws (BBL). In the latest edition (2005) of the NBC, some aspects of energy conservation and sustainable development have been consistently dealt with in various parts and sections through appropriate design, usage and practices with regard to building materials, construction technologies, and building and plumbing services. The document focuses on energy efficiency in the following:

- Use of pozzolanas (such as fly-ash, rice husk ash, metakaoline, silica fume, ground granulated blast furnace slag, etc.) in concrete production
- Daylight integration (indoor lighting levels to be met via day lighting)
- Artificial lighting requirements (levels) for indoor spaces
- Ventilation standards (natural and mechanical) for optimal human health and well-being
- Electrical standards (minimum power factor, allowances for diversity, etc.)
- Select HVAC design norms

However, so far the NBC is not integrated with the ECBC.

The Bureau of Energy Efficiency (BEE) has several programmes to set labels and energy efficient standards for refrigerators, air-conditioners, motors and other appliances. Energy labelling on voluntary basis for refrigerators and tubular fluorescent lighting was launched in 2006.

Existing residential and commercial buildings offer energy saving potential through suitable retrofit options. Energy saving potential for the residential sector is on an average 20 per cent and that for commercial buildings is 30 per cent.

1. Background

A Case Study of Energy Efficient Construction

Centre for Environmental Sciences and Engineering (CESE) Building, Indian Institute of Technology, Kanpur

Brief Description

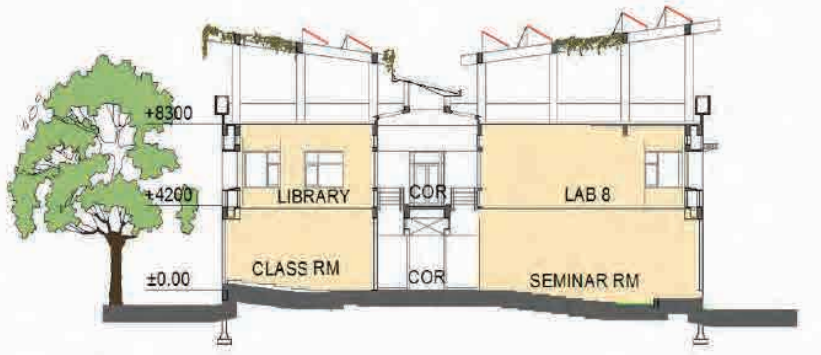
The CESE building is a research facility at the Indian Institute of Technology (IIT), Kanpur. The facility houses laboratories, seminar rooms, and discussion rooms for various disciplines of environmental sciences. Given the function of the building, it was decided that it should be designed in an environment friendly manner. The building has been rated to get FIVE STARS under TERI-GRIHA rating system and is compliant with the ECBC. The building has incorporated many green features following TERI-GRIHA recommendations. These features are integrated in sustainable site planning to maintain a favourable microclimate around the building. The architectural design has been optimized as per climate and sun path analysis. Passive strategies such as an earth air tunnel have been incorporated in the air handling units to reduce the cooling load.

The box above illustrates an initiative already taken in energy efficient construction.

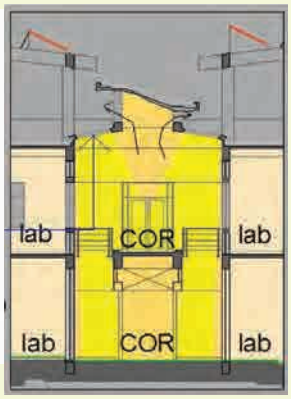
Energy Efficiency and Green Features in the Building

The following energy efficiency measures have been incorporated in the building to reduce annual energy consumption of the building. This has been achieved in the following ways:

1. Architectural design optimized as per the climate of Kanpur, sun path analysis, predominant wind direction and existing vegetation.
2. Optimized building envelope to comply with the ECBC, to reduce cooling load in the air conditioned spaces and to achieve thermal comfort in the non air-conditioned areas. Walls and roofs have been insulated with insulation material.
3. Efficient window design by selecting efficient glazing (high performance glazing), external shading to reduce solar heat gain but at the same time achieve glare free natural daylight inside all the laboratory spaces of the building.
4. Roof shaded by bamboo trellis and green cover to reduce external solar heat gains from the roof.
5. Common circulation areas are naturally day lit and naturally ventilated through integration of skylights and ventilators.
6. Water cooled chiller selected that complies with the efficiency recommended by the ECBC.
7. Variable Frequency Drive installed in the Air Handling Units (AHUs).
8. Low energy strategies such as replacement of water cooler by water body to cool the condenser water loop, integration of thermal energy storage and earth air tunnels to enable reduction in chiller capacity.
9. Integration of energy efficient lighting design that complies with the recommendations of ECBC.
10. Integration of daylight with artificial lighting.
11. Optimized architectural design and integration of energy efficient fixtures has resulted in significant reduction in annual energy consumption from GRIHA's benchmark. The predicted energy consumption (in space conditioning and lighting only) of the air conditioned spaces is 86 kwh/sqm per annum in comparison to the benchmarked value of 140 kwh/sqm/annum.
12. The ECBC compliant building entails an initial incremental cost of 20 per cent as compared to the base building, with a payback period of 5-6 years. Net savings in total cost are estimated to be 15 per cent in 15 years of the CESE building.



Corridor Sections Showing Skylights and Ventilators to Naturally Light and Ventilate the Space.



Architectural Building Section Showing Passive Strategies

Source: TERI

1. Background

Indian Green Buildings Council (IGBC) Building - India's First Platinum Rated Green Building at Hyderabad. Constructed in 2003.

In formulating climate change strategies, mitigation efforts need to be balanced with those aimed at adaptation. There are interactions between vulnerability, adaptation and mitigation in buildings through climate conditions and energy systems. As a result of a warming climate, heating energy consumption will decline, but energy demand for cooling will increase while at the same time passive cooling techniques will becomes less effective. The net impact of these changes on GHG emissions is related to the available choice of primary energy used for heating and the efficiency of technologies that are used for heating and cooling needs. Fortunately, there are many potential synergies where investments in the building sector may reduce the overall cost of climate change – in terms of both mitigation and adaptation. For instance, if new buildings are constructed, the design can address both mitigation and adaptation aspects. Among the most important of these are reduced cooling loads. For instance, using advanced insulation techniques and passive solar design to reduce the expected increase in air conditioning load. In addition, if high-efficiency electric appliances are used, the savings are increased due to reduced electricity demand for air-conditioning, especially in commercial buildings. Roof retrofits can incorporate increased insulation and storm security in one investment. In addition, the integrated design of well-insulated, air-tight buildings, with efficient air management and energy system, leads not only to lower GHG emissions, but also to reduced thermal stress to occupants, reducing extreme weather-related mortality and other health effects.

Policies that actively promote integrated building solutions for both mitigating and adapting to climate change are especially important for the building sector. It has been observed that building users responding to a warmer climate generally choose options that increase energy consumption rather than other means, such as insulation, shading or ventilation, which consume less energy. A prime example of this is the tendency of occupants of existing poorly performing buildings (mainly in developing countries) to buy portable air conditioning units. These trends, which clearly will accelerate in warmer summers to come, may result in a significant increase of GHG emissions from the sector. However, well designed policies supporting less energy-intensive cooling alternatives can help combat these trends. Good urban planning, including increasing green areas as well as cool roofs in cities, has proven to be an efficient way to limit the heat island effect. Cities like the Municipal Corporations of Rajkot, Nagpur, Pune and Mumbai already offer property tax rebates to implement certain good practices (eg. use of solar water heaters, etc.) The following box illustrates case studies of the incentivising of green buildings by an urban local body and a residential building project which has mainstreamed sustainable practices.

Eco-Housing Programme

The Eco-Housing Programme launched by the Municipal Corporation of Greater Mumbai (MCGM) promotes the adoption of environment friendly practices, energy efficient products and techniques by the construction industry. Applicable to the housing sector, the eco-housing voluntary rating and certification mechanism will help quantify the environmental performance of residential projects and will provide a meaningful differentiation of buildings in the marketplace. The MCGM eco-housing program encourages developers to adopt the eco-housing assessment criteria to certify the environmental performance achieved by their residential project. The criteria developed for both new and existing projects are applicable to residential buildings/building complexes and single family residences. The criteria include a checklist of measures aimed at architects, builders, financial institutions and homeowners. Measures in each category ensure resource conservation during the life cycle of the project. Every measure has some requirements to ensure compliance and is assigned points depending on its impact on the environment and its relevance to local condition. The criteria span the following areas:

- Site Selection
- Environment Architecture
- Efficient Building Materials
- Energy Conservation and Management
- Water Conservation
- Segregation of Waste
- Other Innovative Measures

A rating mechanism has also been adopted, details of which are given below:

Points	Points	Star Rating
New Construction	Retrofit Projects	
500-600	150-200	*
601-700	201-300	**
701-800	301-400	***
801-900	401-500	****
901-1000	501-600	*****

Validity of the Eco-Housing certification granted by MCGM is for 5 years after which the certification has to be renewed. Random checks will be carried out by the Eco-Housing Technical Cell to ensure that the systems installed in the housing complex are in working condition and are being maintained. Incentivization in the form of rebate in development charges and assessment tax is principally approved by the corporation.

Source: MCGM

1. Background

Carbon Emission Reduction in Residential Construction

Biodiversity Conservation India Limited (BCIL) has created numerous eco-housing projects that aim at autonomy on energy, water and waste management in and around Bangalore city. BCIL's residential projects, ranging from 300,000 sq. feet to 1 million sq feet, have demonstrated successfully the offering of such services to customers including the TZed Homes, which is a Rs. 70 crore residential project, that has secured Carbon Emission Reduction (CERs) of about 22,000 tonnes at the construction level, with a further annual emission reduction of about 7,000 tonnes, due to the application of about 48 different systems, technologies and processes that enhance efficiency in use of these resources. Funds secured through selling these CERs go into economizing the project or are shared with the customers on a monthly basis to subsidize the O&M costs.

Source: BCIL India

The Ministry of New and Renewable Energy (MNRE) is promoting solar water heating systems for various classes of consumers through its scheme for loans at nominal rates of interest i.e two percent to five per cent for domestic, institutional and industrial consumers, capital subsidy for developers and incentives to municipalities/utilities for the amendment of building byelaws/provision of rebate in property tax or electricity tariff. A scheme has also been introduced to incentivize green buildings which includes a rebate in registration fee, to the extent of 90 per cent, incentives to architects and design consultants ranging from Rs. 2.5 lakh to Rs. 5 lakh and incentives to urban local bodies that announce rebates in property tax for green buildings as well as awards to the best performing urban local bodies. MNRE recently announced the Solar City initiative which will provide seed funds to cities for developing and implementing similar strategies at the city level. MNRE has developed climate zone-wise energy efficiency and passive architectural guidelines for residential and commercial buildings which could be followed by CPWD and Municipal Corporations all over the country. The guidelines are in harmony with ECBC 2007, NBC 2005, EIA Notification 2006 and other relevant IS codes. These can be incorporated in existing bye-laws. The boxes below illustrate two cases in Kolkata and Pune, where non-conventional energy sources have been harnessed.

India's First Solar Housing Complex at Kolkata

India's first solar housing complex has been constructed in the New Town area of Kolkata city in the State of West Bengal. It comprises independent houses, a community hall and a swimming pool. The project has been executed by the West Bengal Renewable Energy Development Agency with partial support of Ministry of New and Renewable Energy. Both solar active and passive concepts have been adopted in the project. The houses have been designed based on solar passive architecture and have been integrated with solar water heaters and photovoltaic modules. The community hall has a building integrated Photo Voltaics (BiPV) and roof top Solar Photo Voltaic (SPV) system connected to the grid. The swimming pool is planned to be heated through solar energy. The approach roads of the complex have solar street lights. Energy efficient electrical appliances have been installed in the houses and the complex. The complex is a unique model in India and has been developed on the concept of 'zero use of conventional electricity'. The salient features of the complex are given below:

Community Hall and Surrounding Areas

- A swimming pool heated with solar collector
- 8 Kw roof top solar PV system (grid connected)
- 4 Kw BIPV system (grid connected)
- Demonstration of 1.2 Kw concentrating type solar PV system (grid connected)
- Stand alone high mast solar street lights with battery at the top and high power FL
- Battery operated pick-up van
- Solar PV operated name plate and signage
- Solar PV operated garden lights

The complex comprises 25 houses, each of duplex type, with floor area of 1760 sq. ft. and an open area of 860 sq. ft.

Solar Water Heating Systems in Magarpatta Housing Complex, Pune

Solar Water Heating Systems (SWHS) are fast catching up in urban areas such as Bangalore, Pune, Hyderabad and Mysore. The Programme of the Ministry of Non-Conventional Energy Sources of soft loans and other incentives has created a favourable environment for use of solar water heating systems. Significant infrastructure for the manufacture, installation, financing and servicing of solar water heating systems has also been developed. The low pay-back period for urban households is an added attraction. The result is that a number of builders and colony developers are now offering houses and apartment blocks fitted with solar water heating systems. The latest to adopt this is Magarpatta City, a large housing complex which is coming up on the outskirts of Pune.

Magarpatta is one of the biggest housing complexes in India covering over 550 acres. Magarpatta City is situated off Solapur road at Hadapsar, Pune. SWHS are fitted as an amenity to its flat holders and the cost is included in the cost of the flat. The complex will eventually accomodate about 10,000 dwelling units in the form of individual houses and apartment blocks of various sizes including some buildings with as many as 11 floors. The complex will also have several buildings that will accommodate information technology related businesses. Currently about 3194 solar collectors have been installed in all the residential neighbourhoods comprising about 3500 flats in Phase I and II of Magarpatta City.

The total capacity of the installed system is 4,03,150 Litres Per Day (LPD) and the saving of carbon emission in tonnes per year is 6047.25. The electrical units saved per year are 68.94 lakh Kwh. Upon completion of Magarpatta City, there will be a total of 7160 solar collectors. Approximately nine lakh litres of water per day will be heated through these collectors. The savings in electrical units would be 1,45,48,000 units per year which would mean saving Rs. 5.81 crore/year in cost of power. The savings in carbon emission would be 13,483 tonnes per year.

When completed, the township will probably have the biggest concentration of solar water heaters in any residential complex in India. It should serve as a model for future townships and residential colonies in the country.

A Housing Complex With Each House Having a Solar Water Heater

Source: MNRE

1. Background

Development City Level Energy Efficiency and Renewable Energy Policy and Actions

Under the Local Renewable Project of the ICLEI – Local Governments for Sustainability, cities like Bhubaneshwar and Nagpur have developed and adopted city level EE and RE policies. Similarly under some other initiatives by ICLEI cities of Visakhapatnam and Vijayawada have adopted similar policies and set implementation targets for themselves. A number of other cities such as Surat, Rajkot, Thane and Coimbatore through various EE and RE projects are demonstrating their commitment towards better energy management.

Source: ICLEI-SA

The main barriers in the adoption of various energy efficiency practices are knowledge gaps, issues related to enforcement and implementation and the cost of green technologies and technology development. This also requires a stronger political commitment and more ambitious policy-making, including careful design of policies as well as enforcement and regular monitoring.

1.4 Water Supply and Waste Management

1.4.1 Water Resource Management and Drinking Water Supply in Urban Areas

As per the data compiled by the Ministry of Water Resources, the total annual water availability is assessed at 1869 Billion Cubic Metres (BCM). The usable water resources are to the extent of 1123 BCM of which 690 BCM is surface water and 433 BCM is ground water. The projections of water requirement made by the National Commission of Integrated Water Resources Development are 710 BCM, 843 BCM and 1180 BCM for the years 2010, 2025 and 2050 respectively. The total storage capacity created so far is 225 BCM and the envisaged storage capacity from the projects under construction would be 64 BCM. Under the JNNURM, 151 water supply projects at an estimated cost of Rs. 19654.86 crores, have been sanctioned. Futher, two desalination plants with a capacity of 100 mld each are envisaged for augmenting water supply in Chennai city.

As per the information received from the state governments, as of March 2004, about 93 per cent of the urban population has access to drinking water supply facilities. The coverage figures indicate only the accessibility, whereas adequacy and equitable distribution and per-capita provision of these basic services may not be as per the prescribed norms in some cases. For instance, the poor, particularly those living in slums and squatter settlements, are generally deprived of these basic facilities. Similarly, the issue of water supply is critical not only for day-to-day needs of drinking water but also for agriculture and allied activities. There have been reports suggesting drying up of sources of water which creates acute stress on rural systems. Scientific evidence conveys the message that climate change will impact the water cycle and water resources in India and worldwide. Thus, there is a need for institutionalizing harvesting through check dams and rain water harvesting. Rainwater harvesting has been made mandatory by amending building rules in most of the states. The Government of Andhra Pradesh has initiated the Rainwater Harvesting Project in August 1988. The Hyderabad Metro Water Supply and Sewerage Board (HMWSSB) has constructed 4684 rain water harvesting structures at a cost of Rs. 5 crore. This has helped in recharging ground water to a substantial extent. The Government of Tamil Nadu has prepared a Manual on Rain Water Harvesting and has also issued a notification with amendments to Tamil Nadu District Municipalities Building Rules, 1972 and Multistoried and Public Buildings Rules, 1973 with provisions for conservation of rainwater by implementation of rainwater harvesting in all existing and new buildings. Several initiatives have been taken in this area by both individuals and entities. The following cases illustrate some of these initiatives:

Source: Replacement of Thatipudi pipe line, Andhra Pradesh

Bangalore – Bharat Electronics Limited (BEL)

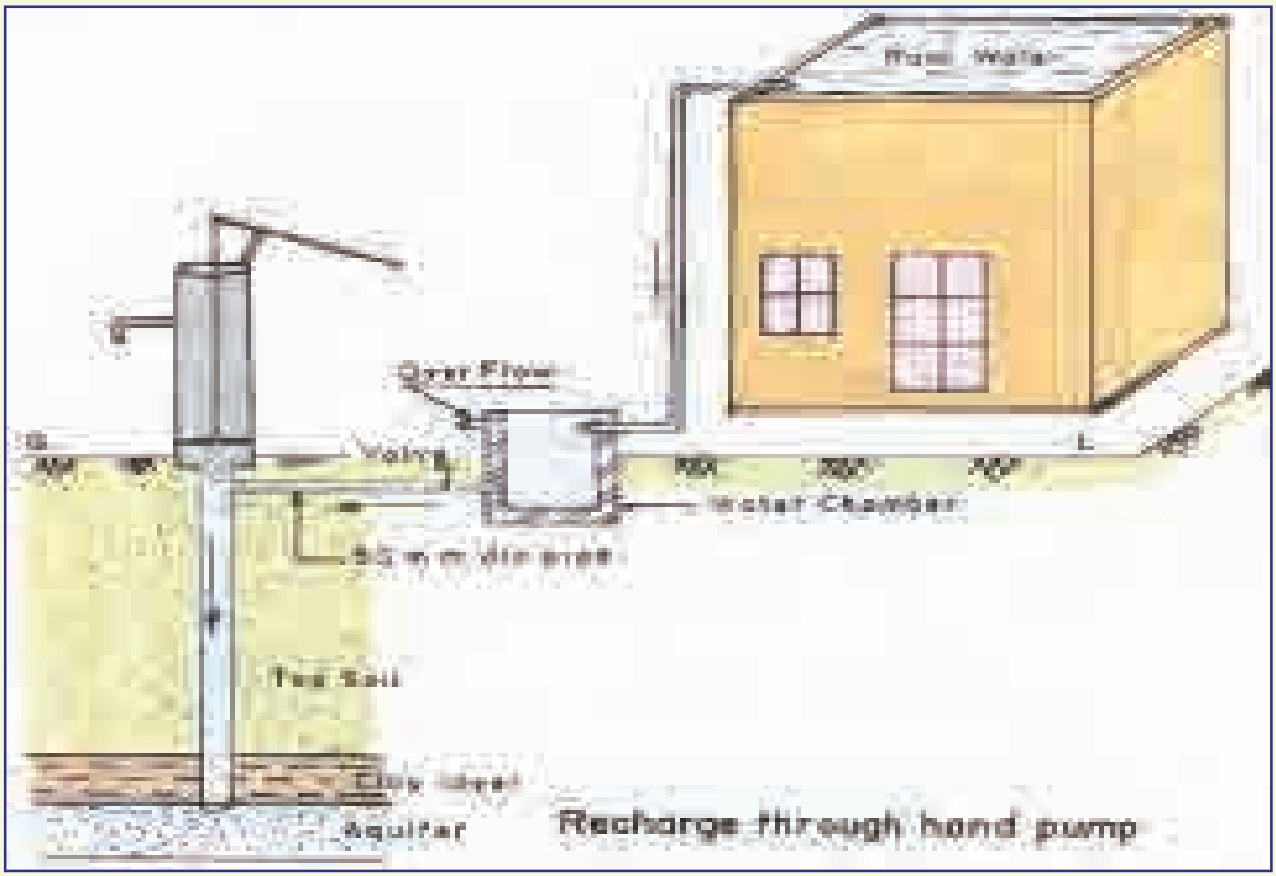
Having realised that saving water is imperative, the corporate sector has taken major initiatives to sustain its water sources.

Bangalore is a city located at an altitude of over 900 m above sea-level. It has no perennial river flowing into it. The city receives water mainly from the Cauvery river, that provides for more than 70 per cent of the city's requirement. It also receives water from Hesaraghatta and Thippagondanahalli reservoirs. There is a huge energy cost involved in the supply of water. The Bangalore Water Supply and Sewerage Board (BWSSB) has to pay nearly 60 per cent of its revenue to Banglalore Electricity Supply Company (BESCOM) since the energy cost of pumping is huge. The demand for water is growing in direct proportion to the city's growth. All this means that it is imperative to protect and sustain its water sources and rainwater harvesting and this is one of the ways of doing it. Thankfully, major initiatives have been taken in the corporate sector to this end. One of the many measures taken up by Bharat Electronics Limited (BEL) to save water, reduce water consumption and recharge ground water table is the Rain Water Harvesting Project initiated in 2000. The project stores rain water during monsoons for later use, thereby reducing the water consumed from other sources. Known to be the first of its kind to be constructed by any public sector industry in India, the capacity of the rain water harvesting reservoir near the north gate of the factory is 170 million litres, completed at a cost of Rs. 57 lakh.This project not only significantly augments the water supply needs of the factory but also benefits the surrounding area and society. People living in the surrounding areas have reported recharge of borewells. TERI was approached to make a feasibility study on the project. Their report revealed that rain water harvesting system could be established successfully at the proposed site. The preliminary study also brought out the fact that the project could harvest rainwater to the extent of 234 million litres per year, which is equivalent to 650 kl per day. A detailed study identified the area near the north gate of the factory for receiving and storing rainwater from the colony area. An earthen pond was proposed to store 135 million litres of water. The study, based on 100 years' rainfall pattern and 28 years of average rainfall, disclosed that there was a possibility to harvest about 500 ml of water annually, assuming an average rainfall of 476 mm. The design, proposed by TERI, was accepted and the work that commenced around November 2001 was completed by February 2002. The earthen pond was constructed in the north-east corner of the estate. The embankment with an enclosed area of 37,229 sqm (10 acres) was constructed in a record time of 120 days. The storage capacity of the pond, which has started functioning, is 170 million litres.

