

दिल्ली सरकार

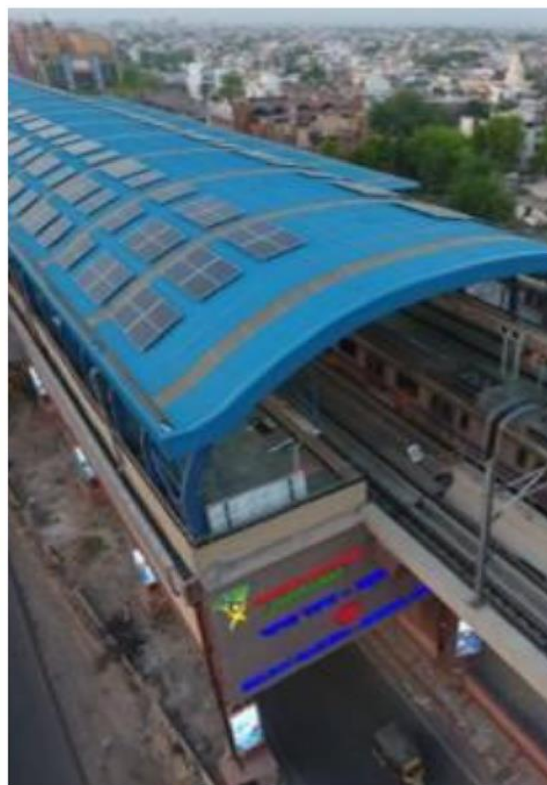
आप की सरकार



Ministry of Environment, Forests &
Climate Change
Government of India

Delhi State Action Plan on Climate Change

Department of Environment,
Government of NCT of Delhi



Executive Summary

The Delhi's Action Plan on Climate Change (SAPCC) has been formulated in accordance with the principles and guidelines of the National Action Plan on Climate Change (NAPCC). India's NAPCC released in 2008 outlines its strategy to meet the challenge of climate change. The Government of India through the Ministry of Environment, Forest and Climate Change (MoEF&CC) has directed each state to identify their Climate Change concerns and prepare an Action Plan to combat the local impacts and devise mitigation strategies, taking advantage of the various Missions of the NAPCC. The strategies thus required to be formulated as a part of the SAPCC are as per the state specific circumstances. The SAPCC of every state is required to formulate and prioritize financeable strategies and actions that can be made operational.

On 2 October 2016, India ratified the Paris Agreement. India's Nationally Determined Contribution (NDC) targets to lower the emissions intensity of GDP by 33% to 35% by 2030 below 2005 levels, to increase the share of non-fossil based power generation capacity to 40% of installed electric power capacity by 2030 (equivalent to 26–30% of generation in 2030), and to create an additional (cumulative) carbon sink of 2.5–3 billion tCO₂e through additional forest and tree cover by 2030.

According to the IPCC 5th Assessment Report, human influence has been detected in warming of the atmosphere and the ocean, in changes in the global water cycle, in reductions in snow and ice, in global mean sea level rise and in changes in some climate extremes. This evidence for human influence has grown since AR4. It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century. The atmospheric concentrations of the greenhouse gases carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O) have all increased since 1750 due to human activity. The deep interconnections between the vulnerability of natural and human systems to climate change calls for expeditious coping strategies and response measures. Climate proofing of vulnerable sectors, programmes, natural systems and communities by integrating adaptation and mitigation options into planning processes and interventions are increasingly becoming an integral part of the development/environment lexicon and action worldwide.

The climate response strategy of Delhi has key elements such as accelerating inclusive economic growth, promoting sustainable development, and safeguarding ecosystem services. Further, the strategy envisaged should not be viewed as a standalone action; instead it should be integrated into the regular developmental planning process. Similarly, while it is important to pursue both mitigation and adaptation measures, considering the overall socio-economic and ecological contexts and vulnerabilities, it would be of importance to give priority to adaptation options including Disaster Risk Reduction especially for State like Delhi.

The Department of Environment of the Government of NCT of Delhi acted as the State Nodal Agency for the preparation of SAPCC. The Delhi SAPCC integrates the action plan of Delhi with the ongoing and proposed developmental programmes in the state, and in tandem with the eight national missions along with the principles and guidelines listed out in the NAPCC. State Steering Committee under the chairmanship of Chief Secretary was constituted. Thereafter, the line departments dealing with the sectors sensitive to climate change constituted the seven sectoral Working Groups (WGs). The working group was represented by members from different relevant sectors/departments who contributed to the sectoral action plans prepared by the working group. These working groups were chaired by Chairman/ Secretary of the respective sector with a

designated nodal officer. In addition to the experts from the concerned department/ministry, the working groups had participation of experts from the Science and Technology, academia, research, NGOs and Civil Societies. The working groups were sensitised with the climate change issues in Delhi. Orientation for approach and methodology to be followed in the preparation of SAPCC was conducted in early March 2011. Deliberation and discussions were made in subsequent months which were used as the guiding principle in formulating the action plan for various sectors. Extensive consultations within the working group members and other concerned stake holders were carried out from 2011 to 2018. Actions, budget and period of implementation of the proposed actions across the sectors based on the above deliberations were included in to the Delhi's SAPCC. Draft report was further circulated to the stakeholders for comments.

Beginning with the brief background, Chapter 1 provides with the information about the SAPCC background, its objective and information on development issues and priorities. This chapter also details out the rationale and need of the SAPCC.

Chapter 2 deals with the approach and methodology being followed for preparation of the SAPCC. The step wise process is described in detail. The SAPCC preparation process is described in detail. A schematic flow of institutional framework is also presented along with the sectoral working groups formation and details of concerned departments & agencies engaged throughout the preparation of SAPCC. An internal feedback loop for 'validation and refinement' has been included to enhance the robustness of the process, which is further enhanced by actively involving local stakeholders in a multi-stakeholders consultation process using and by using a variety of tools.

Chapter 3 provides an introduction and profile to Delhi. It gives information on its geographical location, population growth trends, land use pattern, climate, connectivity, economic growth and other socio economic profile of Delhi.

Chapter 4 details out the Observed Climate trends and Climate Projections in Delhi. It also presents the projections of future temperature and rainfall which are identified using IMD gridded rainfall and temperature data for the period 1951-2010 and 1969-2005 respectively and simulations of global model NCAR_CCSM3 and regional model RegCM4.3.

Chapter 5 presents the activities and initiatives of the various departments of Government of NCT of Delhi with respect to NAPCC missions. This chapter also includes information on past and recently concluded activities undertaken by the local administration to deal with the issues of climate change.

Chapter 6 presents the Energy profile of the Delhi state. It covers the sectoral energy consumption patterns, fossil fuel consumption, CNG consumption, Industrial fuel, Energy consumption in governments owned operation, Sewerage pumping & treatment and street lighting.

Chapter 7 presents the energy demand Forecast and associated expected GHG Emissions for Delhi. It also covers macro-economic Indicators & their Projections, estimated Growth Rates of Different Sectors, primary energy consumption forecast under Different Scenarios.

Chapter 8 presents the Delhi GHG Emissions profile for the year 2014. It provides all the Energy intensive sectors energy consumption and related greenhouse gas emissions along with the carbon sink potential as per the international recognized accounting protocol.

Chapter 9 to 14, 16, 17 presents the comprehensive existing situation and proposed actions for including existing issues and challenges for Energy & Power Sector; Water resource; Forest and Biodiversity; Health; Transportation; Urban Planning; Agriculture and Horticulture; and Strategic Knowledge on Climate Change. It list the institutions Involved in respective sectors and their existing policies, programmes and projects. And then it presents the proposed sectoral strategies and actions to address Climate Change along with the budgetary provisions.

Chapter 15 presents the vulnerability assessment results including fragile sectors, climate change impacts, and vulnerable groups. It details the level of exposure, sensitivity and adaptive capacity of six sectors that are currently fragile and expected to be vulnerable to the impacts of climate change were identified for the state of Delhi, including: (a) Health, (b)Energy, (c)Water Resources, (d)Urban Planning (infrastructure, waste management and land use), (e)Transport, and (f)Agriculture, Forest & Biodiversity. In the end, it includes multiple fragile sectors targeted Policy and Infrastructure oriented actions and measures.

Chapter 18 presents the schematic flow and design of Monitoring & Evaluation (M&E) System and Implementation of the SAPCC plan. It also includes the details of all the identified and prioritized sectors budgetary provisions. Monitoring and evaluation framework is to measure and assess performance of the identified key strategies. It is proposed to select Research Institutions and universities and train on methods and approaches on monitoring mitigation and adaptation projections. Line departments have their inbuilt monitoring mechanism which may take care of monitoring and evaluation once trained. M&E would enable appropriate short-term and mid-term changes to the identified adaptation and mitigation strategies, correcting past mistakes and improving practices. Monitoring indicators, in the nature of output or outcome, have been selected and listed for each of the interventions, in the SAPCC. Monitoring frequency appropriate to each of the monitoring indicators, in so far as the SAPCC is concerned, has also been suggested.

Towards the end of the report, annexure includes the list of working groups along with the details of respective Chairperson, Conveners and members; Highlights of the meeting held with the MoEF&CC to take inputs of the Government of India on the Delhi SAPCC; and Working Groups meeting minutes.

The SAPCC is a dynamic and flexible policy framework which will follow a continuous and interactive process to reflect the changes and developments happening at the national, State and local levels. The stakeholder consultation process is an important aspect of SAPCC. Stakeholder engagement and consultation align them into the planning framework, and broadens and deepens perspectives and involvement in implementation of the State Action Plans for building a climate resilient economy. The Delhi SAPCC has been designed following stakeholders concerns and issues. The SAPCC has followed a structured approach to formulate and implement adaptation strategies, policies and measures to ensure human development in the face of climate variability and change. The implementation of Delhi SAPCC will be based on the strong stakeholder engagement and capacity development at all levels of the society to enable better acceptance and implementation of CC mitigation and adaptation measures.

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Abbreviations

ASI	Archaeological Survey of India
AT&C	Aggregate Technical and Commercial Losses
BARC	Bhaba Atomic Research Centre
BEE	Bureau of Energy Efficiency
BNHS	Bombay Natural History Society
BTPS	Badarpur Thermal Power Plant
CAGR	Compounded Annual Growth Rate
CBWTF	Common Bio- Medical Waste Treatment Facility
CCSR	Centre for Climate Systems Research
CETP	Common Effluent Treatment Plant
CDP	City Development Plan
CFL	Compact Fluorescent Lamp
CGS	Central Generating System
CGWA	Central Ground Water Authority
CMS	Central Monitoring Stations
CPWD	Central Public Works Department
CWC	Central Water Commission
DCB	Delhi Cantonment Board
DDA	Delhi Development Authority
DERC	Delhi Electricity Regulatory Commission
DJB	Delhi Jal Board
DMRC	Delhi Metro Rail Corporation
DPCB	Delhi Pollution Control Board
DPCC	Delhi Pollution Control Committee
DSIIDC	Delhi State Industrial and Infrastructure Development Corporation Limited
GDP	Gross Domestic Product
GPCD	Gallons Per Capita Per Day
CNG	Compressed Natural Gas
DTC	Delhi Transport Corporation
DUDTF	Delhi Urban Transport Development Fund
ECBC	Energy Conservation Building Code
EDMC	East Delhi Municipal Corporation
ETP	Effluent Treatment Plant
GHG	Greenhouse Gas
GSDP	Gross State Domestic Product
IMD	India Meteorological Department
INCCA	Indian Network for Climate Change Assessment
IPGCL	Indraprastha Power Generation Company Limited
ITS	Improving Transport Supply
IITM	Indian Institute of Tropical Meteorology
IPCC	Intergovernmental Panel on Climate Change
JICA	Japan International Cooperation Agency
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
LED	Light Emitting Diode
LPD	Litres per Day

LPG	Liquid Petroleum Gas
MDG	Millennium Development Goals
MGD	Million Gallons per Day
MGICCC	Mahatma Gandhi Institute of Climate Change Challenge
MoEF	Ministry of Environment & Forest
MNRE	Ministry of New and Renewable Energy
MRTS	Mass Rapid Transit System
MTD	Managing Travel Demand
NAPCC	National Action Plan on Climate Change
NATCOM	The National Communication of India to UNFCCC
NCTD	New Delhi Capital Territory
NDMC	New Delhi Municipal Corporation
NEERI	National Environmental Engineering Research Institute
NRCD	National River Conservation Directorate
NTPC	National Thermal Power Corporation
PRECIS	Providing Regional Climate for Impact Studies
PPCL	Pragati Power Corporation Limited
PWD	Public Works Department
RWA	Residents Welfare Association
RWH	Rainwater Harvesting
SAPCC	State Action Plan on Climate Change
SDMC	South Delhi Municipal Corporation
SFR	State of Forest Report
SPS	Sewage Pumping Stations
SRES	Special Report on Emissions Scenarios
STP	Sewage Treatment Plant
TERI	The Energy and Resources Institute
TPD	Tonnes per Day
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
WTP	Water Treatment Plant
YAP	Yamuna Action Plan

Preface

Science has indicated that climate change is likely to have adverse impacts on most of the economic sectors in India that are driven by climate such as Water resources, Agriculture and Horticulture, Biodiversity and Forests. These in turn are likely to affect livelihoods dependent on these sectors. Human health is another area of concern as some of the diseases are propagated by vectors that are climate dependent.

To address the climate change concerns the Government of India first defined its policy vis a vis climate change in June 2008 through a National Action Plan on Climate Change (NAPCC). The eight missions covered in this action plan were considered with a view to design strategies for adaptation to climate change that would ensure and enhance ecological sustainability and explore solutions towards more efficient technologies. The Honourable Prime Minister had called upon the States to expeditiously prepare the State Action Plans on Climate Change (SAPCC) which should be parallel to the strategy outlined in NAPCC. Translating national policies into action, especially at sub regional level, and decentralizing NAPCC objectives into local context is the greatest challenge. The preparation of State Level Action Plans is of great importance in this context.

Observation shows that Delhi falls in the areas of greatest climatic variability, maximum vulnerability and lowest adaptive capacity. Already, water resources in the State are scarce and have a highly uneven distribution both temporally and spatially. A threat such as climate change thus calls for timely and coherent response and actions that will help reduce vulnerability and build resilience of the State to the likely climate impacts. Considering these impacts of Climate Change, Delhi Government has prepared SAPCC focussing on Transport, Urban Planning, Water, Forest and Biodiversity, Agriculture and Horticulture, Health, Energy, Strategic Knowledge on Climate Change Sectors.

Message by Chief Minister

The challenge posed by climate change has become one of the critical issues of planet Earth. Each one of us has a responsibility to preserve the planet for our own betterment and to ensure a sustainable future for generations to come. The Government cannot be immune to this urgent task. Delhi is one of the fastest growing urban centers of the country. It faces the issues of ever-increasing population, urbanization, pollution, depleting natural resources and ultimately Climate Change.

The Government of NCT of Delhi has adopted best practices in various sectors including Transport, Energy Conservation, Health, Education, Water Conservation, Greening, Waste Management, etc. Delhi Government has taken number of initiatives for instance preparation of the green vision in line with the global Sustainable Development Goals and then the Green Budget to carefully plan the allocation of the financial resources for the development priorities with due consideration of the natural resources, environment and climate change. Some of the other initiatives includes lowering the pollution levels in Delhi with help of Odd-Even Scheme, Car-Free-Day on October 22nd 2015, banning plastic bags of thickness less than 50 microns and implementing Plastic Waste Management Rules, strengthening the monitoring framework for vehicular pollutions.

All these steps have been implemented or being implemented for making National Capital a better place to live for our coming generations however still we have long way to go and need to implement more such stringent and robust measures to tackle the issues of environmental degradation and climate change. It is important to prepare a long-term strategy since it is expected and believed that the climate change may undermine our development efforts with adverse consequences across the board on our people's livelihood, the environment in which they live and work and their personal health and welfare. Considering a vital need for a better strategy, Delhi Government has prepared this State Level Action Plan on Climate Change (SAPCC). Delhi's SAPCC sets forth the ways considering the need for combating climate change. We have outlined our progress and future plan of actions across all of the development sectors.

I am pleased to see that the various departments of the Government of NCT of Delhi have worked together and contributed in the preparation of Delhi's SAPCC. Delhi's SAPCC has been prepared so as to set up a common but shared agenda for climate change mitigation and adaptation. This State Action Plan is a document which aims to connect between evolving climate science, policies and practices. The Delhi's SAPCC is a dynamic and flexible document and would be subject to periodic review so as to revisit the suggested strategies and constantly refine them.

I hope that the priorities identified under the SAPCC will lead to sound implementation of strategies that will help to address the challenge of climate change in the State and ensure a future of sustainable development. The aim is to sets out sector specfici actions, which are achievable in the next few years in the context of our developmental priorities to achieve the objectives of sustainable, resilience and liveable society.

Message by Environment Minister, GNCTD

Climate Change is on top of the development debate these days & the reason being unpredictable consequences it can have on our habitat. As a developing mega city each citizen has to contribute to ensure that adverse impacts of global warming are controlled and mitigated by taking measures which help to reduce Greenhouse Gases.

Delhi's SAPCC clearly brings out the actions necessary as outlined in the NAPCC and creates a framework for implementing a series of actions by different departments of the Government of Delhi. Government of Delhi has been leading the clean and sustainable development in number of sectors. We have taken strong measures such as Odd and Even Scheme, massive tree plantation, prevention of biomass and garbage burning, greening of public spaces, ban on BSLV III engines and implementing policy to ensure that only eco-friendly BSLV IV engines are manufactured, implementing Bio-Medical Waste Management Rules, and ban on plying 15 years or more old commercial/transport vehicles etc. During 2016-17 a total of 8.72 Lakh sapling and 12.31 Lakh shrubs had been planted by the Forest Department alongwith other greening agencies. During 2017-18, about 5.5 lakh saplings and 7.93 lakh shrubs have already been planted till December, 2017.

The report highlights the activities already being done by the Government of Delhi to achieve those ends and the measures that need to be taken in the future. It is action at the ground which makes all the difference in achieving our goals. Every citizen has a role to contribute. Development & Sustainability should go hand in hand. With involvement of civil societies, Government Departments & common people, we need to work together to address the needs of development, meet the aspirations of the people and addresses the concerns of our planet. It is the right time to incorporate the concerns of climate change in our development agenda and Delhi SAPCC attempts to do that. With the citizens cooperation it is possible to address all the issues comprehensively. I hope this document will be read and discussed by all civil society groups and within the government for its successful implementation.

While engaging with national policies and programmes, it is important for us to develop well researched and formulated mitigation and adaptation strategies specific to the Delhi to respond effectively to the possible impacts of Climate Change. To address the changing climatic conditions SAPCC has been developed by the Government of NCT of Delhi. The SAPCC has flagged important issues which require attention. The action plan has highlighted key sectoral concerns and strategies for action in order to lead the way.

Message by Chief Secretary, GNCTD

Climate Change is an unprecedented threat to humanity and has implications on sustained economic growth which is exclusively top concern for country like us. Climate change risks is expected to increase the frequency and intensity of current hazards, an increased probability of extreme events, spur the emergence of new hazards and vulnerabilities with differential spatial and socio-economic impacts. This is expected to further degrade the resilience and coping capacities of poor and vulnerable communities. Delhi has reason to be concerned about Climate Change, as we witness increased frequency of hot days, air quality levels exceeding the maximum limits, warm spells exacerbate urban heat island effects, causing heat-related health problems, as well as an increase in energy demand for warm season. A threat such as climate change thus calls for timely and tangible policy response and action that will help reduce vulnerability and build resilience of the State to likely climate impacts.

The Government of India issued the NAPCC to address the challenges of climate change on June 30, 2008 and in the year 2009 the Prime Minister's Council on Climate Change called upon the Indian states to prepare SAPCCs consistent with the strategy outlined in the NAPCC.

Delhi SAPCC has been prepared with great efforts from all of the concerned department of Government of NCT of Delhi. It include key development sectors existing development issues, scenarios and actions measures with budgetary provisions. We all are supposed to work together for the successful implementation of the climate change related measures. It is only through our collaborative and joint effort we can make Delhi a truly sustainable and climate resilient.

This also gives us a unique opportunity to implement the concerns of Climate Change in our policies and ensure ultimate objective of sustainable development with inclusive growth. This State Action Plan aims to connect between climate research findings, Government policies and activities. Delhi SAPCC is a dynamic document and would be continuously updated to reflect the development priorities and progress on the meeting the sustainable development objectives.

I express my appreciation to all the working groups and concerned department for their generous support and cooperation throughout the journey of preparation of Delhi's SAPCC.

Message by Secretary, Environment, GNCTD

Development Agenda can be marshaled to meet the objective of preserving our planet. Mother earth provides us with all our needs. But in our desire to get most out of it, we have neglected its health and as per the report of the United Nations Inter-Governmental Panel on Climate Change, planet earth needs urgent resuscitation to continue to provide for our needs. Department of Environment, Government of NCT of Delhi is the State Nodal Agency for the coordination and preparation of SAPCC. The Sectoral Working Groups with officers of concerned departments dealing with the sectors sensitive to climate change were constituted. In addition to the experts from the concerned department, the working groups had participation of experts from the various concerned departments of the Government of NCT of Delhi, Science and Technology, academia, research, NGOs and Civil Societies etc.

The policy prescriptions given in the document need to be adopted and implemented as part of our development goals. It will mean a new thinking to be infused in our planning processes and harnessing new technologies as well as making innovative programs, which can meet the objectives set forth by us. It seeks to redefine the growth imperatives for mankind, by ensuring sustainability of planet earth's bio diversity and natural balance, as part of the development process. Unless each one can put the effort and be concerned about it, and contribute to achieve this, there can be irretrievable damage to mother earth. Delhi's SAPCC consists of following key chapters: Greenhouse Gas Emissions Profile, Energy Consumption Profile, Energy and Power, Transportation, Urban Planning, Forest -and Biodiversity, Health, Agriculture and Horticulture, Vulnerability Assessment, Water, Strategic Knowledge on Climate Change, Monitoring & Evaluation System and Implementation of the Plan. Based on the discussions, inputs provided by the various state departments, the SAPCC of Delhi has been prepared for our benefit.

It is now well recognized that the only way to ensure that the global balance of factors which can arrest the worsening trends towards climate change, is the need to cut down on the emission of Greenhouse Gases or those emissions which destroy the Ozone layer and accelerate the pace of Global Warming. The time to act is now. Each of us as citizens, planners, policy makers, administrators, business people, and students can enhance our ability to contribute to a more to prevent worsening of our environment. I appreciate the efforts of various state departments and professionals associated with Climate Change for their commendable work.

Acknowledgment

The Department of Environment, Government of NCT of Delhi hereby acknowledges continuous expert guidance of Chief Secretary, Delhi for Charing the Steering Committee and acknowledges the contribution of the line departments, think-tanks, academic and research institutions, NGOs, industry associations and individual experts who have contributed towards the development of the content of the Delhi State Action Plan on Climate Change (SAPCC). These include:

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Finally, the Department of Environment would like to thank all the members of the working groups, concerned officials of Government of NCT of Delhi and external experts who participated in this process by attending meetings, stakeholder workshops, public sessions, and providing their crucial comments.

1. Background

The future predicted impacts of climate change include a decrease in snow cover in the Himalayas, erratic monsoons, rising sea levels and an increase in the frequency and intensity of floods¹. There is already evidence of prominent increase in the intensity and/or frequency of extreme weather events across Asia.

Climate change will impact across the sectors. The outcome of climate change on the developing and the least developed countries are excessively high due to three main reasons: first geographical location, second high dependence of people on natural resources that are highly sensitivity to climate change, third low adaptive capacity due to fewer amounts of resources available to them.

In 2016, India's CO₂ emissions increased by about 4.7% to about 2.5 Gt CO₂². This was mainly due to continuing GDP growth, paired with increases in fossil fuel consumption. The largest increases in per cent were seen in the consumption of natural gas and oil products of 9.5% and 8.6%, respectively. Coal consumption increased by 3.9%. India's CO₂ emissions mainly stem from coal combustion, which has a share of 72% in total fossil fuel combustion emissions, with 25% from oil products³.

Future emissions are set to grow rapidly, owing to high economic growth rates and carbon-intensive development. With current development patterns and business-as usual growth, India could be responsible for up to 6 billion tonnes of GHG emissions by 2030, and lock-in carbon-intensive practices in all areas of growth (industry, buildings, transport, and power).

The Indian government has pledged to cut its carbon intensity by 33 to 35 percent below 2005 levels by 2030. This will require that necessary actions in specific sectors are undertaken to reduce emission intensity with necessary provisions of financial and technological resources including the domestic and international support for achieving low carbon sustainable development. India's Five Year plans include a strategy for sustainable growth resulting in low carbon sustainable development.

Apart from engaging in the UN multilateral negotiations on climate change through the UN Framework Convention on Climate Change (UNFCCC), the Indian government has also developed its own national level strategy to combat the threat in an effort to secure its own economy and growth which is closely linked to natural resource management. The national strategy will help 'firstly, to adapt to climate change and secondly, to further enhance the ecological sustainability of India's development path.' The national action plan is based on 8 National Missions, 'representing multi-pronged, long-term and integrated strategies for

¹ India's National Communications to the UNFCCC, 2007

² Olivier J.G.J. et al. (2017), Trends in global CO₂ and total greenhouse gas emissions: 2017 report. PBL Netherlands Environmental Assessment Agency, The Hague

³ BP (2017). Statistical Review of World Energy 2017. <http://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-worldenergy.html> [Accessed 5th May, 2018]

achieving key goals in the context of climate change.’ These missions are briefly outlined in next section.

1.1 Regional development issues and priorities vis-à-vis national priorities and NAPCC

The fifth assessment report of the Intergovernmental Panel on Climate Change (IPCC) indicated from its direct observations that the earth’s climate is changing at an unprecedented pace leading to potentially serious economic impacts and implications for sustainable development. Climate projections for India predict that impacts are likely to be varied and heterogeneous posing huge risks to human life and threat to the sustainability of the country’s growing economy.

Recognizing the need of the hour, the Government of India came ahead with the plan that could address the urgent and critical concerns of the country, promote our development objectives while also yielding co-benefits for addressing climate change effectively. The Prime Ministers Council on Climate Change, in its first meeting on 13th July, 2007, decided that “A *National document compiling actions taken by India for addressing the challenge of Climate Change, and the action it proposes to undertake*” be prepared. On June 30 2008, Government of India announced its First National Action Plan on Climate Change (NAPCC) with an *objective* to adapt and to enhance ecological sustainability of country’s development path. The *principal* behind NAPCC is to maintain a high growth rate and reduced vulnerabilities with the *vision* to create a prosperous and self sustaining economy. Identified eight cores “national missions” in the NAPCC focuses on:

National Missions	
1.	National Solar Mission
2.	National Mission for Enhanced Energy Efficiency
3.	National Mission on Sustainable Habitat
4.	National Water Mission
5.	National Mission for Sustaining the Himalayan Ecosystem
6.	National Mission for a Green India
7.	National Mission for Sustainable Agriculture
8.	National Mission on Strategic Knowledge for Climate Change

- Enhancing energy efficiency;
- Increasing the penetration of solar photo-voltaic and solar thermal in the total energy mix;
- Developing climate friendly sustainable habitats;
- A water mission for integrated water resources management;
- A mission on sustainable agriculture for making it more resilient to climate change;
- A green mission for enhancing ecosystem services of forests and for enhancing its Carbon sequestration capacity;
- A mission on Himalayan ecosystem for sustaining and safeguarding the Himalayan glacier and mountain ecosystems; and the last mission is aimed towards
- Developing strategic knowledge base to address the concerns of climate change

India's immense geographical diversity adds to the complexity of developing and implementing an adaptation strategy. The impacts will vary across states, sectors, locations and populations. Consequently, there can be no one-size-fits all climate change strategy. Hence, it is required that approaches designed will need to be tailored to fit state and local vulnerabilities and conditions. In keeping with the wider objectives of the NAPCC, the Prime Minister called on the states and the union territories to initiate the preparation of State Action Plans consistent with the strategies in the National Plan in an address on August 18, 2009. To support the states in this complex undertaking, Ministry of Environment and Forest (MoEF) circulated a set of guidelines for the states: "A framework for the preparation of State Action Plan on Climate Change (SAPCC)" in November 2010. Each state government has been directed to formulate its own state level policy on climate change to coordinate the implementation of the national plan at the state level.

1.2 Need for State Level Action Plans on Climate Change

With the formulation of a national policy on climate change, it has become imperative to achieve coherence between the strategies and actions at national and state levels. Adaptation challenges are experienced most acutely at the state level. The governments (both national and state) have considerably enhanced budgetary outlays for development over the years; the livelihoods of communities in rural and urban areas remain vulnerable to the impacts of climate change. Unless adequate actions are taken at the state level, climate change may become a major impediment to the endeavor of realizing national development priorities including the Sustainable Development Goals (SDGs). Hence, there is an urgent need for State Governments to prepare SAPCC, which will enable them to understand the uncertainty of future climatic conditions and engage effectively in a process of developing adaptation programmes.

The processes of intervention will focus more on the local level covering all the formal as well as informal sectors. In the process of preparation of such action plan, there may be the requirement to re-look into existing policies of the state with the perspective of reframing and restructuring along with creating mechanism for integration/coordination at sectoral and spatial level.

In Jan 2009, GNCTD became the first federal state to have adopted a Climate Mitigation and Adaption Plan⁴ within the broad outlines of National Action Plan on Climate Change. A framework for implementing a series of action under the plan was initiated by the GNCTD. The plan had a 65-point four-year agenda to fight climate, the plan further had been consolidated to 36 agenda points. It basically, aimed to encourage use of solar power, increase in use LEDs, setting up of an electronic waste facility, more CNG buses to promote public transport, promoting use of bio-fuel and shutting down coal fired power plants. It also planned to encourage reuse of construction waste, increase green cover by developing more city forests and parks, preserve natural heritage, create Biodiversity Parks, enrich biodiversity of existing greens, restore water bodies and reuse waste water. Over the years,

⁴ Climate Change Agenda for Delhi, 2009-2012

various order of the Hon'ble Supreme Court has also helped the GNCTD to take strict measures with regards to environmental protection and climate change.

Further, The Government of NCT of Delhi has prepared the SAPCC for beyond 2012 considering the impacts of Climate Change on all of the priority sectors namely Energy and Power, Transportation, Urban Planning, Forest and Biodiversity, Health, Agriculture and Horticulture, and Water. New SAPCC provides the details on existing scenario, issues, development priorities and schemes along with specific action and budgetary requirements.

2. The Process of Preparation

2.1 Steps of Preparation of Delhi-SAPCC

In Jan 2009, GNCTD became the first federal state to have adopted a climate mitigation and adaptation plan with the broad outlines of NAPCC. The GNCTD has initiated several programs towards addressing adaptation and mitigation of climate change which have linkages with activities under the NAPCC.

Sectoral working groups comprising of officials from concerned departments were formed for the preparation of the Delhi's SAPCC. The working groups were represented by members from different relevant sectors/departments who contributed to the sectoral action plans. These working groups were chaired by heads of the respective sector with a designated nodal officer. In addition to the experts from the concerned department, the working groups had participation of experts from the Science and Technology, Academia, Research, NGOs and Civil Societies.

The first series meeting of the working groups was convened on 15th March, 2011. The workshop was organised by the Department of Environment and Forests, GNCTD, which is the nodal agency for climate change matters in the government. The workshop was chaired by the Secretary, Department of Environment, GNCTD. The Secretary stressed the need to Delhi's SAPCC. He stated it is a mandatory task for every state in India to design strategies to mainstream climate change concerns in its planning and implementation of various developmental programmes to adapt to the adverse impacts of climate change.

The working groups were sensitised with the climate change issues in Delhi in the overall process. Orientation for approach and methodology to be followed in the preparation of SAPCC was discussed during working groups meeting. Deliberation and discussions made during meetings and action taken/inputs received were used as the guiding principle in formulating the action plan for various sectors. Extensive consultations within the working group members and other concerned stake holders were carried out. Actions, budget and period of implementation of the proposed actions across the sectors based on the above deliberations were drafted in to action plans. Draft report was further circulated to the stakeholders for comments. The draft report was updated with the comments duly received. The series of meeting of the working group on Climate Change were held during the course, under the Chairmanship of Additional Secretary (Environment) to discuss and take stock of the draft SAPCC.

This was followed by 2 day workshop on 16-17, February, 2015 organized by MOEF & CC, Government of India to bring out clarity and understanding on linkage of National Missions with SAPCC. Consequently, a review presentation on Delhi's SAPCC was held before Hon'ble Minister (Environment & Forest), GNCTD. This was followed by workshop on 28th May 2015 with stakeholder departments/agencies. This workshop had department wise discussion on the action points for combating Climate Change & Chapters

were prepared. The draft SAPCC report at this stage was circulated again to all of the concerned departments/agencies. The action was reviewed by Secretary (Environment) on 7th August, 2015. After incorporation of comments/inputs of all concerned departments, a final meeting with stakeholder departments was convened on 23rd September, 2016.

The following key sectors have been identified by working groups which took shape of specific chapters in the main document.

- Energy and Power
- Transportation
- Urban Planning
- Forest and Biodiversity
- Agriculture and Horticulture
- Health
- Vulnerability Assessment
- Water Resources
- Strategic Knowledge on Climate Change
- Monitoring & Evaluation System and Implementation of the Plan.

The due consideration to India's Nationally Determined Contributions (NDC) have been made while preparation of the Delhi's SAPCC in way to contribute to the overall national target of reduction in the emissions intensity of its GDP by 33 to 35 per cent by 2030 from 2005 level and to create an additional carbon sink of 2.5 to 3 billion tonnes of CO₂ equivalent through additional forest and tree cover by 2030.

Delhi's SAPCC heavily relies on community and private sector involvement. The government plans to leverage its partnership approach here. It has been well established that policy processes that include public participation are well grounded and successfully implemented. Especially in the field of environmental policy, where the problems are highly complicated and value laden, different forms of public involvement and consultation have been used in agenda-setting and policy formulation as well as in conflict resolution for many years. Moreover, involving representatives from multiple agencies helps in cross sectoral participation leading to identify access and leverage existing programs, resources and tools developed by other organizations. The key stakeholders in the formulation of Delhi's SAPCC typically includes but not limited to the following institutions:

- State Agencies like DDA, Transport Department, Delhi Jal Board, Municipal Corporations, PWD, DPCC and NDMC etc.
- Universities, academia and research institutions like IIT, Delhi University, Mahatma

Gandhi Institute for Combating Climate Change (MGICCC) etc.

- Industries and Industry Associations which will include all small, medium and large scale industries, CII, FICCI.
- Non Governmental Organizations like ICLEI South Asia, CSE, TERI, etc
- Bilateral and Multilateral Organizations like UNDP, DFID, World Bank etc.
- Civil Society Organizations
- Press and Media

Based on the discussions, inputs provided by the various state departments, the Draft State Action Plan for Climate Change for Delhi is prepared.

3. Delhi State Profile

Delhi's position in the States of India is very unique and this is the only city State in India with an urban population of 97.5 per cent. As per Census 2011, it has a population of 1.67 crore (16.7 million). With a density of 11.297 persons per sq. Km. It is India's second largest urban agglomeration after Mumbai. Delhi is expected to be highly prone to the consequences of climate change because of its sensitive geo-ecological set-up, strategic location, presence of the mountain ranges, transboundary river systems, inhabitation of ecosystem by people of different ethnic groups and inherent socio-economic differences. Given the fact that it is the capital of the country, Delhi needs to prepare a climate change adaptation and mitigation plan integrated with the strategic developmental plan to be a showcase.

3.1 Location, Geography and Climate

Delhi is located in northern India between the latitudes of 28°-24'-17" and 28°-53'-00" North and longitudes of 76°-50'-24" and 77°-20'-37" East. It has an area of 1,483 sq. kms and shares borders with the States of Uttar Pradesh and Haryana.

In January 2012, Delhi Municipal Corporation had been trifurcated into three smaller Municipal corporations - North Delhi Municipal Corporation, South Delhi Municipal Corporation, East Delhi Municipal Corporation for the better management of urban services. The areas included in the three Municipal corporations are as follows;

- North Delhi Municipal Corporation - Districts of Central Delhi, North Delhi, North West Delhi.
- South Delhi Municipal Corporation - Districts of South Delhi, South East, West Delhi, South West Delhi (excluding Delhi Cant).
- East Delhi Municipal Corporation - Districts of East Delhi, North East Delhi and Shahdara.

The Yamuna River and terminal part of the Aravali hill range are the two main geographical features of the city. Delhi is situated on the right bank of the river Yamuna at the periphery of the Gangetic plains. Delhi is bounded by the Indo-Gangetic alluvial plains in the North and East, by Thar Desert in the West and by Aravalli hill ranges in the South. The terrain of Delhi is flat in general except for a low North-eastern and South-western trending ridge that is considered an extension of the Aravalli hills of Rajasthan.

Figure 1: Map of Delhi



Delhi has a semi-arid climate, with hot summers, average rainfall and moderate winters. Mean maximum monthly temperatures as in 2017, range from 9.1°C in January to 40.1°C in May. The annual precipitation recorded in 2017 is about 779 mms, out of which 583.4 mms was recorded during the monsoon months (July-Sept.). Heavy rainfall in the catchment area of the Yamuna results in a dangerous flood situation for the city. Dust storms are frequent during the summer months leading to an immense build-up of particulate matter in the atmosphere.

3.2 Demographic Trends

Delhi’s urban population growth during 2001-2011 is the fastest at 26.8 per cent, with Mumbai and Kolkata being way behind, at 12 percent and 6.9 percent, respectively. It hosts over 16.75 million people as per estimates of 2011 census. A large part of this rapid growth has been due to the increased urbanization and uncontrolled migration. This pace of urbanization has had its impact on the socio economic make up of Delhi and on its infrastructure.

Table 1: Population of Delhi-Decennial Growth⁵

Region	Period	Population	Percentage variation since previous Census
Total	1911	413,851	1.98
Urban		237,944	11.13
Rural		175,907	-8.24
Total	1921	488,452	18.03
Urban		304,420	27.94

⁵Directorate of Census Operations, Delhi- 2011

Region	Period	Population	Percentage variation since previous Census
Rural		184,032	4.62
Total	1931	636,246	30.26
Urban		447,442	46.98
Rural		188,804	2.59
Total	1941	917,939	44.27
Urban		695,686	55.48
Rural		222,253	17.72
Total	1951	1,744,072	90
Urban		1437,134	106.58
Rural		306,938	38.1
Total	1961	2,658,612	52.44
Urban		2,359,408	64.17
Rural		299,204	-2.52
Total	1971	4,065,698	52.93
Urban		3,647,023	54.57
Rural		418,675	39.93
Total	1981	6,220,406	53
Urban		5,768,200	58.16
Rural		452,206	8.01
Total	1991	9,420,644	51.45
Urban		8,471,625	46.87
Rural		949,019	109.86
Total	2001	13,850,507	47.02
Urban		12,905,780	52.34
Rural		944,727	0.45
Total	2011	16,753,235	20.96
Urban		16,333,916	26.56
Rural		419,319	-55.61

3.3 Socio- Economic Profile

As the country's capital, Delhi experiences vibrant trade and commerce and excellent employment opportunities. It has attracted people from all over the country and its population today truly reflects the wealth and diversity of India wherein diverse religions, languages, customs and cultures co-exist in splendid plural harmony.

Delhi has one of the fastest growing economies in the country. At the same time, this affluence acts as a magnet for immigration from neighbouring states and drives the rapid growth in the city's population. The growing population, coupled with the growing per capita has led to the quick growth of the services sector while the high proportion of immigration has provided a ready pool of resources for the unorganized sector of the city.

3.4 Ecological Profile

The unprecedented pace and scale of urbanization over the last few decades in Delhi has created enormous stress on the natural resources of the city. This degradation includes impact on green cover, loss of biodiversity and aesthetics, air pollution, surface and ground water pollution, loss of water bodies, receding water table, high incidence of diseases and mortality.

With the rising economic growth, city has faced environmental problems due to high levels of air pollution. Major sources of air pollution in Delhi include transport, power and industrial sectors. Although the SO_x & CO levels are just within the permissible limits but the levels of NO_x, suspended particulate matter and the respiratory particulate matter in the air are alarming.

Delhi's sources of water typically consist of surface and ground water where surface water contributes to over 86% of Delhi's total drinking water. Yamuna provides the major share of this water. Other sources of drinking water supply to Delhi include the Himalayan Rivers through different interstate arrangements and sub-surface sources like Ranney wells and tube wells. It is reported that there are 1022 water bodies including lakes, ponds and reservoirs in Delhi but most of them have depleted. In addition to quantity, the quality of groundwater is also deteriorating becoming unfit for human consumption.

The river Yamuna enters Delhi at Palla at north and exits at Jaitpur in south after passing through 52 km in Delhi stretch. The 22 km urban stretch below Wazirabad reservoir of the river is virtually a sewer. The flood plains have been encroached and degraded due to dumping of solid waste and whatever left is under agriculture. Almost all the wetlands are silted and filled.

The degradation of the forest cover in Delhi sums up the threat to not only the environment but to the overall sustainability of the city. The Ridge area of Delhi has degraded tremendously due to by roads, buildings, traffic, and garbage dumping, lopping of trees and grazing by livestock. Mining and quarrying activities in the past have degraded the South-Central Ridge causing enormous loss to biodiversity. The Ridge is predominantly composed of an alien invasive species – *Prosopis juliflora* and the alien weed species such as *Lantana*. An ecologically important location, the Asola Wildlife sanctuary, was established to protect and conserve the city's flora and fauna.

The city suffers from all the health related problems caused by the polluted atmosphere. High occurrence of respiratory infections, heart problems, sickness from water and vector-borne diseases and other diseases because of exposure to ambient and indoor pollutants and inappropriate disposal practices of municipal solid waste have become the way of life in the city. Poor living conditions, constant exposure to the pollutants, untreated wastes has resulted in high incidence of diseases like diarrhea, hepatitis, dengue and others.

Large scale of commercial activities, rapid urbanization and development has resulted in large influx of people every year. Coupled with city's own population this has brought forth the acute environmental problem in the form of air, water and noise pollution and in particular a severe problem of GHGs emissions. Delhi is the only city in NCR with real time online air quality monitoring station.

In general, combustion is the chief contributor to outdoor air pollution and GHG emissions. In most cities, the major source of GHGs are released through consumption of electricity in residences, commercial setup, industries, street lighting or other municipal activities, through vehicles using fossil fuels, as well as through solid waste disposal and dumping, among others activities. The major source sectors for GHG emission in Delhi include Road Transport, Thermal Power Plants, Domestic, commercial, Industries and Landfill sites.

GNCTD has undertaken a number of actions in all infrastructural / developmental projects. This has been done by all developmental agencies which have resulted, directly or indirectly in combating climate change. Delhi government have better facilities, public transport, regular electricity and waste disposal. Delhi is the first state in India to have Climate Change agenda 2009-2012.

4. Observed Climate and Climate Projections

4.1 Extreme Events

Extreme minimum and maximum temperature events appear to be increasing in Delhi. In December of 2006, Delhi had the lowest temperature since 1935 (0.2°C). In June 2007, Delhi had a maximum temperature of 44.9°C. While these extreme temperatures cannot be directly linked to climate change, the challenge facing Delhi is variability in weather patterns and the potential for exacerbated extreme events due to climate change. There are some months when temperature and precipitation were greater than standard deviation from the mean. The hottest summer was in 1944, the coldest winter in 1935 and the wettest monsoon in 1958, however recent years have seen similar extremes in temperature in 1978, 1988 and 1996 and precipitation in 1994, 1995, and 2003.

Table 2: Past Extreme Events in Delhi

S.No	Past Extreme Events
1.	Extreme Temperature: May 1978; April 1988; May 1996 Max. Recorded Temp.:47.2 °C May 29, 1944 Lowest Recorded Temp.: -00.6 Jan 16, 1935
2.	Extreme Precipitation: July 1994; July 1995; June 2003 Max. Rainfall in 24 hours: 266.2mm Jul 21, 1958

Table 3 gives the frequencies of the occurrence of cold waves and hot waves in Delhi for different time periods⁶.

Table 3: Cold Waves and Heat Waves in Delhi

Period	Cold Waves	Heat Waves
1901-10	-	-
1911-67	-	-
1968-77	4	1
1978-99	15	2
1901-99	19	3

Delhi, the metropolis, is highly vulnerable to natural hazards like floods, earthquakes and epidemics. The city is unsystematically urbanized, densely populated, having thousands of unplanned building structure, sizeable number of urban slums, unauthorized colonies and stuffed industrial clusters which compound vulnerabilities in Delhi.

IPCC's Fifth Assessment Report (AR5)⁷ clearly signifies that the climate change has significant influence on the frequency and magnitude of natural hazards worldwide. The GNCTD has established a nodal agency, namely Delhi Disaster Management Authority, to facilitate, coordinate and monitor disaster management activities and promote good disaster

⁶ De U S, Dube R K and Prakasa Rao G S (2005), *Extreme Weather Events over India in the last 100 years*, J. Ind. Geophys. Union Vol.9, No.3, pp.173-187

⁷ <http://www.ipcc.ch/report/ar5/> [Accessed 5th May, 2018]

management and mitigation practices in the State. Delhi's Disaster Management Authority has prepared disaster preparedness and mitigation plan which attempts to protect the lives and properties of the people of Delhi from potentially devastating hazards by the implementation of an effective long term Delhi Disaster Management Policy. The initiatives under this plan lay down certain objectives and suggest definitive strategies leading to the achievement of goals in a set time frame. The ultimate goal for the GNCTD with respect to various hazards is to have prepared communities in a way that when the hazards strike, there is little or no loss of life; least number of injuries and the losses to property and infrastructure are not critical.