1. Background

Urban Rainwater Harvesting in Delhi

New Delhi regularly faces water shortages in the summer. A primary school teacher in New Delhi began a collaborative project to design and install rooftop rainwater harvesting, which has raised the local water table and dramatically reduced the school's dependence on the municipal water system. The Sri Ram School is part of a larger movement to install rainwater harvesting systems on buildings and apartment complexes around the city. Encouraged by its success and support from the community, the school has started numerous other environmental projects as well, such as a "zero-waste" policy, vermicomposting and no-plastic drives. From about 1997, water shortages began making headlines in India. Delhi, receiving only 611 mm of rain annually, was one of the urban centers affected by droughts. In the summer of 1999 the school, along with an engineer from CSE and a representative from the Central Groundwater Authority (CGA), designed the system, involving laying of drains and pipes leading down from the roof where water could be captured from three points on 6,000 square metres of rooftop. The water, which earlier just drained into the sewers, was funneled down via a system of underground pipes which eventually drained into a filtration pit in the schoolyard to recharge the groundwater. The overflow from this tank is channelled into a borewell 200 mm in diameter and 30 m deep. A single borewell supplies the whole school, and is supplemented by the municipal water supply. The borewell is connected to pipes which lead into the school's plumbing system and the water for drinking goes into a separate filtration system. The total volume of rainwater harvested was 1,890,000 litres or 55 per cent of the total water harvesting potential. The system cost Rs. 125,000, or about US$3,000. It became operational in May 2000 and was inaugurated by the Chief Minister of Delhi as the capital's first school to harvest rainwater. Since the beginning, groundwater levels have risen from 45 metres below ground level in 1999 to 34 metres today and dependence on the municipal water supply is marginal.



Source: www.rainwater harvesting.org/urban/shriram.htm

Other innovative approaches for augmenting water supply include utilization of ground water, tapping sub-surface flow of streams in hilly areas and evolving combined water supply schemes for groups of villages. The following boxes illustrate three cases.

1. Utilisation of Ground Water to Augment Surface Water Supply by Revival of Open Wells and Fixing Mini Filter Units and Supply of Drinking Water in Belgaum City

Background, Objectives and Implementation

Before the commencement of the Rakaskop Water Supply Scheme in 1964, Belgaum city was dependent on open wells. The wells were of an average of 30-35 diameter and have a 60-70 feet average water column even in summer. These wells were abandoned once tap water was introduced. Subsequently, in the year 1995, the reservoir that supplies water to the city dried up due to the variation in monsoon. At this juncture, the Belgaum City Corporation (BCC), after studying the viability of revival of these wells, initiated the process of utilisation of ground water from open wells to augment surface water supply and thereby protected the under ground water table and the environment. BCC identified open wells with high yields. An expert committee organized by the Head of the Department of Geology, Goa University studied the viability of the revival of open wells by observing the yield, recuperation rate, ground water table and quality of water, etc. and gave an encouraging report. Open wells were cleaned by dewatering and desilting. A mini filter with an average design capacity of filtration of 50,000 lt/hr along with an alum dozer and chlorinator were fixed. After the filtration and chlorination process, water is tested and is connected to the existing distribution network for supply to the citizens. An average of 4 lakh litres of water can be supplied from each unit and there are 15 such units serving a population of 10,000 on an average per unit. Even small open wells are cleaned and are fixed with pumps and water is supplied through public stand posts. An average of Rs. 2.5 to 5 lakh is spent on each mini-filter project which can be recovered within a one month period.

Output and Outcomes

The BCC has revived open wells and used the water to supply an average population of 10,000 from 15 open wells. Expenditure on energy charges has been minimal. The regular use of wells helps in recharging. Due to the scheme, BCC is able to save the amount spent on drilling the bore-wells and on engaging private tankers for water supply during the scarcity. Customers are now satisfied with the availability of water as per their local demands.

Source: National Urban Water Awards, 2008

1. Background

2. Combined Water Supply Scheme for 156 Villages and Two Towns in Daryapur

Background, Objectives and Implementation

The Daryapur town water supply scheme was maintained by the Municipal Council of Daryapur (C class MC). The town was served from an individual scheme having supply a wells on the bank of river Shahanoor which resulted in poor yield due to scanty rainfall. Moreover, with a high number of leakages and power failures, the system provided erratic and unreliable water supply ranging from 7 to 15 days. To avoid these problems, a combined water supply scheme for Daryapur, Anjangaon and 156 villages located in saline areas of Amravati district was proposed by the Government of Maharashtra with Shahanoor dam as a source with metallic lines. Before starting the work, a meeting with key beneficiaries including MLAs, Sarpanchs, Panchayat Samiti members, Municipal Council members, Council Presidents, *tehsildars* was sought for the execution of work to avoid delays and also create awareness regarding savings and economical use of water.The contractor carried out the survey of the network and got approval for the hydraulic designs, drawings, etc. A 10 lakh litres raw water sump, 50 mld treatment plant, 50 lakh litres pure water sump were constructed including 800 mm dia DI (Ductile Iron) gravity main of 714 m length. Along with the pure water gravity main, necessary sand bedding, controlling valves, kinetic air valves, scour valves, etc. were installed. Master Balancing Reservoirs (MBRs) and Elevated Service Reservoirs (ESRs) were constructed with a minimum of two outlets to both ESRs and MBRs for proper zoning, effective maintenance and better services. The MBRs and ESRs are connected with Ductile Iron (DI) and Cart Iron (CI) leading mains which in turn are connected to the distribution lines. Daryapur Municipal Council handed over the Daryapur town water supply scheme to Mahatma Jyotiba Phule University (MJP) for day-to day maintenance and revenue collection. All networks are controlled with the help of wireless stations. The staff required for day to day maintenance was already with MJP and the MJP personnel would distribute computerized bills to the customers and collect the water bills. Plumbing and pipe work are executed by the MJP to avoid probable damages of main pipes. The cost of material for house connections is borne by the consumer except the saddle which is of superior quality and is provided by MJP to avoid leakages and maintain uniformity. Necessary steps such as frequent visits to the customer HHs have been taken to improve the cost recovery. All connections are 100 per cent metered and the water charges adopted are Rs.10.20/kl. There is no provision of Public Stand Post (PSP) and group connections are provided for the poor to avoid wastage of water and related revenue. Action towards 24x7 water supply in Daryapur is also in progress.

Output and Outcomes

- This combined scheme resulted in a saving of Rs. 82.63 crore as it avoided unwanted expenditure on repeated works such as laying of pipelines, treatment plants, etc.
- Savings of Rs. 1 crore per year against energy charges as the whole network runs by gravity starting from canal to consumer.
- Reduction of emission of CO_2 due to non-usage of pumping machinery.
- Maintenance cost of the scheme is very low.
- Reliability due to metallic lining is more than expected.
- Willingness to pay is high due to increased level of service, which is reflected in the cost of recovery (more than 75 per cent).
- Waste reduction due to elimination of stand posts.
- Increase in ground water level as extraction of underground water is stopped.
- Change in life pattern of the beneficiaries due to safe and assured water supply.
- Reduced medical expenses and time savings to the consumers.
- Due to stoppage of pumping operations, the operators are diverted to carry out billing and collection of cash.

Source: National Urban Water Awards, 2008

3. Uttaranchal Koop

Background, Objective and Implementation

Natural springs and *gadheras* (sources like rivers and streams) serve as major sources of water in hilly areas of Uttrakhand state. Water from springs can be directly used but these are not in abundance. Moreover, the discharge of available springs is decreasing day by day. Small towns and villages in hilly areas of the state in general draw water from surface sources (*gadheras*) but the water from *gadheras* is polluted and cannot be used directly. Water from *gadheras* is diverted to the supply main by constructing Boulder Filled Galleries (BFG) against the flow. A number of problems have been encountered in BFGs as the construction of BFGs requires expert supervision because of technicalities involved in construction, such as a huge quantity of construction material which is not easily available, lack of arrangements for turbidity removal, high monetary and man power resources for maintenance, etc. Therefore, it was necessary to develop an alternative, which could overcome these problems. And this need has been achieved to a great extent with the innovation of Uttaranchal Koop. Uttaranchal Koop is a device to tap the sub-surface flow of the stream in hilly regions where small springs and streams are the major sources of the water supply.

Uttaranchal Jal Sansthan (UJS) has prepared a simple device for tapping potable drinking water, particularly in areas where pumps and other water supply machines do not work. The innovative device, based on indigenous technology, is being used to tap sub-surface flow of streams in all water–starved areas. Uttaranchal Koop is a hollow cylindrical steel pipe with radical perforated pipes, connected with a welded outlet socket at the middle of a vertical cylinder for joining the outlet pipe, a 1-1.5 m long pipe is placed vertically 3-4 m below the bed of the stream with the open end at the bottom and closed end at the top. The device is placed over the impermeable strata of streams, tapping the entire alluvial field. After placing the Koop, the space graded filter media envelopes the Koop up to the natural bed level of the stream. The base flow of the stream rises inside the cylindrical pipe through its open end and the perforated radial pipes, due to hydrostatic pressure of the submerged surface, maintains a static level in the cylindrical pipe. The outlet socket, placed almost at the middle of the Koop, is connected to the 'gravity-main' of the water supply scheme. The gravity main starts drawing water from the Koop. The static level of the well is maintained through hydrostatic pressure, thus a continuous flow is obtained. The scheme is designed in such a way that it works even during the minimum discharge of the scheme during the summer and winter. Around 750 Koops throughout the state have been installed by UJS.

Output and Outcomes

- The Uttaranchal Koop is a dependable source of water supply in the hilly area.
- Less chances of getting damaged during monsoon period.
- Turbidity, suspended particles and coliform are removed to a great extent by stream bed filtration process which is a natural process of filtration.
- Negligible maintenance cost.
- Construction is easy and speedy.
- Cost is only 15 per cent of the conventional BFG system.

Source: National Urban Water Awards, 2008

The water supply sector also offers a significant opportunity in terms of mitigation potential through reduction of Non-Revenue Water (NRW). Studies on leakage control management have recorded substantial loss of water in the transmission mains. It has been noted that there is 70 per cent leakage in consumer connection pipes and malfunctioning of water meters. One of the measures that can be taken is to replace all GI pipes in the distribution system with High Density Polyethylene (HDPE) pipes. Another option to be explored is energy saving in pumping efficiency. Other possible measures that can be taken include improving the power factor and replacement of old and inefficient pumps, etc.

1.4.2. Wastewater Management

Most urban centres in India have partial sewerage and sewage treatment facilities. These inadequacies reflect limited capacities of urban local bodies (ULBs) to invest in capital infrastructure. As per the information received from the state governments, about 63 per cent of the urban population has access to sewerage, low cost sanitation and septic tank facilities. As per the assessment made by the Central Pollution Control Board (CPCB) on the status of wastewater generation and treatment in Class I cities and Class-II towns during 2003-04 (Table I.3), about 26,254 mld (9.51 BCM) was generated in 921 Class I cities and Class II towns in India (housing more than 70 per cent of the urban population).

The wastewater treatment capacity developed so far is about 7044 mld accounting for 27 per cent of wastewater generated in these two classes of urban centers (2.57 BCM/year). Under the JNNURM, 106 sewerage projects at an estimated cost of Rs.14621.37 crore have been sanctioned.

Effective management of waste water would result in availability of treated water for reuse, capture of methane gas for power generation and improvement in the quality of the environment. Earning carbon credits is also possible. Methane gas (CH_4) is emitted during wastewater transport, sewage treatment process and leakage from anaerobic digestion of wastewater sludge. The natural treatment process and septic tanks in developing countries may result in relatively large emissions of methane. Nitrous oxide (NO_2) is also generated from sewage. In developing countries, due to rapid population growth and urbanisation without concurrent development of wastewater infrastructure, CH_4 and NO_2 emissions from wastewater are generally higher than the developed countries. According to the National Communication Report (NCR) (2004), the CO_2 emission from municipal wastewater was 7.53 million tonnes in the year 1994. Central Public Health and Enviromental Engineering Organisation (CPHEEO) has estimated that the CO_2 emissions from wastewater from 423 Class I cities by 2012 would be 27.80 million tonnes. The box below illustrates a case of utilization of recycled wastewater as well as generation of biogas.

Table I.3: Status of Water Supply, Wastewater Generation and Treatment in Class I Cities / Class II towns in 2003-04

Parameters	Class I Cities	Class II Towns	Total
Number (As per 2001 census)	423	498	921
Population (millions)	187	37.5	224.5
Water Supply (mld)	29782	3035	32817
Water Supply(lpcd)	160	81	146
Wastewater generated (mld)	23826	2428	26254
Wastewater generation (lpcd)	127	65	116
Wastewater treated (mld)	6955 (29 per cent)	89 (3.67 per cent)	7044 (27 per cent)
Wastewater untreated (mld)	16871 (71 per cent)	2339 (96.33 per cent)	19210 (73 per cent)

Source: CPHEEO

Utilisation of Recycled Domestic Waste Water and Bio-Gas for Power Generation in Sewage Treatment Plants at Chennai

Background, Objectives and Implementation

The secondary treated effluent from Sewage Treatment Plants (STPs) at Chennai Water Board was earlier partially used for cultivation of para grass which was auctioned. The remaining treated sewage was discharged to the nearby watercourses. In order to prevent untreated sewage flow reaching waterways, Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB) proposed to construct additional sewage treatment plants at four locations totaling to a 264 mld capacity. Tenders were invited to design and build sewage treatment plants with O&M for ten years by the contractor. Keeping in mind the cost of land, it was proposed to load 5 per cent of guideline value of the land cost in the total tender cost so that bidders would propose a minimum land area for the STP construction. Bonus and penal clauses on the consumption of power from the grid were also indicated in the bid document to reduce power consumption. These STPs are operated under an activated sludge process with sludge digesters from which biogas is generated. The biogas produced during digestion of sludge in the digesters has been stored in the gas holding tank and methane content (60-70 per cent) of the bio-gas has been used as fuel for running gas engines after removal of moisture and hydrogen sulphide in a scrubber. The production of electricity is based on the methane content of bio-gas.

Output and Outcomes

- Contractor has used minimum land for construction thus saving land for future expansion.
- Due to penalty and bonus clauses for power consumption from the grid, contractor has been encouraged to generate more biogas and produce maximum power from gas engine instead of drawing power from grid.
- The methane content of bio-gas produced during sludge digestion is used for power generation. This not only saves power bills but the waste drawn from grid can be utilized for some other purposes.
- Since methane gas is one of the GHGs having 21 times global warming potential than CO_2, this methane gas is captured for power generation instead of being released into the atmosphere, which helps in mitigating global warming.
- Average power production through gas engine and power savings in 4 STPs is around Rs. 387.45 lakh.
- Conserves natural resources (mainly fossil fuels) that would otherwise be consumed in generating equivalent electricity in grid-connected sources.
- The project activity improves the living conditions of the people in the vicinity of the sewage treatment plants.
- Additional revenue could be obtained through carbon credits under Clean Development Mechanism (CDM).
- Less quantities of potable water are used by the usage of recycled water in industries. This lowers water supply cost, as potable water is expensive and limited, treatment costs and the need to build more dams.
- Sewage discharge is reduced, lowering the stress on streams.
- Revenue of about Rs.10 crore is being obtained per year through sale of treated sewage to the industries.

Source: National Urban Water Awards, 2008

Replacement of waste water pumping equipment to improve the system efficiency through energy saving should be considered. Experiments in utilization of recycled domestic waste water and of bio-gas for power generation in Sewage Treatment Plants (STPs) that were successfully attempted at Chennai should be replicated.

1.4.3 Municipal Solid Waste Management

About 42 million MT of solid waste is generated daily in the urban areas of the country. Most urban centres lack systems for scientific management of municipal solid waste system. MSW is rarely segregated at source in accordance with the MSW Rules 2000. Mixed waste is being dumped into the depression or earmarked low lying areas in and around the towns. Municipal solid waste comprises 40%-60% of bio-degradable (organic) matter, 10%-20% inert matter and 10%-25% recyclables. The organic fraction of municipal solid waste can be profitably converted into useful products like compost (organic manure), methane gas (used for cooking, heating, lighting, production of energy), etc. through the following processes:

(a) Waste to Compost

i. Aerobic / Anaerobic Composting

ii. Vermi-Composting

(b) Waste to Energy

i. Refuse Derived Fuel (RDF) / Pelletization.

ii. Bio-methanation for heat and/or power

iii. Incineration (but difficult due to low calorific value and high moisture).

(c) Recycling of Wastes

(d) Sanitary Landfilling

According to the NCR (2004), the CO_2 emission from municipal waste was 12.22 million tonnes in the year 1994. It has been reported in the World Bank Report (2006) that roughly about 1.40 million tonnes of methane (CH_4), which is equivalent to about 30 million tonnes of CO_2 can be generated from MSW disposal in India per year. However, there is very limited practical experience. Under JNNURM, 42 solid waste management projects at an estimated cost of Rs. 2026.47 crores has been sanctioned. In another Central sector scheme which predates JNNURM, solid waste management projects have been completed in eight airfield towns. The following box illustrates a successful case of effective Solid Waste Management (SWM):

Solid Waste Management – The Namakkal Experience

Namakkal is a small district headquarters town in Tamil Nadu, situated on the main highway from Salem to Dindigul. It is the first municipality in the country involved in privatisation of all components in SWM. By the institutionalisation of door-to-door collection with segregation at source, manufacturing of vermi-compost from organic waste and sale of recyclable meterial from inorganic waste, Namakkal has the distinction of becoming the only zero garbage town in the country. In order to achieve this, they follow a ten point charter:

1. Extend the scheme of door-to-door collection with segregation to the entire town and make the streets and roads garbage free.
2. Introduce night sweeping at bus stand and important roads, etc., and maintain cleanliness 24 hours.
3. Extend the scheme of door-to-door collection and sweeping on holidays and Sundays and make the town clean on all days by continuous sweeping.
4. Make the parks and burial grounds beautiful and attractive through NGOs and voluntary agencies.
5. Remove encroachments on all roads and streets.
6. Prevent road-side hotels, lorry repair shops, etc., on the national highway and maintain it beautifully by planting trees.
7. Remove pigs and dogs from the town.
8. Levy service charges on hotels, Kalyanamandapams, commercial complexes and garbage generating industries.
9. Encourage manufacture of vermi-compost from organic waste through voluntary organisations/private agencies on B.O.T. basis, sell the inorganic recyclable garbage and convert the compost yard into Nandavanam.
10. Engage two mop-up teams with two auto model carriers to remove the waste then and there, round the clock, and make the town garbage free.

Since door-to-door collection is being done by private groups, municipal *safai karamcharis* have been engaged for night sweeping on main roads, bus stand, markets and industrial areas. This activity is also carried out on all Sundays and holidays. Sanitary inspectors have been appointed to impose spot fines upon those who resort to littering. For vermi-composting a unit has been set up 2 kms outside the town over an area of 8.53 acres. The compost is either sold or utilised for parks / gardens under the supervision of the municipal authorities.

This experiment has been successful due to a holistic approach with all agencies cooperating together under the leadership of the District Collector. The committee includes the district administration, the municipality, consortium of NGOs, women's self-help groups, schools, market associations, industrial associations, Residential Welfare Associations (RWAs) and ragpickers. Although Namakkal is a small town, with a population of 60,000 to 70,000, it has two major industries – building bodies of 60 per cent of Compressed Natural Gas (CNG) tankers in the country and a very large and well-organised poultry industry. Hence, if no effort was made, the town would have virtually turned into a garbage ridden town. Now an awareness has been created where every citizen accepts the responsibility of keeping the town clean and ensuring that nothing is thrown anywhere except in a bin.

To address the issue of mitigation of GHG emission from municipal waste, appropriate actions are required through adoption of scientific solid waste management systems with options for recovery of wealth from waste, i.e. compost and energy recovery from solid waste. Improved waste management will not only provide for significant GHG mitigation, but will also improve public health and environment quality. As regards Aerobic/Anaerobic composting, the technologies proven / established in India may be preferred. In the case of waste to energy, non-compostables may be converted to RDF which may be used for cement kilns. Technologies such as Pyrolysis / Plasma gasification are yet to be proven in Indian conditions.

1.4.4 Urban Storm Water Management

Urban areas always present some risk of flooding when rainfall occurs. Heavy and prolonged rainfall produces very large volumes of surface water in any city, which can easily overwhelm drainage systems. Most of the cities in India do not have proper drainage systems and rely on natural drainage canals. Climate change has the potential to increase flooding risks in two ways: from the sea (higher sea levels and storm surges) and from rainfall. Extreme precipitation is expected to show a substantial increase over a large area over the west coast and in central India. Gujarat, one of India's most prosperous states has experienced severe flooding for three consecutive years starting in 2004, causing large economic losses in some cities due to extreme precipitation in upstream catchments. The devastating Mumbai floods of 2005 were caused by an extreme weather event. The bulk of city services were shut down for the first time in recorded history for almost five days with no contact via rail, road or air with the rest of the country. Over 1000 people lost their lives in the region and economic life in the city came to a halt due to a combination of institutional failures, poor preparedness and extremely high vulnerability of the poor. The need for better storm water drainage cannot be overemphasized and needs to be integral component of spatial planning and cities.

Under JNNURM, 68 storm water management projects at an estimated cost of Rs. 8061.50 crore have been approved. In addition, a special project named BRIMSTOWAD i.e. Brihan Mumbai Storm Water Drainage Project has been sanctioned for Mumbai city at an estimated cost of Rs. 1200 crore.

Service Level Benchmarks

The Ministry of Urban Development (MoUD) has formulated benchmarks for service delivery in the above four areas. The purpose of formulating these benchmarks is to shift the focus from infrastructure creation to service delivery. The benchmarks

WATER SUPPLY		
S. no.	**Proposed Indicator**	**Benchmark**
1	Coverage of water supply connections	100 %
2	Per capita supply of water	135 %
3	Extent of Non-Revenue Water	15 %
4	Extent of metering	100 %
5	Continuity of water supplied	24 %
6	Efficiency in redressal of customer complaints	80 %
7	Quality of water supplied	100 %
8	Cost recovery	100 %
9	Efficiency in collection of water supply related charges	90 %
	SEWERAGE	
1	Coverage of toilets	100 %
2	Coverage of sewerage network	100 %
3	Collection efficiency of sewerage network	100 %
4	Adequacy of sewage treatment capacity	100%
5	Quality of sewage treatment	100 %
6	Extent of reuse and recycling of sewage	20 %
7	Extent of cost recovery in wastewater management	100 %
8	Efficiency in redressal of customer complaints	80 %
9	Efficiency in collection of sewage water charges	90 %
SOLID WASTE MANAGEMENT		
1.	Household level coverage	100 %
2.	Efficiency of collection of solid waste	100 %
3.	Extent of segregation of MSW	100 %
4.	Extent of MSW recovered	80 %
5.	Extent of scientific disposal of MSW	100 %t
6.	Extent of cost recovery	100 %
7.	Efficiency in collection of SWM charges	90 %
8.	Efficiency in redressal of customer complaints	80 %
STORM WATER DRAINAGE		
1.	Coverage	100 %
2.	Incidence of water logging	0 numbers

1. Background

1.5 Urban Transport

The transport sector plays a crucial role in energy use and emission of GHGs. In 2004, transport energy use amounted to 26 per cent of world energy use and the transport sector was responsible for about 23 per cent of the GHG emissions (International Energy Agency, (IEA) 2006). The 1990-2002 growth rate of energy consumption in the transport sector was the highest among all the end-use sectors. Each gallon of gasoline when burnt, pumps 28 pounds of CO_2 into the atmosphere. In India, transport which includes road, rail, aviation and navigation has been a major contributor to GHG emissions. According to a report prepared by the Ministry of Environment and Forests (MoEF) in 1994, the transport sector was responsible for 12 per cent of the country's total energy related CO_2 emissions (i.e. 679.47 million tonnes of CO_2). Thus, it is necessary to initiate measures that, *inter alia*, help in reducing fossil fuel consumption and consequently GHG emissions. Integrated Energy Policy (IEP,) 2006 states that no economic substitutes are obvious for the transport sector at least till 2031-32. Therefore, energy efficiency of vehicles, use of mass transport, pedestrianisation, cycling and transport demand management measures have to get high priority. Among transport sub sectors, road transport is the main source of CO_2 emissions which accounts for 90 per cent of total transport sector emissions. Considering this, the emphasis in this mission is mainly on measures to reduce emissions from operation of road transport.