4.2 Possible Future Climate Scenarios

Observational studies over India have shown warming of about 0.5°C per 100 years on an all India average basis though pockets of higher values and even cooling exist over different parts of India. Future projections of climate change using global and regional climate models, run by Indian Institute of Tropical Meteorology (IITM) with different IPCC emission scenarios, indicate temperature changes of about 3 – 5°C and increase of about 5-10% in summer monsoon rainfall. It is also projected that number of rainy days may decrease by 20 to 30% which would mean that the intensity of rainfall is expected to increase. Extremes in temperature and rainfall also show increase in their frequency and intensity by the end of the year 2100. As per the assessment of IITM, in the daily rainfall for over 50 years show similar trends in extreme rainfall. Crop models run with such scenarios also show fall in food production per acre in India by about 20%. Further hydrological models show fall in India's water resources which when combined with the recession of Himalayan glacier would pose a serious threat to the food and water security of the rising population of India.

4.3 Model Projections

High resolution climate change scenarios for Indian, generated by PRECIS indicate a rise in annual mean surface air temperature for all parts of India. Temperatures are likely to rise by 2-5°C and 2.5-4°C in A2 and B2 IPCC SRES emission scenarios by the end of 21st century (2071-2100), with warming more pronounced over the northern parts of India. The warming is also expected to be relatively greater in winter and post-monsoon seasons than in the summer monsoon season. Spatial pattern of rainfall change estimates a 20% rise in all India summer monsoon rainfall for the future in both A2 and B2 scenarios.

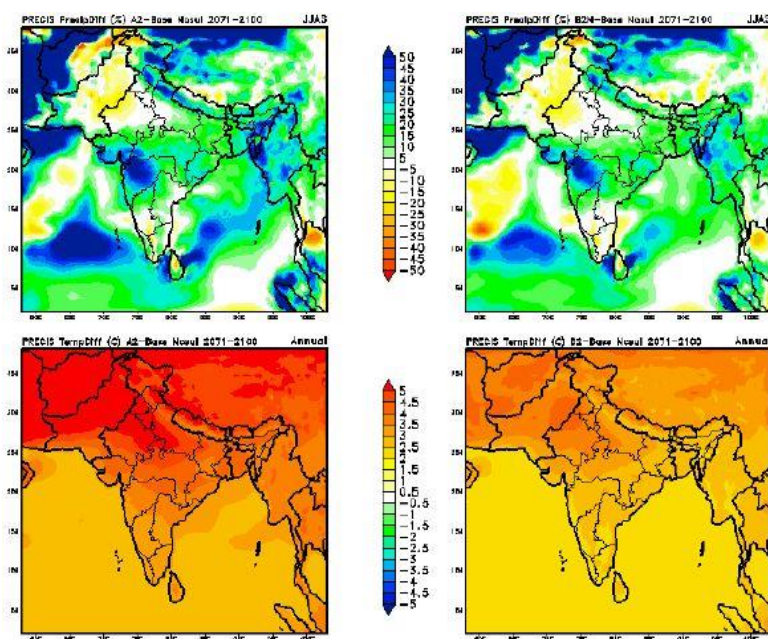
The A2 scenarios are of a more divided world. The A2 family of scenarios is characterized by: A world of independently operating, self-reliant nations; continuously increasing population; regionally oriented economic development.

The B2 scenarios are of a world more divided, but more ecologically friendly. The B2 scenarios are characterized by:

- Continuously increasing population, but at a slower rate than in A2.
- Emphasis on local rather than global solutions to economic, social and environmental stability.
- Intermediate levels of economic development.
- Less rapid and more fragmented technological change than in A1 and B1.

The four SRES scenario families of the <i>Fourth Assessment Report</i> vs. projected global average surface warming until 2100		
AR4	More economic focus	More environmental focus
Globalisation (homogeneous world)	A1rapid economic growth (groups: A1T; A1B; A1FI) 1.4 - 6.4 °C	B1global environmental sustainability 1.1 - 2.9 °C
Regionalisation (heterogeneous world)	A2regionally oriented economic development 2.0 - 5.4 °C	B2local environmental sustainability 1.4 - 3.8 °C

Figure 2: Projected changes in summer monsoon rainfall (upper panel) and surface air temperature (lower panel) for A2 and B2 scenarios for 2071-2100 (Kumar et al 2006)



The figures below from the IITM, Pune show some results using a range of IPCC emissions scenario and a range of global climate models.

Figure 3: Expected Future Changes in Rainfall and Temperature over India under IPCC SRES A1B GHG Scenarios

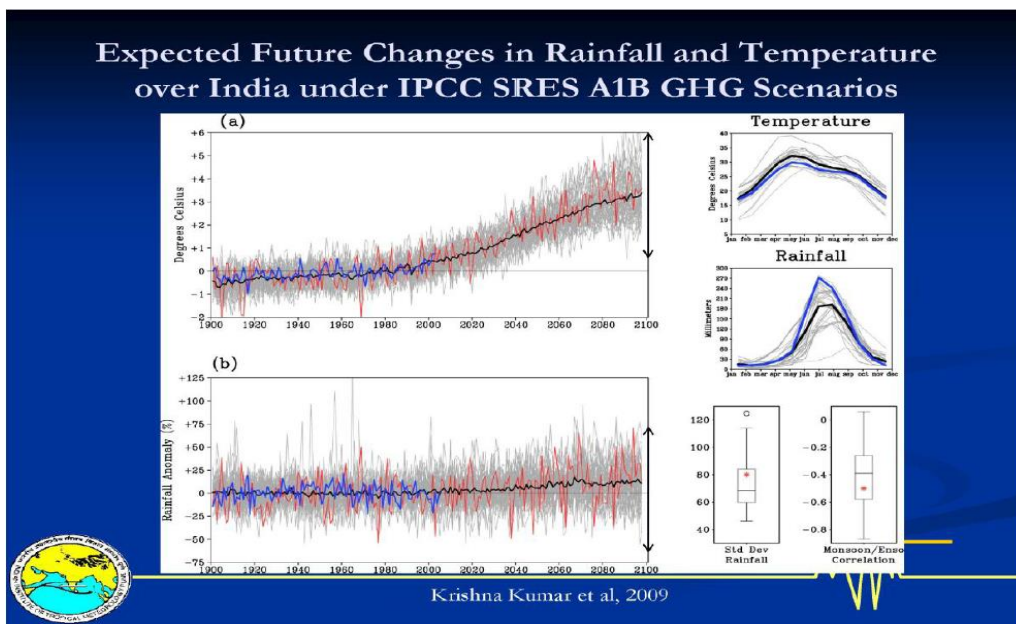


Figure 4: Expected Future Change in Monsoon Rainfall and Annual Surface Temperature for 2020's, 2050's and 2080's.

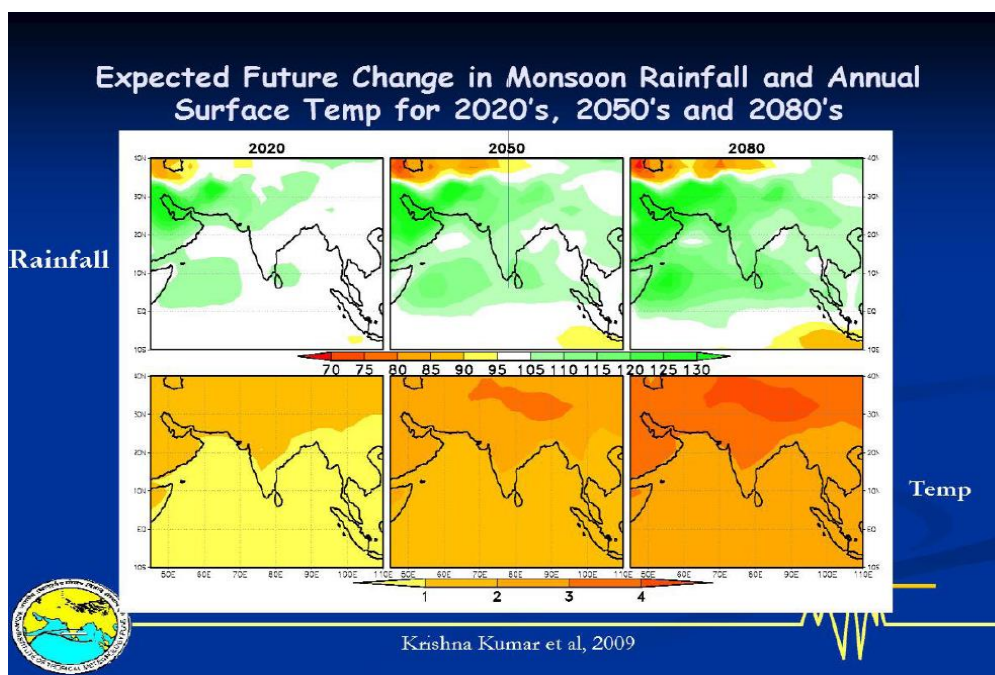
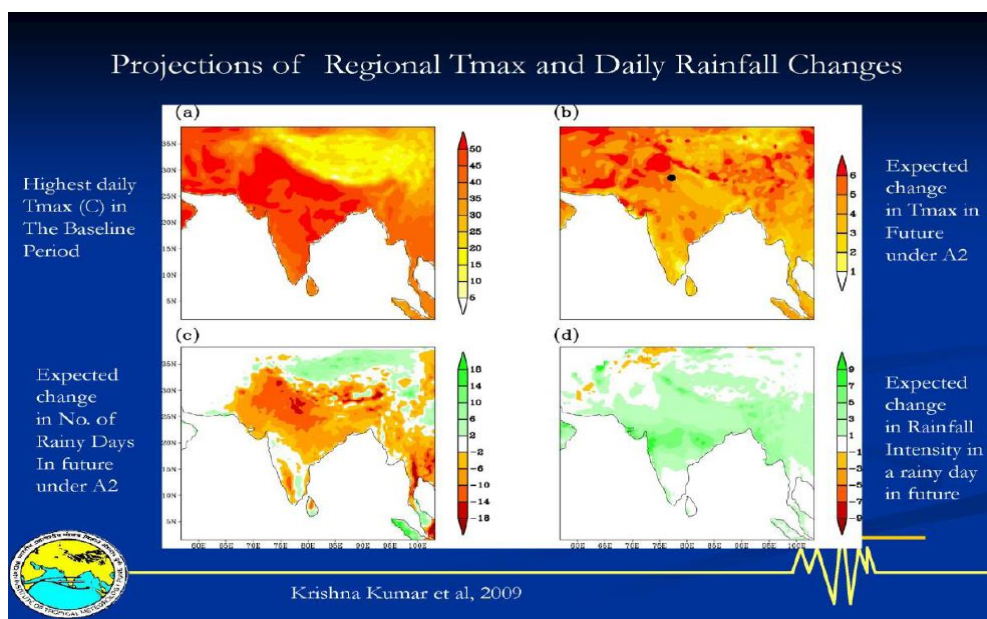


Figure 5: Projections of Regional Temperature max and Daily Rainfall Changes



Annual mean temperature is expected to rise between 2.5°C and 5 °C degrees under range of scenarios with warming more pronounced in the northern parts of India. There may be a general increase in monsoon precipitation in the monsoon season but an overall decrease in the number of rainy days and an increased intensity of rainfall. For South Asia, most of the AR4 models project a decrease in precipitation in December, January and February. The IPCC 4 AR identified that the number of people under severe water stress is likely to increase substantially in absolute terms in South and South East Asia in the foreseeable future⁸. There are however considerable uncertainties about the future behaviour of the monsoon which makes precise prediction difficult.

Based on Climate Modelling done by Center for Climate Systems Research (CCSR), Columbia University, as in Mehrotra et al., 2009, below figures summarize observed and projected temperature and precipitation trends for Delhi.

⁸ IPCC 4 AR chapter 10, 10.4.2.3

¹⁰ Centre for Climate Systems Research, Columbia University, 2009

Figure 6: Observed Temperatures in Delhi¹⁰

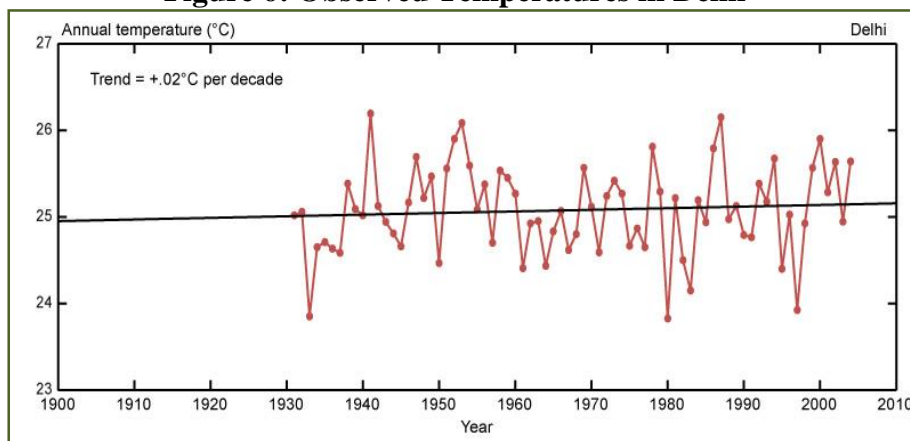


Figure 7: Observed Precipitation Delhi¹⁰

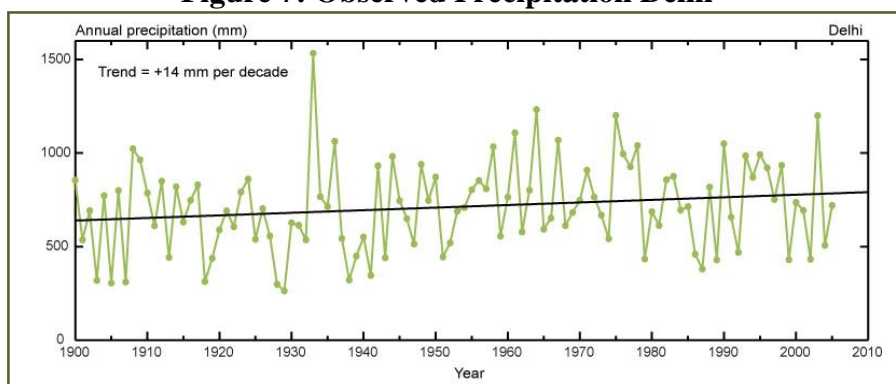


Figure 8: Projected Temperature Delhi¹⁰

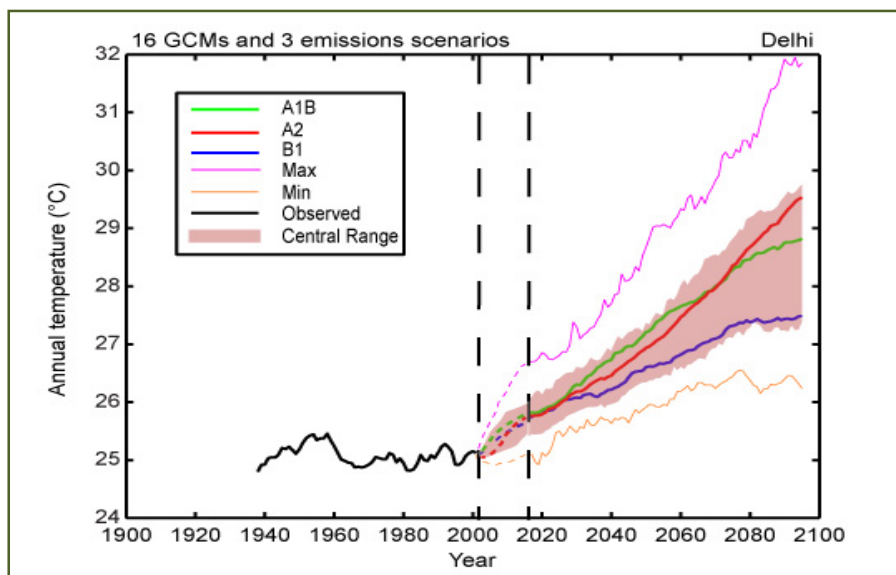
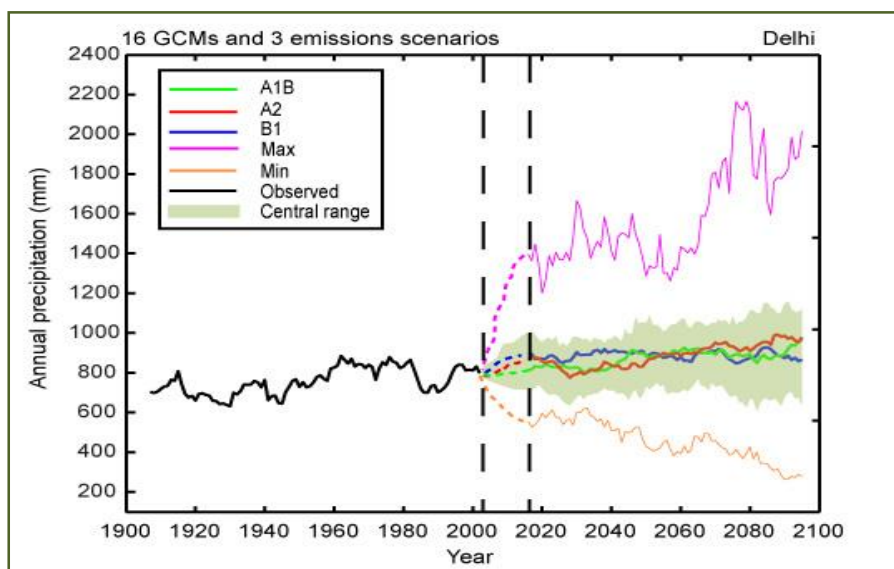


Figure 9: Projected Precipitation Delhi¹⁰

4.4 Temperature and Rainfall and their Extremes in Delhi

A study titled "**Changes in the characteristics of temperature and rainfall and their extremes in Delhi**" by Prof. S. K. Dash, Centre for Atmospheric Sciences, Indian Institute of Technology Delhi has analyzed the Changes in the surface air temperature, rainfall and their extreme events in the city of Delhi based on daily observed gridded ($0.5^{\circ} \times 0.5^{\circ}$) datasets from the India Meteorological Department (IMD). In this study, IMD gridded rainfall and temperature during the period 1951-2010 and 1969-2005 respectively and simulations of global model NCAR_CCSM3 and regional model RegCM4.3 are used for projecting the future temperature and rainfall events. Daily surface air maximum and minimum temperatures and precipitation values are averaged over different time scales to get respective mean values. Further, these daily parameters are used to analyse their respective extreme events.

Regional Climate Model system RegCM – Fourth Version (REGCM4)

The Regional Climate Model system RegCM, originally developed at the National Center for Atmospheric Research (NCAR), is maintained in the Earth System Physics (ESP) section of the ICTP. The first version of the model, RegCM1, was developed in 1989 and since then it has undergone major updates in 1993 (RegCM2), 1999 (RegCM2.5), 2006 (RegCM3) and most recently 2010 (RegCM4). The latest version of the model, RegCM4, is now fully supported by the ESP, while previous versions are no longer available. This version includes major upgrades in the structure of the code and its pre- and post-processors, along with the inclusion of some new physics parameterizations. The model is flexible, portable and easy to use. It can be applied to any region of the World, with grid spacing of up to about 10 km (hydrostatic limit), and for a wide range of studies, from process studies to paleoclimate and future climate simulation.

Future projections based on RegCM4.3: Projected changes in the surface temperature and rainfall at Delhi in the near future of 2015-2044, are examined and summarized in table 4 and 5.

Table 4: Summary of future projections of maximum and minimum temperatures and temperature extremes during 2015-2044 based on RegCM4.3 simulations

Categories of temperature		City (Delhi)
Maximum Temperature		+
Minimum Temperature		▲
Warm Days	TX90p	+
	TX95p	+
	TX99p	+
Cold days	TX10p	↓
	TX05p	▼
	TX01p	-
Warm Nights	TN90p	+
	TN95p	+
	TN99p	+
Cold Nights	TN10p	▽
	TN05p	▼
	TN01p	-

Increasing (Decreasing) trends at 10%,5% and 1% significant levels are marked by the symbols △,▲and↑ (▽,▼and↓) respectively and +(-) indicates increasing(decreasing) trend without any statistical significance.

Results show that in the near future (2015-2044), the annual maximum temperatures may increase in Delhi but without any statistical significance. The annual minimum temperatures may increase at Delhi significant at 5% level. The extreme temperature events based on RegCM4.3 projections are also analyzed here. The warm days of all the three types (TX90p, TX95p and TX99p) may increase in Delhi without any statistical significance. The cold days of the types TX10p and TX05p may have decreasing trend in Delhi significant at 1% and 5% levels respectively. The warm nights of all the three types (TN90p, TN95p, TN99p) may have increasing trends in Delhi but without any statistical significance. The cold nights of the types TN10p and TN05p may decrease in Delhi significantly at 10% and 5% levels respectively. Thus there is a robust projection of decrease in cold days and nights in Delhi.

Table 5: Summary of future projections of JJAS mean rainfall and rainfall extremes during 2015-2044 based on RegCM4.3 simulations

Categories of Rainfall events	City (Delhi)
JJAS mean rainfall	+

Increasing trends at 10%, 5% and levels are marked by Δ , \blacktriangle and \uparrow (∇ , \blacktriangledown and \downarrow) respectively and \pm indicates increasing(decreasing) trend without any statistical significance. RegCM4.3 projects an increase in monsoon rainfall in Delhi, which may not be significant. The different categories of rainfall events projected by the model shows that low and moderate intensity rain events may decrease and heavy rainfall events may increase at Delhi but with no statistical significance.

Low intensity	-	(Decreasing) 1% significant the symbols
Moderate Intensity	-	
Heavy Intensity	+	

Community Climate System Model – Third Version (CCSM)

The Community Climate System Model (CCSM) is a coupled climate model for simulating the earth's climate system. Composed of four separate models simultaneously simulating the earth's atmosphere, ocean, land surface and sea-ice, and one central coupler component, the CCSM allows researchers to conduct fundamental research into the earth's past, present and future climate states. This version of the CAM 3.0 incorporates significant improvements to the physics package (e.g. generalized cloud overlap for radiation calculations), new capabilities such as the incorporation of thermodynamic sea ice, and a number of enhancements to the implementation (e.g. clean separation between physics and dynamics).

Future projections based on CCSM3

In this study, the daily mean temperatures and rainfall based on CCSM3 projections at resolution 1.40° X 1.38° are interpolated to 0.5° X 0.5° resolution for suitable comparison with IMD data and RegCM4.3 simulations using a simple interpolation technique. The CCSM3 projections of mean surface air temperature and rainfall are summarized in tables 6 and 7 respectively.

Table 6: Summary of future projections of annual mean temperature and temperature extremes during 2015-2044 based on CCSM3 simulations

Categories of temperature		City (Delhi)
Mean Temperature		\uparrow
Warm Events	T90p	+
	T95p	+
	T99p	+
Cold Events	T10p	-
	T05p	-
	T01p	-

Increasing (Decreasing) trends at 10%,5% and 1% significant levels are marked by the symbols Δ , \blacktriangle and \uparrow (∇ , \blacktriangledown and \downarrow) respectively and \pm indicates increasing(decreasing) trend without any statistical significance.