As per the recent study conducted by MoUD through M/S Wilbur Smith and Associates, the growth of registered motor vehicles is increasing at four times the rate of growth of population in the six major Indian Metropolitan cities viz. Delhi, Ahmedabad, Bangalore, Hyderabad, Mumbai and Chennai. The share of public transport has declined from 69 per cent to 38 per cent in cities with a population of more than four million, from 1994 to 2007. Operating bus services in congested streets has become increasingly difficult in a congested network with turnabout times increasing by the day. The fleet sizes of nearly all the public undertakings have declined rather than increased to meet the growth in demand. Only about 20 cities, out of 87 cities, which are 0.5 million plus or state capitals, have some kind of organised public transport. However, even when there is organised public transport, the quality of buses and the city bus service is such that it is patronised only by people who have no other alternative. Congestion, increase in trip length due to urban sprawl, increase in purchasing power of people and inadequate facilities for cycling have contributed to reducing the modal share of cycling which is down from 30 per cent in 1994 to less than 11 per cent in 2007. With the growth in the economy, the demand for road transport both on account of freight and passenger is likely to increase considerably. This would mean increased fuel consumption and emissions. According to one estimate, the total fuel consumption of on road vehicles in India under the Business-As-Usual (BAU) scenario in 2035 will be over six times than that in 2005.

From an energy conservation perspective, public transport makes the most optimum use of the available road space and fuel by transporting the maximum number of people per unit of road space and passenger kms/litre. Public transport causes less environmental damage in terms of air and noise pollution, optimization of road space, increased per unit throughput and reduction in traffic congestion, as compared to personal vehicles. Studies show that energy consumption in motorized individual passenger traffic is up to ten times as high as consumption in a well organized and demand-oriented public transport system. The same holds for green house gas emissions. A recent study of 52 cities, mainly in developed countries, shows a strong corelation between modal split in cities and emissions. Cities with a high share of public and non-motorized transport need up to ten times less energy per person for passenger transport than cities where urban transport is mainly based on individual motorization. Another study carried out by ADB shows that on a per passenger basis, a car uses six times more energy than a bus. IEA estimates that there can be a 100 per cent difference in oil use, carbon dioxide emissions in a future scenario that is dominated by travel in high quality bus systems as compared to one that is dominated by private vehicles in Delhi.

IEA postulates that even the dirtiest bus emits far less CO_2 per passenger km than other vehicles. The developed world, particularly Europe, despite its obsession with cars, has begun to rebuild its public transport agenda to enhance fuel saving and reduce CO_2 emissions. According to a study conducted in Bangalore, an increase in public transport share from 62 per cent to 80 per cent in the year 2020 will lead to a fuel saving of 765,320 tonnes of oil equivalent, which is equivalent to about 21 per cent of the fuel consumed in the baseline case (TERI, 2007). The other advantages that ensue are a 23 per cent reduction in total vehicles (642,328) and road space creation (equivalent to removing 418,210 cars off the road), and less traffic congestion. Air pollution in the city drops significantly: a 40 per cent drop in carbon monoxide (CO), 46 per cent in hydrocarbons (HC), 6 per cent in nitrogen oxides (NOx) and 29 per cent in Particulate Matter (PM). The total carbon dioxide (CO_2) mitigation potential over the fifteen-year period (2005-2020) is 13 per cent. However, a rapid growth in motorization in most cities is causing the relative share of buses to decline. This is because of the following major factors:

- Poor quality of public transport service; although it is low cost, it is often overcrowded, dirty, unreliable and highly polluting and has important personal security and safety issues.
- Poor access to bus services and service quality.
- Poor image of bus and public transport.
- Improper planning and provisioning of infrastructure facilities.
- Improper route planning, issue of permits without any survey or scientific data.
- Lack of passenger information systems, institutional and regulatory hurdles.
- Lack of uniformity regarding the institutional arrangements for providing public transport services.

The transport sector GHG emissions are expected to soar if it follows the path of the highly motorised nations without integrated land-use transport policies in place. This will require accelerated urban reform, improved urban structure (for example, to protect mass transit rights of way in the early stages of development) and urban road traffic (for example, to implement effective traffic restraint) together with innovative transport-demand management and access and mobility planning to support the main social and economic activities that take place in a city.

To accomplish this, the National Urban Transport Policy (NUTP) has laid major emphasis on promoting investments in public transport in Indian cities as well as measures that make its use more attractive than in the past (MoUD 2006). Towards this end, the policy states that the central government would encourage all state capitals as well as other cities with a population of more than one million to start planning for high capacity public transport systems, and promote shift from personal modes of transportation to public modes of transportation. The composition of vehicle population in India is skewed towards personal transport. The share of buses in all vehicles excluding trucks declined from 15.18 per cent in 1950-51 to 1.1 per cent in 2003-04 while the personalized mode of transportation has increased from 62 per cent in 1950-51 to 93.78 per cent in 2003-04. The bulk of increase is seen in two wheelers. India is expected to have a population of 236 million two wheelers in 2035 (see Table1.5), up from 35.8 million in 2005 which, reflects a large increase. This forecast for cars is likely to be exceeded with the availability of extremely affordable Rs.1 lakh car in the market from 2008-09.

There is a wide range of public transport technologies: one is high capacity and high cost such as the underground metro systems and on the other hand, there are low-capacity bus systems running on a shared right of way, which cost much less. Within these extremes is a range of intermediate possibilities, such as buses on a dedicated right of way, elevated sky buses, monorail systems and electric trolley buses. In India, high-capacity rail systems and buses

on shared right of way are the only ones experimented upon. Electric trolley buses have been running in San Francisco, (USA) and Beijing, People's Republic of China (PRC). The Bus Rapid Transit System (BRTS) operating on segregated lanes has become popular in Bogota, Colombia and Curitiba, Brazil. BRTS can offer high speed user-friendly mass transit at high capacities but with a considerable cost reduction in per kilometre investment versus metro or light-rail system. Well designed BRTS also helps in substantially improving the traffic flow for other private vehicles due to elimination of interference from the conventional bus or para transit operation. The box gives details of a state of the art modern city bus service recently introduced.

Table 1.5: Forecast by Class of Vehicle Populations in India *(in Millions)*

Population	2005	2008	2015	2025	2035
Two - wheeler	35.8	46.1	87.7	174.1	236.4
Three - wheeler	2.3	3.0	5.3	8.8	13.1
HCV	2.4	2.9	4.6	9.1	16.2
LCV	2.4	3.2	5.7	12.5	26.9
Car, SUV	6.2	8.8	18.0	41.6	80.1
Total	**49.1**	**63.9**	**121.3**	**246.1**	**372.7**

Source: 2006 ADB Study on Energy Efficiency

Indore City Transport Services Limited

Indore has introduced a state-of-the-art bus service on a Public Private Partnership (PPP) basis. A company called the Indore City Transport Services Limited (ICTSL) has been set up to manage public transport and procure operations from private operators. This concept of ICTSL is very close to the concept of Unified Metropolitan Transport Authority (UMTA) being recommended under the National Urban Transport Policy (NUTP). The Company has Indore Municipal Corporation and Indore Development Authority as the joint partners with a 50:50 partnership. The Company has all the stake holders on its Board of Directors and includes Road the Transport Office (RTO), Superintendent of Police and all the operators as special invitees on a permanent basis on all the board meetings. Some of the innovative features are as follows:

1. The Company has identified eighteen high travel demand routes. The routes have been colour coded as blue, orange and magenta. The routes are bid out to private operators. The bidder who quotes the highest licence fee is awarded the contract. The conductor and driver are provided by the operator.

2. The bus specifications, which are for modern semi low floor buses (650 mm from ground to step entry), are part of the contract document. All the buses are equipped with a GPS system for on-line monitoring.

3. Fully computerized palm held Electronic Ticketing Machines (ETM) are used for issuing the daily passenger tickets.

4. Through GPS and a fully automated vehicle tracking system, it is ensured that the city buses reach the bus stops at a fixed time. Each bus stop has a Passenger Information System (PIS) board which displays the scheduled arrival time and expected arrival time of buses for each route.

5. Realising the importance of training in a service company, the training of drivers and conductors is organized by ICTSL. The drivers are trained on the technical aspects on traffic rules and driving styles. The conductors are trained in the area of customer service and soft skills training.

6. A Pilot BRTS Project for Indore for 14 kms has been sanctioned. Once the engineering infrastructure work is completed, the same buses which are plying as city bus services will be shifted to the BRTS corridor.

1. Background

Broadly speaking strategies for reducing GHG emissions in the transport sector could include the following:-

a) Greater Use of Non-Motorized Mode

Measures that discourage the use of personal motor vehicles would have to go hand-in-hand with measures that encourage the use of non-motorized modes, as they are "greener" modes of travel. All safety concerns of cyclists and pedestrians have to be addressed by encouraging the construction of segregated right of way for bicycles and pedestrians. This can be done by:

(i) investing in a segregated right of way for bicycles and pedestrians;

(ii) converting crowded areas like marketplaces into no-vehicle zones;

(iii) improving bicycle technology;

(iv) providing safer parking facilities for bicycles in workplaces;

(v) launching a public cycle Programme on PPP;

(vi) organising cycle rickshaws through PPP and finally,

(vii) promoting cycling and walking as healthy activities.

b) Improving Access and Reducing Passenger and Freight-Kilometres

The greatest GHG mitigation can be achieved in the medium to long term through proper integration of land use and transport planning to improve access to goods and services, while minimizing the need to travel through innovative means and without compromising economic growth. Travel demand is a function of population, the per capita trip rate, and the average trip length. With rapid urbanisation, there is little possibility of reduction in the per capita trip rate. This is because a larger share of the population would be securing employment (especially women) and more children would be attending schools. Efforts to reduce travel demand have, therefore, to focus on reducing the average trip length. From a transport perspective in mega cities, small and self-contained clusters are considered desirable as people are expected to move to residences that are closer to their workplace, or seek work closer to home. It is essential that the transport network guides the urban form, rather than the urban form guiding the transport system. Also, it would be equally important to link the peri-urban and rural community with fast mass transit, and promote the use of Information and Communication Technology (ICT) policies to enhance economic development.

c) Emphasis on Railways for Passenger and Freight Transport

Conventional bus transport in crowded cities is stretched to its limits and cannot meet the rapidly growing transportation demands. Railways have to play an increasing role in the integrated multi modal transport system to capture the new traffic thrown up by the growing Indian economy. To realize this, the railways need to seriously consider the provision of a complete logistic solution to its customers, in addition to providing superior services, running of suburban trains on SPV mode through partnering with state and city governments.

d) Tough Fuel Economy Standards

Tougher fuel economy standards would significantly increase new vehicle efficiency across the fleet. The current fuel economy standards should be averaged for each category and should take into account its economic impact. Attempts should be made to increase fuel efficiency during the Eleventh Plan and beyond. The average fuel economy of all new cars, commercial vehicles and two wheelers could be increased by about 45 per cent by 2012. Indeed this may seem to be a tough measure and vehicle manufacturers may protest. As demonsrated through experience in the USA when tough measures in this regard were taken, the initial protest from vehicle manufacturers turned to compliance. High initial cost is a major

obstacle to the widespread production and sale of hybrid and fuel cell vehicles. Tax incentives could be offered in order to stimulate mass production and support initial sales of these innovative vehicles. The amount of the tax incentive (or most of the incentive) should be based on the fuel economy achieved. Also vehicles should have relatively low pollutant emissions as well as high fuel efficiency in order to be eligible for a tax incentive. Taxes and duties on public transport vehicles and taxies should be much lower than that on personal vehicles.

e) Alternate Fuels

The Ministry of New and Renewable Energy is also promoting Programmes for the development of alternative systems of fuel/fuel systems for transportation like battery operated vehicles, hydrogen and fuel cell based vehicles and bio-fuel operated vehicles. Among the bio-fuels, use of ethanol as a fuel is also one of the prominent alternative fuels.

f) Battery Operated Vehicles (BOV) and Hybrid Vehicles (HV)

Battery operated vehicles can have niche applications for replacing fossil fuel vehicles in hospitals, sanctuaries, zoos, bio-sphere reserves, etc. However, for general use, more focus should be on development and deployment of hybrid vehicles, which have a better performance in terms of speed and range. The transition to BOVs /HVs can be achieved through the appropriate policy support, fiscal incentives and technology development. Technology development should be supported in the area of BOVs and HVs to achieve increased operational range, mass production and commercial availability at affordable prices. There is a need to develop high energy and power density, light weight and inexpensive batteries and also to improve the overall performance, reliability, and durability of the BOVs. Several companies, research groups/institutions are developing different types of advanced batteries for use in electric vehicles.

g) Use of Hydrogen

Combustion of hydrogen in engines/turbines does not produce pollutants like carbon monoxide and hydrocarbons as in the case of fossil fuels. However, oxides of nitrogen are present in the exhaust from the engine/vehicle. But when hydrogen is used as a fuel in fuel cells, there are no pollutants emitted through the tail pipe of the vehicle, and water is the only product of the electro-chemical reaction in fuel cells. The Banaras Hindu University, Varanasi, has modified the petrol driven motorcycle and three-wheeler so that it can operate with hydrogen as a fuel. Fifteen such motorcycles and a three-wheeler are being demonstrated on the campus of the university. Southern Petrochemical Industries Corporation (SPIC) Science Foundation, Tuticorin, developed and demonstrated a fuel cell battery hybrid vehicle, which logged more than 3000 kms under a project sponsored by the Ministry of New & Renewable Energy. Fuel cells have also been used in the REVA electric car to extend its range of operation. A National Hydrogen Energy Road Map has been prepared under the aegis of the Ministry of New and Renewable Energy (MNRE). The road map envisages that about one million hydrogen-fuelled vehicles would ply on Indian roads by 2020. About 75 per cent of these vehicles would be two and three wheelers. However implementation of this technology would entail resolution of technological challenges as well as challenges related to creation of distribution infrastructure.

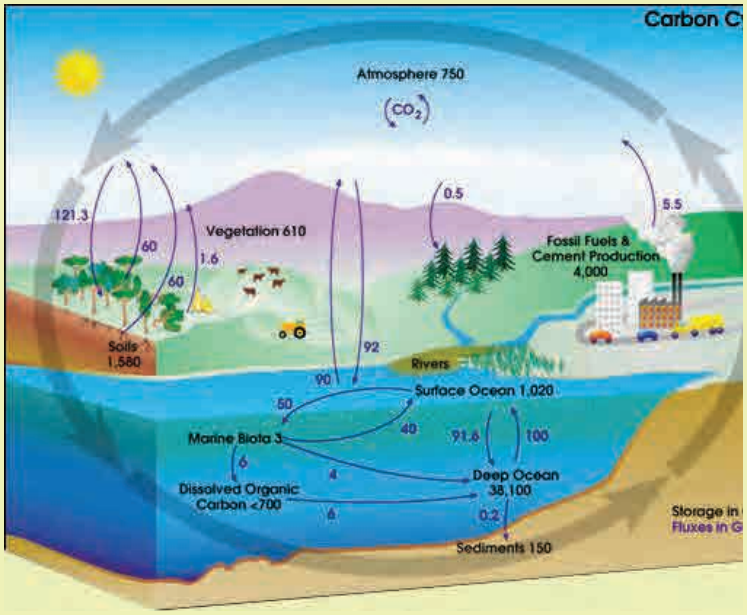
h) Compressed Natural Gas

CNG blended with hydrogen has been used as a fuel in the USA and European countries and it has been observed that emissions (carbon monoxide and unburnt CNG) from the vehicles, which use such blended fuel, are lower as compared to the vehicles using only CNG as fuel. However, emissions of oxides of nitrogen are found to be higher.

1. Background

i) Bio-Fuels

Bio-Fuels can be defined as combustible fuels produced from biomass. These fuels are generally in the form of alcohols, esters, ethers and other chemicals produced from biomass. The two most common types of bio-fuels that can be used in vehicles are ethanol and bio-diesel. Use of bio-fuels as a blend to fossil fuels can provide a solution for reducing the emission problems. Blending of ethanol with petrol at 5 per cent in all states and optionally up to 10 per cent in the states where adequate ethanol is available would require a continuous supply and availability of ethanol of the required quality on a sustainable basis, which in turn is dependent on the availability of molasses vis-à-vis sugarcane production. Blending of bio-diesel with diesel for use in vehicles will require development of production capacity for sustained availability of bio-diesel. Another promising technology is that of cellulosic ethanol as the annual generation of cellulosic biomass from crop residues in India is significant. However, the available technology is not yet competitive with petroleum based fuels.



Urban transport is primarily a state sector activity. However, the initiatives of the MoUD with the launch of JNNURM and the approval of the NUTP, 2006 have led to significant improvements. Some of these are as follows:

S.No.	Subject	Action taken by the States/Union Territorities (UTs)
1.	Promoting public transport.	City bus service on PPP model has been introduced/is being introduced in Bhopal, Jodhpur, Udaipur, Jalandhar, Ludhiana and Jaipur. BRTS projects have been sanctioned in the city of Ahmedabad, Rajkot, Surat, Indore, Bhopal, Pune, Pimpri-Chinchwad, Vijayawada, Vishakhapatnam and Jaipur under JNNURM Scheme. Metro projects have been sanctioned and are being implemented in Delhi, Kolkata, Mumbai and Bangalore. Further proposals for Metro Rail Project (MRP) in Chennai, Kolkata and Hyderabad have been approved and are in different stages of progress.
2.	Developing a Comprehensive Mobility Plan (CMP) integrating land use and transport planning.	Sixteen cities including Bangalore, Vadodara, Surat, Indore, Ajmer-Pushkar, Coimbatore, Madurai and Ranchi have developed CMPs and other cities are also developing CMPs.
3	Promoting pedestrianisation and non-motorised transport – development of properly designed cycle network.	All projects for BRTS, which have been sanctioned during 2006-2007, 2007-2008 have dedicated paths for pedestrians and cyclists.
4	Setting up of Unified Metropolitan Transport Authority (UMTA).	The Governments of Rajasthan, Andhra Pradesh, Maharashtra, Tamil Nadu and Karnataka have set up a UMTA in their State capital cities.
5	Designating one department as a nodal department for urban transport at the state level.	The Government of Haryana and The Government of Himachal Pradesh have designated their transport department and Town and Country Planning Department (TCPD) respectively as nodal departments for matters relating to urban transport/NUTP. Similarly the Government of Andhra Pradesh has also nominated the municipal administration and the Urban Development Department (UDD) as the nodal department for urban transport matters for all one million plus cities. The Government of Madhya Pradesh has nominated the UDD as the nodal department for urban transport.
6	Banning any development less than 500 metres on the side of new by passes so that they remain as by passes.	The Government of West Bengal intimated that the Traffic and Transportation Master Plan (TTMP) for Kolkata will incorporate the assigned priority. The Urban Transport (UT) of Andaman and Nicobar has agreed to incorporate the concerned points for financial assistance.
7	Reserving a lane for public high capacity bus system/high occupancy vehicles in all new roads/link/widened roads	The Government of Delhi has asked the department of urban development, DTC, Delhi Police, PWD and Delhi Integrated Multi-Modal Transit System (DIMMTS) for necessary action on the matter. The Government of Rajasthan has asked the Urban Development Department (UDD), housing, PWD and Town Planning Department to implement this measure.
8	Setting up of a dedicated Urban Transport Fund (UTF) exclusively for urban transport needs	Surat and Pimpri-Chinchwad have set up a dedicated fund for urban transport.

1. Background

1.6 Urban Planning

Sound urban practices lead to long term sustainability. The National Commission on Urbanisation (NCU) India (1988) recommended Low-Rise High Density (LRHD) built-urban form for Indian cities. It stated that such a form is less expensive to maintain and has other advantages like equity. It says 'income profile and affordability suggest that a range of small and medium sized plots, between 50 sqm and 100 sqm (with some plots perhaps up to 200 sqm) can satisfy the needs of over 95 per cent of the urban population.' The Commission felt that this typology is more economical than apartments because less space is required for public circulation and lifts, besides it also provides much better living conditions. According to NCU, a 50 sqm plot per family with five members will generate a net density of 1000 persons per hectare (i.e. a gross residential density of 500 persons per hectare). Similarly, a 100 sqm plot would generate a gross residential density of 250 persons per hectare. It also states that high gross densities in the inner city can be tackled by interventions in the city structure and by adjusting land use allocation within the city itself to create spaces for social overheads. Its recommendations for built form specify that residential sites should be provided so that : (1) 50 per cent of the land is in plots between 25 and 100 sqm; (2) 25 per cent of the land is in the plots between 100 and 200 sqm and (3) 25 per cent of the land is either in these size of plots or any other sizes. The report also says that, 'as long as our cities remain within stipulated density thresholds (i.e. neighbhourhood densities of 250 to 1000 persons per hectare) there are efficient and cost effective solutions within our resources. It further points out that the densification can be increased at selected nodal points depending on the holding capacity of the area. It recommends that densification should be related to the mass public transport network.

On the one hand, high population density aggravates negative externalities like air pollution, noise and loss of green space, on the other it may improve accessibility of services, reduce per capita domestic energy consumption and also promote infrastructure efficiency and use of public transport.

In general, advantages of densification can be summarized as follows:

- protection of the countryside, green space and biodiversity;
- reduction of travel distance, emission of green house gases and thus global warming;
- reduction in use of material for construction of infrastructure;
- economies of scale in providing social and institutional services like hospitals, banks etc; and
- better interactive community life.

The disadvantages are:

- overcrowding;
- traffic congestion;
- ill health;
- crime; and
- high energy demand in compact high rise buildings. Arriving at an optimum form would require a balance between densification and expansion.

Transport plays an important role in urban sustainability. One of the challenges of sustainable urban form is to strike a balance between economic performance objectives and environmental sustainability. The land use and transport policies will have to match the demand of different activities. The idea is to create a city that performs well economically and conforms to the objectives of environmental sustainability. In order to be economically efficient a city needs to reduce production costs, eg. costs of receiving inputs and distributing outputs. It also needs to reduce travel time by proper organisation of land use and activities in a city.

The urban "heat island" effect compounds and exacerbates climate change. Pavement, buildings and other structures typical of urban areas replace natural vegetation and minimise cooling provided by vegetation through both shade and evapo-transpiration. This

contributes to the formation of ground-level ozone, which is detrimental to human health. In urban areas rise in temperature due to this process can be between two and ten degrees farenheit. Further, the compounding effects of the urban heat island and increased temperatures from climate change result in increased demand for air conditioning. Increased air conditioning means increased generation of electricity which again contributes to the emission of greenhouse gases. These need to be examined in the context of new paradigms for evolving solutions through settlement planning.

Apart from urban form, urban planning needs to cater to adaptation requirements. In this context, the Urban Development Plan Formulation and Implementation (UDPFI) guidelines can serve as a useful reference. The guidelines touch upon measures in the context of planning of settlements that could cater to risk mitigation due to cyclones, floods, and landslides. Auroville Perspective Plan has taken into consideration UDPFI Guidelines.

The prospect of climatic change offers an opportunity to re-evaluate our priorities. Various dimensions of sustainability need to be integrated. Aspects related to environmental and social sustainability need to be considered along with economic sustainability to ensure sustainable development of various settlements.

Auroville Perspective Plan

Auroville Perspective Plan (APP) follows the UDPFI guidelines. The basic concept of Auroville is to have high density core surroundings. The city will be within 5 sq kms surrounded by a green belt of 15 sq kms. Even within 5 sq kms the population of 30000 - 40000 thousand would be confined to one-fourth the area. In the Auroville Perspective Plan the green areas are productive areas. Although the city is not designed to use 100 per cent alternate energy for development the direction in the plan is to use renewable energy to its threshold level. In Auroville, the concern is not only for the immediate surrounding village but for the entire bio-region. The 5-year plan shows the areas to be developed, the parameters involved and the mechanism for implementation.

Source: TCPO

City-Level Action Plans for Climate Change

Numerous International, Independent and Non-Government agencies are carrying out studies and are supporting cities to develop, adopt and implement sustainable and climate safe practices. This includes efforts by the World Wildlife Fund in the cities of Kanpur and Meerut, the Rockefeller Foundation in cities of Surat, Gorakhpur and Indore. The Clinton Foundation's work in Delhi and Mumbai, ICLEI-SA as a part of their Climate Roadmap Initiative has discussed and developed generic action plans for 41 cities and under the DFID's KUSP program developed a climate change roadmap for KMA region covering 41 ULBs. While these agencies are assisting the cities develop local action plans to address climate change there is a need to facilitate them and also disseminate learnings through a common source.

Source: ICLEI-SA

2. Objectives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2. Objectives

- To exploit the potential for mitigating climate change through reduction in demand for energy in the residential and commercial sectors by adopting various energy efficiency and conservation measures. With respect to adaptation, the aim would be to promote greater use of renewable sources and to reduce dependence on a single source. In formulating climate change strategies, mitigation efforts need to be balanced with those aimed at adaptation.

- To adopt a comprehensive approach in the management of water, municipal solid waste and waste water with a view to realize their full potential for energy generation, recycling and reuse, and composting.

- To address the issue of mitigating climate change by taking appropriate action with respect to the transport sector such as evolving integrated land use and transportation plans, achieving a modal shift from private to public mode of transportation, encouraging the use of non-motorised transport, improving fuel efficiency, and encouraging use of alternate fuels, etc. To evolve strategies for adaptation in terms of realignment and relocation, design standards and planning for roads, rail and other infrastructure to cope with warming and climate change.

- To reorient urban planning with a view to address climate change with respect to mitigation as well as adaptation and improve the responsiveness to disasters by strengthening community based disaster management and to provide better warning systems for extreme weather events.

- To facilitate adoption of technologies and research and development which lead to energy efficiency and reduction in emissions.

- To promote patterns of urban growth and sustainable urban development that help secure the fullest possible use of sustainable transport for moving freight, public transport, and encourage cycling and walking; thereby reducing the need to travel, especially by car.

Source: Sangath, an architect's studio, Ahmedabad

- To promote measures that improve resilience of infrastructure and human systems to cope with vulnerability consistent with social cohesion and inclusion.
- To conserve the natural resources that are the key to sustainability of human habitats like water, clean air, flora and fauna, recognising the integrated nature of human and other systems.
- To reflect the development needs and interests of communities that are especially vulnerable to climate change.
- To encourage competitiveness and technological innovation in mitigating and adapting to climate change.
- To develop a transparent, flexible, predictable, efficient and effective planning system that will produce the quality development needed to deliver sustainable development and secure sustainable communities. National policies and regional and local development plans provide the framework for planning for sustainable development and for that development to be managed effectively.
- To encourage community involvement in ensuring more sustainable patterns of development.
- To bring together key stakeholders at the central, state, district and local levels for a co-ordinated and comprehensive response to vulnerabilities arising out of climate change.
- To promote and strengthen efforts aimed at generating awareness related to climate change.

3. Strategies and Methodol

for Mitigation

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3. Strategies and Methodologies for Mitigation

Within the scope of the National Mission for Sustainable Habitat, mitigation measures would encompass promotion of energy efficiency in the residential and commercial sectors, capture of green house gases as part of water, wastewater and solid waste management, exploitation of mitigation potential in the area of urban transport and reorienting urban planning. Adaptation measures would include water efficient techniques, reducing leakages in the supply system, water recycling, rain water harvesting, designing of urban storm water management systems and urban planning measures, etc.

3.1 Promoting Efficiency in the Residential and Commercial Sectors

Though the current energy saving potential in new and existing buildings along with technology and policy options to implement energy efficiency in the building sector have been identified, it is important to discuss the implementation barriers in order to direct growth in the building sector towards sustainable development. The main barriers include knowledge gaps at several levels, issues related to enforcement and implementation, cost of green technology and lack of technology development. These barriers are discussed further and some of the solutions are identified below.

3.1.1 Knowledge Gap

A major barrier to green building development is lack of technical, economic and general knowledge related to green buildings. This knowledge gap exists not only among building designers and architects, but also among politicians, investors, and consumers. Beginning with the design side, there is lack of knowledge among designers regarding how best to incorporate building code requirements into building design. This is due to the novelty of building codes in India as well as the novelty of energy efficiency concepts. Also, since the byelaws vary from state to state and between climatic regions, it has been difficult to implement nationwide education programmes regarding byelaws. Further,

Source: Torrent Research Centre, Ahmedabad

the capability of designers and architects to perform energy simulations to quantify the potential savings from energy efficiency is also very limited. There are very few consultancy firms in India that can effectively perform the lighting and thermal analysis of buildings to evaluate their performance. Even where green buildings have been designed effectively, the building and construction industry is not prepared to apply these measures practically on site. The construction industry remains unaware of the environmental impacts of its operations.

There needs to be a demand for green buildings from investors, developers, and building occupants. This demand is currently low due to lack of awareness of the financial, social and health benefits of green buildings. Firstly, there is a lack of knowledge about green investment and returns on green buildings in the society. Much analysis has been performed to show that green buildings do not have to cost more initially, and even when initial design or construction costs are higher, the overall returns can be much higher due to efficiency of operations. Very few people have detailed knowledge about the Clean Development Mechanism (CDM) and the possibility to obtain additional funding for their projects through the CDM. Since consumers are also unaware of the comparative costs of future operation and maintenance of buildings, they do not take building efficiency into consideration when making purchasing decisions. Because of this, most builders in India do not consider the future costs of functioning the building during design and construction stage. Finally, in the actual building operation, there is a lack of awareness of the financial and environmental benefits of operating buildings efficiently. Most consumers are currently unaware about the availability of green products and BEE-labelled products. They are also unaware about the economic, environmental and health benefits of using such green and efficient products or appliances. Since there is a lack of awareness about the life cycle cost benefits of efficient products, the higher upfront cost prevents purchase. Despite the extent of the knowledge gap, there are many ways to address this barrier through effective outreach and education campaigns. Until consumers are more aware of the environmental and financial impacts of buildings, there will remain a limited demand for such designs. Yet designers and architects cannot create green buildings without improved education regarding the ways to incorporate and analyse code requirements and efficiency recommendations. Bridging the knowledge gap will require outreach and education for all sectors simultaneously.

Programmes that educate the engineering and architecture communities – both in universities and for current building professionals – about green design should be undertaken by the government, educational communities and companies. Educational programmes for green buildings should focus on regional solutions, because of the variations in climatic factors and the cultural differences in various parts of India.

Demonstration projects at key geographical locations of the country to test the effectiveness of code recommendations on real time projects would introduce the design and construction industry to best practices. These demonstration projects would also help introduce consumers and investors to the economic, health, environmental and aesthetic benefits of green buildings.

There should also be awareness programmes to motivate consumers and emphasise the importance of energy efficiency in buildings. These should address the economic benefits of green buildings, particularly reductions in operation costs from energy consumption. These could encourage consumers to look for green buildings in all new purchases or retrofit existing buildings. Awareness programmes should also focus on marketing and increasing labelling of life cycle costs and cost saving potential in efficient products. The economic benefits of BEE-labelled products should be disseminated further.

Some outreach programmes should focus on the next generation. One way to do so would be to retrofit energy efficient lighting and appliances into existing schools. Building greener and more efficient school buildings should also be a priority. Monitoring and

information collection in schools could demonstrate the benefits to the community. Students could also be educated through a voluntary shutdown of power. In metropolitan areas, social groups or schools could take the responsibility of organizing families to participate. Social events in community centers could be held for families that had shutdown power. Additionally, public offices should participate in such a way as to raise awareness about voluntary shutdowns.

Mandating certification of energy performance for all buildings rented and sold, would allow consumers to compare the energy performance of all buildings. Once the public is made aware of the costs of running a building before purchasing and operating the structure, builders will be held accountable and responsible for creating more efficient buildings.

A general approach to bridge the knowledge gap in all areas would be to create a dedicated website with information and relevant documents related to building efficiency codes, benefits of green buildings and technical recommendations for designing and constructing green buildings.

3.1.2 Enforcement and Implementation

While many strategies to encourage or mandate green buildings or energy efficiency have been introduced by the government as discussed in earlier sections of this report, these programmes still require greater implementation. There is a major gap between the political statements and actual action or changes in building design and construction.

While the government has taken initiatives to encourage integration of the ECBC with the NBC for uniform and larger adoption of the energy code, there is currently no concrete plan for implementation of the code, or monitoring and verification.

Additionally, though the Bureau of Energy Efficiency (BEE) has developed a strategy and implemented energy audits for important government buildings, there is a lack of policy to mandate the energy saving recommendations made during these audits. There is also a lack of such programmes for commercial buildings.

Incentives, both financial and symbolic, are crucial for wide spread adoption of these programmes. The following are some suggestions to increase the enforcement and implementation potential of the existing green building strategies.

3.1.3 Implementation and Incentives

Building byelaws should be written at the state and city levels to include an energy code incorporating aspects of the ECBC and green design best practices. The byelaws should include a combination of mandatory rules and voluntary guidelines. In particular, meeting minimum energy performance standards should be mandatory for new buildings, but the methods used to achieve these reductions should be voluntary. This would greatly increase energy efficiency but continue to allow for flexibility in design. Significant work has been done in identifying green parameters through initiatives such as GRIHA which need to be factored in.

Since existing policies related to building byelaws are complex and divided between many government departments at the state and federal levels, there is a need to simplify and coordinate building byelaws and building policy. It should be integrated between different government departments at both the union and state levels, to ensure that separate policies do not contradict or hinder the implementation of others.

The government should attract real estate builders' participation and partnership in creating regulation and promoting efficient buildings. Engaging the stakeholders while developing policy will aid in education and implementation.

The capacity of the state-level and city-level bodies, which would be responsible for the final implementation of the energy code, should also be strengthened.

3.1.4 Building Performance Certification and Rating Systems

In order to encourage the adoption of voluntary energy efficiency measures and the design of buildings that exceed minimum performance standards,

certification of energy performance and building rating systems should be put into place to recognize higher performance buildings.

A programme of benchmarking and certification of buildings at the time of rental and sale should be put into place. As in many international examples, certification should be mandatory for buildings beyond a certain size. A simple building certification system could rely on a quantitative assessment of total energy consumption over the year, per square metre. If a building receives a score below a benchmarked level, it should not be possible to sell or rent that structure. This would encourage renovations and efficient new construction. Since the building would be re-evaluated after each rental and sale, each owner and resident would have an incentive to green the building.

Such certification could also be accompanied by mandatory energy audits. The BEE has already made energy audits mandatory for many Government buildings. It has planned to mandate energy audits for all commercial buildings above a certain threshold of connected load. It remains important to develop mechanisms to ensure that the recommendations of the audit are implemented in a stipulated time. Auditing combined with certification of energy performance could work in tandem to ensure implementation of energy efficient systems.

These performance ratings should be harmonized across India, while incorporating regional climatic and cultural differences, as has been successful in Europe.

Building ratings should be voluntary, but the Government should increase recognition and awards for architects who receive high building ratings. Increased marketing of the building rating system is required, so that the rating scheme will become more well-known and more frequently used by consumers to compare performance.

Source: American Institute of Indian Studies, Gurgaon

3.1.5 Financial Incentives

When energy efficiency measures and codes are put into place, it is important to ensure that developers and architects will be able to fund and finance these efficient projects. A policy directive to public sector banks could mandate that they would only fund buildings that are code compliant or those that reach a set level of energy performance based on building ratings. Government controlled financial institutions could also be encouraged to fund projects that utilize green-labelled products.

Furthermore, soft construction loans could be offered for green buildings, with more efficient buildings attracting lower interest rates. Corporate banks could also be encouraged to incorporate these soft green construction loans as part of their corporate social responsibility programmes.

Many stakeholders identified tax incentives as a primary method for encouraging green building adoption and that could be incorporated with a programme of tax penalties for inefficient buildings. These tax incentives and penalties could include tax rebates (either for residents or developers), corporate tax reductions and penalties for inefficiency to phase out old buildings.

Many international cities have had success in implementing tax breaks for green buildings based on efficiency; platinum buildings receive an even bigger tax break than silver buildings. While the developer receives the tax break, this should be passed on to the user because of lower construction costs. Such an incentive can be seen as “priming the system” for green development. As long as the occupants do actually benefit from lower costs, this method would increase their demand.

Another option would be to implement a housing or property tax rebate of between 5 to 10 per cent based on energy performance. Again, more efficient buildings would receive larger rebates. There is some concern regarding the split incentives in such a model. While builders and developers will pay the initial cost of green design and construction, only the residents will receive the benefits. However, since building occupants and owners are best suited to push developers to make green buildings, any benefits that they receive will increase their demand for green buildings and force developers to build green.

An additional financial incentive for green buildings would be to adjust power tariffs. Consumers could be offered a lower power tariff based on the efficiency of

Source: Torrent Research Centre, Ahmedabad

their buildings. A more efficient building (measured as electricity use per square metre) would pay less per kilowatt-hour than a typical lower-performance building. This would provide increased incentives for efficiency, as more efficient homes would already be paying less on their electricity bills just by using less energy. Such schemes already exist in some cities that reward users for installation and use of solar water heating. In Rajasthan, users with solar water heating systems receive a rebate of 5 paise per kwh, while in Karnataka similar rebates are 15 paise per kwh and 40 paise per kwh in West Bengal.

Tariffs could also be adjusted by implementing "Time-of-Day Power Tariffs" which would help utilities to reduce the need for increased energy supply. Time-of-day tariffs have been shown to reduce demand at peak hours, because costs would be higher at those times. This would provide greater incentives for companies to utilize energy storage and to reduce peak demand. To implement this, the partnership of energy companies would be necessary, and meters that would differentiate between times of day would also need to be installed.

While implementing financial incentives such as purchase preferences, policy directives to banks, soft construction loans, tax incentives, property tax, rebates, subsidized power tariffs, etc. it should be ensured that they are economically justified.

While the government has been active in encouraging CDM projects throughout India, greater focus should be placed on encouraging CDM certification for energy efficiency programmes and making developers aware of the financial benefits of CDM certification. One such programme would be a programmatic CDM for BEE–labelled products, where the manufacturers could bundle and sell the products. The Government could also institute utility-linked DSM programmes and allow the utilities to bundle efficiency measures for CDM credit as well.

3.1.6 Technology Development and Lowering Cost

In order for any of the implementation strategies to be successful, green building materials, equipment and systems need to be available and reasonably priced in all parts of India. This will require significant investment in research for suitable technologies, as well as government programmes to push the market development further and faster.

Since energy codes are relatively new in India, green products and services including insulation, Compact Flourescent Lamps (CFL) and T5 lamps, efficient glass, and efficient HVAC systems, required by buildings to comply with the code requirements are not readily and abundantly available or competitively priced. Market monopoly by a handful of manufacturers of energy efficient products has exacerbated the problem, resulting in a non-competitive market for green products.

Government, research universities and private developers need to identify R&D options for investment to arrive at innovative low-cost technology options for arriving at sustainable development in the building sector.

Large private investors should be encouraged to focus on green growth and to develop local production of efficient materials. This encouragement could occur through government commitments for purchasing green products (thus ensuring a market) or through reduced business taxes for manufacturers of green products.

The Government should have a purchasing preference policy for green equipment. If the Government is a significant product consumer, then the manufacturer will reconfigure the assembly line in order to meet the Government demand for green equipment.

The Government has mandated the use of solar water heating in many applications because such systems have fairly rapid payback periods even at current costs. Such programmes will greatly increase

the purchase of such systems, further bringing down the cost and payback time. Similar support should be given to CFLs. If the government mandates the use of CFLs, as Australia has done, the market will expand rapidly, driving down the cost and allowing the CFL to dominate the market for all levels of society in rural as well as urban areas.

Life cycle cost analysis for materials and systems should be used and marketed. Evaluating products based on the full cost of their production and operation makes the benefits of green products and the high cost of inefficiency much more apparent.

Additionally, while developing lower cost technology and encouraging market expansion to drive down costs, the government can also implement financial incentives to overcome the short-term cost barriers of green technology.

An initial boost to promotion of energy efficient products and services is required, and could take the form of reduced excise taxes or reduced VAT for efficient products.

Overcoming these major barriers is a significant task and will require the cooperation and coordination of many Government bodies as well as corporate interests and research groups. However, if green-building policies can be implemented and provided with appropriate incentives, major improvements can be made to the existing and new building stock. As mentioned initially, the implementation of existing energy efficiency measures could achieve 30 per cent energy savings in new residential buildings and 40 per cent energy savings in new commercial buildings. These savings could be even larger as research and development related to energy efficient technologies improve.

The methods for building more efficient buildings already exist and have proven to be successful. It is up to all stakeholders – from business, government, civil society, and consumer sectors – to join together for the implementation and wider adoption of these methods. To summarize, these measures include:

- **Creating of educational programmes for students and professional architects, engineers and urban planners on green buildings, focusing on regional solutions** - Courses with various college curriculum for students along with the Quality Improvement Programme (QIP) at the faculty level should be integrated. These could be offered through the various Regional Engineering Colleges (RECs), National Institutes of Technology (NIT), Councils of Architecture, Associations of Engineers, Institutes of Town Planners, etc. The courses could be developed in association with All India Council for Technical Education (AICTE), Indira Gandhi National Open University (IGNOU), TERI University, etc.

- **Building of green demonstration projects of best practices in key locations across India** - Important public buildings in the various climatic zones of the country could be designed as green buildings and serve as demonstration projects for best practices in green buildings. The carbon footprints of such projects could be monitored and information shared for a larger adoption of the green building design principles.

- **Implementation of consumer awareness programmes focusing on economic and environmental benefits from energy efficiency and green buildings** - The awareness programmes could be launched through radio, television, hoardings and print media with national newspapers (for example, the TEACH India and LEAD India programmes launched by the Times of India).

- **Increasing appliance labelling and marketing for BEE-labelled products, including the life-cycle cost benefits from efficient products** - Publishing and projecting the advantages (including life-cycle cost benefits) of using labelled appliances and financial incentives to manufacturers of labelled appliances. Launch awareness campaigns to increase demand for such appliances.

- **Outreaching young students through school efficiency programmes, energy usage monitoring and voluntary shutdowns** - Awareness programmes could be introduced as summer projects and classroom discussions.

- **Creating a dedicated website with information on building codes, green building benefits, and technical advice** - A Sustainable Habitats Mission website could host the information with regular interaction and blogs from technical experts in the area. Existing information on financial incentives, codes, etc. could be compiled for easy reference by various stakeholders.

- **Writing building byelaws at the national, state and city levels to include minimum energy performance standards and higher performance guidelines** - A legal implementation and monitoring process should be adopted by national, state and city level bodies which could be defined in order to minimise gaps in implementation. The emphasis will be on performance standards and not on particular technologies. Encouragement of solar water heating can also be built into the byelaws.

- **Engaging stakeholders in policy creation** - Hold open days for various builders' associations, property developers, material and product manufacturers in addition to technical experts from various regions to present their views that would contribute towards policy creation.

- **Increasing capacity of city-level and state-level bodies for code implementation and enforcement** - Hold training programmes for evaluators, officials of Economic Advisory Councils (EACs) and Student Environmental action coalitions (SEACs) on the ECBC, environmental clearance process, etc.

Source: ITC Centre, Gurgaon

3. Strategies and Methodologies for Mitigation

- Mandating certification of energy performance for all buildings, rented or sold.
- Increasing BEE energy auditing and develop monitoring mechanisms to ensure recommendations are implemented.
- **Undertaking outreach and marketing on rating systems** - Mandate rating for development of projects of certain size. It could facilitate a single point system for study of carbon footprint, roof top solar programmes and impact land use planning at zonal level.
- Increasing recognition and awards for high rated buildings.
- **Providing financial incentives** - Offer softer loans for green buildings from public sector banks, encourage private banks to do the same. It should adopt a purchase preference policy for green equipment to increase market demand and guarantee investors a stable market for green products, offer tax incentives to developers, owners, or occupants of efficient buildings, reduce power tariffs or offer rebates on electricity bills for high performance buildings, and implement Time-of-Day metering and billing to reduce peak demand. Further, the government should bundle CDM building efficiency programmes and increase awareness of potential for CDM benefits, encourage investment in green technology development through marketing and reduced taxation for green product manufacturers and reduce excise taxes or VAT of green products, systems or materials.
- **Increasing R&D funding for research to create higher efficiency and lower cost green products -** The R&D needs should focus on the development of energy-efficient products pertaining to energy-efficient buildings and building components/ systems, development of energy efficient windows, development of simulation software to predict the energy used in buildings and building integrated renewable energy systems, etc.
- **Studying impact of roof-top solar programme** and continue expansion of mandatory solar water- heating systems and consider expansion to other green products especially (CFLs).

- **Incentivizing efficient lighting systems**, particularly street lighting.

- **Developing technologies for recycling of construction waste.**

- **Developing energy efficient construction technologies for housing for EWS/LIG categories.**

- **Developing national standards for energy efficient construction** on priority basis in collaboration with Burean of Indian Standards (BIS). Harmonisation of ECBC with NBC and Environmental Impact Assessment Guidelines (EIAG) of the MoEF also needs to be done.