Table 7: Summary of future projections of JJAS mean rainfall and rainfall extremes during 2015-2044 based on CCSM3 simulations

Categories of Rainfall events	City (Delhi)
JJAS mean rainfall	△
Low	-
Moderate	+
Heavy	+

Increasing (Decreasing) trends at 10%,5% and 1% significant levels are marked by the symbols △,▲and↑ (▽,▼and↓) respectively and +(-) indicates increasing(decreasing) trend without any statistical significance. The annual mean surface air temperature may significantly increase at Delhi. The projection of extreme temperature events indicates an increase in warm events (T90p, T95p and T99p) and decrease in cold events (T10p, T05p and T01p) in Delhi without any statistical significance. Based on CCSM3 simulations, the heavy rainfall event may increase in Delhi but without any be significance.

RegCM4.3 projects a robust increase in annual minimum temperature significant at 1% level during 2015-2044. Further, there is robust projection of decrease in cold days and nights in Delhi. Based on CCSM3 simulations there is a projected significance increase in the annual mean temperature at Delhi. Hence, it is a robust sign of future change. CCSM3 also projects somewhat robust increase in the monsoon precipitation at Delhi in the near future since JJAS precipitation may significantly increase at 10% level. Similarly, there is a somewhat robust increase in heavy rainfall event in Delhi.

4.5 Future Studies

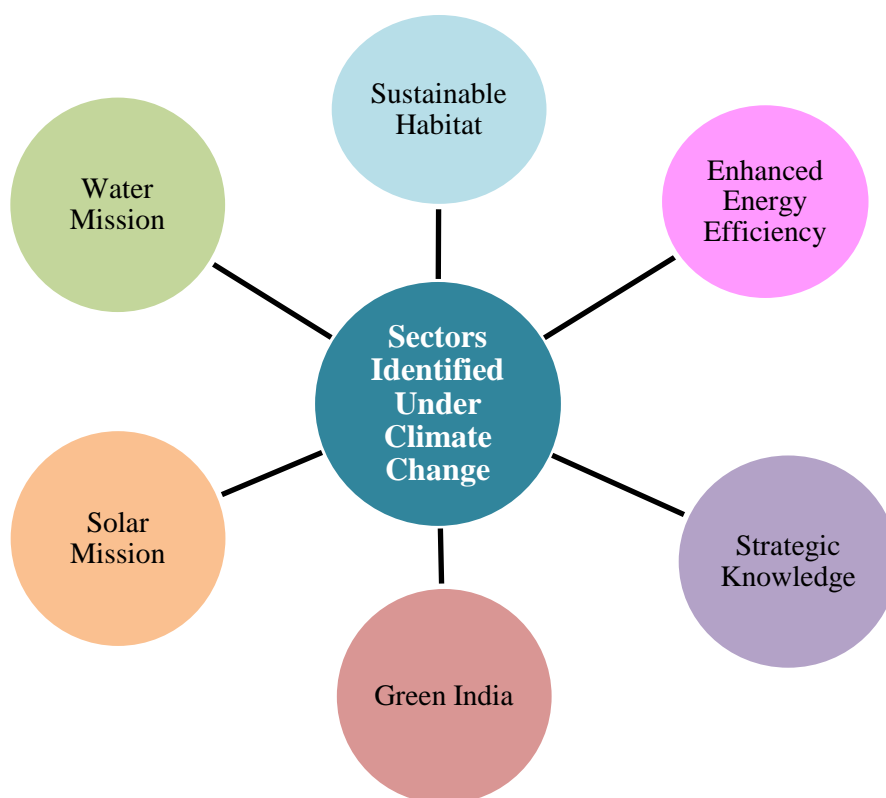
It was recognized that there are important science issues that need to be addressed, and also that the present efforts by GNCTD to deal need more inter and intra departmental integration and networking. There aren't many hazard risk mapping and climate modelling analysis studies available for Delhi. A further in-depth detailed study for extreme climate events especially in terms of rainfall, temperature and wind extremes by the use of dynamic high resolution regional climate modelling is advised.

Future research priorities should include research to support policy improvement, and in particular implementation, evaluation, linkages between policies and consideration of the effects on ecosystems. Research organisations and networks may be best placed to take the initiative on these issues, and in particular to communicate research information to policymakers in appropriate ways. Research priorities also include support for governance, particularly addressing the mismatch between eco-system health, environmental flows and the water demands of various sectors in an integrated manner. Within this, a series of components should also be suggested for addressing technical, environmental and social issues as well as support in negotiation and community participation.

5. Initiatives by Delhi Government

Delhi Government had initially drafted an action plan for Climate Change which got expired in 2012⁹. It broadly follows the NAPCC except two aspects of Himalayan Ecosystem and Agriculture and is adapted to urban challenges of Delhi as an emerging global metropolis. The modified Climate Change Agenda for Delhi 2009-12 has put forth 36 key actions items that the Government intends to undertake in the coming years. The agenda contains the framework for implementation of a series of action by various stakeholders. Following paragraphs discusses identified sectors and various actions undertaken by Delhi government to combat climate change in details:

Figure 10: Different Sectors identified under Climate Change Action Plan



Further, on the expiry of the Delhi Climate Change Agenda in 2012. The Department of Environment, Government of NCT of Delhi started preparing Delhi's SAPCC beyond 2012 on the lines of NAPCC and as per the guidelines of the Government of India. The following sections provide the details of activities in Delhi on the given themes of NAPCC missions.

⁹ Climate Change Agenda for Delhi, 2009-12

5.1 Solar Mission

Solar energy has a lot of potential in Delhi to reduce the dependence on coal fired electricity and hence contributing to reduction in Greenhouse Gases which is one of the main elements of the NAPCC.

Under the Energy Conservation Act 2001, the use of solar water heating devices has been made compulsory in all industries, hostels, educational institutions, hotels, canteens, and residential buildings on plots above 500 sq. meters. While some of the steps like providing subsidy on solar heating systems have created awareness about solar water heating systems, but a lot remains to be done to make this a part and parcel of the life of common people. There is a need to constantly upgrade the new technologies. Govt. of Delhi also plans in getting solar energy installed capacity of 150 MW of Solar Power by the end of FY 2018-19 in Delhi from present capacity of 88.86 MW.

Progress activities
<ul style="list-style-type: none"> Solar power policy is cleared by Delhi Government. The policy recommends installation of 1 GW (1,000 Mega Watts) solar power capacity in Delhi by the year 2020. Other important points include Mandatory deployment of solar on Govt./Public institution, Concept of Virtual Net Metering, Group Net Metering, Generation Based Incentive for 3 years, Tax breaks, benefits and subsidies etc Solar Water heating made mandatory in all industries, hostels, hotels and residential buildings on plots above 500 Sq.m. 130 kWp SPV plant commissioned at ISBT, Kashmere Gate. Roof top Solar PV Plant installed in four Government School of each 40 kWp and four government Hospital of each 100 kWp. 1 MWp Solar PV Plant installed at site of I.P. Thermal Power Plant. All Delhi Govt. Housing will be provided with SWH system at 30% subsidy from Energy Efficiency and Renewable Energy Management Centre. Solar tariff announced by DERC for projects on Rooftop PV and Small Solar Generation programme of MNRE. Small Rooftop (grid & off grid) demonstration projects setup by DISCOMs. 1 MW Rooftop Solar Power plant was setup at Thyagraja Stadium. Solar system upto 200 KWp are exempted from certification by Electrical inspector.

Table 8: Solar Photovoltaic Systems Installed In Delhi

DISCOM	Sytems installed till 31.03.2015	Systems installed from 01.04.2015-31.12.2015	Total Systems installed till 31.12.2015	Capacity (MWp)
BSES Rajdhani Power Limited (BRPL)	3	59	62	5.78
BSES Yamuna Power Limited (BYPL)	19	14	33	3.56
Tata Power Delhi-Distribution Limited (TPDDL)	14	1	15	1.67
New Delhi Municipal Council	1	1	2	0.94
Total	37	75	112	11.95

Source: Official website of Department of Power, GNCTD

5.2 Enhanced Energy Efficiency

Progress activities
<ul style="list-style-type: none"> • NDMC Area as Solar city, under scheme of “Development of Solar Cities” of MNRE has been sanctioned. • Initiatives towards energy conservation include Rooftop Solar Power Generation, LED use, Cool Roof, Green Building Technology, Waste to Bio Fuel, Waste to Energy etc. • 1 MW Solar PV Plant has been installed in Thyagraj Stadium for generation of electricity of about 1.4 million units/annum • Lightening & Illumination through SPV at Safdarjung Tomb (10.4 KWp)- Completed • Lightening & Illumination through SPV at Jantar Mantar (9KWp)- Completed • SPV power plant of 335 KWp through BYPL – Completed • SPV Power Plant of 100 KWp at Vikas Bhavan – II • Adoption of mandatory Energy Conservation Building Code in all Government Building and in all new building projects. • Promotion of LED in all buildings, street lightings and hoardings, advertisements etc.

The Energy Conservation Act of 2001 provides a legal mandate for the implementation of the energy efficiency mandates. The large buildings like hospitals, corporate offices, malls, hotels etc. have been identified for taking up energy audits to reduce the energy consumption by almost 30% in these buildings. All the street lights on major roads covering nearly 700 kms are being replaced by energy efficient lighting systems identified after going through a process of consultations with the Lighting Association of India and finalizing the specifications to improve the lux levels and conserve energy. In the long run, it is assumed that it will save nearly 100 MW of electricity per annum.

Progress activities

- Increasing number of CNG buses in DTC fleet on the roads. Presently, 4352 DTC & 1758 Cluster buses, 238 metro feeder buses, and 802 mini private stage carriage buses are being operated. Efforts are being made by Transport Department to augment the city bus fleet by within about one year
- Restriction of vehicles by using Odd/Even formula. First Phase & second phase was implemented from 1.01.2016 to 16.01.2016 & 15.04.2016 to 23.04.2016 respectively. Air quality was monitored before and during the implementation was done for first phase and second phase.
- Ban on 15 years old commercial vehicles, 10 years old diesel vehicles entry of Transport vehicles registered before 2006 in compliance of Hon'ble Supreme Court order is in place.
- Ban on registration in NCR of private cars/ SUVs of the capacity of 2000 cc and above using diesel as fuel upto 31 March, 2016 in compliance of Hon'ble Supreme Court order.
- Rates of tax on private vehicle have been increased by an additional amount of 25 % of the existing rates/ amount. To cap on total number of vehicles, it is suggested that a uniform vehicle taxation policy for the entire NCR need to be adopted.
- Levy of Environment Compensation Charge imposition as per Hon'ble Supreme Court Order on goods vehicles entering Delhi to discourage non-destined vehicle entry in the City.
- A notification has been issued to restricted entry of Trucks within city.
- 5 vacuum cleaning machines are being operated by PWD from 1st April, 2016 for cleaning of road. More have been added.
- Norm of 50ppm Sulphur in petrol/diesel implemented from 1st April, 2010.
- Development of intelligent traffic system to regulate movement and to obtain efficiency.
- Switching over to gas based power plant. IP Power Station is closed. Rajghat Power House is not capable of meeting the standards of 50 mg/NM³. Therefore the plant is not allowed to operate. Badarpur Thermal Power Station (BTPS) installed online emission monitoring system. BTPS has been allowed to operate two units of 210MW subject to meeting the standards of PM 50 mg/NM³.
- Online monitoring and Emission Control System in Thermal Power Plants, Waste-to-energy Plants, and Incinerators have been made mandatory.
- Subsidy scheme for promoting BOVs and e-rickshaws authorized by Transport Department and registered in the NCT Delhi. Owners of newly purchased battery operated 4 wheelers and 2 wheelers are given subsidy by GNCTD, in addition to subsidy by Govt. of India @ Rs 2000-5500 for two wheelers and Rs. 30000/-to1,50,000/-. One time fixed subsidy of Rs. 30,000/- is given to Battery Operated e-rickshaw owner
- Inspection followed by levy of penalty on violating construction projects for dust control as per NGT order dated 10.04.2015 in OA 21/2014.
- Inspection followed by levy of penalty on violation of Prohibition on burning of garbage/leaves/ plastic etc is being carried out and action is being taken as per NGT order dated 10.04.2015 in OA 21/2014
- Ban on bursting of firecrackers/fireworks on all occasions except religious occasions. Hon'ble Supreme Court has further on banned sale of firecrackers in NCR.
- Considering the air pollution conditions in the NCR, Hon'ble Supreme Court has accepted graded response action plan of CPCB which has detailed measures to be taken during emergent air pollution situations.
- 15 Government buildings being taken up for retrofitting Energy Conservation Building Code notified and adopted for all new buildings. All building having connected load of 500 KW or more, the ECBC code will be applicable.
- 3 Star GRIHA rating for Government buildings.
- In the buildings completed/under construction many provisions of green building concept have been incorporated. All upcoming stations and Receiving Sub Stations (RSS) of DMRC phase –III are

designed and constructed as Green Buildings. 19 stations and 3 RSS which have become operational have been certified to highest rating i.e. 'Platinum' under IGBC Green MRTS and Green New Building Rating System respectively DMRC's operational headquarters viz. Metro Bhawan has been certified as a Gold rated Green building under IGBC Green Existing Buildings rating System.

- Solar PV on metro stations are being undertaken.
- 2 Common Bio-Medical Waste Treatment Facility CBWTFs are operational in Delhi
- A 16 MW Waste-to-Energy plant at Okhla implemented by Jindal Ecopolis for utilizing 1950 TPD of Municipal Solid Waste
- 12 MW Waste-to-Energy Plant at Ghazipur is on trial run by East Delhi Waste Processing Limited (EDWPCL) for utilizing 1300 TPD for Municipal Solid Waste –
- 24 MW Waste-to-Energy Plant at Narela, Bawana is under trial run by Delhi MSW Solutions (DMSWSL) for utilizing 3000 TPD waste.
- Launch of periodic special drive for penal action against vehicles using pressure horns.
- Expand Sewerage network of the city with interceptor sewer project.
- Encouraging decentralized waste management
- Increased green cover of Delhi upto 20.22%.

5.3 Sustainable Habitat

The mission on Sustainable Habitat aims to make habitat sustainable through improvements in energy efficiency in buildings, management of solid waste and modal shift to public transport. The adoption of the Green Building Code is a good beginning and the star rating of electrical equipments is a good message to use energy efficient appliances and technology for the purpose. The Bureau of Energy Efficiency has made excellent strides in star rating of electrical appliances. As part of the initiative of the government to infuse energy efficiency in new buildings, the buildings and stadia constructed for the Commonwealth Games 2010 were all Green buildings incorporating the latest energy efficiency standards. These buildings are Thygaraja Stadium, Delhi International Airport building; Civic Centre of MCD; Chattarsal Stadium, and Delhi Transco Ltd. is constructing a 9,000 m² corporate office that is ECBC compliant and will cut its current energy consumption by 30 percent. On-going action plan with timeline has been prepared to control Air Pollution in Delhi.

5.4 Mission for Green India

Recognizing the importance of the green cover, Delhi has taken the lead in greening with the effective green cover increasing from 26 sq kms to 300 sq kms in 15 years which is about 20.22% of the area of Delhi. This is proposed to be increased to 25% by 2030.

Progress activities
<ul style="list-style-type: none"> • Today, Delhi has nearly 20,000 small/medium/big parks and gardens, 42 city forests in different locations in the city, 5 ridge areas, 6 bio-diversity parks, restored water bodies in flood plains and developed other greens. • Plantation 10 lakh trees and 5 lakh shrubs per annum till 2030. • Replenishment policy has been set in place to change existing old/worn out trees to native species. • During the financial year 2017-18 upto till March 2018, DPGS has financially assisted 261 RWAs/NGOs to maintain 1164 parks in 370 Acres area. • RWA's/NGO's/Institution and other agencies have got planted 4.90 Lakhs trees and 6.25 Lakhs shrubs in parks and other common areas. • At present more than 100 RWAs are making in house composting from leafy/grassy waste in the colony and using the same for park maintenance. Compost pits have been provided in parks (1 acre and above area) to ensure proper collection of horticulture waste (bio-mass). Composting-cum-gardening approach to be followed by DPGS and concerned horticulture agencies RWA's/NGO's. and 346 parks have compost in compliance • 49.77 Ha of degraded forest land identified for raising compensatory afforestation. • Department of Forests in cooperation with 20 other greening agencies is planting saplings and it has been planned to do plantation of around 12 lakh saplings in 2015-16 Proposed system for online application for tree felling permission. • Introduction of replenishment policy for matured/outlived trees. • Tree helpline (No. 1800118600) is functional for receiving complaints / grievances of public about conservation and protection of trees in Delhi. • House Sparrow has been declared as the state bird • Herbal parks are being developed by RWAs parks through DPGS scheme. • Vermi-composting encouraged in schools, colleges & in RWAs.

5.5 Water Mission

The Water Mission takes into account the provisions of the National Water Policy and develops a framework to optimize water use by increasing water use efficiency by 20% through regulatory mechanisms with differential entitlements and pricing. Delhi depends on the river Yamuna for its water needs but the disputes between the basin states of Himachal, Punjab, Haryana, Rajasthan, Uttaranchal and Delhi have made the utilization of the Yamuna contentious. New strategies need to be tried out to conserve water and use waste water efficiently since 80% of raw water is waste water and its effective use can achieve the target set by the water mission. The recent initiative of Delhi Jal Board for interceptor sewers to trap the waste water and treat it before discharge in the river will hopefully achieve this objective.

The prime objective had been to restore water quality of River Yamuna and for this efforts had been and are being made towards restricting the outfall of industrial and domestic untreated wastewater into the river via drains / directly from source of generation.

Treatment of Industrial Effluents

For reducing water pollution from industrial effluents, industries operating in various industrial areas, have installed ETPs to meet the prescribed standards. Action is taken by Delhi Pollution Control Committee (DPCC) against the units, which are found operating in violation of the pollution control laws. More than 1400 units have installed Effluent Treatment Plants (ETPs) to treat their effluents.

Progress activities
<ul style="list-style-type: none"> • Construction of recycling plants at 4WTPs • Regular water quality monitoring is carried out by DPCC at 24 drains, 9 locations along River Yamuna, Water Bodies/ponds, 21 STPs and 2 mini STPs, 13 CETPs monitored for 17 parameters based on inlet and outlet, 10 WTPs, ground water (34 locations). • Steps taken for reducing water consumption, quality, monitoring and regulatory measures for misuse and theft • Promotion of Rain water harvesting scheme. A rebate of 10% in total bill amount was allowed as per Delhi Water & Sewer (Tariff & Metering) Regulations, 2012 in Plot/Properties of 2000sqm and above having installed functional RWH system. This rebate scheme has been extended for plots of 500sqm and above. • Building byelaws require all buildings with wastewater generation of over 10,000 lpd to have Recycling Structures • Scheme for incentivizing water recycling systems • All new STPs to have tertiary level treatment. • Use of treated effluent for non-potable uses • Metering and curtailing use of ground water by all industrial units & promoting effluent. • Reuse of waste water by Double piping proposed to be adopted for new residential projects. • Wastewater is being reused for Horticultural purposes. • Steps for Construction of STPs at various location are under progress • Interceptor sewer project under progress • The DPCC and CI office are making efforts for enforcement of ETPs in Polluting industries. Action was taken against industrial areas which do not have ETP. • online monitoring system at CETPs and Seriously Polluting industries • Penalty on dumping of mulba/garbade/waste on banks of River Yamuna. As per NGT orders • Penalty on throwing of religious material in River Yamuna s per NGT orders • 1012 water bodies being rejuvenated by DJB and other concerned departments.

21STPs are being monitored on monthly basis for the compliance of standards. Most of the STPs meet the treated wastewater standards before final discharge into River Yamuna. 13 Common Effluent Treatment Plants (CETPs) have been installed at various industrial areas (Lawrence Road, Wazirpur, Mangolpuri, Mayapuri, Nangloi, Badli, SMA, GTK, Okhla, Jhilmil, Narayana, Narela and Bawana). Online Monitoring Stations have been installed at CETPs.

Major water polluting activities have been included in the F-27/33 category of industries so as to ensure the closure of these units from the non-conforming area, as directed by Hon'ble Supreme Court vide its order dated 7th December, 2000. Interceptor Sewer Concept is being implemented along three major drains to intercept sewage flowing in their subsidiary small drains and conveying to the nearest sewage treatment plants for treatment to ensure that only treated sewage is discharged into drains and Yamuna River.

Decentralized wastewater treatment

Shopping malls/construction projects etc. have been brought into the ambit of pollution control laws. These projects are being insisted for installation of STPs/ETPs, Rainwater harvesting system etc. Many on-site STPs/ Effluent Treatment Plants have been installed by these project proponents.

Implementation of YAP-II

Five capital works project (Construction/ Rehabilitation of STPs and Trunk sewers) under Yamuna Action Plan, Ph-II (YAP-II) of Ministry of Environment and Forest, Govt. of India have been implemented by DJB Public Participation and Awareness as well as study project under YAP-II are also being implemented by MCD.

S.No.	Package	Total Cost as per Administrative Approval (Rs. in Lacs)
1	O Construction of 564 MLD (124 MGD) Wastewater Treatment Plant (WWTP) with effluent standard of BOD - 10Mg/L, TSS-10Mg/L or better and power generation on DBO basis at Okhla Under YAP (III)	66,043.72
2	K1 Rehabilitation of Trunk Sewer No.4 (Kondli Zone)	7,688.00
3	K2 Rehabilitation of Trunk Sewer No.5 (Kondli Zone)	7,621.00
4	K3 Rehabilitation of old three WWTPs of total 181 MLD (45MGD) capacity at Kondli	23,213.51
5	K4 Rehabilitation of Rising main from various Sewage P/Stations (Kondli Zone)	3,194.85
6	R 1a Rehabilitation of Trunk/Peripheral sewer of Ashok Vihar & Jahangirpuri (Rithala Zone)	3,574.00
7	R 1b Rehabilitation of Rising Main from Bharat Nagar SPS to Pitampura	5,153.95
8	R2 Rehabilitation of Rithala Ph-I WWTP of 182 MLD (40 MGD)	18,181.52
9	PO Public Outreach Programme	2,050.00
A	Base Cost	136,720.55
a	Price Escalation	12,304.85

b		Centage @8%	11,922.03
		Total A	160,947.43
B		Consulting Services	
a		Base cost	3,823.00
b		Price Escalation	481.00
c		Centage @8%	344.32
		Total B	4,648.32
		Total (A+B)	165,595.75
		Say	Rs.1,656 Crores

Objective of YAP-III project are essentially to improve sewage conveyance system and wastewater treatment plant in the command of Okhla, Kondli & Rithala drainage zone for treatment of waste water to latest standards issued by CPCB/DPCC before being discharged in the river Yamuna thereby improving the quality of river water.

For this purpose, National Mission for Clean Ganga (NMCG), Ministry of Water Resources, Government of India, the borrower, signed an Agreement with Japan International Cooperation Agency (JICA), for a loan amounting to JPY 32,571 million (₹1656 crore) towards the cost of Yamuna Action Plan Project-III (YAP-III). The project cost shall be shared in the ratio of 85:15 between Govt. of India and GNCTD. Work order is issued for following two works:

- Package K1: Rehabilitation of trunk sewer no.4 Narwana road, Anand Vihar, Hargovind Enclave and Vikas Marg sewers of sizes varying from 450mm to 1600mm dia in Kondli zone by CIPP structural lining method.
- Package K2: Rehabilitation of trunk sewer no.5 and Jhilmil colony sewers of sizes varying from 1600mm to 2100mm dia in Kondli zone by standalone structural lining method.