- **Making national network of building centres** to become key institutions for the propagation of energy efficient building materials and technology. Central / state government agencies such as Central Public Works Department and State Public Works Department, Delhi Development Authority, etc. must be mandated to integrate energy efficiency measures in respect of building activity taken up by them.

3.2 Water Supply, Wastewater and Solid Waste Management

The potential for mitigation in the water supply sector can be realized through a reduced need for pumping which in turn would reduce the demand for energy, reduction of Non-Revenue Water (NRW), energy audit of all the water utilities, rationalization of water tariff to reduce wasteful use of water, minimization of leakages, metering of all water taps and water audit, etc.

In the wastewater sector, GHG mitigation measures could include full collection, conveyance and treatment of wastewater, reuse and recycling of treated effluent and gas recovery from sludge as well as use of treated wastewater for artificial recharge of aquifers to improve the ground water potential. At the household level separation of black water and grey water needs to be promoted to enable recycling of the former for fertilizer and the latter for toilets. Designs will have to be developed for this purpose. It should be ensured that systems for the management of human excreta incorporate conservation principles. Low-water use toilets (3-5 litre) and ecological sanitation approaches (including ecological toilets), where nutrients are safely recycled into productive agriculture can be promoted. Replacement of wastewater pumping equipment to improve the system efficiency through energy saving should be considered. Decentralized waste water management systems for community, housing complexes, commercial buildings need to be introduced for efficient wastewater management. Institutional capacity of all (ULBs) should be strengthened for effective implementation and O&M of sewerage system.

In the solid waste management sector, it should be recognized that urban waste, with a significant proportion of organic constituents, has emerged as a resource for the generation of energy in an environmentally sustainable manner. In developed countries, environmental concerns rather than energy recovery is the prime motivator for waste-to-energy facilities, which help in treating and disposing of wastes. Energy in the form of biogas, heat or power is seen as a bonus which improves the viability of such projects. While biomethanation, refuse derived fuel and incineration are the most common technologies, pyrolysis and gasification are also emerging as preferred options. A common feature in most developed countries is that the entire waste management system is being handled as a profitable venture by private industry or NGOS with tipping fee for treatment of waste being one of the major revenue streams. The major benefits of recovery of energy from urban wastes is to bring about reduction in the quantity of waste by 60 per cent to 90 per cent; reduction in demand for land as well as cost for transportation of wastes to far-away landfill sites; and net reduction in environmental pollution besides generation of substantial quantity of energy. The treatment and processing of waste being generated in Indian cities requires a mix of technologies

as composting alone cannot be the favoured option. With a view to facilitate use of compost as manure, composting either through biomethanation or aerobic processes should be considered only in case of source segregated biodegradable organic fraction and not for the mixed waste. Besides, requirement of land can also be an issue in the selection of technological options for waste processing and treatment. Some of the key areas for R&D in waste-to-energy are the development of processes/equipments for separation of different components of MSW for energy recovery, biomethanation of mix of biodegradable solid wastes from various streams, gasification of MSW for energy recovery, low cost emission control equipment for Waste To Energy (WTE) conversion technologies. The potential of energy recovery from MSW over the next 10 years is expected to increase to over 5000 MW.

Lack of local capital is a key constraint for waste management which must be addressed. Inadequate expertise with local bodies on sustainable technologies like a waste recovery project is also an important barrier which needs immediate attention. Uncontrolled and informal disposal should be regulated. Regional solid waste management facilities should be encouraged. In case of existing landfills, bioremediation of waste is recommended with a view to reclaim the land and convert organic waste into useful products which will result in elimination of GHG emission.

All ULBs should comply with the implementation of MSW (management & handling) rules, 2000 notified by the MoEF. Improved allocation of funds for capital investment and for further operation and maintenance by ULBs may be ensured for efficient SWM systems. Landfill sites, often situated in rural areas adjacent to urban areas, need to be developed scientifically. It should be ensured that areas identified for drainages are not converted to landfill sites since the former plays a crucial role in retaining surface water, maintaining soil moisture, etc.

3.3 Urban Transport

3.3.1 Strengthening of Public Transport System through a Combination of Promotional, Regulatory and Fiscal Measures

Promotional measures could include encouraging private participation in the provision of transport services on remunerative as well as non-remunerative routes, greater functional autonomy to state transport undertakings, a quantum jump in the quality of city buses and city bus services by introducing sleek, ergonomically designed buses with wider doors and windows, level boarding and alighting, comfortable seating and suspension, passenger information system, GPS enabled with electronic fare collection, etc; introduction of state of the art ITS enabled modern buses on PPP mode, reserving of one lane out of three lanes or more for high capacity bus systems/ public transport and high occupancy vehicles carrying six people or more.Urban transport demand is characterized by patterned travel and non-patterned travel. Even for patterned travel, patterns are complex. No public authority can acquire complete information about these demand patterns whereas private sources would have a serious pecuniary interest in obtaining such information. A realignment of policy on this basis i.e. public provision for trunk routes and supplementary private provision regulated in terms of safety, omissions and road space can be explored.

Fiscal measures could include charging of fee for using congested parts of a city, levying of high parking fees, increasing vehicle registration charges and increasing fuel tax, pollution-based annual road tax (where low-powered, low-emission, hybrid and newer vehicles pay less road tax than the high-powered, higher-emission and poorly maintained old vehicles), etc. Such fiscal measures can help reduce private vehicle operation leading to reduced congestion and air pollution. Some initiatives in this direction have already been taken by the Ministry of Urban Development at the centre by advising the states to consider levying an additional

registration fee on cars and two-wheelers so that the additional cess on vehicles could be set aside in a dedicated transport fund and used for financing public transport at the state as well at the city level. In addition, the Ministry has suggested that the states levy additional sales tax on vehicles besides imposing cess on renewal of permits of commercial vehicles as also on the renewal fee on driving licences and vehicle registration. If all the States were to agree to the suggestion, the Ministry's calculations estimate an annual mop up of Rs. 25,000 crore through the dedicated taxes that could solve the hardship which the urban commuters face across India. To avail central assistance for transport projects under the JNNURM, the MoUD has requested the state governments to submit action taken reports on NUTP which underlines the need for setting up a dedicated transport fund for revamping the public transport system. A World Bank estimate shows that the total tax burden per vehicle per km is 2.3 times higher for public transport buses than cars in Indian cities which needs to be rationalised and harmonised with a view to improve the public transport system. Besides, the existing tax structure for commercial vehicles shows wide variations across states due to different classification of principles for the taxation of vehicles, variations in the application of lifetime and annual tax rates to vehicle categories, use of specific and ad valorem rates and the multiplicity of rates. There is a need to study the economic implications of rationalization/harmonization of the tax structure across the country in terms of its impact on the reduction of transaction costs. In addition, the cost of modern buses has to be brought down through reduction in tax and duties so as to make their introduction financially viable. Presently the cost of various central taxes and duties and also state taxes account for 30 per cent to 35 per cent of the total cost for the modern buses.

Control measures include physical restrictions on the use of personal vehicles in some corridors, limiting the availability of parking space in city centres, using parking fee as a Travel Demand Management (TDM) measure, banning of parking on arterial roads, having

a parking policy for the city, limiting the availability of road space for personal vehicles, restricting ownership of vehicles to mitigate emissions and making owning of parking space compulsory to acquire a new private vehicle. A good parking policy with parking charges reflecting the economic cost of land use of such parking, graded scale of parking fee, differential rate of parking during peak hours and non peak hours and differential rates for street parking (which should be high), etc. can be used as not only an effective measure of controlling the demand for personal vehicle uses, but also for generating resources for a dedicated urban transport fund which can be used to provide public transport. A good example of control measures is the congestion-charge operating in Singapore and more recently, in London, as well as the quota-based certificate of entitlement scheme for restricting vehicle ownership in Singapore. Both measures are enforced to change the preferences of people and promote public transport systems.

Besides, with a view to rid the sector of unscrupulous practices and to improve the quality of service, a prerequisite is strict enforcement of rules. For this, specially designated regulatory bodies need to be set up, with the authority to lay down minimum basic service standards for the industry, impose heavy fines, suspend or even cancel licenses and launch and vigorously pursue prosecutions for accidents. Only then will it be possible to attract large players and enhance the attractiveness of investment in this industry.

3.3.2 Reducing the Fuel Consumed per Passenger Travel through Modal Shift

Significant GHG mitigation can be achieved through modal shift by providing all arterial roads more than 25 m right of way to have minimum of 2.5 m pedestrian path (with trees) and proper street furniture and 2.5 m bicycle path preferably in each direction as a mandatory measure. Where it is not possible to provide a dedicated cycle path because of right of way being narrow, traffic calming measures to reduce the speed of traffic to 30 kmph need to be adopted. Without properly engineered pedestrian path and bicycle path, the roads are unsafe for walking and bicycling and safety of walking and bicycling needs to be ensured.

3.3.3 Improving Access to Goods and Services through an Integrated Urban Plan

The greatest GHG mitigation can be achieved through linking spatial planning with transportation planning to improve access to goods and services while minimizing the need to travel through charging the cost of externalities such as congestion, pollution, climate change, public infrastructure and reducing subsidies to private vehicles. Urban sprawl is not energy efficient or conducive to the provision of sustainable public transport system. As such, major transport axes need to be identified and the development should take place along pre-defined major transport axes.

3.3.4 Integrating Inter-City Road Passenger Transport with Urban Transport Systems

Long-distance passenger travel needs to be closely integrated into the urban environment, facilitating fast traveller-friendly mass-transport access to well located terminals and airports. Carefully planned highway system improvements are required to reduce travel times for goods and passengers while improving road safety, congestion, fuel consumption and emissions.

3.3.5 Shifting from Fossil Fuels to Natural Gas, Renewable and Alternate Fuels

With the abundant availability of renewable sources like biomass across the country, India has a vast potential to replace the current usage of fossil fuels in various commercial vehicles. Changing to fuels that have a lower carbon footprint in sufficient quantities would have a major impact on GHG emissions from on the road transport.

3.3.6 Establishing and Implementing Fuel Efficiency Standards for New as well as Existing Vehicles

Improving the maintenance condition of in-use vehicles (in terms of quality and frequency) is important. Under the Energy Conservation Act 2001, regulations are to be made for the following three complimentary strategies:

a. Fuel economy standards to set benchmarks for efficient engine technology.

b. Fuel economy labelling of vehicles to help increase consumers' demand for fuel efficient vehicles.

c. Fiscal incentives to be linked to fuel economy of the vehicles.

Energy efficiency standards need be implemented throughout India for all forms of motorized transport for which a time frame for the finalization of the vehicle fuel efficiency standards and its implementation should be set.

3.3.7 Facilitating R&D Activities

Automobile industry and R&D organizations should be encouraged to develop and commercialize new products, processes and technologies which have the potential to contribute substantially to energy conservation and protection of the environment.

3.3.8 Discouraging Diesel Propelled Personal Vehicles

There has been a considerable increase in diesel vehicles as passenger vehicles and some of them are used as a personal mode of transport, it is important to ensure that these vehicles meet the same performance standards as other vehicles. This has increased pollution levels in some cities. There is a need to restrict the manufacture of these vehicles and to discourage their use as personal transport.

3.3.9 Exploring Technological Options

Measures such as reduction in vehicle loads by using light weight materials; improving aerodynamics; reducing roll resistance of the tyres on the road; using mobile air-conditioning systems with new refrigerants such as HFC152a, improving drive train efficiency; adopting advanced direct injecting gasoline engines that can yield about 35 per cent greater fuel economy than conventional gasoline engines. Improvements in transmissions and frictional losses in the engines, introducing variable valve timings and hybrid drive trains also need to be undertaken.

3.3.10 Creating Public Awareness

The Government should launch intensive awareness specially on health and well being. The campaigns should seek peoople's support for initiatives like greater use of public transport and non motorized vehicles, proper maintenance of their vehicles and adopting "Green Travel Habits". Emphasis should be laid on bringing about such awareness amongst children through inputs in their school curricula, organizing various painting and essay competitions, etc. Use of public transport should be encouraged through instruments such as tax rates, parking policy, etc.

3.3.11 Multimodal Integration

To provide for seamless connectivity over a widespread network of various public transport modes, the government should insist on setting up unified Metropolitan Transport Authorities (UMTA) in all one million plus cities. This will facilitate more coordinated planning and implementation of urban transport programmes and projects as well as an integrated management of urban transport systems.

3.3.12 Comprehensive Mobility Planning and Management using Intelligent Transport Systems

The advances in information technology and electronics have to be used for setting up of Traffic Information Management Control Centers in all one million plus cities for better traffic management, thereby reducing the problem of congestion and idling of vehicles.

3.1.13 Central Financial Support

There is a need for continuous engagement by the Central Government in this sector by providing central financial assistance on a reform based agenda which may be integrated with JNNURM. In addition to JNNURM, there is also a need to create a dedicated central urban transport fund.

3.3.14 Service Level Benchmarks

The Ministry of Urban Development brought out Service Level Benchmarking covering public transport facilities, pedestrian infrastructure facilities, Non Motorized Transport (NMT) facilities, level of Usage of Intelligent Transport System (ITS) facilities, travel speed (Motorized and Mass transit) along major corridors, availability of Parking Spaces, road safety, pollution levels, Integrated Land Use Transport System, financial sustainability of public transport by bus. Details of the same are given in Annexure G.

3.4 Urban Planning

3.4.1 National Level Strategies

At the national level it is imperative to have a National Urban Policy, (NUP) incorporating incentives and disincentives that encourage and support sustainable habitat. Urban Development Plan Formulation and Implementation (UDPFI) guidelines formulated by MoUD would be a useful reference in this regard. It needs to be ensured that plans and policies are based on thorough analysis and a scientific basis. Outcome of the analysis should facilitate policy makers to take appropriate decisions. As envisaged in the National Urban Housing and Habitat Policy (NUHP) 2007, the states should prepare dynamic plans with provision for review every five years. Climate change concerns should be appreciated in the planning process in a manner that optimises development objectives.

3.4.2 Regional Level Strategies

Planners should take into account specific effects of climate change while planning for a district/region. Some issues need to be tackled at the regional level such as conservation and sustainable development of natural resources.

The needs and broader interests of the community to secure a better quality of life for the community as a whole need to be ensured through plans that are drawn up for a longer time scale, and need not focus

only on short term gains. Planning authorities should consider both long term and short term policies.

The planning process should not impose disproportionate costs in terms of environmental and social impacts, or by unnecessarily constraining otherwise beneficial economic or social development. It should also take into account the resources likely to be available for implementation and the costs likely to be incurred.

3.4.3 City Level Strategies

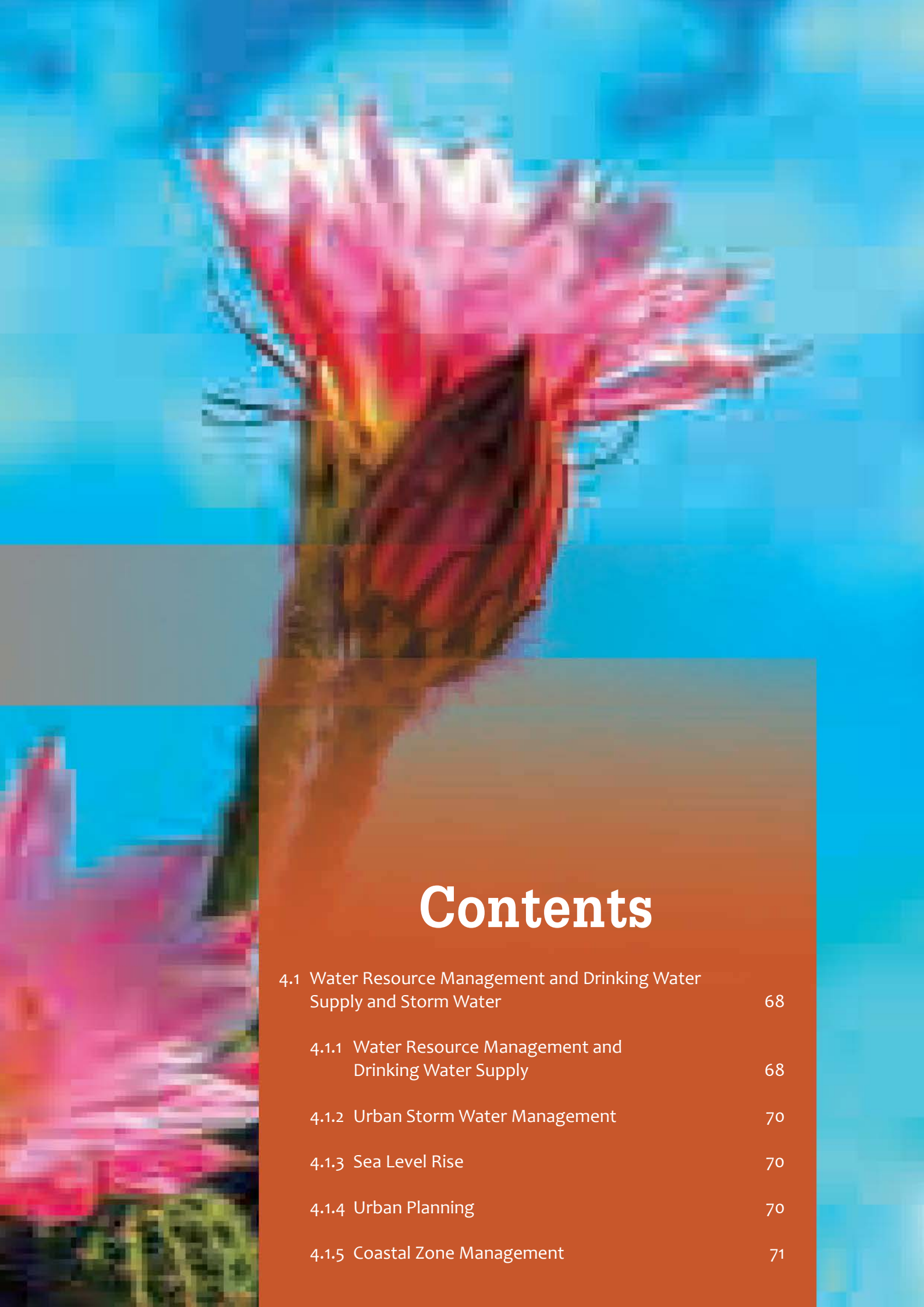
The local role includes enforcing policies and regulations (e.g. restricting urban sprawl). It is the local government which must define the future growth strategies through urban planning. Preparation of master plan and zonal plan should be made mandatory for all urban settlements by considering sustainable development norms.

Land use integrated with transport system in cities should help in reducing the trip length. Greater use of the Public Transport System and walking and cycling should be encouraged. Building byelaws/building regulations should focus on environmental standards that contribute to sustainability and simultaneously address GHG mitigation. Some of the specific strategies could include:

- Increasing green cover as part of the urban and regional planning exercise.
- Reduce the heat island effect.
- Re-development/redensification of existing urban habitat. Mixed land use, integrated and shared social space, and multiple transport options should be considered and implemented. This would minimize infrastructure requirements, energy use in intra-city travel as well as the diversion of agricultural land to urban use. This model would also ensure greater living space per citizen or alternately greater public space.
- Development of green belts as envisaged in the National Urban Housing and Habitat Policy 2007.
- Environmental impact assessment of master plans, and other mega urban infrastructure projects.
- Promoting mixed use zones as appropriate to reduce travel,
- Initiating urban renewal programmes.
- Responsive urban design to climate change and incentivisation.

Poverty reduction is the key for sustainable urban development. As long as there is poverty, environment will not be seen as a priority. People have no choice but to use the cheapest energy options, which may be environmentally harmful (e.g. charcoal). The major concern is poverty itself and its reduction will help in mitigation of climate change. It is therefore imperative for all the state governments to work on poverty reduction mechanisms by partnering with one another to develop new means of tackling the poverty reduction issue.

4. Adaptation



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4. Adaptation

4.1 Water Resource Management: Drinking Water Supply and Storm Water

4.1.1 Water Resource Management and Drinking Water Supply

As per the data compiled by the Central Public Health and Environmental Engineering Organisation (CPHEEO), only 91 per cent of the urban population is covered by drinking water supply facilities at present. Climate change is likely to aggravate this situation.

Due to continued population growth, contamination of both surface and ground water, uneven distribution of water resources and periodic droughts, there is a need to explore new sources of water. Water reclamation, recycling and reuse represent significant components of the hydrological cycle in urban; industrial and agricultural uses. The reclaimed water can be used for non-potable uses such as toilet flushing, construction, ground water recharge, recreation, horticulture, etc. which will result in conservation of fresh water. Sequential use of water between domestic and irrigation sectors needs to be attempted. In sequential use, while pathogen concentrations are reduced, the nutrient content of wastes as well as water are available to agriculture. This could be one of the policy objectives. In water-scarce regions, water supply may take place by desalination of saline water. Frequent droughts could exacerbate problems and there is a need for alternate supplies during drought. Further, water needs to be used more efficiently across all sectors. Measures to be taken include water efficient irrigation techniques and water-saving appliances, reduced leakage in supply systems, and water recycling and rain water harvesting. Low-water use technologies like eco-san also reduce demand for water and could provide a sustainable alternative in areas with a very high water table or areas with acute water scarcity where conventional technologies do not work efficiently.

Ecological Sanitation–ECOSAN

Ecological Sanitation is a new paradigm in sanitation that recognises human excreta and water from households not as waste but as resources that can be recovered, treated where necessary and safely used again. Ecosanitation comprises three distinct components to collect urine, excreta and wash water separately unlike the conventional water toilets wherein all get mixed up complicating the system. The Ecosan toilet presents a paradigm change from purely disposal oriented to reuse oriented sanitation which destroys pathogens at site and excreta is composted onsite and harvested as manure. The Ecosan programme aims to resolve the increasingly pressing problems related to global water and sanitation crisis and helps to achieve the Millennium Development Goals (MDG) of the United Nations.

The Commissionerate of Town Panchayats, Tamil Nadu has created examples of ''smart practice'' in sanitation for the ''International Year of Sanitation 2008'' by networking with three Sanitation Specialist NGOs (Scope, Trichy; Eco Solutions, Trivandram and Ecosan Services Foundation, Pune) to construct Ecosan model toilets in Mamallapuram- a special grade town panchayat in Tamil Nadu for use in households, schools and anganwadis.

There is a need to devise systems, drawings and standards for roof water harvesting structures with filters directly connected to households or community sumps or with overflows which are led to recharge structures so that both direct collection of water and recharge of ground water can be taken up simultaneously as a part of the design of buildings. Such standards besides being adopted in the National Building Code (NBC) should give a range of options which may be suitable for all types of houses and buildings. A specific design should be encouraged for all newly developed townships/peripheral urban areas which are in the process of designing systems. There is a need to observe caution in preventing surface water or other pollutants from polluting ground water aquifers through recharge mechanisms. A separate manual suggesting different recharge mechanisms for different soil types can be prepared. Due precautions

such as in-built filtering may be considered to prevent contamination of ground water. In addition water harvesting through check dams needs to be given importance. Changes in behavior will be required and can be supported through adequate water pricing. While considering various options for augmentation, it needs to be ensured that sharing of water resources should be equitable, sustainable and just between rural and urban areas. The box below illustrates innovative practices in the management of water resources.