To supplement efforts of State Governments in abatement of pollution of river Yamuna, Yamuna Action Plan (YAP) was launched by the Government of India with financial assistance from Japan International Cooperation Agency (JICA) in a phased manner as well as from internal resources. The first phase of YAP which was started in April, 1993 in the three States of UP, Delhi & Haryana covering 21 towns was completed in February, 2003 at a cost of ₹703.10 crore and 38 sewage treatment plants with treatment capacity of 753.25 mld, (of which 401.25 mld in U.P., 322 mld in Haryana and 30 mld in Delhi) were created. YAP Phase-II was started in 2003 also with JICA assistance. An expenditure of ₹811.31 crore has been incurred in three States of Delhi, Haryana and Uttar Pradesh under this phase. New sewage treatment capacity of 189 MLD (Delhi 135 MLD and Uttar Pradesh 54 mld) was created and rehabilitation of 328 mld existing STP capacity at Delhi was done under this phase.

The Central Government has approved Phase-III of YAP at a total cost of Rs 1656 crore for Delhi with loan assistance from JICA. The project cost will be shared between the Govt of India and the Government of NCT of Delhi on 85:15 basis. The share of GoI in the

project will be Rs 1407.60 crore and that of Govt of NCT of Delhi will be Rs 248.40 crore. Loan agreement with JICA has already been signed. The project is scheduled for completion by December, 2018.

Waste Management by DMRC

All the Construction and Demolition (C&D) waste generated from DMRC projects are sent to the C&D waste re-cycling facility at Burari or Shastri Park or Ranikhera (own plant). So far, approximately 245,000 tons of C&D waste has been recycled. From April 2013, 232,643 tons of C&D waste has been processed at Burarri/Shastri Park plant and the remaining 12,357 tons have been processed at DMRC's own plant at Ranikhera from April 2018.

Ground Water Regulation and Management

For groundwater regulation and management in the City, a notification containing directions under section 5 of EP Act has been issued on 12th July, 2010 as amended to date. Groundwater permission is subject to wastewater treatment & reuse and rainwater harvesting system.

5.6 Mission for Strategic Knowledge

Strategic Knowledge Mission aims to identify challenges of climate change by ensuring focused research. Delhi has identified the Climate Change Cell and MGICCC as the field level institution which will pioneer efforts in creating strategic knowledge about climate change. These institutions will partner with leading institutions in creating awareness and conducting research in this area.

MGICCC is an autonomous body under the Department of Environment, GNCTD. It imparts knowledge on Climate Change to various stakeholders like University, College, Polytechnics, ITI & School/College teachers & students, RWAs, Farmers, Rural Women and Youth. It also imparts training to various departments of Government of NCT of Delhi on various Climate Change issues including the mandate given by SAPCC of Delhi. The Institute also has Solar Energy Techniques like video presentation on Solar Energy Technologies, Solar Photovoltaic Technologies, and Solar Thermal Technologies with campus visit for demonstration on various non-renewable energy sources. The Institute also organize capsule program/3 months certificate course for College, Polytechnics & ITI students.

The MGICCC has delivered 50 number of Community Participation Programme for school children, villagers; 24 training Programme for Teachers/ Professors & college/ university & it is Students and RWA's; 2 number of two days awareness program/workshop on climate change; about 3000 number of people trained in these training programmes/workshops on various issues related to combating climate change in the year 2017-18. During 2017-18, Rs 380 lakh had released to MGICCC in three instalments.

Progress activities

- R&D project for production and use of bio fuels from waste oil
- About 2000 eco-clubs have been selected in schools & colleges for creating environmental awareness & action oriented activities involving students & teachers.
- The Conservation Education Centre (CEC) with the partnership of Bombay Natural History Society (BNHS) as an expert agency on nomination basis has been setup at Asola-Bhatti wildlife Sanctuary, Tughlakabad for facilitating conservation education and wildlife interpretation.
- Awareness campaign namely “Greening Delhi” “Say Yes to Eco-friendly Bags” “Anti Fire Crackers” Waste minimization”, “play holi with safe and natural colours”, E-Waste management etc.
- Observing various national and international environment related days such as World Environment Day, Earth Day, Biodiversity Day, Forests Day etc.
- Successful technologies for handling waste such as BARCNISARGUNA technology is being developed.
- Project to convert organic waste generated in Delhi Secretariat into biofuel (based on BARC technology) has been setup
- Awareness/collection drive on e-waste is conducted in 200 eco-clubs schools with regards to handling and disposal of e-waste in collaboration with Nokia and GIZ.
- Advertisements released in Newspaper to spread environmental awareness.
- Digital display has been done at important traffic intersections.
- Metro coaches and metro stations carry environmental messages regularly.
- Jingle on FM radio is released.
- Participation in seminars, conferences, workshops, exhibitions, is a regular feature.

The Delhi Government has, in its Approach Paper of 12th Five Year Plan, outlined mission objectives that embrace human development goals, irrespective of class and status. These goals includes environmental sustainable urbanization, provisioning of basis amenities in all the habitats irrespective of their status, urbanization for more inclusive growth with provisioning of social services, skill development and policy initiatives for productive employment for EWS workers.

6. Energy Consumption Profile

This chapter details out the total energy consumption for Delhi. The idea is to identify the total energy consumption from different energy sources in the city and the sector wise distribution of energy consumption amongst various sectors like: Residential, Commercial, and Industrial and the Municipal.

6.1 Energy Consumption

The peak demand increased from 3490 MW in 2004-05 to 5846 in 2015-2016, Delhi has the highest per capita power consumption of electricity among the States and Union Territories of India. Peak demand deficit of Delhi is low around 1.5% against the national average of 12.3%. The performance of Delhi Transco Limited during the 2004-05 to 2015-2016 is presented in the table 9.

Table 9: Electricity Supply over the Years

Year	2010-11	2011-2012	2012-13	2013-14	2014-15	2015-16
Peak Demand met in MW	4,720	5,028	5,642	5,653	5,925	5,846
Energy Consumption in MUs	25,581	25,593	27,235	28,021	29,035	30,559
Load Shedding in MUs	74	83	138	77	117	42.05
Load Shedding as % of energy consumption	0.29	0.32	0.51	0.27	0.40	0.13
Transmission Losses (%)	1.28	1.20	1.17	0.95	0.69*	0.85
System availability (%)	98.58	98.39	97.17	97.43	98.6*	99.03

* Figure up to Jan 2015 Source: Baseline data for Vision, 2030

Delhi's highest ever peak power demand of 6,526 MW was recorded in 2017-18 and may breach the 7,000 MW mark this year. The load growth pattern of Delhi was of the order of 6.32% during the years 2009 to 2015. The per capita consumption of electricity of Delhi is much higher than the national average. The load demand in the capital is estimated to grow approximately 7% per annum. Government prepared a proposal for islanding of Delhi, which was approved by Government of India. Delhi's power demand has been increased continuously and the dependence on the power from outside has been increasing simultaneously. The total power purchase in Delhi has grown by 59.26% during the last ten years, increased from 23,537 MU in 2005-06 to 37,484 MU in 2014-15. While 13.17% of total power purchase is sourced from own generation by Delhi Govt. Power Plants, 86.83% is purchased from Central Govt. and other sources. The supply of electricity in Delhi periphery increased from 23,537 million units in 2005-06 to 37,484 million units in 2014-

15. The following is the list of the Power plants that account for Power generation by Delhi domestically:

Table 10: Power Generating Stations in Delhi¹⁰

Station	Gas Turbine Power Station	Pragati Power Station	Pragati Power Station II Bawana	NTPC Badarpur	Rithala Gas (TPDDL)	Timarpur Okhla Waste Management Ltd.
Station Capacity (MW)	270	330	1500 (Nominal)	705*	94.8	16
Units	6x30 (GT)+ 3X30 (STGs)	2x104 (GT)+ 1x122 (STGs)	4x250 (GT)+ 2x250 (STGs)	95x3+210x2	31.6x3	5.5MW each
Year of Commissioning	1986 &1996	2002 - 03	GT-1: 27.12.2011 GT-2: 16.07.2012 STG-1 14.12.2012	1973-75 (95MW units) 1980-81 (210 MW units)	2011- 2012	2012
Coal Fields/Gas	GAIL HBJ Pipeline	GAIL HBJ Pipeline	GAIL Pipeline	Coal India	GAIL	MCD Waste
Beneficiary Areas	BRPL, BYPL, TPDDLND MC, MES	BRPL, BYPL, TPDDL NDMC	BRPL, BYPL, TPDDL,NDMC, MES, Haryana, Punjab	BRPL, BYPL, TPDDL,NDMC, MES	TPDDL	BRPL

**Only two units of capacity 210MW are operating.*

The average electricity distribution loss in Delhi was 15.43% combining all of the distribution companies in the year 2015-16 which is quite high and gives immense scope to mitigate these loss by improving the service delivery infrastructure.

Table 11: Distribution companies electricity distribution Losses

Year	BYPL	BRPL	NDPL	AT&C Losses in (%) - Average
2005-06	43.87	35.53	26.52	35.31
2006-07	39.03	29.92	23.73	30.89
2007-08	29.80	27.17	18.56	25.18
2008-09	24.02	20.59	16.74	20.45
2009-10	24.32	20.53	15.16	20.00
2010-11	21.95	18.82	14.15	18.31
2011-12	22.07	18.11	11.49	17.22
2012-13	21.14	17.12	10.73	16.33
2013-14	21.53	16.20	10.35	16.03
2014-15	14.50	12.50	13.83	13.61
2015-16	18.83	14.12	13.33	15.43

(Source: Baseline Data for Vision Document, 2030)

¹⁰Department of Power, Government of NCT of Delhi

6.2 Sectoral Electricity Consumption Pattern for Delhi

The power consumption status of various sectors is given in the table 12. The domestic, industrial and commercial sectors accounts for 95% of power consumption out of total supplied.

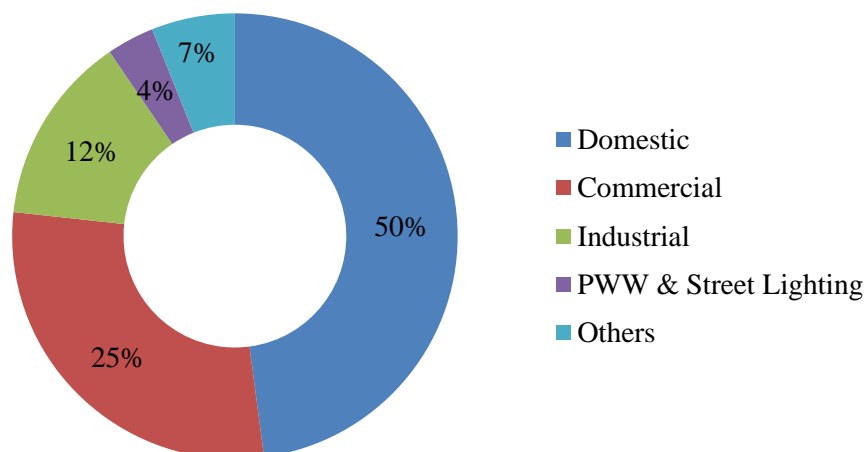
Table 12: Power Consumption by Various Sectors in Delhi

S. No.	Sectors	Consumption of Electricity (MU)						
		2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
1	Domestic	9,723	10,396	10,796	11,609	12,649	1,2560	14,059.68
2	Commercial	5,074	6,253	5,569	6,786	6,370	6,053*	7,257.06*
3	Industrial	3,008	2,989	2,979	3,064	3,062	3,135*	3,088.37*
4	PWW & Street Lighting	734	748	870	838	1,219	1,027	1,097.65
5	NDMC & MES	75	NA	NA	NA	NA	NA	NA
6	Others	1,144	1,314	1,147	1,484	1,810	1,262	1,362.39
Total		19,758	21,700	21,361	23,781	25,111	24,037	26,865.15

(Source: Delhi Statistical Handbook 2017) * Commercial and Industrial includes both LT and HT Consumption, Note: In the year 2010-11 NDPL data not included.

About 50% of electricity consumption is in domestic sector, 25% by commercial, 12% by industries and 4% by public water works & water supply and 7% by others. Below graph depicts the pattern of electricity consumption in Delhi in 2014-15.

Figure 11: Sectoral Electricity Consumption (2014-15)



(Source: Department of Power, GNCTD)

6.3 Fossil Fuel Consumption in Delhi

Petrol, Diesel, LPG, CNG are the main fuels used in the Delhi city. Usage of diesel is higher comparing with petrol consumption. The Petrol, Diesel and other fuels consumption of the city is given below:

Table 13: Fuel Consumption in Delhi City ('000 M Tons)

Items/Years	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	
Petrol (M.S)	825	813	787	797	831	901	906	
Diesel	HSDO	804	930	1,029	1,129	1,507	1,269	1,267
	LDO	7	4.2	9	4	1	3	0.5
Cooking Gas (LPG)	709	731	716	702	732	768	798	
Kerosene Oil	107	48	42	9	1	1	1	
Other energy/product	1,621	1,768	1,557	1,650	1,680	1,706	1,909	
CNG sale	596	649	695	698	717	738	804	
Consumption of Natural Gas (mmscmd)	-	-	-	0.17	0.18	0.18	0.19	

(Source: Delhi Statistical Handbook- 2017)

Mmscmd-Million Metric Standards cubic Metre per day

Delhi has significant reliance on its transport infrastructure. The state has developed a highly efficient public transport system with the introduction of the Delhi Metro, which is undergoing a rapid modernization and expansion. There are 10,482,757 registered vehicles in the city according to the data of 2016-17 from 8.39 million registered vehicles in 2014. As table 14 and 15 indicates, the number of private vehicles is close to 8.05 million and that of commercial vehicles is 0.33 million in Delhi. According to a study done by CRR in the year 2009, the daily Vehicle Miles Travelled (VMT) for Delhi is 94 million. NCR loses nearly 42 crore (420 million) man-hours every month while commuting between home and office through public transport, due to the traffic congestion. Therefore serious efforts, including a number of transport infrastructure projects, are under way to encourage usage of public transport in the city.

Table 14: Private Vehicles Registered up to 30th June, 2014 class wise (Exlc. NOC token/Converted Vehicles)

S.No.	Class Description	No. of Vehicles
1	Invalid carriage	410
2	LMV (CAR)	2,516,200
3	LMV (IMP)	8,513
4	LMV (JEEP)	67,894
5	LMV (VAN)	74,257
6	MOPED	100,277
7	Motor Cycle	2,695,148
8	Motor Cycle (IMP)	742
9	Motor Cycle with side Car	10
10	OMNI bus (Private Use)	5

11	Scooter	2,588,247
12	Scooter with side car	729
13	Three Wheeler Private	33
14	Three Wheeler (Passenger)	2
15	Tractor (Agriculture)	40
Total		8,052,507

(Source: Transport Department, GNCTD)

**Table 15: Commercial Vehicles Registered up to 30th June 2014 class wise
(Excl. NOC taken/Converted/Replaced Vehicles)**

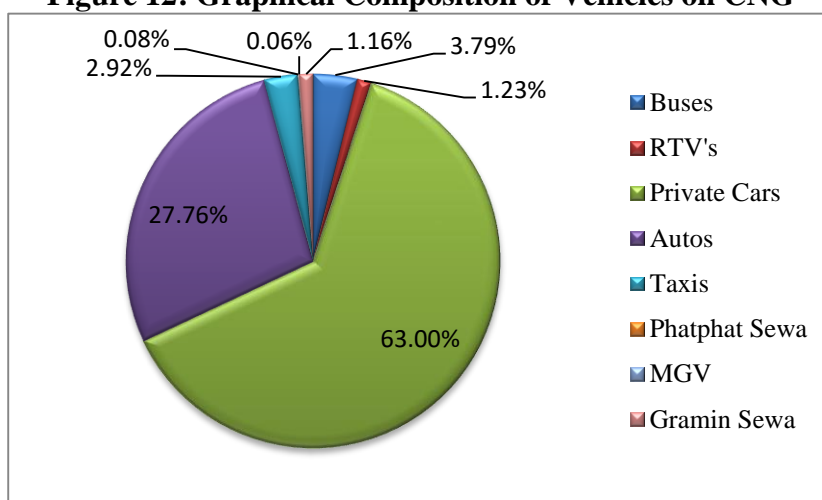
S.No.	Class Description	No. of Vehicles
1	Ambulance	1478
2	Ambulance (IMP.)	35
3	Bus	19,688
4	Cab Scheme	3,896
5	Eco Friendly Sewa	628
6	Economy Radio Taxi	4,103
7	Gramin Sewa	6,153
8	Heavy Goods Vehicle (IMP.)	11
9	Heavy Goods Vehicle	6,338
10	Light Goods (3 Wheeler)	60,477
11	Light Goods Vehicle (IMP.)	10
12	Light Goods Vehicle	77,539
13	Light Pass. Vehicle	11,285
14	Light Passenger (Taxi)	3,509
15	Light Passenger (IMP.)	60
16	Local Taxi	7,205
17	Maxi Cab	134
18	Maxi Cab (School Cab)	10,305
19	Medium Goods Vehicle	6,511
20	Medium Good Vehicle (IMP.)	8
21	Mobile Service Van	10
22	Motor Cab (School Cab)	1,640
23	Phatphat Sewa	38
24	Radio Taxi	6,006
25	Utility Van	69
26	Three Wheeler (Passenger)	78,967
27	Tourist Taxi	29,111
28	Tourist Taxi Deluxe	820
29	Tourist Taxi Deluxe (IMP.)	2,130
30	Tractor	1,612
	Sum	339,776

(Source: Department of transport, GNCTD, New Delhi)

6.4 CNG Consumption

The Compressed natural Gas (CNG) is mostly used for the purpose of transportation in Delhi. The tremendous shift in fuel usage and the adoption of CNG as a transportation fuel has not only improved the level of pollution but also has resulted in the improved air quality in Delhi. GNCTD has mandated the compulsory use of CNG in all the commercial vehicles plying on the roads of Delhi. As a result of this enforcement, the pollution level has drastically reduced and the air quality has improved a lot. The CNG is not only a clean fuel but is also brought an option of cheap fuel to the customers. The CNG consumption in Delhi as given by Indraprastha Gas Limited (IGL) is 75.61 lakhs kilograms per day. The total sale of CNG as reported by IGL is 75.61 lakhs kilograms per day. Total number of CNG stations in Delhi is 324 of which 58 are mother stations, 245 are online stations, 21 are daughter/daughter booster stations. Total numbers of vehicles operating on CNG are 438,900. The figure 12 classifies the type of vehicles operating on CNG.

Figure 12: Graphical Composition of Vehicles on CNG



6.5 Industrial Fuel Consumption

Delhi is an important commercial capital in Asia. The service industry contributes the largest chunk of the State Domestic Product (SDP) which is about 70% followed by manufacturing (25.2%) and agriculture (3.85%). The key industries include Information Technology, Telecommunications, Hotels, Media, Banking and Tourism. The manufacturing industry of Delhi has also expanded as many consumer goods industries have established manufacturing units and offices in the region. Delhi's large consumer market and its abundance of skilled labour have attracted foreign investments to Delhi. The data for industrial fuel consumption is tabulated hereunder:

Table 16: Industrial Fuel Consumption

Fuel Type	Consumption (2013-14)
LPG (million gallons)	1.8
CNG (million cu. Meters)	46.4

HSD (million gallons)	1.6
LDO (million gallons)	0.6
Diesel (million gallons)	0.8

(Source: The Commissioner of Industries, GNCTD)

6.6 Energy Consumption in Government Owned Operations

Water supply, sanitation and solid waste management constitute basic essential services for which the main responsibility lies with the public authorities. Provision of potable water and safe sanitation to all is the ultimate goal of the government. However, achieving this goal and providing services at the desired level have been the main challenge for public authorities concerned with these services. Solid waste management is another essential service, the responsibility for which lies with the local governments. All these basic services have a major impact on the health of the citizens and therefore need to be accorded high priority in planning and implementation. However, in order to understand the magnitude of the problem, an overview of the status of these basic services is necessary.

Water Supply and Treatment

The Delhi Jal Board is responsible for the Production and Distribution of potable water after treating raw water from various sources like river Yamuna, Bhakhra Storage, Upper Ganga Canal & Groundwater and also provides treatment and disposal of waste water. The Delhi Jal Board provides water in bulk to the NDMC and Cantonment areas. Sewage from these areas is also collected for treatment and disposal by the Delhi Jal Board.

The installed capacity of Water Treatment Plants is 906 MGD and by optimization through Tubewells, Ranney Wells etc., about 900 MGD potable water is being supplied by Delhi Jal Board. Delhi Jal Board is committed for augmentation of water supply in Delhi and has taken many steps in this direction. 40 MGD Water Treatment Plant at Dwarka, 20 mgd at Bawana have been commissioned. The water supply has been augmented from the battery of the tube wells at Palla by redeveloping them.

With a view to rationalise the distribution of water Delhi Jal Board has drawn up an elaborate plan for construction of Under Ground Reservoirs and Booster Pumping Stations (UGR/ BPS). During the Year 2015-16, 12 UGR/ BPS at various locations have been commissioned giving rise to total number of 117 reservoirs. Table 17 gives the details on water consumption states in Delhi City.

Table 17: Consumption of Water in Delhi

	Description	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
1	No. of Metered Connection	1,480,441	1,540,968	1,542,825	1,602,099	1,862,753	1,949,150	2,316,210
2	No. of Unmetered connections	314,774	399,930	438,791	469,705	265,925	389,694	178,845

	Description	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
3	Water Consumption (in lakhs kL)	13,754	14,085	13,837	13,837	14,085	14,914	14,914
3a	Domestic	13,754	12,789	13,837	-	-	-	-
3b	Commercial / Industrial	NA	1,296	NA	-	-	-	-
4	Per capita consumption of water (gallons per capita per day)	50	50	49	48	48	48	47

(Source: Statistical Hand book 2017)

Table 18: Installed Capacity of Various Water Works at the End of Current Five Year Plans (M.G.D.)

S.No.	Name of the water works	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2016-17
1	Chandrawal I & II	90	90	90	90	90	90	90	90
2	Wazirabad I, II & III	120	120	120	120	120	120	120	120
3	Rainy Wells and Tube Wells	100	100	100	100	100	100	100	80
4	Haiderpur I & II	200	200	200	200	200	200	200	200
5	Bhagirathi Shahadara	100	100	100	100	100	100	100	100
6	Nangloi	40	40	40	40	40	40	40	40
7	Sonia Vihar	NA	140	140	140	140	140	140	140
8	Bawana	NA	NA	NA	20	20	20	20	20
9	Recycling Plants						37	37	45
10	Dwarka							50	50
11	Okhla							20	20
Total		650	790	790	810	810	847	847	905

(Source: Delhi Jal Board, New Delhi)

Table 19: Electricity Consumption on Water Treatment/Pumping (ekWh)

Name of Water Pumping/ Treatment Plant	Electricity Consumption on water treatment/pumping (ekWh)				
	2006-07	2007-08	2008-09	2009-10	2015-16
Wazirabad Water Works	5,86,39,396	5,81,73,432	5,87,66,928	5,57,08,592	5,08,98,520
MGD Okhla Water Works	68,21,282	72,48,840	75,29,084	66,33,380	95,93,606
140 MGD WTP Sonia Vihar	1,89,79,380	4,06,61,340	5,35,51,050	5,07,63,600	5,07,82,733
90 MGD Chandrawal WTP	2,91,22,959	28,49,50,141	2,70,47,130	2,81,22,264	2,78,46,224

(Source: Delhi Jal Board, New Delhi)

Sewerage Pumping and Treatment

The development of sewerage system in Delhi started soon after New Delhi was built in 1938. A Sewage Treatment Plant (STP) of 82 mld capacity was constructed at Okhla. By 1956, the capacity of this plant was augmented to 164 mld. Additional STPs were later constructed at coronation pillar (55 MLD) and at Keshopur (55 MLD) in 1957 and 1960 respectively. The treatment capacity increased from 273 MLD in 1961 to 1,273 MLD in 1993. The present sewage treatment capacity in Delhi stands at around 2,330 MLD. Presently, the urban area of Delhi is served by a gravity collection sewerage system involving a large network of branch sewers, intercepting sewers, peripheral and trunk sewers, of about 6,000 km length. As per DJB there are 28 main trunk sewers with size ranging from 700 mm to over 2,400 mm diameter with a total length of around 140 km.

Table 20: Electricity Consumption of water pumping/treatment plans (ekWh)

Name of Water Pumping/ Treatment Plant	Electricity Consumption on water treatment/pumping (ekWh)				
	2006-07	2007-08	2008-09	2009-10	2016-17
120 mgd Wazirabad Water Works	5,86,39,396	5,81,73,432	5,87,66,928	5,57,08,592	4,76,30,850
200 mgd Haiderpur	6,19,60,980	6,19,39,206	6,17,98,740	6,77,38,260	5,64,18,180
20+6 MGD Okhla Water Works	68,21,282	72,48,840	75,29,084	66,33,380	95,01,820
140 MGD WTP Sonia Vihar	1,89,79,380	4,06,61,340	53,5,51,050	5,07,63,600	4,99,04,010
90 MGD Chandrawal WTP	2,91,22,959	2,84,95,0,141	2,70,47,130	2,81,22,264	2,79,65,965
100 mgd Bhagirathi					2,22,20,790
40 mgd Nangloi	88,74,720	82,48,000	82,98,000	94,36,900	1,84,86,808
20 mgd Bawana	---	---	---	---	40,58,790
50 mgd Dwarka	---	---	---	---	1,31,38,194
1 mgd CWG Village	---	---	---	---	5,65,046
Total					24,98,90,453

While the balance length comprises peripheral sewers with smaller diameter that form the linkage between trunk sewers and the smaller internal sewers in colonies with the smallest internal sewers having diameter of 150 mm. There are 36 major pumping stations of capacities ranging from 6 MLD to 455 MLD. In the past the emphasis was for the provision of drinking water supply only to both urban & rural areas. As a result, growth in sewerage facilities has not been commensurate with the sewage generation. Even today, only about 60% of the population of Delhi is served by the sewerage system. For the purposes of sewerage and drainage, Delhi can be divided into six zones 1) Rithala, 2) Coronation Pillar 3) Keshopur 4) Okhla 5) Trans Yamuna and 6) Outer Delhi. Besides this, there are newly developed areas or urban extensions mostly contiguous with urban limits such as Narela, Pappan Kalan, Nazafgarh, Ghitroni, Vasant Kunj, Mehrauli & Sarita Vihar. At present STPs are located at 17 different places in Delhi with a cumulative treatment capacity of 2,330 MLD (512.5 MGD).

Table 21: Capacity of Various Sewage Treatment Plants at the End of Five Year Plan (in MGD)

S. No.	Sewage Treatment Plant	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2016-17
1	Okhla	140	140	140	140	140	140	140	140	140
2	Coronation Piller	40	40	40	40	40	40	40	30	30
3	Keshopur Pillar	72	72	72	72	72	72	72	72	72
4	Rithala	80	80	80	80	80	80	80	80	80
5	Yamuna Vihar Yamuna Vihar-New	20	20	20	20	20	20	20	10 25	10 25
6	Oxidation Ponds	6	6	6	6	6	6	6	NIL	NIL
7	Vasant Kunj	5	5	5	5	5	5	5	5	5
8	Kondli	45	45	45	45	45	45	45	70	70
9	Dr. Sen Nursing Home	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
10	Najafgarh Nalla	5	5	5	5	5	5	5	5	5
11	Ghitorni	5	5	5	5	5	5	5	5	5
12	Papan Kalan Pappankalan-II	20	20	20	20	20	20	20	20 20	20 20
13	Narela	10	10	10	10	10	10	10	10	10
14	Delhi Gate Delhi Gate-II	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2 15	2.2 15
15	Nilothi Nilothi -II	40	40	40	40	40	40	40	40 20	40 20
16	Mehrauli	5	5	5	5	5	5	5	5	5
17	Rohini	15	15	15	15	15	15	15	15	15
18	Commonwealth games Village						1	1	1	1
19	Molarband						0.66	0.66	0.66	0.66
20	Bakkerwala						0.66	0.66	Nil	0.66
21.	Kapashera								5	5
22.	Chilla								9	9
Total		512.4	512.4	512.4	512.4	512.4	514.72	514.72	544.72	607.06

(Source: Delhi Jal Board, New Delhi)

The table below list the amount of electricity consumed at various STP & SPS over the years:

Table 22: STP and SPS Electricity Consumption

Name	2006-07	2007-08	2008-09	2009-10	2016-17
Sewage Treatment Plant	32,613,174	31,673,585	33,398,408	29,223,107	211,304,126
Sewage Pumping Station	32,632,630	34,437,269	31,494,799	28,843,366	52,241,754
Total					26,354,880

(Source: Delhi Jal Board, New Delhi)

Street Lighting

Street lighting is one of the major energy consumer parts among the various services provided by the local government. City street lighting in India has never been designed, operated or maintained very efficiently. This leads to high-energy consumption and less lighting level or uneven distribution of lighting in the street. In the past efficient lightning technology had not been a viable option because it had to be imported and was expensive. But new energy efficient lighting equipment and good controls are now available on the Indian market. As on date 31st March 2018, 5472 LED lights are installed and energised. Work was executed by PWD for MCDs and the works executed has been handed over to MCDs for maintenance. Street Lighting Energy Efficiency project will reduce electricity consumption by improving street lighting efficiency in the municipal street lighting services. The Delhi Street Lighting System details are as follows:

Table 23: Units of Street Lights in Delhi

Deptt.	20W	40W	70W	100W	150W	200W	250W	400W
MCD	13	21123	68612	529	163665	2	29217	1323
NDMC	NA	2566	2239	NA	NA	NA	10313	896
Total	13	23689	70851	529	163665	2	39530	2219

(Source: MCD & NDMC)

Table 24: Number of Street lights in Different Category

	20W	40W	70W	100W	150W	200W	250W	400W	Total
NDPL	NA	NA	NA	NA	NA	NA	NA	NA	98233
BYPL	13	4841	17765	20	69181	2	6755	1280	99857
BRPL	NA	16282	50847	509	94484	NA	22462	43	184627
Total	13	21123	68612	529	163665	2	29217	1323	284484

(Source: Municipal Corporation of Delhi (MCD))

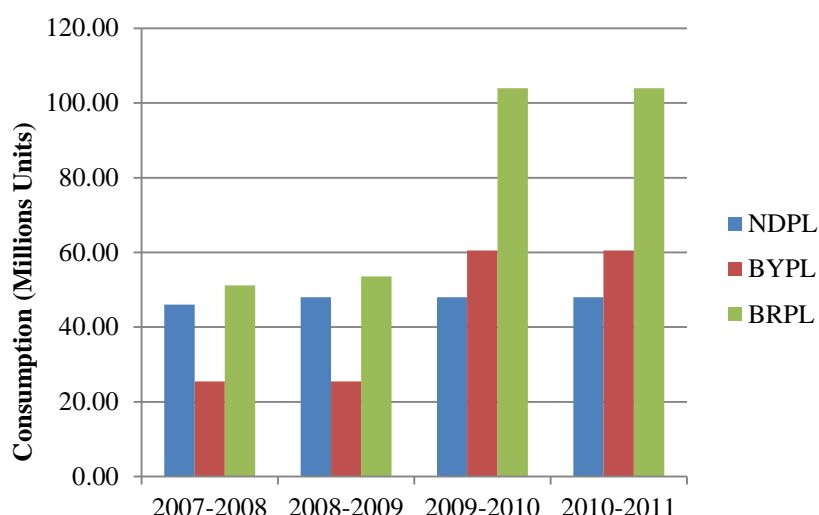
Table 25: Yearly Electricity Consumption (MU) in Street Lighting

Years	Electricity Consumption (Million Units)					Total
	MCD			NDMC		
	NDPL	BYPL	BRPL			
2007-2008	46.08	25.5	51.16	0.047		122.79
2008-2009	48.01	25.5	53.58	0.047		127.14
2009-2010	48.01	60.56	103.97	0.048		212.59
2010-2011	48.01	60.56	103.97	0.048		212.59

(Source: MCD & NDMC)

It need to be noted that the 1.10 % of total electricity supplied is consumed in street lighting services in the year 2009-10, whereas the actual consumption of electricity for public lighting in Delhi was 24037 MUs in the year 2015-16.

Figure 13: Energy Consumption in Street Lights



(Source: Municipal Corporation of Delhi (MCD))

Table 26: Number of Street Light Units in Different Category

Year	Sodium Vapor Lamps		Tube Lights	High Mast	Total
	70 W	250 W	40 W	400 W	
2009-2010	2239	10313	2566	896	16014
2008-2009	2239	10313	2566	896	16014
2007-2008	2275	11129	2211	896	16511
2006-2007	2275	11129	2211	896	16511

(Source: Municipal Corporation of Delhi (MCD))

GNCTD reduced price of electricity by half for the domestic consumers in Delhi. And since then in the last three years, electricity prices have not increased in Delhi. It had a positive effect on Delhi's overall economy. At present, there are about 37.28 lakh of domestic electricity consumers in Delhi, which is 82.84 percent of total domestic consumers, who are getting electricity at half of the applicable tariff compared to three years ago. This scheme will continue as well and for this the proposed budget is of Rs 1720 crore whereas the proposed total expenditure of 2190 crore for Energy sector in 2018-19.

7. Energy Need Forecast of NCT-Delhi and Expected GHG Emissions

In the last two decades Delhi's population, motor vehicles and commercial activities all have increased by manifold. In the past 30 years, its population has more than tripled and vehicle population has increased almost fifteen fold. Delhi has been consecutively ranked among the top states in terms of Monthly per capita expenditure (MPCE) over the past few years, which indicates a flourishing state of Delhi's commercial sector. Delhi's energy consumption growth in all sectors, following changing lifestyle patterns as well as booming economic growth has resulted in a rise in per capita primary energy consumption of Delhiites. In the year 2010, 98.74% of the total households were dependent on Electricity for their lighting needs. Similarly in the same year 85.14% households were using LPG and 1.82% firewood as the primary source of cooking in Delhi. In economic terms, Delhi seems poised to be the next emerging giant city, in both economic and energetic terms.

In this part of the report an assessment of the future energy needs and expected GHG emissions under different scenarios over the period 2010 to 2025 is made for the state of Delhi. End use sector-wise projections are made for Domestic, Transportation, Commercial and Industrial sectors, as these are the major consumers of energy in NCT-Delhi. For each sector, drivers of energy, technology and historical growth are indentified. Accordingly trends are then analyzed and used for projection of future growth.

In the present study we have created three scenarios to characterize what is likely and what is possible. One scenario – representing a 'Business as usual' course – is an estimation of present trends, modified to reflect existing and likely demand of energy in future. The second scenario, termed as 'Low Growth Scenario', is reflecting a state of slow economic growth over the next fifteen years and consequent energy demand and GHG emissions under such a scenario. In the third scenario, termed as 'High Growth Scenario', we assume a rapidly growing economy under which all the sectors are characterized by high energy demand. Results of this analysis provide valuable inputs to the understanding of realistic energy demand scenarios for NCT-Delhi.

7.1 Macro-Economic Indicators & their Projections for NCT-Delhi

For Delhi as a whole, the macro-economic indicators are given in Table 27. These projections are based on the various Five-Year Plans of the planning commission and Census of India studies. The data reflects that the percentage of Delhi's population would increase by about more than 50% in the year 2025.

Delhi's population in the year 2011 was 16.75 Million (16,753,235); the expectation is that the population of Delhi may range between 27 to 28 million in the year 2025. A sharp increase in population can also be attributed to large number of people migrating to Delhi from other parts of the country in search of better life and employment opportunities. Delhi

is highly urbanized with 93.18% of its population living in urban areas as against the national average of 27.81%. The percentage of Delhi’s population living below the poverty line has also been more or less steadily decreasing in the past few years. This trend is likely to continue in the coming future also resulting into increasing aggregate and per capita energy demand.

Delhi’s economy is also likely to grow by more than four fold in the next fifteen years. Under the ‘Business as usual’ scenario 8 % growth rate of GSDP is considered over entire modelling period. The ‘Low Growth Scenario’ assumes a low growth of GSDP at the rate of 6 % per annum. The ‘High Growth Scenario’ assumes a high growth of GSDP at the rate of 10 % per annum. All other assumptions with respect to technologies and other parameters are similar under all the three scenarios.

Table 27: Macro-economic Indicators and their Projections for NCT-Delhi

Scenario	Historical			Business as Usual			Low Growth Scenario			High Growth Scenario		
	1990	2006	2010	2015	2020	2025	2015	2020	2025	2015	2020	2025
Population (000’)	8,207	16,021	18,451	21,285	24,485	27,982	21,285	24,485	27,982	21,285	24,485	27,982
Population Growth Rate (%)	3.81	2.12	2.80	2.90	2.80	2.70	2.90	2.80	2.70	2.90	2.80	2.70
GDP, 1990-91 (US\$)	base	1,253	2,857	4,198	6,168	9,063	3,823	5,116	6,847	4,601	7,410	11,934
GDP Growth rate (%)	base	8.90	10.92	8.00	8.00	8.00	6.00	6.00	6.00	10.00	10.00	10.00

(Source: Census of India’2001; Planning Commission of India)

7.2 Estimated Growth Rates of Different Sectors

Projections under three different scenarios are typically presented at the sectoral level such as domestic, transport, commercial and industrial without further disaggregation. Historical energy consumption and energy-related CO₂ emissions data back to 1990 were analyzed in order to interpret energy consumption trends over time.

Factors driving the energy consumption can be grouped in three main categories. The first is the size of the population. The more people who need to meet their energy needs, the more resources are consumed. The second is how and to what extent we congregate our needs. According to wealth and cultural practices, these needs are met differently. The third is the pattern of development, broadly defined to include technological levels.

Domestic Sector: The basic assumption for the projection of energy need for domestic sector is that energy demand in the domestic sector is directly proportional to the population, number of households & GSDP growth rate keeping other factors constant. Energy services in the residential sector mainly includes cooking, space heating, lighting & major appliances. The different energy sources used to meet these services includes electricity, LPG, natural gas and kerosene. For a city like Delhi, which is largely urban & still in the developing stage, the energy intensity of households is likely to increase with a rise in per capita income of people. Historical trends have shown an increase in per capita consumption of energy with an increase in per capita income.

Transport Sector: The basic assumption for the projection of energy need in the transport sector is that energy demand in the transport sector is directly proportional to number of vehicles, type of vehicles & GSDP growth rate keeping other factors constant. Road transport is the major travel mode in Delhi, though some shift has come with expansion of Metro Rail service in Delhi and NCR. The major mode of transport in Delhi includes buses, metro rail, cars, two-wheeler & autos. The various fuels consumed in the transport sector include petrol, diesel and CNG. The total number of vehicles in Delhi has gone up from 3.3 million in 2000-01 to 9.25 million in the year 2015-16. Historical trends have shown a rise in number of personal vehicles with a rise in per capita income of people. Though this trend is likely to continue, it is expected that with expansion of Metro and better bus transport the growth of private individual vehicles will be controlled. With a rise in aggregate number of vehicles the total fuel requirement will also increase in the future, nevertheless introduction of new technology will play important role.

Commercial Sector: The basic assumption for the projection of energy need in the commercial sector is that energy demand in the commercial sector is directly proportional to population & GSDP growth rate keeping other factors constant. The growth of commercial activities is closely related to the growth of other sectors. The commercial sector includes service businesses, such as shops and stores, hotels and motels, restaurants, and hospitals, as well as a wide range of facilities, such as public schools, specialized governmental facilities, and religious organizations. In the commercial sector the major sources of energy consumption are electricity and cooking gas. Over the next 15 years commercial energy demand will continue to rise, as a result of increasing commercial activities from growing population and higher per capita income of people.

Industrial Sector: The basic assumption for the projection of energy need in the industrial sector is that energy demand in the industrial sector is directly proportional to the type of commodities produced by industries in Delhi. Industrial energy consumption can be divided into two sub-sectors: energy-intensive industries and light (or non-energy-intensive) industries. In Delhi, majority of industries are non-energy intensive industries and as a result the consumption of energy in industrial sector in Delhi is less as compared to other sectors. In the industrial sector the major sources of energy consumption includes electricity and fuels like soft coke, LDO etc. Over the next 15 years the aggregate industrial energy demand is expected to increase but at a rate lower than that of other sectors &

historical growth rate, an outcome of the increase in share of service sector in the economy. The historical and estimated growth rates of the four sectors under different scenarios are given in table 28.

Table 28: Estimated energy consumption growth rates of different sectors for NCT-Delhi

Scenario	Historical			Business as Usual			Low Growth Scenario			High Growth Scenario		
	1990	2006	2010	2015	2020	2025	2015	2020	2025	2015	2020	2025
Domestic Sector (%)	4.11	6.54	8.38	8.40	7.40	6.40	6.40	5.40	4.40	10.40	9.40	8.40
Transport Sector (%)	8.28	7.10	9.33	8.00	7.00	6.00	6.00	5.00	4.00	10.00	9.00	8.00
Commercial Sector (%)	4.74	5.73	11.04	9.00	8.10	7.20	7.00	6.10	5.20	11.00	10.10	9.20
Industrial Sector (%)	3.35	6.03	12.00	7.20	6.30	5.40	5.20	4.30	3.40	9.20	8.30	7.40

7.3 Primary Energy Consumption Forecast of NCT-Delhi under Different Scenarios

Historical energy consumption

Historically, the major sectors consuming energy in Delhi includes transport, domestic, commercial & industrial sector. The total energy consumption of these four major sectors in the year 1990 was 77,020,264 (GJ), which increased to 156,513,427 (GJ) in the year 2010 at a CAGR of 3.61% between the same period.

The share of transport sector in consumption of total energy in the year 1990, 2006 & 2010 was 58%, 52% & 47% respectively. The total energy consumed by transport sector in the year 1990 was 45,020,851 (GJ) which increased to 74,126,305 (GJ) in the year 2010 at a CAGR of 2.52 % between the same period. Though the share of transport sector has fallen, the aggregate energy consumption has increased due to the increase in total number of vehicles in Delhi. The growth in energy demand in transport sector also showed a similar pattern like domestic sector, with the rise in population & income level of people, the total number of vehicles in Delhi has more than doubled in last 10 years.

The share of domestic sector in consumption of total energy in the year 1990, 2006 & 2010 was 32%, 33% & 35% respectively. The total energy consumed by domestic sector in the year 1990 was 24,505,547 (GJ) which increased to 54,360,127 (GJ) in the year 2010 at a CAGR of 4.10 % between the same period. The growth in energy demand was much higher in the period of 2000-2010 as compared to the period of 1990-2000. The high growth rate

of energy demand in the last ten years can be attributed to two major factors viz. increase in the number of households & rise in per capita income of people.

The share of commercial sector in consumption of total energy in the year 1990, 2006 & 2010 was 5%, 9% & 11% respectively. The total energy consumed by commercial sector in the year 1990 was 3,934,800 (GJ) which increased to 17,067,600 (GJ) in the year 2010 at a CAGR of 7.61 % between the same period. The high growth rate of the energy demand in commercial sector can be attributed to a number of factors like increase in population, per capita income & changing lifestyles of people.

Similarly, the share of industrial sector in consumption of total energy in the year 1990, 2006 & 2010 was 5%, 6% & 7% respectively. The total energy consumed by industrial sector in the year 1990 was 3,559,066 (GJ) which increased to 10,959,396 (GJ) in the year 2010 at a CAGR of 5.78 % between the same period.

Knowing the current patterns of energy use and assumptions about future trends in economic activity, we constructed an activity driven model to forecast what would be the natural long term evolution of energy use in NCT-Delhi for each end use sector by 2025. Through analysis of current patterns of energy use, drivers of energy use were identified at the sectoral level. We then connected trends in activity drivers with projections of GDP to determine what would be the impact of economic growth on drivers of energy use. We have also considered fuel or technology switching in the forecast for some sectors. Accordingly we have constructed three different scenarios of future energy need for NCT-Delhi.

Business-as-usual Scenario

The Business-as-usual (BAU) scenario assumes the economy to grow at 8.0% per annum for a period of next fifteen years from 2010 to 2025. The first observation is that the current picture of energy consumption breakdown is not expected to dramatically change as demand for all end users will grow simultaneously. The same activities that require energy today will continue to consume energy in 2025. The total energy consumed by all the four sectors in the year 2010 is 156,513,427 (GJ), which is expected to reach 445,245,459 (GJ) in the year 2025 at a CAGR of 7.22 % under the BAU scenario.

Under the BAU scenario the share of transport sector in the total energy consumption in the year 2015, 2020 & 2025 is expected to be 46.94%, 46.45% & 45.91% respectively as compared to 47% in the year 2010. The total energy consumed by transport sector in the year 2010 is 74,126,305 (GJ), which is expected to reach 204,427,513 (GJ) in the year 2025. The energy demand in the transport sector is expected to grow at a CAGR of 7.00% between the year 2010 and 2025. The increase in transport energy demand will result from the increase in number of vehicles on the roads of Delhi. In the transport sector the share of diesel & petrol is expected to decrease from current share, whereas that of CNG will drastically increase. The primary reason driving the reduction of petrol & diesel consumption would be rise in prices of fossil fuels; nonetheless various other factors like availability of alternative technology, concern for environment & policy initiatives will also play a minor role. According to our assumptions the share of CNG in total energy

consumption of transport sector in the year 2015, 2020 & 2025 is expected to increase to 3.0%, 10.0% and 20.0% respectively. The disaggregation of final energy consumption by fuel type in transport sector in the year 2025 is expected to be 40% of diesel, 30% of petrol, 20% of CNG and 10% of electricity.