Yet another strategy that can be attempted is to achieve synergies between infrastructure construction and enhancing surface water recharge and municipal inerts waste disposal. Linear infrastructure such as highways and railways, typically use large quantites of earth or inerts for construction of embankments.

developed on the basis of which such choices can be made. Water management and the implementation of water policy needs to be capable of responding to unexpected developments caused by climate change. Strategies for adaptation need to be developed and implemented in a flexible way in order to take into account further progress of scientific knowledge. Local and regional authorities will need more practical guidance on how to cope with the local and regional impacts of climate change on water.

Investments that appear to be cost-effective under current conditions may become economically and ecologically unviable when considering climatic predictions and their impacts on water resources. Appropriate financing mechanisms have to be

Recharging of Wells and Tube Wells - Saurashtra Lok Manch

In the parched region of Saurashtra, Gujarat, the Saurashtra Lok Manch, a voluntary organisation, has recharged more than 300,000 wells and tubewells. The organisation has been trying to create water literacy among the masses and to motivate them to actively take up recharging of wells. Recharging wells is easy, inexpensive and requires a very simple technology. Water from a nearby rivulet or drain is led through a plastic pipe to a pit, where it gets filtered through layers of sand powder, uncrushed sand and crushed stone. A pipe then takes the water to the well.

Traditionally the earth has been extracted from the Right of Way (ROW). A policy of procuring earth from outside the ROW from local suppliers, or of municipal inerts from the municipalities, through competitive bidding without distinguishing between earth and inerts will encourage extraction from surface water storage bodies that require desilting, or the creation of new ones, as well as the reuse of construction debris, flash, and steel plant slag.

Due to the sea level rise, there may be chances of salt water intrusion in the ground water systems. There is a need for hydrological barriers and alternative sources. During higher temperatures, there may be chance of poorer influent quality of raw water due to increased concentration of temperature dependent pollutants (microbes) resulting in increased treatment cost to maintain the quality of water for drinking.

It may be necessary to define priority water uses and to find appropriate ways to implement prioritization. Choices may have to be made concerning the allocation of water resources, and criteria need to be

developed to cope with the costs that will occur from adaptation. For this, information on the share of costs and benefits of proposed measures and on the scale, time frame and the cost effectiveness of investments needed for a given region is required.

At present, district wise/region wise/basin wise ground water data is available with the Central Ground Water Board, which alone may not be sufficient to formulate drinking water supply schemes for cities and towns. Therefore, it is necessary to have town wise/city wise groundwater data in respect of availability and quality of water. Piped water supply should be provided in all 5161 towns with reliable sources of supply in order to cover 100 per cent of the population with water supply facilities. Scientific results and research will play a crucial role in enabling and facilitating the adaptation process. Through research, more detailed information will become available on the impacts of climate change on the water cycle. Research will also contribute to the identification of the most adequate adaptation measures and strategies.

4.1.2 Urban Storm Water Management

Since extreme precipitation (similar to the extreme 2005 Mumbai, the 2005 and 2006 Gujarat flood events) is expected to show a substantial increase over a large area over the west coast and in Central India, it will require a significant revision of urban planning practices across cities in the flood affected regions and neighborhood scales to integrate flood and climate change mitigation and adaptation measures into day-to-day urban development and service delivery activities. ULBs have the main responsibility for planning, implementation and managing storm water management systems that can diminish risks of flooding from the direct and indirect impact of climate change through provision of infrastructure and services, disaster preparedness and the planning and regulatory framework. Due to the higher proportion of precipitation in more intense events, there is a need to increase the margin of design safety of buildings, bridges and flyovers to enhance the hydraulic capacity of the sections which will result in additional investments. There is a need for embankment of low lying areas, especially for coastal cities, better disaster warning systems and construction of shelters.

More investment is required to design the urban storm-water management system than the current level of funding. An appropriate financing mechanism has to be developed to cope with the costs that will occur from adaptation. Adequate technical guidelines in the form of a manual on SWM needs to be formulated for the planning and implementation of the SWM system. Institutions need to be strengthened to carry out the adaptation measures due to climate change.

4.1.3 Sea Level Rise

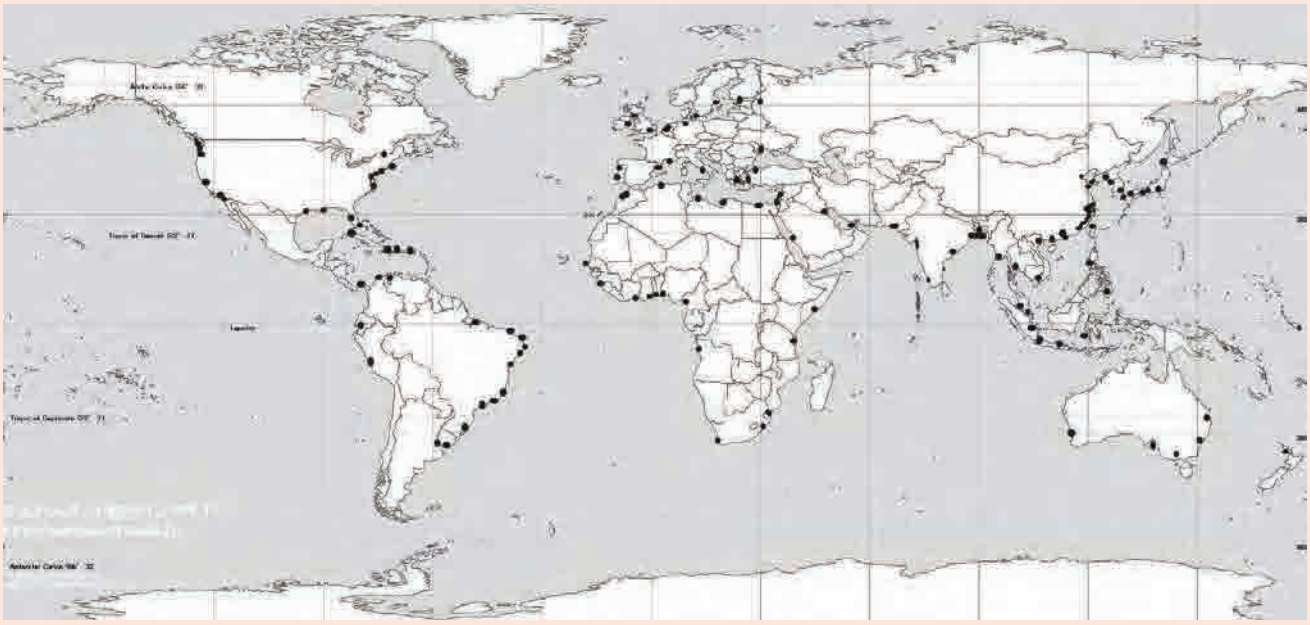
Map showing locations in various countries that have been affected by Sea-Level Rise.

4.1.4 Urban Planning

Low rise and higher density is a way to improve the overall energy efficiency of urban areas. General urban consolidation and more intensive mixed use of local activity centres close to public transport nodes provide opportunities to lower carbon emissions.

The planning of housing areas can significantly affect living comfort during heat waves. Innovative cooling systems contribute to limitation of emissions.

Planting trees around buildings to shade urban surfaces and green roofs to reduce their temperature lead to substantial reductions in energy consumption for air-conditioning and sequester carbon while growing. Trees to shade roads and parking lots reduce evaporative emissions from gasoline, which contribute to increased levels of urban ozone. Biomass from trees



Source: IPCC Report

and shrubs can be used as wood energy to replace fossil fuels, thus contributing to climate adaptation.

Planners should take into account specific effects of climate change while planning for a district/region. Some issues which need to be tackled at the regional level include flexible management of resources, including allocation of water, preservation of threatened areas.

Urban planning is a key determinant of demand for mobility: whether it is a compact city where the various functions - residential and commercial, services, education and recreation – are located and how they interconnect; whether public transport is available for newly developed areas, etc. City governments should be made accountable for greenhouse gas emissions caused by poorly planned suburban sprawl. Some of the specific strategies could include the following:

1. Comprehensive urban renewal - implementing master plan proposals/redevelopment plans for special areas.
2. Sustainable Urban Design - Zonal Development Plan/Area Specific Plan/Layout Plans and implementation and enforcement of Development Control Regulation (DCR) and Building byelaws (BBL) – energy efficient design.
3. Increasing tree cover - by mandatorily setting aside spaces for plantation at plot level. A new legal category of temporary protected forest can be created to enable afforestation of vacant public lands and enable their protection under the Indian Forest Act and Forest Conservation Act until such time that they are required for recognized public use. They would enhance groundwater recharge and also provide other economic environmental benefits.
4. Orientation of buildings - site planning.
5. Increase use of non-conventional energy sources through incentivisation and building design.
6. Better enforcement of Urban Development Plan Formulation and Implementation (UDPFI) guidelines.

4.1.5 Coastal Zone Management

The IPCC-2007 report has noted that anticipated threats to coastal areas need to be taken seriously and all countries should initiate suitable action to face the threats. It has further warned that inaction will cost more. In view of the emerging dangers of the sea level rise scenarios, the following approaches are being proposed by the IPCC 2007 report, which has much relevance to the Indian context.

Coastal Adaptation (IPCCCZMS. 1990)	Adaptation Objectives (Klein and Tol, 1997)	Adaptation Responsed (after Cooperet al., 2002; DEGRA, 2001)	Examples
		Advance the line →	Land claim; polders
Protect →		Hold the line →	Dyke; beach nourishment
Accommodate →		→	Flood proof buildings Floating agricultural systems
Retreat →	Enhanced adaptability →	Retreat the line →	Managed realignment
		Limited intervention →	Ad hoc seawall
		No intervention →	Monitoring only
	Reversing maladaptive trends →	Sustainable adaption →	Wetland restoration
	Improved awareness and preparedness →	Community-focussed adaption →	Flood hazard mapping; flood warmings

Source: IPCC Report, 2007

4. Adaptation

Coastal Regulation Zone Notification 1991

As per the notification, coastal land up to 500 m from the High Tide Line (HTL) and a stage of 100 m along banks of creeks, estuaries, backwater and rivers subject to tidal fluctuations is called the Coastal Regulation Zone (CRZ). For regulation of developmental activities, the coastal stretches within 500 m of HTL on the landward side are classified into four categories and restrictions have been imposed on construction activities in these zones. The following activities are prohibited within the CRZ:

1. Setting up of new industries and expansion of existing industries, except those directly related to water front or directly needing foreshore facilities.
2. Manufacture or handling or disposal of hazardous substances.
3. Setting up and expansion of fish processing units including warehousing (excluding hatchery and natural fish drying in permitted areas).
4. Setting up and expansion of units/mechanism for disposal of waste and effluents into the water course.
5. Discharging of city untreated waters and effluents from industries, cities or towns and other human settlements.
6. Dumping of city or town waste for the purposes of land filling or otherwise, the existing practice, if any, shall be phased out within a reasonable time not exceeding 3 years from the date of notification.

The CRZ notification 1991 is under revision

Source: Ministry of Environment and Forests (MoEF)

The Indian warning system for storm surges is well developed. The present system is expected to be adequate to cope with the future needs. However, we need to study aspects such as availability of safe shelters for people to go to once the warning is issued. As an adaptation strategy, it is important to strengthen the ecological foundations by establishing bio-shields through raising mangrove forests and plantations like casuarinas, bamboos, etc. that are suitable to the coastal regions. Further, as part of coping strategy and adaptation, we need to take up the following measures:

- Understand existing coping mechanisms and adaptation options
- Study the existing risk management framework
- Identify key institutions, which could help coastal communities to build coping strategies and strengthen adaptation measures
- Integrate adaptation strategies as part of the coastal development planning process.

Apart from the above, in order to develop a good understanding, we may have to devise relevant response strategies, and reduce vulnerabilities in the coastal region. A concerted effort has to be made to promote the following elements:

Awareness: Awareness is critical for the implementation of any response strategy. Currently, there is a huge gap in terms of understanding the cause, effect and available options to overcome the potential impacts of a phenomena such as sea-level rise. There are huge gaps in the awareness levels of the general public, central, state and local planners and managers. A targeted approach is needed to educate people on various aspects (physical, socio-economic, preparedness) related to climate change.

Capacity Building: Appraisal of potential climate change impacts and subsequent management of the coastal zones need specialized knowledge, specifically in terms of predicting the future scenarios, assessing the associated vulnerabilities, planning

for eventualities and designing remedial measures. Presently the capacities associated with prediction, interpretation and preparation are very limited at all levels (both at the institutional and community levels). Capacity enhancement on all the above aspects needs attention.

Information Needs: Timely information is critical for proactive planning and policy actions. Development of tools, methodologies and data sets are key to gathering meaningful information (eg. GIS) and promoting relevant policies. There is also a need to develop integrated assessments linking physical vulnerability with economic analyses and planning options and to assemble and assess coastal zone planning adaptation options to facilitate their use by central, state and local decision makers. Institutional inertia is a key barrier to change. Synergy and cooperation between various agencies is vital and needs focus. At the community level, use of Information and communication technologies (eg. village knowledge centers) could play a key role in terms of communicating right information at the right time. Advance warning systems are a critical element of community preparedness and need to be institutionalized.

Climate change is not a stand alone, one time event. The perturbations and disturbances occur across space and time. Hence there is a need to constantly assess, evaluate and monitor the coastal areas, leveraging the existing network of site observations, as well as the growing array of coastal observing systems in order to save the lives and livelihoods of millions of people living in the coastal regions.

5. Training, Capacity Buildi

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ng and R&D

5. Training, Capacity Building and R&D for the National Mission on Sustainable Habitat

In view of the several new initiatives that would be required, both in respect to adaptation and mitigation, creation of knowledge and suitable capacity at each level of government to facilitate implementation of appropriate measures, assume great importance.

5.1 Capacity Building

With respect to energy efficiency, augmentation of capacity would be essential in areas such as green design and building focusing on regional solutions for architecture and engineering professionals, energy audit and certification, retrofiting of buildings, monitoring of energy performance of residential and commercial buildings, creating a national network of institutions for the propagation of energy efficient building material and technology, demonstration projects for recycling of construction waste, setting up of testing labs for testing the performance of various materials for window systems, roofing systems, envelope performance etc.

In the transport sector, capacity will have to be created for integrated land-use and transport planning, comprehensive mobility planning, optimization of various transport modes, improving efficiencies, route allocation, data collection and computer based data analysis, performance monitoring and development of monitoring frameworks including benchmarking, traffic management measures, transit planning etc.

In the water and sanitation sector, capacity will have to be developed for deployment of sustainable technologies like waste to energy, waste recovery, landfill management, wastewater management including effective O&M of sewerage systems, implementation of decentralized systems, use of treated wastewater for artificial recharge of aquifers, segregation of black and grey water at the household level and reuse of wastewater for non-potable purposes, urban storm water management particularly in the context of adaptation, water audit, designing systems and preparation of drawings and standards for roof water harvesting and recharge structures, appliance labeling, monitoring of ground water and certification of rainwater harvesting structures, use of GIS and MIS in network planning and management, hydraulic and network analysis, meter and distribution system management, leakage control and detection etc. Preparation/revision of manuals and revision/ formulation of rules will also be required. In addition, capacity building will be required for the development of CDM projects in all the above areas.

Augmentation of capacity of urban local bodies would be essential for monitoring implementation of byelaws that would be revised taking into account the need for sustainability and also for institutionalizing service level benchmarking in the urban local bodies and parastatal agencies.

Building of capacity will also be required for implementation of warning systems, evacuation plans, salvage, emergency services in respect of coastal, riverine and hill settlements, prediction, interpretation and preparation at the community/institutional level with respect to coastal zones.

5.2 Research and Development

With respect to energy efficiency in buildings, some of the areas that can be taken up for research include development of simulation software to predict the energy used in commercial and residential buildings which can also be used for retrofitting buildings, energy efficient technologies like hybrid and low energy systems, innovative HVAC technologies, building integrated renewable energy systems, development of energy efficient appliances and products such as insulation, efficient glass and HVAC systems, low cost water efficient fixtures, life cycle cost analysis of various equipment, materials and appliances, very low energy consuming circuits for stand-by power, low-cost light emitting diode (LED) based lamps for space lighting etc. Further, since internationally developed technologies are generally superior compared to those available in the country, particularly in respect of energy efficient lighting and space conditioning and solar evacuated tubular panels, the issue of cost-effective technology transfer will need to be addressed.

In the urban transport sector, research will be required for mainstreaming the use of bio-fuels, developing advanced engines, fuel cell technology, hybrid electric drive trains, lightweight materials, battery operated vehicles, recycling of vehicles etc.

For the sewerage sector, in the area of biochemical conversion, research will be required for developing cost effective sewage gas engines for production of electricity. In order to facilitate, recycling and reuse of wastewater, research will have to focus on tertiary treatment options including "indirect reuse of treated sewage systems through ground water recharge". In order to facilitate utilization of sewage for purposes such as farming, research is required to examine the impact of utilization of sewage on different types of crops, in different types of soil and climatic conditions. In the solid waste management sector research would be required in the areas of development of processes/equipment for separation of different components of MSW for energy recovery, biomethanation of mix of biodegradable solid wastes from various streams, gasification of MSW for energy recovery, low cost emission control equipment for WTE technologies,upgradation of plastic waste recycling technologies to reduce occupational and environmental hazards, recycling technologies for construction and demolition waste etc.

The following agencies would act as nodal agencies at the Central Government level for training, capacity building and R&D:

(i) Bureau of Energy Efficiency (BEE) ,Buildings Material and Technology Promotion Council (BMPTC) and The Energy and Resource Institute (TERI) for energy efficiency in the residential and commercial sectors

(ii) Central Public Health and Environmental Engineering Organisation (CPHEEO), Centre for Science and Environment (CSE) and other centres of excellence recognized by the Ministry of Urban development for the water and sanitation sector

(iii) Town and Country Planning Organisation, Human Settlements Management Institute and other centres of excellence recognized by the Ministry of Urban Development for urban planning

(iv) Institute of Urban Transport and centres of excellence recognized by the Ministry of Urban Development for Urban Transport

(v) National Disaster Management Institute for disaster management (early warning system)

Other institutions will also be co-opted on a case to case basis.Apart from capacity building and R&D, the nodal agencies will also be issuing guidelines for effective implementation which may include formulation and enforcement of performance standards, certification of private agencies to carry out design review and inspection, effective engagement with state governments and municipalities to integrate the Energy Conservation Building Code (ECBC), in city building byelaws, encouraging States to develop transparent and easy to use measures for compliance mechanism, facilitating the adoption of proven technologies/best practices globally to suit India's conditions.

At the level of state governments, several agencies would need to enlarge and redefine their goals and areas of operations. For example, State Electricity Regulatory Commissions would need to concern themselves with regulatory decisions that ensure higher energy efficiency, greater use of renewable energy etc. Similarly, water regulators, State Town and Country Planning organisations etc would have to mainstream climate change concerns in their functioning. Cities/local bodies would need to create capacity on regulatory measures, particularly for ensuring energy efficiency in new buildings as well as programmes of retrofits. In respect of adaptation measures, local capacity and the involvement of communities, in actions to adapt to the impacts of climate change would be crucial. Public awareness on climate change would have to be spearheaded and driven by the government at all levels. Emphasis on schools and colleges is essential.

6. Main Components of the Mission

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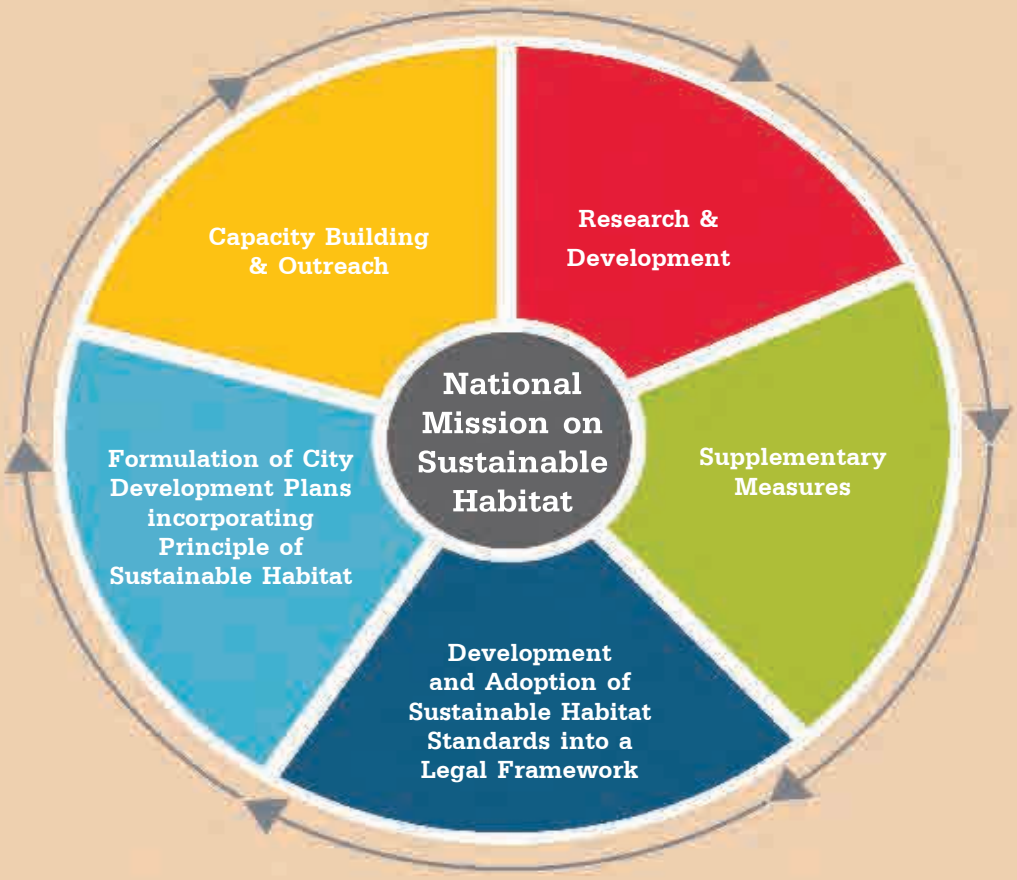
6. Main Components of the Mission

The National Mission on Sustainable Habitat seeks to promote sustainability of habitats through improvements in energy efficiency in buildings, urban planning, improved management of solid and liquid waste including recycling and power generation, modal shift towards public transport and conservation. It also seeks to improve ability of habitats to adapt to climate change by improving resilience of infrastructure, community based disaster management and measures for improving advance warning systems for extreme weather events. The Mission is to be implemented through appropriate changes in the legal and regulatory framework, viz. building byelaws, development control and regulation, etc.; mainstreaming of climate change and sustainable development concerns in city planning through city development plans including those related to adaptation, promotion of modal shift in public transport through comprehensive mobility plans, capacity building and outreach; and implementation of pilot projects.

The first step towards implementation of the mission would be development of sustainable habitat standards which should include standards aimed at increasing energy efficiency in the residential and commercial sectors, urban transport, water supply and sewerage, urban planning and municipal waste. Adoption of benchmarks related to water supply, solid waste management, sewerage and storm-water drainage shall be promoted as an integral component of sustainable habitat standards as it provides useful framework for addressing issues relating to both adaptation and mitigation apart from performance improvements in these sectors. The sustainable habitat standards would be developed and would integrate standards related to energy performance of buildings, structural safety (against extreme events), energy efficient constructions, harmonizing of ECBC norms with NBC and EIA norms, mandatory rain water harvesting, integration of economic, transport, environment and risk planning with overall spatial and urban planning, level of disaster preparedness as well as regulations to discourage personal modes of transport. Energy efficiency and passive architectural guidelines for residential and commercial buildings will be incorporated in the standards. In addition, norms for mandatory solar water heating will be incorporated.



These standards would subsequently get integrated with the building byelaws, development control and regulations and Motor Vehicle Act, (MVA) etc. to ensure that future developments are aligned in accordance with concerns related to climate change and harness win-win opportunities towards overall sustainable development. The adoption of these standards would be incentivized through existing schemes like the JNNURM and other schemes of Government of India and shall avoid unsound regulatory practices or unreasonable costs for any sector. While the sustainable habitat standards are developed and mandated through appropriate changes in the legal framework, concerns of all legitimate stakeholders would be addressed and the focus would be on win-win situations to avoid unreasonable costs for any particular sector. Unsound regulatory practices will have to be avoided.

Comprehensive and holistic urban planning through city development plans that mainstream sustainable habitat standards would be a key component of the implementation strategy of the mission. The city development plans could cater to the requirements of both adaptation and mitigation and would include activities related to reducing vulnerabilities of communities against inadequate level of municipal services pertaining to water supply, waste water management, SWM, apart from integrated urban planning. City development plans should factor in preparedness for sudden disasters such as droughts, floods, cyclones, storms, and hurricanes as well as steady trends such as beach erosion, heat stress, heat island effects, thermal pollution, etc. The CDP should contain a separate chapter on disasters clearly delineating a roadmap for dealing with them as and when they occur. City development plans should also incorporate renewable energy options identified in the solar city master plans prepared under the Solar City Programme of MNRE. Costs of implementation should be reflected in the CDP i.e. costs incurred from fiscal sources as well as those from outside the fiscal framework including those involved in compliance with regulation. The mission document provides estimates of the order of funding that may be required for meeting adaptation needs of the most vulnerable communities. Preparation of city development plans shall be supported under JNNURM and capacity building funds.

A set of complimentary actions comprising pilot projects related to green buildings, energy efficient construction material and technologies, recycling and reuse of solid and liquid waste, decentralized waste water management, use of low water technology, separation of grey water and black water, ecological sanitation, outreach activities aimed at raising awareness about economic and environmental benefits of energy efficiency and conservation, national network of key institutions working on issues relevant to the mission, facilitating research and developmental activities, exploring technological options for higher efficiency and lower cost green products, creation of a dedicated website for wider dissemination of relevant information, institution of awards for high performance buildings and systems and financial incentives for energy efficient constructions are required.

Urban transport is a key element of promoting sustainability of habitats. Towards this end, the mission proposes to support comprehensive mobility plans which would address issues related to transport planning and land use integration, optimization of various public transport modes, discouraging personal vehicles, development of appropriate parking norms and strategies, pedestrianization and strengthening of institutions. The comprehensive mobility plans would supplement the sustainable habitat standards in this regard.

The lack of capacity for efficient urban planning has been taken into account while developing the mission strategy and constitutes an important element of overall implementation framework. The capacity building measures would cater to needs related to increasing energy efficiency in residential and commercial sectors, urban transport, waste water management, SWM, adaptation as well as those related to development of projects related to CDM.

The key deliverables of the mission would include a) development of sustainable habitat standards that lead to robust development strategies while simultaneously addressing climate change, b) preparation of city development plans that comprehensively address adaptation and mitigation concerns, c) preparation of comprehensive mobility plans that enable cities to undertake long-term, energy efficient and cost effective transport planning and d) capacity building for undertaking activities relevant to the mission.

6. Main Components of the Mission

1.	National Sustainable Habitat Standards (Legal/Regulatory Measures)	Timelines	Fund Requirement for Pilot Projects	Estimated Investment Requirement
1.1	Increasing Energy Efficiency in the Residential and Commercial Sectors	2010-11		
1.1.1.	Development of model building byelaws to mandate minimum energy performance standards for residential and commercial buildings and promoting higher performance	2010-11		
1.1.2.	Mandating of certification of energy performance for all buildings	2010-11		
1.1.3.	Harmonising ECBC with NBC and MoEF's EIA guidelines.	2010-11		
1.1.4.	Incorporation of standards into building byelaws	2010-11		
1.1.5.	Development of National Standards for energy efficient constructions and recycling of construction waste on priority basis in collaboration with BIS	2010-11		
1.1.6.	Incorporation of National Standards into byelaws	2010-11		
1.2	Urban Transport			
1.2.1	Development of norms integrating measures related to taxation, parking, congestion charges, public carriage specifications and service norms, etc. to encourage public transport	2010-11		
1.2.2	Development of norms for pedestrianisation/cycling	2010-11		
1.2.3	Development of model regulation to restrict registration of diesel propelled personal vehicles	2010-11		
1.2.4	Model regulations for integrating transport planning (CMP) with spatial planning (master plans)	2010-11		
1.2.5	Adoption of model regulations/norms by various States /Union Territories (UTs)	2010-11		
1.3	Water Supply			
1.3.1	Amendment of building byelaws to make rain water harvesting mandatory in all states	2010-11		

	National Sustainable Habitat Standards (Legal/Regulatory Measures)	Timelines	Fund Requirement for Pilot Projects	Estimated Investment Requirement
1.3.2	Designing systems and preparation of drawings and standards for roof water harvesting and recharge structures.	2010-11		
1.3.3	Mandating water audit and energy audit of water utilities	2010-11		
1.4	Solid Waste Management			
1.4.1	Imposition of penalty for non-compliance with Municipal Solid Waste (Management and Handling) Rules 2000 notified by Ministry of Environment and Forests	2010-11		
1.4.2	Development of norms for marketing of municipal compost and energy from waste	2010-11		
1.4.3	Revision of manuals/rules	2010-11		
1.5	Urban Storm-Water Management			
1.5.1	Standards for increasing margin of design safety of buildings, flyovers to enhance the hydraulic capacity of the sections	2010-11		
1.5.2	Standards for embankment of low lying areas, especially for coastal cities, better disaster warning systems and construction of shelters	2010-11		
1.6	Urban Planning			
1.6.1	Modification of Town & Country Planning Act / DCR for promoting urban renewal, environmental management, improved coastal zone management, spaces for plantation at plot level for increasing tree cover, structural safety, hazard and risk mitigation, transport planning and optimal urban forms, etc.	2010-11		
1.7	Mandating adoption of Sustainable Habitat Standards by cities through additional reforms under JNNURM.			

6. Main Components of the Mission

2.	Principles of Sustainable Habitats to be Incorporated in City Development Plans	Timelines	Fund Requirement for Pilot Projects	Estimated Investment Requirement
2.1	Water Supply			
2.1.1	Providing water supply to uncovered population (9 per cent)[1]	2010 - 2017	-	Rs. 11012 crore
2.1.2	Desalination of saline water in water-scarce regions in selected cities			This will be taken up and provided for on a case by case basis
2.1.3	Refurbishment of distribution system and control of UFW through replacement of GI Pipes in the distribution system with HDPE Pipes in 441 Class I cities[2]	2010 -2017	-	Rs. 19005 crore
2.2	Wastewater Management			
2.2.1	Providing sewerage and sewage treatment facilities for uncovered population[3]	2010 - 2014	-	Rs. 9161 crore
2.2.2	Recycling and reuse of treated wastewater in Class-I and Class-II towns[4]	2010 -2017	-	Rs. 7403.51 crore
2.2.3	Replacement of wastewater pumping equipment to improve the system efficiency through energy saving in Class I cities[5]	2010 -2017	-	Rs. 477 crore
2.3	Solid Waste Management			
2.3.1	Bio-remediation of existing landfill sites and methane gas recovery from existing landfills in Class 1 cities[6]	2010 -2017	-	Rs. 2862 crore
2.3.2	Treatment facilities like aerobic composting for source segregated biodegradable organic fraction (for all 5161 cities)[7]	2010 -2017	-	Rs. 2602 crore
2.3.3	Energy recovery methods like Biomethanation, RDF, incineration, etc. and utilization of energy in Class I cities[8]	2010 -2017	-	Rs. 609 crore

*Annotations 1-8 are given at pg 90

3.	COMPLIMENTARY ACTIONS	Timelines	Fund Requirement for Pilot Projects
3.1	Increasing Energy Efficiency in the Residential and Commercial Sectors		
3.1.1	Support for building green demonstration projects of best practices in key locations across India.	2010 - 2017	Rs. 50 crore
3.1.2	National outreach programme for creating consumer awareness programmes focused on economic and environmental benefits from energy efficiency and green buildings and dissemination of programmes.	2010 - 2017	Rs. 15 crore
3.1.3	Outreach to young students through school energy efficiency programmes, energy usage monitoring, and voluntary shutdowns		Rs. 15 crore
3.1.4	Create a dedicated website with information on building codes, green building benefits, and technical advice	2010 - 2011	Rs. 1 crore
3.1.5	Undertake outreach and marketing on rating systems	2010 - 2011	Rs. 1 crore
3.1.6	R&D funding for research to create higher efficiency and lower cost green products.	2010 - 2017	Rs. 10 crore
3.1.7	Increase recognition and awards for high rated buildings	2010 - 2017	Rs. 50 lakh
3.1.8	Provide financial incentives for energy efficient construction	2010 - 2017	-
3.1.9	Award for incentivisation of efficient lighting systems, particularly street lighting	2009 - 2010	Rs. 2 crore
3.1.10	Demonstration projects for recycling of construction waste	2010 - 2017	Rs. 1 crore
3.1.11	Demonstration projects for energy efficient construction technologies for housing for EWS/LIG Categories	2010 - 2017	Rs.12 crore
3.1.12	Creating a national network of building centres as key institutions for the propagation of energy efficient building material and technology	2010 - 2017	Existing arrangements such as Nirmithi Kendras of HUDCO will be used.

3.	COMPLIMENTARY ACTIONS	Timelines		Fund Requirement for Pilot Projects
3.1.13	Increase energy auditing and develop monitoring mechanisms to ensure recommendations are implemented	2010 - 2017	This will be funded through capacity building initiatives	
3.1.14	Augmentation of certified energy auditors	2010 - 2017		
3.2	Urban Transport			
3.2.1	Creating public awareness	2010 - 2017		Rs. 10 crore
3.2.2	Conducting studies for reducing the fuel consumed per passenger travelled through modal shift	2010 - 2017		Rs. 5 crore
3.2.3	Demonstration project for improving access to goods and services through an integrated transport plan	2010 - 2017		Rs. 5 crore
3.2.4	Demonstration project for integrating inter-city road passenger transport with urban transport systems	2010 - 2017		Rs. 5 crore
3.2.5	Comprehensive mobility planning and management using intelligent transport systems	2010 - 2017		Rs. 390 crore
3.2.6	Establishment of unified metropolitan transport authorities for ensuring multimodal integration	2010 - 2017	-	-
3.2.7	Facilitating R&D activities and exploring technological options.	2010 - 2017	This will be done through existing initiatives of various Ministries such as Ministry of Petroleum, Road Transport, etc.	
3.3	Wastewater Management			
3.3.1	Demonstration projects for promotion of low- use water toilets and ecological sanitation approaches where nutrients are safely recycled into productive agriculture	2010 - 2017		Rs. 10 crore
3.3.2	Demonstration projects for promoting use of treated waste water for artificial recharge of aquifers	2010 - 2017		Rs. 20 crore
3.3.3	Demonstration projects for decentralized waste management systems for community, housing complexes, buildings	2010 - 2017		Rs. 50 crore
3.3.4	Demonstration projects for development of eco-safe towns which will serve as models for safe and sustainable systems of human waste disposal in peri-urban areas	2010 - 2017		Rs. 100 crore

3.	COMPLIMENTARY ACTIONS	Timelines	Fund Requirement for Pilot Projects
3.3.5	Pilot project for segregation at the household level of black and grey water so that the former can be recycled for fertilizer and latter for toilets	2010 - 2017	Rs. 20 crore
3.4	Solid Waste Management		
3.4.1	Awareness programme for segregation and storing bio-degradable and non-abiodegradable waste.	2010 - 2017	Rs. 30 crore
3.4.2	R&D in the areas of development of processes/equipment for separation of different components of MSW for energy recovery,biomethanation of mix of biodegradable solid wastes from various streams, gasification of MSW for energy recovery, low cost emission control equipment for WTE Technologies	2009 - 2017	Rs. 10 crore
3.5	Establishment of National Commission on Sustainable Urbanisation which shall delineate strategies for sustainable urbanisation	2010 - 2012	
3.6	Increase appliance labelling for equipment for promoting energy efficiency, water conservation, reduction of life cycle costs	2010 - 2017	Rs.5 crore
3.7	Studies in vulnerability assessment/climate scenarios at city level	2010 - 2017	Rs. 5 crore
3.8	Demonstration projects and capacity building activities related to climate resilience	2010 – 2017	Rs.5 crore

6. Main Components of the Mission

4. CAPACITY BUILDING MEASURES		Timelines	Fund Requirement for Pilot Projects
4.1	Increasing Energy Efficiency in the Residential and Commercial Sectors		
4.1.1	Augmentation of capacity for implementation and enforcement of various measures such as facade improvement, orientation, etc.	2009 - 2012	Rs. 10 crore
4.2	Urban Transport		
	Capacity building in transport planning and land use integration, optimization of various public transport modes, strengthening of institute of urban transport	2009 - 2012	Rs. 98 crore
4.3	Water Supply		
4.3.1	Developing a manual for recharge of various soil types	2009 - 2014	-
4.3.2	Capacity building for monitoring of ground water table and certification of rainwater harvesting measures	2009 - 2014	Rs. 5 crore
4.4	Waste Water Management		
4.4.1	Strengthening institutional and technical capacity of all ULBs for effective O&M of sewerage system and for recycling and reuse of waste water for non-potable uses.	2009 - 2017	Rs. 20 crore
4.5	Solid Waste Management		
4.5.1	Capacity building for sustainable technologies like waste recovery, waste to energy projects, segregation, etc.	2009 - 2017	Rs. 10 crore
4.6.1	Capacity building in providing warning system, evacuation plan, salvage, emergency services in respect of coastal, riverine and hill settlements	2009 - 2013	Rs. 20 crore
4.6.2	Capacity enhancement associated with prediction, interpretation and preparation at institutional and community level with respect to coastal zones	2009 - 2013	Rs. 20 crore

4.	CAPACITY BUILDING MEASURES	Timelines	Fund Requirement for Pilot Projects
4.6.3	Strengthening of institutions for carrying out adaptation measures due to climate change	2009 - 2013	Rs. 20 crore
4.7	Developing CDM projects relevant to Urban sector including those related to: a) landfill management, b) waste to energy, c) energy efficiency in buildings, d) service utilities, e) transport, f) waste water management g) construction	2009 - 2013	Rs. 20 crore

Annotations

1. The amount has been calculated taking into account a figure of Rs. 3349 as per capita investment for providing water supply on the basis of CDPs received under JNNURM (2005-06) and 9% of the projected urban population for the year 2012 (365.36 million)

2 . The amount has been worked out based on the per capita cost of Rs. 865 per head as per the DPR prepared for Bangalore water supply project.

3 . The amount has been calculated taking into account a figure of Rs. 2786 as per capita investment for providing water supply on the basis of CDPs received under JNNURM (2005-06) and 9% of the projected urban population for the year 2012 (365.36 million).

4 . The amount has been worked out on the basis of capital cost of Rs. 1.3 crore for treatment of 1 mld of sewage up to tertiary level, projected population in the year 2012, projected sewage generation at 80% of water supplied (135 lpcd) and treatment to the level of 20% of wastewater generated.

5. The amount has been worked out for a total capacity of 1.905 lakh BHP by assuming replacement of 50% of the existing pumping machines in 423 Class-I cities.

6. The cost of bio-remediation has been considered about Rs. 200/MT assuming organic waste accumulated in last 7 years.

7. The amount has been worked out based on the per capita cost of Rs. 280 per head which is based on the JNNURM project.

8. The amount has been worked out based on the per capita cost of Rs. 2.30 lakh/MT which is based on the cost approved under JNNURM (20% of the total waste generated has been assumed to be the available waste for recovery.

7. Institutional Arrangements Monitoring and Evaluation

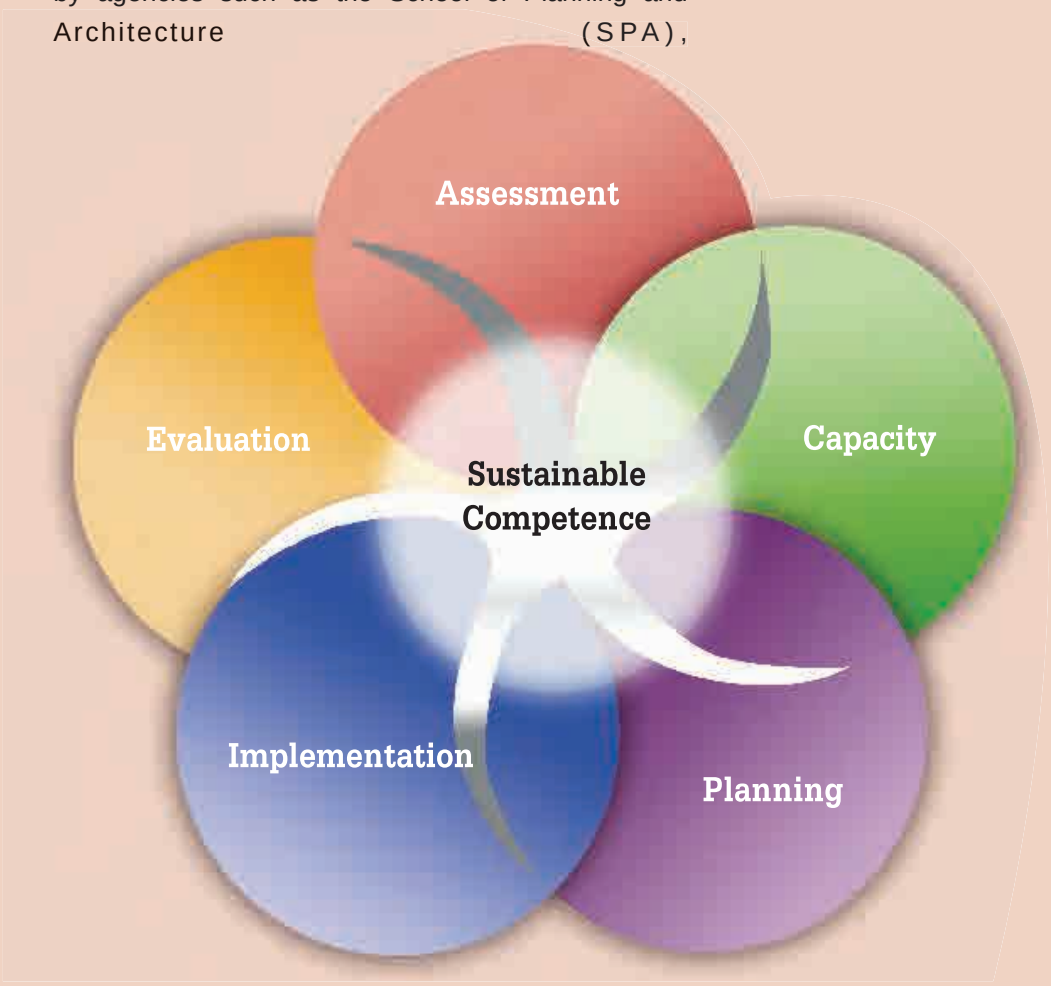
Contents

7. Institutional Arrangements, Monitoring and Evaluation

It is proposed that the National Mission on sustainable habitat may be headed by an Inter Ministerial Group (IMG). The composition of the group and terms of reference is suggested in Annexure A. The Group may be headed by a Secretary (Urban Development) with senior level representation from other key Ministries. The IMG shall set policies for implementation, monitor and review progress and suggest corrections where necessary. It shall also sanction projects/activities in pursuance of the objectives of the mission. It shall be supported by a Mission Implementation and Monitoring Group whose task will be to appraise proposals and submit recommendations to the IMG for consideration. The composition of the group is suggested in Annexure B. A Mission Directorate shall be set up in the MoUD which shall carry out day-to-day monitoring of activities as well as receive proposals from state governments/city/local governments for appraisal and submission before IMG. The composition, terms and reference of the Mission Directorate is placed in Annexure C. The Mission Directorate will be aided by agencies such as the School of Planning and Architecture (SPA), National Environmental Engineering Research Institute (NEERI), Urban Transport Division of MoUD, Bureau of Energy Efficiency (BEE), Central Public Works Department (CPWD), Town and Country Planning Organisation (TCPO), Central Public Health and Environmental Engineering Organisation (CPHEEO) and the University of Petroleum and Energy Studies (UPES) in the appraisal of projects.

At the state level, the activities of the National Mission will be coordinated by a State Level Apex Co-ordination Committee (SLACC) on sustainable habitat to be headed by the Chief Secretary (Annexure D). It shall review and prioritize proposals for inclusion in the mission. The SLACC will be supported by nodal agencies who will invite project proposals, appraise them and manage and monitor the mission.

In urban areas, a city- level committee will be constituted (Annexure- F).