Under the BAU scenario the share of domestic sector in the total energy consumption in the year 2015, 2020 & 2025 is expected to be 35.06%, 35.36% & 35.61% respectively as compared to 35% in the year 2010. The total energy consumed by domestic sector in the year 2010 is 54,360,127 (GJ), which is expected to reach 158,546,413 (GJ) in the year 2025. The energy demand in the domestic sector is expected to grow at a CAGR of 7.40% between the year 2010 and 2025. The rise in domestic energy demand will result from increase in number of households, floor area per capita & appliance ownership. Whereas the consumption of electricity will continue to increase, the consumption of LPG will marginally fall and that of Piped natural gas (PNG) will increase, resulting in a fuel switch in cooking gas over the period of next 15 years. According to our assumptions the share of PNG in total energy consumption of domestic sector in the year 2015, 2020 & 2025 is expected to increase to 5%, 10% and 20% respectively. We also assume that by 2025 there will be no use of kerosene in domestic sector for lighting purpose. The disaggregation of final energy consumption by fuel type in domestic sector in the year 2025 is expected to be 60% of electricity, 20% of LPG and 20% of PNG.

The share of commercial sector in the total energy consumption under the BAU scenario in the year 2015, 2020 & 2025 is expected to be 11.32%, 11.79% & 12.33% respectively as compared to 10.90% in the year 2010. The total energy consumed by commercial sector in the year 2010 is 17,067,600 (GJ), which is expected to reach 54,879,146 (GJ) in the year 2025. The energy demand in the commercial sector is expected to grow at a CAGR of 8.10% between the year 2010 and 2025. The increase in per capita income & standard of living of people has resulted into a change in lifestyle & culture of Indians. This trend is likely to continue in future, with the increase in purchasing power of people the demand for commercial activities is expected to grow resulting in a rise in the share of energy consumption from commercial sector.

Similarly, the share of industrial sector in the total energy consumption under the BAU scenario in the year 2015, 2020 & 2025 is expected to be 6.69%, 6.40% & 6.15% respectively as compared to 7.0% in the year 2010. The total energy consumed by industrial sector in the year 2010 is 10,959,395 (GJ), which is expected to reach 27,392,387 (GJ) in the year 2025. The energy demand in the industrial sector is expected to grow at a CAGR of 6.30% between the year 2010 and 2025. Though the aggregate industrial energy demand is expected to increase over the period of next 15 years, the pace of growth of industrial sector is declining. The main reasons behind this fall of growth rate are less number of industrial activities in Delhi, majority of the industries is light industries and an expected increase in the share of service sector in Delhi's economy over the period of next 15 years. The disaggregation of final energy consumption by fuel type in industrial sector in the year 2025 is expected to be 90% of electricity and 10% of industrial oils. The historical and

estimated primary energy consumption of the four sectors under BAU scenario is given in table 29.

Table 29: Sector-wise primary energy consumption of NCT-Delhi under BAU scenario

Scenario	Historical (GJ)			Business as Usual (GJ)			2010-25 CAGR (%)
Year	1990	2006	2010	2015	2020	2025	
Total	77,020,264	148,906,394	156,513,427	232,054,776	328,847,840	445,245,459	7.22
Domestic	24,505,547	48,570,807	54,360,127	81,362,985	116,264,808	158,546,413	7.40
Transport	45,020,851	77,842,787	74,126,305	108,915,861	152,760,130	204,427,513	7.00
Commercial	3,934,800	13,428,000	17,067,600	26,260,618	38,764,431	54,879,146	8.10
Industrial	3,559,066	9,064,800	10,959,395	15,515,312	21,058,471	27,392,387	6.30

Low Growth Scenario

The Low growth scenario (LGS) assumes the economy to grow at 6.0% per annum for a period of next fifteen years from 2010 to 2025. Under the LGS, the current picture of energy consumption breakdown is not expected to dramatically change as demand for all end users will grow simultaneously but at a slow economic growth rate. The total energy consumed by all the four sectors in the year 2010 is 156,513,427 (GJ), which is expected to reach 335,695,484 (GJ) in the year 2025 at a CAGR of 7.22 % under the LGS scenario.

Under the Low growth scenario the share of transport sector in the total energy consumption in the year 2015, 2020 & 2025 is expected to be 46.93%, 46.44% & 45.88% respectively as compared to 47% in the year 2010. The total energy consumed by transport sector in the year 2010 is 74,126,305 (GJ), which is expected to reach 154,033,388 (GJ) in the year 2025. The energy demand in the transport sector is expected to grow at a CAGR of 5.00% between the year 2010 and 2025. In the LGS, it is expected that the growth in number of private vehicles will be slow due to a low per capita income resulting in more use of public transport by people. As a consequence, the use of CNG in transport sector is expected to be more as compared to diesel and petrol. Accordingly, the disaggregation of final energy consumption by fuel type in transport sector in the year 2025 is expected to be 35% of diesel, 30% of petrol, 25% of CNG and 10% of electricity.

Under the Low growth scenario the share of domestic sector in the total energy consumption in the year 2015, 2020 & 2025 is expected to be 35.07%, 35.37% & 35.62% respectively as compared to 35% in the year 2010. The total energy consumed by domestic sector in the year 2010 is 54,360,127 (GJ), which is expected to reach 119,589,803 (GJ) in the year 2025. The energy demand in the domestic sector is expected to grow at a CAGR of 5.40% between the year 2010 and 2025. According to our estimates, the increase in

population will be accompanied by a slow growth in per capita income of people resulting in a low per capita energy consumption and low appliance ownership. On the whole the impact would be a slow growth of domestic energy consumption. All other assumptions for the domestic sector with respect to fuel switch, technologies, disaggregation of final energy consumption by fuel type and other parameters are similar to those as BAU scenario.

The share of commercial sector in the total energy consumption under the Low growth scenario in the year 2015, 2020 & 2025 is expected to be 11.32%, 11.81% & 12.35% respectively as compared to 10.90% in the year 2010. The total energy consumed by commercial sector in the year 2010 is 17,067,600 (GJ), which is expected to reach 41,471,235 (GJ) in the year 2025. The energy demand in the commercial sector is expected to grow at a CAGR of 6.10% between the year 2010 and 2025. The overall slowdown in the economy will impact the commercial activities of the city resulting in a lower growth of energy demand from commercial sector. All other assumptions for the commercial sector with respect to fuel switch, technologies, disaggregation of final energy consumption by fuel type and other parameters are similar to those as BAU scenario.

Finally, the share of industrial sector in the total energy consumption under the Low growth scenario in the year 2015, 2020 & 2025 is expected to be 6.68%, 6.39% & 6.14% respectively as compared to 7.0% in the year 2010. The total energy consumed by industrial sector in the year 2010 is 10,959,395 (GJ), which is expected to reach 20,601,058 (GJ) in the year 2025. The energy demand in the industrial sector is expected to grow at a CAGR of 4.30% between the year 2010 and 2025. All other assumptions for the industrial sector with respect to fuel switch, technologies, disaggregation of final energy consumption by fuel type and other parameters are similar to those as BAU scenario. The historical and estimated primary energy consumption of the four sectors under Low growth scenario is given in table 30.

Table 30: Sector-wise primary energy consumption of NCT-Delhi under Low growth scenario

Scenario	Historical (GJ)			Low Growth Scenario (GJ)			
	1990	2006	2010	2015	2020	2025	2010-25 CAGR (%)
Total	77,020,264	148,906,394	156,513,427	29,854,434	38,932,164	48,730,906	5.22
Domestic	24,505,547	48,570,807	54,360,127	11,887,236	15,309,578	18,931,497	5.40
Transport	45,020,851	77,842,787	74,126,305	9,481,424	12,826,851	16,636,919	5.00
Commercial	3,934,800	13,428,000	17,067,600	5,333,642	6,905,052	8,563,859	6.10
Industrial	3,559,066	9,064,800	10,959,395	3,152,131	3,890,683	4,598,630	4.30

High Growth Scenario

The High growth scenario (HGS) assumes the economy to grow at 10.0% per annum for a period of next fifteen years from 2010 to 2025. Under the HGS, the current picture of energy consumption breakdown is not expected to dramatically change as demand for all end users will grow simultaneously at a robust economic growth rate. The total energy consumed by all the four sectors in the year 2010 is 156,513,427 (GJ), which is expected to reach 587,471,951 (GJ) in the year 2025 at a CAGR of 9.22 % under the HGS scenario.

Under the High growth scenario the share of transport sector in the total energy consumption in the year 2015, 2020 & 2025 is expected to be 46.94%, 46.47% & 45.94% respectively as compared to 47% in the year 2010. The total energy consumed by transport sector in the year 2010 is 74,126,305 (GJ), which is expected to reach 269,890,157 (GJ) in the year 2025. The energy demand in the transport sector is expected to grow at a CAGR of 9.00% between the year 2010 and 2025. In the HGS, it is expected that the growth in number of private vehicles will be very high due to an increase in per capita income and booming economy resulting in more use of private vehicles by people. All other assumptions for the transport sector with respect to fuel switch, technologies, disaggregation of final energy consumption by fuel type and other parameters are similar to those as BAU scenario.

Under the High growth scenario the share of domestic sector in the total energy consumption in the year 2015, 2020 & 2025 is expected to be 35.06%, 35.34% & 35.59% respectively as compared to 35% in the year 2010. The total energy consumed by domestic sector in the year 2010 is 54,360,127 (GJ), which is expected to reach 209,102,320 (GJ) in the year 2025. The energy demand in the domestic sector is expected to grow at a CAGR of 9.40% between the year 2010 and 2025. The factors contributing to a rise in aggregate domestic energy demand & high growth rate of domestic sector are similar to those of BAU scenario. All other assumptions for the domestic sector with respect to fuel switch, technologies, disaggregation of final energy consumption by fuel type and other parameters are similar to those as BAU scenario.

The share of commercial sector in the total energy consumption under the High growth scenario in the year 2015, 2020 & 2025 is expected to be 11.31%, 11.77% & 12.30% respectively as compared to 10.90% in the year 2010. The total energy consumed by commercial sector in the year 2010 is 17,067,600 (GJ), which is expected to reach 72,249,881 (GJ) in the year 2025. The energy demand in the commercial sector is expected to grow at a CAGR of 10.10% between the year 2010 and 2025. The factors contributing to a rise in aggregate commercial energy demand & high growth rate of commercial sector are similar to those of BAU scenario. All other assumptions for the commercial sector with respect to fuel switch, technologies, disaggregation of final energy consumption by fuel type and other parameters are similar to those as BAU scenario.

Finally, the share of industrial sector in the total energy consumption under the High growth scenario in the year 2015, 2020 & 2025 is expected to be 6.69%, 6.41% & 6.17% respectively as compared to 7.0% in the year 2010. The total energy consumed by industrial sector in the year 2010 is 10,959,395 (GJ), which is expected to reach 36,229,593 (GJ) in the year 2025. The energy demand in the industrial sector is expected to grow at a CAGR of 8.30% between the year 2010 and 2025. The factors contributing to a rise in aggregate industrial energy demand & low growth rate of commercial sector are similar to those of BAU scenario. All other assumptions for the industrial sector with respect to fuel switch, technologies, disaggregation of final energy consumption by fuel type and other parameters are similar to those as BAU scenario. The historical and estimated primary energy

consumption of the four sectors under High growth scenario is given in table 31. The graphical representation of estimated primary energy consumption of the four sectors under different scenarios is shown in Figure 14. The graphical representation of total estimated primary energy consumption of NCT-Delhi over the next 15 years is shown in Figure 15.

Table 31: Sector-wise primary energy consumption of NCT-Delhi under High growth scenario

Scenario	Historical (GJ)			High Growth Scenario (GJ)			
Year	1990	2006	2010	2015	2020	2025	2010-25 CAGR (%)
Total	77,020,264	148,906,394	156,513,427	254,309,631	395,270,629	587,471,951	9.22
Domestic	24,505,547	48,570,807	54,360,127	89,150,920	139,705,158	209,102,320	9.40
Transport	45,020,851	77,842,787	74,126,305	119,381,155	183,682,706	269,890,157	9.00
Commercial	3,934,800	13,428,000	17,067,600	28,759,899	46,529,024	72,249,881	10.10
Industrial	3,559,066	9,064,800	10,959,395	17,017,657	25,353,741	36,229,593	8.30

Figure 14: Sector-wise primary energy consumption of NCT-Delhi under different scenarios

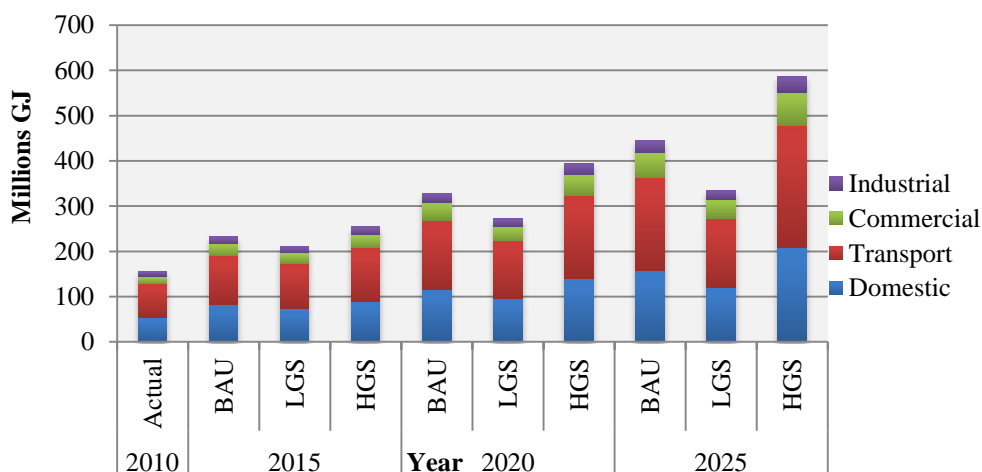
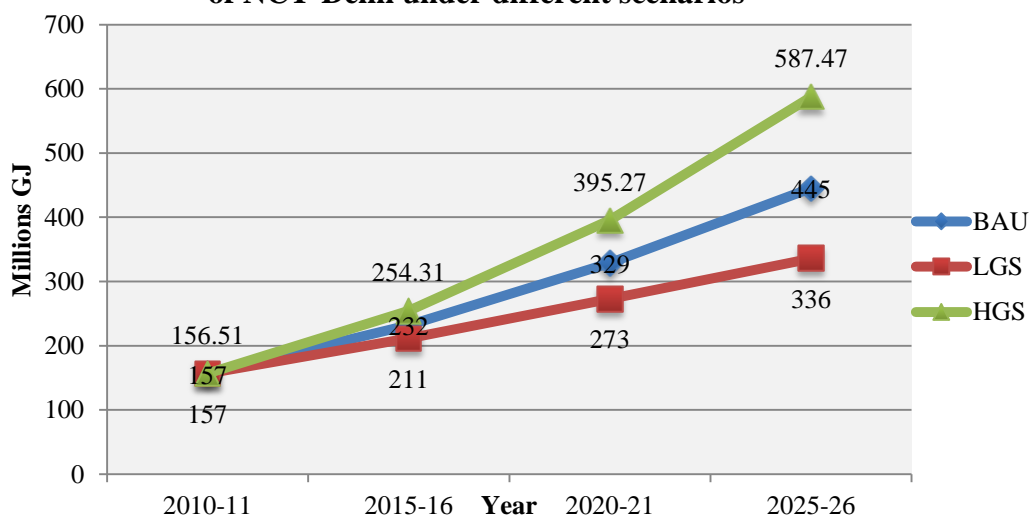


Figure 15: Total primary energy consumption of NCT-Delhi under different scenarios



Disaggregation of Final Energy Consumption by Fuel Type in NCT-Delhi in the year 2025

The total energy consumption by various fuel type in NCT-Delhi in the year 2010 is 179,066,149 (GJ), which under BAU scenario, LGS and HGS is expected to reach 499,402,913 (GJ), 375,677,641 (GJ) & 690,671,564 (GJ) respectively, in the year 2025. The aggregate final energy consumption by various fuel types under BAU, LGS and HGS is expected to grow at a CAGR of 7.08%, 5.06% & 9.42% respectively, between the year 2010 and 2025.

The aggregate consumption of electricity in the year 2010 is 75,574,588 (GJ), which under BAU scenario, LGS and HGS is expected to reach 229,532,816 (GJ), 173,140,480 (GJ) & 334,465,810 (GJ) respectively in the year 2025. The share of electricity in the total energy consumption by fuel type under the BAU scenario, LGS and HGS in the year 2025 is expected to be 45.96%, 46.09% & 48.43% respectively as compared to 42.20% in the year 2010. The electricity demand under the BAU scenario, LGS and HGS is expected to grow at a CAGR of 8.86%, 6.83% & 11.63% respectively, between the year 2010 and 2025. Electricity is predominantly consumed in all the sectors of the economy, according to our estimates the share of electricity in all the major sectors will continue to increase over the period of next 15 years. The strong growth in electricity demand implies that drastic improvements should be made both to the efficiency of the power infrastructure and to electric end uses for meeting the future demand of electricity.

The aggregate consumption of petrol in the year 2010 is 30,934,320 (GJ), which under BAU scenario, LGS and HGS is expected to reach 68,142,504 (GJ), 51,344,463 (GJ) & 89,963,386 (GJ) respectively in the year 2025. The share of petrol in the total energy consumption by fuel type under the BAU scenario, LGS and HGS in the year 2025 is expected to be 13.64%, 13.67% & 13.03% respectively as compared to 17.28% in the year 2010. The petrol demand under the BAU scenario, LGS and HGS is expected to grow at a CAGR of 6.15%, 4.16% & 8.13% respectively, between the year 2010 and 2025. Though the aggregate consumption of petrol is expected to increase over the period of next fifteen years, its share in the total energy consumption will fall due to its rising prices and availability of alternative automotive fuels like CNG. In the transport sector, the moderate growth in consumption of petrol will be driven by a rapid increase in personal vehicles ownership in the region of NCT-Delhi.

The aggregate consumption of diesel in the year 2010 is 46,805,000 (GJ), which under BAU scenario, LGS and HGS is expected to reach 93,900,271 (GJ), 62,190,880 (GJ) & 123,976,691 (GJ) respectively in the year 2025. The share of diesel in the total energy consumption by fuel type under the BAU scenario, LGS and HGS in the year 2025 is expected to be 18.80%, 16.55% & 17.95% respectively as compared to 26.14% in the year 2010. The diesel demand under the BAU scenario, LGS and HGS is expected to grow at a CAGR of 5.49%, 2.63% & 7.46% respectively, between the year 2010 and 2025. Diesel is mainly consumed in the transport sector by heavy commercial vehicles (HCV) & buses,

the persistent fall in the share of diesel consumption over the period of next 15 years in Delhi will be driven by more use of CNG as automotive fuel by HCV & buses.

The aggregate consumption of LPG in the year 2010 is 19,927,661 (GJ), which under BAU scenario, LGS and HGS is expected to reach 35,232,536 (GJ), 26,575,512 (GJ) & 46,467,182 (GJ) respectively in the year 2025. The share of LPG in the total energy consumption by fuel type under the BAU scenario, LGS and HGS in the year 2025 is expected to be 7.05%, 7.07% & 6.73% respectively as compared to 11.13% in the year 2010. The LPG demand under the BAU scenario, LGS and HGS is expected to grow at a CAGR of 4.60%, 2.66% & 6.55% respectively, between the year 2010 and 2025. Though the aggregate consumption of LPG is expected to increase over a period of next fifteen years, the share of LPG consumption will constantly reduce due to the penetration of Piped natural gas (PNG) as a cooking fuel in domestic and commercial sector in NCT-Delhi.

The aggregate consumption of CNG in the year 2010 is 722,917 (GJ), which under BAU scenario, LGS and HGS is expected to reach 40,885,503 (GJ), 38,508,347 (GJ) & 53,978,031 (GJ) respectively in the year 2025. The share of CNG in the total energy consumption by fuel type under the BAU scenario, LGS and HGS in the year 2025 is expected to be 8.19%, 10.25% & 7.82% respectively as compared to 0.40% in the year 2010. The CNG demand under the BAU scenario, LGS and HGS is expected to grow at a CAGR of 30.87%, 30.35% & 33.31% respectively, between the year 2010 and 2025. According to our estimates, the penetration of CNG as an automotive fuel over the span of next fifteen years will be a landmark change in the energy characteristic of transport sector in Delhi.

The aggregate consumption of PNG in the year 2010 is 187,230 (GJ), which under BAU scenario, LGS and HGS is expected to reach 31,709,283 (GJ), 23,917,961 (GJ) & 41,820,464 (GJ) respectively in the year 2025. The share of PNG in the total energy consumption by fuel type under the BAU scenario, LGS and HGS in the year 2025 is expected to be 6.35%, 6.37% & 6.06% respectively as compared to 0.10% in the year 2010. The PNG demand under the BAU scenario, LGS and HGS is expected to grow at a CAGR of 40.80%, 38.17% & 43.42% respectively, between the year 2010 and 2025. In the domestic and commercial sector of Delhi, the use of PNG for cooking purpose is expected to significantly increase over the period of next fifteen years.

The consumption of kerosene in the year 2010 is 4,914,432 (GJ), having a share of 2.74% in the total energy consumption by fuel type. Presently, kerosene is predominantly used by below poverty line (BPL) families for lighting purpose in their households and to small extent by industries. According to our estimates, by the year 2025 there will be no use of kerosene for lighting purpose, there will be a shift from kerosene to electricity in NCT-Delhi. The historical and estimated final energy consumption by fuel type under different scenarios is given in table 32.

Table 32: Disaggregation of Final Energy Consumption by Fuel Type in NCT-Delhi in the year 2025

Type of Energy (GJ)	Historical		Business as Usual			Low Growth Scenario			High Growth Scenario		
	2010-11	Share (%)	2025	Share (%)	CAGR	2025	Share (%)	CAGR	2025	Share (%)	CAGR
Electricity	75,574,588	42.20	229,532,816	45.96	8.86	173,140,480	46.09	6.83	334,465,810	48.43	11.63
Petrol	30,934,320	17.28	68,142,504	13.64	6.15	51,344,463	13.67	4.16	89,963,386	13.03	8.13
Diesel	46,805,000	26.14	93,900,271	18.80	5.49	62,190,880	16.55	2.63	123,976,691	17.95	7.46
LPG	19,927,661	11.13	35,232,536	7.05	4.60	26,575,512	7.07	2.66	46,467,182	6.73	6.55
CNG	722,917	0.40	40,885,503	8.19	30.87	38,508,347	10.25	30.35	53,978,031	7.82	33.31
PNG	187,230	0.10	31,709,283	6.35	40.80	23,917,961	6.37	38.17	41,820,464	6.06	43.42
Kerosene	4,914,432	2.74	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
Total	179,066,149	100.00	499,402,913	100.00	7.08	375,677,641	100.00	5.06	690,671,564	100.00	9.42

8. GHG Emissions Profile

8.1 Introduction

According to Intergovernmental Panel on Climate Change (IPCC), “Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth’s surface, the atmosphere and clouds”. The GHGs include water vapor (H₂O), carbon dioxide (CO₂), nitrous oxide (N₂O), methane (CH₄), ozone (O₃), sulphur hexafluoride (SF₆), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs). The categorization of the sources and sinks has been done on the basis of the IPCC guidelines (IPCC, 2006).

The sources of GHG emission may include (IPCC, 2006): Energy (fossil fuel production and combustion), Cement industries, Land use (deforestation, afforestation, soil disturbances, other biomass burning), Agriculture (enteric fermentation, animal wastes, rice cultivation, and fertilizer consumption), Transportation, Other industries and power plants, Landfills, Disposal of chlorofluorocarbons. The sinks for the GHGs: Large water bodies, Forested area and dense vegetative area.