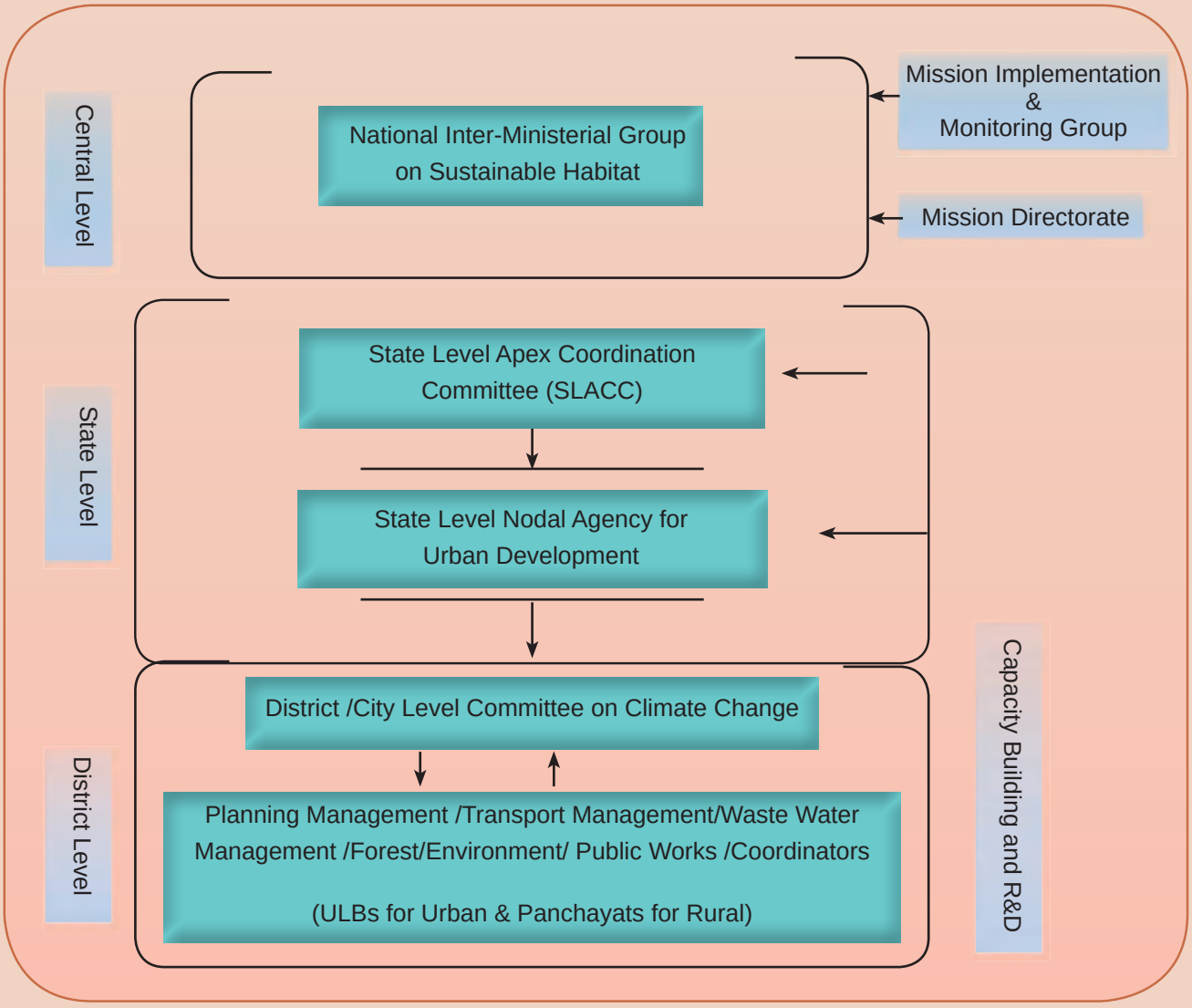
The need for local level initiatives is fully recognized. Towards this end, the mission shall aim to mainstream climate change concerns in 423 class –I towns to begin with. Within these 423 towns, urban agglomerations with populations over 10 lakh as per the 2001 census shall be accorded priority. For the rural areas, prioritization shall be left to the districts and states.

Monitoring and Evaluation under National Mission on Sustainable Habitat

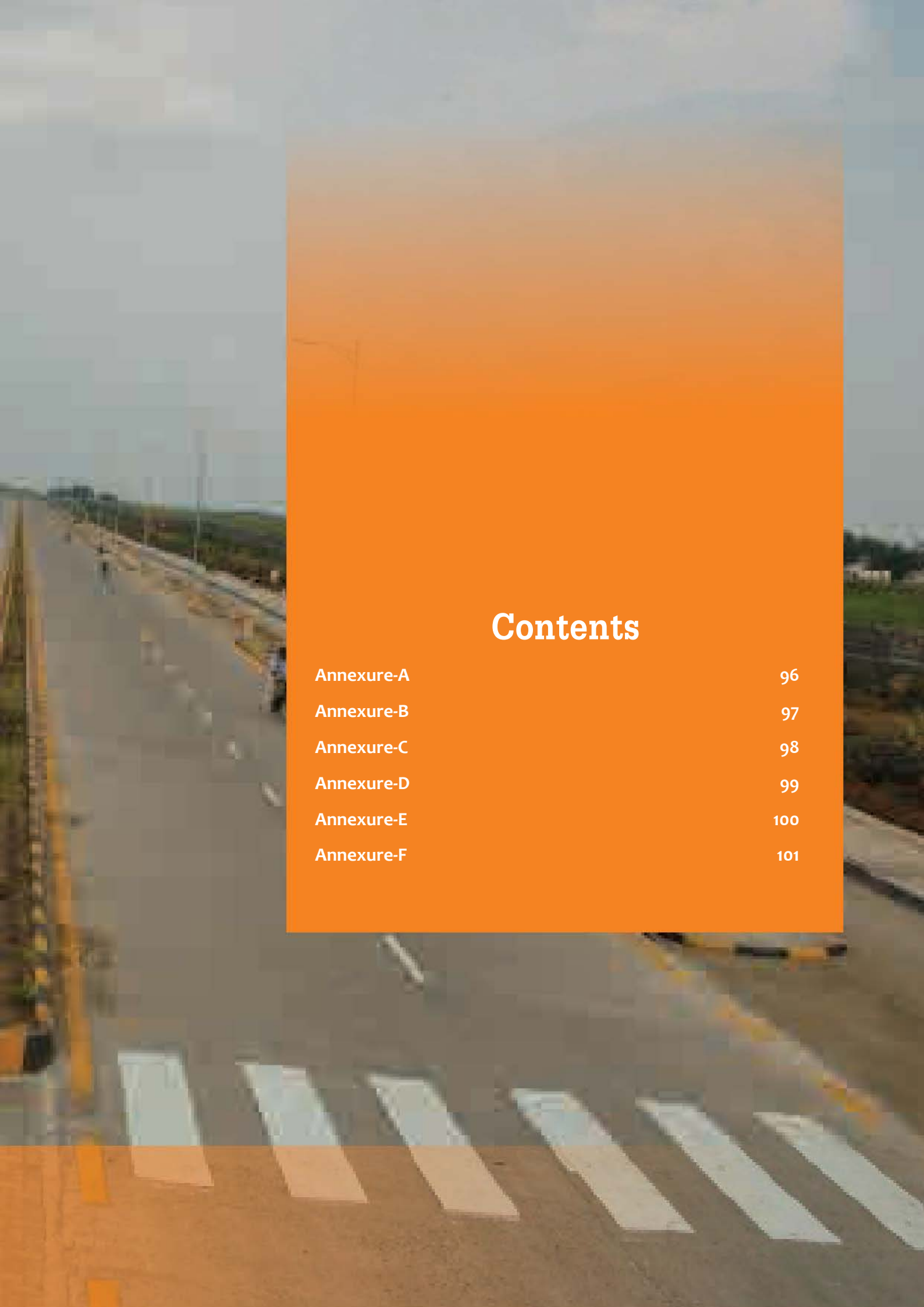
The National Mission on Sustainable Habitat will evolve a state level mechanism for third party monitoring and review of the projects sanctioned. It is intended that the review and monitoring process will keep track of the physical and financial progress of the projects.

The Mission Directorate-MoUD will implement a web-enabled Programme Monitoring and Evaluating System (PMES). The PMES will be designed to capture the physical and financial progress aspects of the projects, both as reported by the project executing agency, the independent review and monitoring agency. The information will be a critical input for processing requests for the release of subsequent installments.

The objective of appointing an independent agency is to review and monitor the performance of the projects funded by assistance provided under the mission through its entire life cycle of implementation, on the basis of detailed on-site review, examination of appropriate documents and discussions with the project executing agency and other key stakeholders.



8. Annexures



Contents

Annexure-A

National Inter-Ministerial Group on Sustainable Habitat

Composition

1.	Urban Development Minister
2.	Deputy Chairman, Planning Commission
3.	Finance Minister
4.	Minister for Housing and Urban Poverty alleviation
5.	Minister for Environment and Forests
6.	Minister for Rural Development
7.	Minister for Water Resources
8.	Minister for New and Renewable Energy
9.	Minister for Power
10.	Secretary, Urban Development – Member – Convenor

Term of Reference

(i) Lay down policy guidelines within the overall framework of the Mission.

(ii) Meanstreaming climate change into various programmes / schemes supported by the central government.

(iii) Facilitate, promote and advocate mission activities.

(iv) Guide and review performance of the Mission.

Annexure-B

Mission Implementation and Monitoring Group

Composition

1.	Secretary (UD)	-	Chairman
2.	DG, BEE	-	Member
3.	Representations of MoEF, MNRE, MoRD, DDWS, Ministry of Petroleum, MoHUPA, MoWR, Planning Commission at the level of JS	-	Members
4.	Representative of NDMA	-	Member
5.	Representatives of 2-3 State Govts. (Secretary/Principal Secretary)	-	Members
6.	Commissioners 2-3 cities	-	Members
7.	Representative of TERI	-	Member
8.	Representative of IRADe	-	Member
9.	Representative of UPES	-	Member
10.	Representative of CII	-	Member
11.	Two Representative of NGOs	-	Member
12.	Representative of professional organisations	-	Member
13.	Joint Secretary (Mission)	-	Member
14.	Joint Secretary (UD)	-	Member
15.	Dir. (WS)	-	Convenor

Terms of Reference

(i) Sanction projects and activities in pursuance with the Mission's objectives.

(ii) Guide and review performance of the Mission Directorate.

(iii) Submission of bi-annual reports to Prime Minister's Office.

(iv) Coordination with other missions.

Annexure-C

Mission Directorate
Composition

1.	Joint Secretary (UD), MoUD	-	Chairman
2.	Director MoHUPA	-	Member
3.	Director, Urban Transport, MoUD	-	Member
4.	Chief Engineer (CPWD)	-	Member
5.	Chief Planner, TCPO	-	Member
6.	Advisor, CPHEEO	-	Member
7.	Director (WS)	-	Convener

The Directorate will be assessed by a technical cell.

Terms of Reference

(i) Receiving Proposals from state\city governments, appraisal thereof and submission to Mission Implementation and Monitoring Group.

(ii) Support to state\district level apex coordination committee.

(iii) Monitoring of day-to-day Mission Activities.

Annexure-D

State Level Apex Coordination Committee

1.	Chief Minister	Chairman
2.	Minister Incharge of Urban Development / Housing	Member
3.	Mayors / Chairperson of ULBS to be decided by the state	Member
4.	Principal Secretary / Secretary in charge of Finance, Transport, Energy, Environment and Forests, Public Works, Water Supply and Sanitation, Rural Development	Member
5.	Representative of NGO	
6.	Representative of professional body	
7.	Secretary Urban, Development	Convenor

Terms of Reference

(i) Mainstream climate change into various schemes supported by central / state Governments.

(ii) Facilitate, promote and advocate Mission activities.

(iii) Coordinate programmes and policies.

(iv) Supervise and guide capacity building and R&D activities.

(v) Monitoring of implementation of activities/projects approved.

(vi) Submission of quarterly reports to Mission Directorate, GOI.

(vii) Submission of proposals to GOI.

Annexure-E

City Level Committee on Climate Change (CLCCC)

1.	Mayor	-	Chairperson
2.	Commissioner	-	Member
3.	Representatives of Urban Transport, Water Supply, Sewerage, Solid, Waste Mgmt., Energy Roads and Biogas, Ministries / Department.	-	Members
4.	Two Representative of NGOs	-	Members
5.	Two Representatives of professional organizations	-	Members

Terms of Reference

1. Coordinate various programmes and activities at the city level to address issues related to mitigation and adaptation.
2. Mainstream climate change concerns into decision making process at the city level.
3. Undertake awareness generation through various mediums available in the city.
4. To undertake capacity building activities at local levels.
5. Preparation of proposals in pursuance of the Mission's objectives.
6. To implement and monitor projects / activities sanctioned in pursuance of the Mission's objectives.
7. Submit quarterly progress reports on implementation of projects / activities to State Level Apex Coordination Committee.

Annexure-F

Level of Service	1. Presence of Organized Public Transport System in Urban Area(%)	2. Extent of Supply Availability of Public Transport	3. Service Coverage of Public Transport	4. Average waiting time for Public in the city	5. Level of Comfort in Public Transport	6. % of Fleet as per Urban Bus Specification
1	>= 60	>= 0.6	>= 1	<=4	<= 1.5	75 - 100
2	40-60	0.4-0.6	0.7- 1	4 – 6	1.5 – 2.0	50 - 75
3	20 - 40	0.2 - 0.4	0.3 - 0.7	6 – 10	2.0 – 2.5	25 - 50
4	< 20	< 0.2	< 0.3 > 10 >	2.5	<= 25	

2. Pedestrian Infrastructure facilities

Level of Service	1) Signalized intersection delay (%)	2) Street Lighting (Lux)	3) % of City Covered
1	<25	>= 8	>= 75
2	25 - 50	6 - 8	50 -75
3	50 - 75	4 - 6	25 - 50
4	>= 75	< 4	< 25

Overall Level of Service of Pedestrian Infrastructure Facilities City wide

Calculated LoS = (LoS1 + LoS2 + LoS3) and identify overall LoS as mentioned below

Overall LoS	Calculated LoS	Comments
1	3 – 5	The City has adequate barrier free pedestrian facilities along overall road network.
2	6 - 8	The City has pedestrian facilities which may need some improvements in terms of improvements in intersections, footpaths, and street lighting as some parts of thecity are not served by it. The footpath available needs improvements. The system provided is otherwise comfortable and sustainable
3	9 -10	The City has pedestrian facilities which may need considerable

		improvements. The pedestrian facilities at intersections, availability of foot path etc needs improvements as also many parts of the city are not served by it.
4	11 - 12	The city lacks adequate pedestrian facilities

3. Non Motorized Transport (NMT) facilities

Level of Service	1. % of network covered	2. Encroachment on NMT roads by Vehicle Parking (%)	3. NMT Parking Interchanges (%)
1	>=50	<= 10	>=75
2	50 - 25	10 - 20	50 - 75
3	25 - 15	20 - 30	25- 50
4	< 15	> 30	< 25

Overall Level of Service (LoS) of Non Motorized Transport facilities (NMT) City-wide

The calculated LoS = (LoS1 + LoS2 + LoS3 + LoS4 + LoS5) and identify overall LoS as mentioned below

Overall LoS	Calculated LoS	Comments
1	5 - 7	The city has adequate ITS facilities
2	8 -10	The city has ITS facilities which may need some improvements in terms of Integrated Ticketing System, Signal Synchronization, GPS/GPRS, PIS etc as some parts of the city are not served by it.
3	11 -15	The city has bare minimum ITS facilities and may need considerable improvements in terms of Integrated Ticketing System, Signal Synchronization, GPS/GPRS, PIS etc as many parts of the city are not served by it.
4	16 - 20	The city lacks adequate ITS facilities.

4. Level of Usage of Intelligent Transport System (ITS) facilities

Level of Service	1. Availability of Traffic Surveillance (%)	2. Passenger Information System (PIS) (in %)	3. Global Positioning System (GPS)/ General Packet Radio Service (GPRS)	4. Signal Synchronization (%)	5. Integrated Ticketing System (%)
1	>=75	> =75	> =75	> =75	>= 75
2.	50 - 75	50 - 75	50 - 75	50 - 75	50 - 75
3.	25 - 50	25 - 50	25 - 50	25 - 50	25 - 50
4.	< 25	< 25	< 25	< 25	< 25

Overall Level of Service (LoS) of usage of Intelligent Transport System (ITS) Citywide

The calculated LoS = (LoS1 + LoS2 + LoS3 + LoS4 + LoS5) and identify overall LoS as mentioned below

Overall LoS	Calculated LoS	Comments
1	5 - 7	The city has adequate ITS facilities
2.	8 - 10	The city has ITS facilities which may need some improvements in terms of Integrated Ticketing System, Signal Synchronization, GPS/GPRS, PIS etc as some parts of the city are not served by it.
3.	11- 15	The city has bare minimum ITS facilities and may need considerable improvements in terms of Integrated Ticketing System, Signal Synchronization,GPS/GPRS, PIS etc as many parts of the city are not served by it.
4.	16 - 20	The city lacks adequate ITS facilities

5. Travel speed (Motorized and Mass transit) along major corridors

Level of Service (KMPH)	1. Average Travel speed of Personal vehicles	2. Average Travel speed of PublicTransport (KMPH)
1	**>= 30**	**>= 20**
2	25 – 30	15 -20
3	15 - 25	10 – 15
4	<15	< 10

Overall Level of Service of Travel Speed along major corridors City wide

Calculated LoS = (LoS1 + LoS2) and identify overall LoS as mentioned below

Overall LoS	Calculated LoS	Comments
1	**2**	**Primarily free flow movement at average travel speeds usually about 70% of the free flow speed for the key corridors.**
2	**3-4**	**Small increase in traffic causing substantial increase in approach delay and hence, decrease in arterial speed.**
3	**5-6**	**Significant approach delays and average travel speed of 1/3 of the free flow speed or lower. Such conditions causinga combination of one or more reasons such as high signal density, extensive queuing at critical intersections and inappropriate signal timing.**
4	**7-8**	**Key corridors at extremely low speeds below 1/3 to 1/4 of the free flow speed. Intersection congestion is likely at critical signalized locations, with high approach delays.**

6. Availability of Parking Spaces

Level of Service	1. Availability of on street paid public parking spaces (%)	2. Ratio of Maximum and Minimum Parking Fee in the City
1	>= 75	> 4
2	50-75	2-4
3	25-50	1-2
4	< 25	1

Overall Level of Service (LoS) for Availability of Parking Space City-wide

Calculated LoS = (LoS1 + LoS2) and identify overall LoS as mentioned below.

Overall LoS	Calculated LoS	Comments
1	2	Paid parking spaces are available in the city and the demand is well managed by incorporating differential parking rates for the CBD.
2	3-4	Paid parking spaces are available in the city and the demand is well managed by incorporating differential parking rates for the CBD. However some improvements may be required
3	5-6	Paid parking spaces provided in the city need to be improved upon and to cater to the demand some differential parking rates for the CBD have been adopted. The city authorities need to initiate considerable improvements measures.
4	7-8	The city authorities need to initiate immediate actions with respect to providing paid parking spaces and demand management for parking.

Annexure-G

7. Road Safety

Level of Service	1. Fatality rate per lakh population	2. Fatality rate for pedestrian and NMT (%)

Abbreviations/Acronyms

1. ADB: Asian Development Bank
2. AHUs: Air Handling Units
3. AICTE: All India Council for Technical Education
4. BOT: Build-Operate-Transfer
5. BAU: Business-As-Usual
6. BCC: Belgaum City Corporation
7. BCIL: Biodiversity Conservation India Limited
8. BCM: Billion Cubic Metres
9. BEE: Bureau of Energy Efficiency
10. BEL: Bharat Electronics Limited
11. BESCOM: Bangalore Electricity Supply Company
12. BFG: Boulder Filled Galleries
13. BiPV: Building integrated Photo Voltaics
14. BIS: Bureau of Indian Standards
15. BOV: Battery Operated Vehicles
16. BRIMSTOWAD: Brihan Mumbai Storm Water Drainage Project
17. BRTS: Bus Rapid Transit System
18. BWSSB: Bangalore Water Supply and Sewerage Board
19. CDM: Clean Development Programme
20 CI: Cart Iron
21. CER: Carbon Emission Reduction
22. CESE: Centre for Environmental Sciences and Engineering
23. CFL: Compact Flourescent Lamps
24. CLIP: Chattisgarh Lighting Improvement Project
25. CMP: Comprehensive Mobility Plan
26. CMWSSB: Chennai Metropolitan Water Supply & Sewerage Board
27. CNG: Compressed Natural Gas
28. CPCB: Central Pollution Control Board
29. CPHEEO: Central Public Health & Environmental Engineering Organization
30. CPWD: Central Public Works Department
31. CRZ: Coastal Regulation Zone

Abbreviations/Acronyms

32. CSE: Centre for Science & Environment
33. DCR: Development Control Rules
34. DDWS: Department of Drinking Water Supply
35. DIMMTS: Delhi Integrated Multi-Modal Transit System
36. DLCC: District Climate Change Committee
37. DSM: Demand Side Management
38. DTC: Delhi Transport Corporation
39 DI: Ductile Iron
40. EACs: Employees Assistance Centres
41. ECBC: Energy Conservation Building Code
42. ESR: Elevated Service Reservoir
43. GHG: Green House Gases
44. GPS: Global Positioning System
45. GRIHA: Green Rating for Integrated Habitat Assessment
46. HDPE: High Density Polyethylene
47. HTL: High Tide Line
48. HUPA: Housing and Urban Poverty Alleviation
49. HV: Hybrid Vehicles
50. HVAC: Heating Ventilation Air Conditioning
51. ICLEI: International Council for Local Environmental Initiatives
52. ICT: Information and Communication Technology
53. IGBC: Indian Green Building Council
54. ICTSL: Indore City Transport Services Limited
55. IEA: International Energy Agency
56. IEP: Integrated Energy Policy
57. IGNOU: Indira Gandhi National Open University
58. IMG: Inter Ministerial Group
59. IPCC: Inter-Governmental Panel on Climate Change
60. JNNURM: Jawaharlal Nehru National Urban Renewal Mission
61. LPD: Litres Per Day
62. LRHD: Low-Rise High Density

Abbreviations/Acronyms

63. MBR: Master Balancing Reservoir
64. MCGM: Municipal Corporation of Greater Mumbai
65. MDG: Millennium Development Goals
66. MHUPA: Ministry of Housing and Urban Poverty Alleviation
67. MJP: Marine Jet Power
68. MNRE: Ministry of New and Renewable Energy
69. MoEF: Ministry of Environment & Forests
70. MoRD: Ministry of Rural Development
71. MoUD: Ministry of Urban Development
72. MoWR: Ministry of Water Resources
73. MSW: Municipal Solid Waste
74. NBC: National Building Code
75. NCU: National Commission on Urbanisation
76. NEERI: National Environmental Engineering Research Institute
77. NGOs: Non-Governmental Organizations
78. NIT: National Institute of Technology
79. NRW: Non Revenue Water
80. NURM: National Urban Renewal Mission
81. NUTP: National Urban Transport Policy
82. PCRA: Petroleum Conservation Research Association
83. PHE: Public Health Engineering
84. PHED: Public Health Engineering Department
85. PMES: Program Monitoring and Evaluation System
86. PPD: Partnership in Population & Development
87. PPP: Public Private Partnership
88. PWD: Public Works Department
89. PSP: Public Stand Post
90. QIP: Quality Improvement Program
91. RDF: Refuse Derived Fuel
92. RECs: Regional Engineering Colleges
93. RTO: Road Transport Office

Abbreviations/Acronyms

94. RWAs: Resident Welfare Associations
95. SEACs: State Environment Appraisal Committees
96. SLR: Sea-Level Rise
97. SPA: School of Planning and Architecture
98. SPV: Solar Photo Voltaic
99. STPs: Sewerage Treatment Plants
100. SWM: Solid Waste Management
101. TCPO: Town and Country Planning Organisation
102. TERI: The Energy Resource Institute
103. TOR: Terms Of Reference
104. UDPFI: Urban Development Plan Formulation and Implementation Guidelines
105. UJS: Uttaranchal Jal Sansthan
106. ULBs: Urban Local Bodies
107. UMTA: Unified Metropolitan Transport Authority
108. UNFCCC: United Nations Framework Convention on Climate Change
109. UPES: University of Petroleum and Energy Studies
110. WTE: Waste-To Energy
111. WTP: Waste-To-Energy Project
111. WWF: World Wide Fund

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