Aggregate GHG emissions from the anthropogenic activities in Delhi in 2014 amounted to 37.91 million tons of the CO_{2e}¹¹. Though, the aggregate GHG emissions from the anthropogenic activities in Delhi in 1990 amounted was 17.33 million tons of the CO₂, 83.4 thousand tons of the CH₄, 0.35 thousand tons of N₂O, 65.6 thousand tons of NO_x, and 71.0 thousand tons for SO₂. In terms of CO₂ equivalent, emissions amount to 19.21million tons¹². The top four contributors to tCO_{2e} emission are: power plants (electricity generation and consumption) (43%), vehicles (32%), burning of municipal solid waste (MSW; 8%) and domestic fuel (7%).

The fossil fuel consumption of coal and natural gas for electricity generation and fuels used in vehicles account for the major emissions in Delhi (82%). The annual per capita tCO_{2e} emission in the city of Delhi was estimated as 2.26 tonne, which is lower than many large cities; Beijing 10.8; London: 6.2 Tokyo: 4.9. However, annual per capita tCO_{2e} emission from Delhi is about 1.5 times of national average. This high per capita emission in Delhi could be attributed to the fact that it is a capital city with high gross domestic product (GDP) and it represents a large urban agglomeration.

The data related to annual CO₂ capture by trees and plants in the city of Delhi are estimated as total biomass: 1.7 million tonne, total carbon: 0.85 million tonne, total CO₂ captured 3.1 million tonne.

¹¹Comprehensive Study on Green House Gases in Delhi, Dr. Mukesh Sharma, and Dr. Onkar Dikshit <http://www.delhi.gov.in/wps/wcm/connect/e97737804fb874318b82ffeb304e9cea/Final+Report+-+Comprehensive+Study+on+GHGs+in+Delhi.pdf> [Accessed 5th May, 2018]

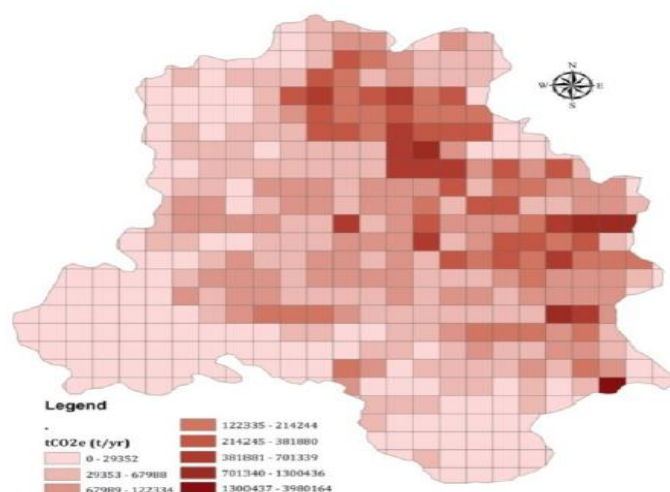
¹²Garg, Amit Shukla, P. R., Emission Inventory of Inventory, 2002, Annexure IV, page no. 257

8.2 City Level GHG Emission Inventory

The tCO₂e emission load in the city is estimated to be 37.91 million tonne for the year 2014. The top four contributors to tCO₂e emission are Power plants (43%), Vehicles (32%), MSW burning (8%) and domestic cooking (7%); these are based on annual emissions. Seasonal and daily emissions could be variable. For example, MSW burning is more frequent in winter than in summer. The estimated emission suggests that there are many important sources and a composite emission abatement including most of the sources will be required to reduce the GHG emission.

CH₄ emission in the city is estimated to be 37078 tonne/yr. The top three contributors to CH₄ emissions are livestock (61%), vehicles (18%), and landfills (9%); these are based on annual emissions. Seasonal and daily emissions could be variable. N₂O emissions are lower than CH₄ emission ~ 7794 t/d. nearly 92% of emissions are attributed to vehicular emissions. Power plants contribute 3% to N₂O emission and are followed by domestic emission (0.5%). The Spatial distribution of tCO₂e emissions (tonne/yr) in the Delhi city in figure 16.

Figure 16: Spatial Distribution of tCO₂e emissions (tonne/yr) in Delhi City.



8.3 Area Sources

From hotels, restaurants, etc: During the field survey it was observed that hotels, restaurants, etc use coal as fuel in tandoors. The average consumption of coal in tandoor, based on a survey was 30 kg/day. The total number of hotels and restaurant enterprises was 36,099 (Delhi Statistical Hand Book, 2014). The emissions of GHG estimated from the activity data from each fuel type and then were summed up in each grid cell. The emission factors given by USEPA (2014) were used for estimating GHG emission.

Table 33: GHG emissions from Hotel/Restaurants in Delhi (Tonne/yr)

CH4	CO ₂	N ₂ O	tCO ₂ e
19	171,595	3	172,942

From Domestic Sector: The data on number of household, fuel usage (coal, LPG, crop residue, cow dung and wood) and population were collected from Census of India (2012).

Table 34: GHG emissions from Domestic Sectors in Delhi (Tonne/yr)

CH4	CO ₂	N ₂ O	tCO ₂ e
148	2,436,054	36	2,450,591

From Municipal Solid Waste Burning: The refuse or municipal solid waste (MSW) burning depends on solid waste generation, extent of disposal and infrastructure for collection. The recent study by Nagpure et al. (2015), in Delhi has estimated 190 to 246 tonne/day of MSW burning (~2–3% of MSW generated).

Table 35: GHG emissions from MSW burning in Delhi (Tonne/yr)

CH4	CO ₂	N ₂ O	tCO ₂ e
1077	3,053,812	142	3,123,102

From Commercial and Industrial Diesel Generator Sets (DG sets): DG sets are used as the source of power in shopping complexes and industries during power-cut hours. It is estimated that there is minimum of 2 hours/day power cut in the city, especially in summers.

Table 36: GHG emissions from MSW burning in Delhi (Tonne/yr)

CH4	CO ₂	N ₂ O	tCO ₂ e
3	49,120	1	49,570

From Agriculture, Green covers and Livestock: The major emissions of paddy cultivation and livestock are in the form of CH₄. The total agricultural area was taken from Statistical Handbook of Delhi (2014). Livestock plays an important role in CH₄ emission, accounting for about 60% of methane emissions in Delhi city. The information of livestock was taken from Delhi Statistical Handbook (2014). Trees capture carbon dioxide by taking it into their cells through photosynthesis. They then store the carbon in their bodies; a tree is comprised of about 50 percent carbon of its biomass. Some CO₂ gets released back into the atmosphere through respiration, but the net effect is large carbon storage.

Table 37: GHG emissions from MSW burning in Delhi (Tonne/yr)

Sector	CH4	CO ₂	N ₂ O	tCO ₂ e
Agriculture	873	57,195	2	79,749
Livestock	22,693	-	-	567,316
Green Cover	147	159,212	72	184,377

From Cremation: There are 53 cremation sites in the city of Delhi, which operates in various zones of Municipal Corporation of Delhi. The woods required per body for the cremation is taken as 216 kg.

Table 38: GHG emissions from Cremation in Delhi (Tonne/yr)

CH4	CO ₂	N ₂ O	tCO ₂ e
3	41,252	2	41,804

From Aircraft: The Indira Gandhi International (IGI) Airport is the primary airport of the National Capital Region, situated in south-west Delhi, 16 km from New Delhi's city center. Total number of flight (landing and taking off) is approximately 800 per day at the IGI Airport.

Table 39: GHG emissions from Aircraft in Delhi (Tonne/yr)

CH4	CO ₂	N ₂ O	tCO ₂ e
11	12,925	0	13,199

From Landfills: There are three major landfills sites (Okhla, Bhalswa and Gazipur) in Delhi.

Table 40: GHG emissions from Landfills in Delhi (Tonne/yr)

CH4	CO ₂	N ₂ O	tCO ₂ e
3,263	3,263	30	93,664

From Incinerator and Boilers: There are 32 health care establishments relevant to air pollutant emissions in the city. These health care establishments are having 14 incinerators (12 (private) and 2 (CBWTF: Common Bio-medical Waste Treatment Facility) and rest have boilers.

Table 41: GHG emissions from Incinerator and Boilers in Delhi (Tonne/yr)

CH4	CO ₂	N ₂ O	tCO ₂ e
88	261,541	12	267,288

From Industries as Area Sources: There are 25 industrial areas in the city. All industries having stack height below 20 m have been considered as an industrial area source. Majority of the industries have small boilers and some also have cupola furnaces.

Table 42: GHG emissions from Industries as area source in Delhi (Tonne/yr)

CH4	CO ₂	N ₂ O	tCO ₂ e
38	520,616	17	526,535

From Drains: Methane is the major GHG that is emitted by wastewater flowing through the drains. There is constant flux of CH₄ from wastewater discharged from the households, which travels through drains to river or to the treatment plants. Total emission of CH₄ and tCO₂e is 493 and 12320 tonne/year respectively from the drains. The estimated CO₂ emission from waste water treatment (excluding energy) was negligible.

From Croplands and Wetlands: The cropland and wetlands GHG emission, excluding the paddy cultivation, is considered under this subhead. Total cropland area was obtained from Delhi Statistical Handbook (2014).

Table 43: GHG emissions from Croplands and Wetlands in Delhi (Tonne/yr)

Sector	CH ₄	CO ₂	N ₂ O	tCO ₂ e
Cropland	176	351,764	126	393,599
Wetlands	18	5,925	11	9,555

From Hydro chlorofluorocarbons (HFCs) from refrigerants: Air conditioners and refrigerator are the most important emission source of HFCs. Emissions from the refrigerants sector results from the manufacturing process, leakage and service over the operational life of the equipment, and disposal at the end of the useful life of the equipment. These gases have 100-year global warming potentials (GWPs), which are typically greater than 1,000 times that of CO₂, so their potential impact on climate change can be significant. Total HFCs emissions from refrigerants are 875 tonne/year and tCO₂e emission is 1,252,053 tonne tCO₂e per year.

Table 44: Contribution of GHG Emissions from Area Sources excluding Vehicles, Power Plants and Large industry (point source)

Sources	Emissions in tonne/yr								
	CH ₄	CH ₄ (%)	CO ₂	CO ₂ (%)	N ₂ O	N ₂ O (%)	HCF	tCO ₂ ^e	tCO ₂ ^e (%)
MSW Burning	1077	3.7	3053812	42.9	142	31.4	-	3123102	33.81
Domestic	148	0.5	2436054	34.2	36	8.0	-	2450591	26.53
Refrigerant	0	0.0	0	0.0	0	0.0	875 (100%)	1252053	13.55
Livestock	22693	78.1	-	-	-	-	-	567316	6.14
Industry Area source	38	0.1	520616	7.3	17	3.7	-	526535	5.70
Cropland	176	0.6	351764	4.9	126	27.7	-	393599	4.26
Incinerator	88	0.3	261541	3.7	12	2.6	-	267288	2.89
Green Cover	147	0.5	159212	2.2	72	15.9	-	184377	2.00
Restaurant	19	0.1	171595	2.4	3	0.6	-	172942	1.87
Landfill	3263	11.2	3263	0.0	30	6.5	-	93664	1.01
Agriculture	873	3.0	57195	0.8	2	0.5	-	79749	0.86
DG Sets	3	0.0	49120	0.7	1	0.3	-	49570	0.54
Cremation	3	0.0	41252	0.6	2	0.3	-	41804	0.45
Aircraft	11	0.0	12925	0.2	0	0.0	-	13199	0.14
Drain	493	1.7	-	-	-	-	-	12320	0.13
Wetland	18	0.1	5925	0.1	11	2.4	-	9555	0.10
Total	29049	100.0	7124275	100.0	453	100.1	875	9237663	100.00

The major contributor in tCO₂e in this category are MSW (34%), Domestic (26.5%), Refrigerants (13.5%) and Livestock (6%). For CH₄, the major contribution is from livestock (78%), followed by Landfills (11%) and MSW burning (3.7%). In case of N₂O, the major contributors are MSW burning (31.4%), croplands (27.7%), Green cover (16%) and Domestic sources (8%).

Comparison with Other Countries

Top 15 GHG emitting countries and their per capita emission compiled by the Energy Information Agency (Department of Energy), which estimates carbon dioxide emissions from all sources of fossil fuel burning and consumption.

Table 45: CO2 and per capita emissions of top 15 emitter countries

2011 Total Emissions Country Rank	Country	2011 Total Carbon Dioxide Emissions from the Consumption of Energy (Million Metric Tons)	2011 per Capita Dioxide Emissions from the Consumption of Energy (Metric Tons of Carbon Dioxide per person)
1	China	8715.31	6.52
2	United States	5490.63	17.62
3	Russia	1788.14	12.55
4	India	1725.76	1.45
5	Japan	1180.62	9.26
6	Germany	748.49	9.19
7	Iran	624.86	8.02
8	South Korea	610.95	12.53
9	Canada	552.56	16.24
10	Saudi Arabia	513.53	19.65
11	United Kingdom	496.80	7.92
12	Brazil	475.41	2.41
13	Mexico	462.29	4.07
14	South Africa	461.57	9.42
15	Indonesia	426.79	1.73

(Source: <http://www.ucsusa.org/>)

While India stands at the 4th level, the per capita emission is the smallest (1.45 Metric Tons CO₂/capita) among 15 countries. However, the Indian economy should grow further and keeping the GHG emissions low as far as possible.

GHG emission in Delhi and comparison with other cities:

In Delhi, the total annual GHG emission was estimated to be 37.91 million tonne of tCO_{2e}. The fossil fuel consumption of coal and natural gas for electricity generation and fuels used in vehicles accounted for the major emissions in the city (82%). The per capita emission of Delhi city is 2.26 tonne per year tCO_{2e}, which is lower than many of the top GHG emitting cities: London: 6.2 Tokyo: 4.9. Delhi with population of 16.75 million is emitting 37.91 million tonne of tCO_{2e}, which is about 4 times less compared to emissions from Beijing, a city of similar population.

Figure 17: Annual per capita tCO₂e emission of different cities

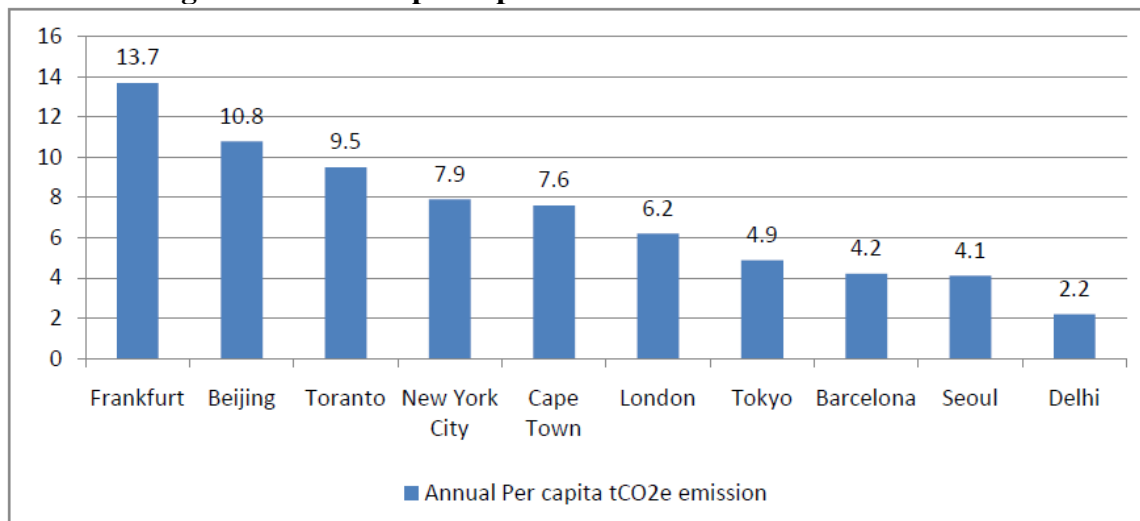
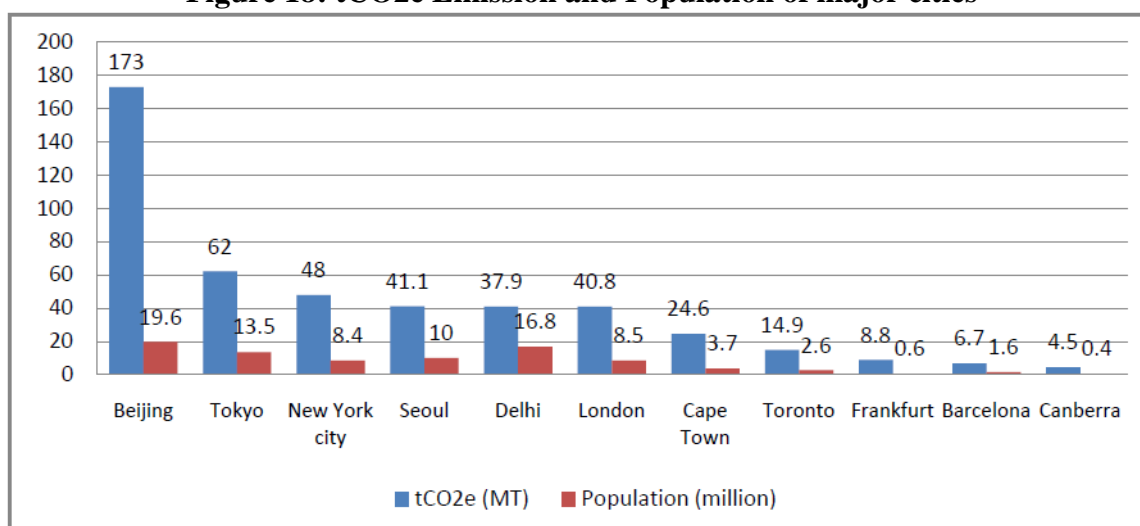


Figure 18: tCO₂e Emission and Population of major cities



It may be noted that per capita emission of India is one of the lowest (among top 15 emitters). Similarly per capita emission in Delhi is also one of the smallest as compared to per capita emission of other cities. However, tCO₂e per capita emission from Delhi is about 1.5 times the national average per capita emission. This large per capita emission in Delhi could be attributed to the fact that it is a capital city with high GDP and solely represent urban area.

Table 46: Overall Baseline GHGs Emission in the Delhi City (in tonnes): Year 2014

S.No.	Sources	CH ₄	CH ₄ (%)	CO ₂ X 10 ⁶	CO ₂ (%)	N ₂ O	N ₂ O (%)	HCF	tCO ₂ e X 10 ⁶	tCO ₂ e (%)
1	Power Sector									
	(1a) Power Plants (Within Delhi)	1,105 315	3.0 0.8	13.40 2.88	40.1 8.6	160 47	2.1 0.6	-	13.48 2.90	35.6 7.6

	(1b) Power Consumption (from Outside Delhi Sources)									
	Total	1,420	3.8	16.28	48.7	207	2.7		16.38	43.2
2	Vehicles	6,606	17.8	9.98	29.9	7,132	91.5	-	12.27	32.4
3	MSW Burning	1,077	2.9	3.05	9.1	142	1.8	-	3.12	8.2
4	Domestic	148	0.4	2.44	7.3	36	0.5	-	2.45	6.5
5	Refrigerant	0	0.0	0.0	0.0	0	0.0	875	1.25	3.3
6	Livestock	22,693	61.2	-		-		-	0.57	1.5
7	Industry (Area Source)	38	0.1	0.52	1.6	17	0.2	-	0.53	1.4
8	Cropland	176	0.5	0.35	1.1	126	1.6	-	0.39	1.0
9	Incinerator	88	0.2	0.26	0.8	12	0.2	-	0.27	0.7
10	Green Cover	147	0.4	0.16	0.5	72	0.9	-	0.18	0.5
11	Restaurant	19	0.1	0.17	0.5	3	0.0	-	0.17	0.5
12	Landfill	3,263	8.8	0.00	0.0	30	0.4	-	0.09	0.2
13	Agriculture	873	2.4	0.06	0.2	2	0.0	-	0.08	0.2
14	DG Set	3	0.0	0.05	0.1	1	0.0	-	0.05	0.1
15	Cremation	3	0.0	0.04	0.1	2	0.0	-	0.04	0.1
16	Industrial (Point Source)	2	0.0	0.03	0.1	1	0.0	-	0.03	0.1
17	Aircraft	11	0.0	0.01	0.0	0	0.0	-	0.01	0.0
18	Drain	493	1.3	-		-		-	0.01	0.0
19	Wetland	18	0.0	0.01	0.0	11	0.1	-	0.01	0.0
20	Total	37,078	100	33.41	100	7,794	100	875	37.91	100

**Industries excluding power plants.*

9. Energy & Power

Power is the most vital sector of every developing or developed economy. History of power supply in Delhi dates back to year 1905, when a private British Firm known as “John Flaming and Co.” established a small generation and distribution company to serve the skeletal population of Delhi. After several re-organizations, “Delhi Electric Supply Board” was formed as per ‘Electricity (Supply) Act, 1948’ and with the enactment of Delhi Municipal Corporation Act (1957), DSEB was replaced by Delhi Electric Supply Undertaking (DESU) as a wing of Municipal Corporation of Delhi (MCD). DESU was under obligation to develop and maintain an efficient and economical system of electric supply for whole of Union Territory of Delhi.

Population of Delhi has grown from 26.5 lakh in 1961 to 1.83 Crore in 2016¹³. The demand for power has also accordingly increased. On 20th May 2016 marked Delhi’s highest ever peak power demand of 6,199 MW and may breach the 6,200 MW mark in coming years. The load growth pattern of Delhi was of the order of 6.32% during the years 2009 to 2015. The load demand in the capital is estimated to grow approximately @ 7% per annum.¹⁴ The process of unplanned urbanization has overtaken the planned development of Delhi putting extra strain on the existing transmission and distribution systems. With a view to carry out the reforms in line with the recommendations of Ballakrishan Committee, Delhi Vidyut Board (DVB) was formed in 1997 as a successor to DESU. Subsequently, Delhi Vidyut Board was unbundled into five entities, w.e.f. 01.07.2002. Simultaneously, Delhi Power Company Limited (DPCL) was set up as the holding company.

- **Transmission Company** - Delhi Transco Limited (DTL)
- **Generation Companies** - Indraprastha Power Generation Company Limited (IPGCL) & Pragati Power Corporation Limited (PPCL)
- **Distribution Companies (DISCOMs)**: (a) Tata Power Delhi Distribution Limited (previously NDPL) (b) BSES Rajdhani Power Limited (BRPL) (c) BSES Yamuna Power Limited (BYPL)

Fifty one percent shares in the distribution business were simultaneously disinvested by GNCTD (focusing on Solar Energy) and other three distribution companies, now known as NDPL, BRPL and BYPL, started looking after the distribution sector in Delhi.

The role and functions of government in the changed scenario of the Power Sector reforms has become more important, vibrant and issue specific with emphasis on the need of taking appropriate policy decision, regulations and legislations in various matters. The ultimate objective of the government is to get the vision realized in making the Power sector in Delhi to be focused towards developing decentralized renewable energy sources and reduce its current dependence on unsustainable and centralised fossil fuel energy while being financially viable. The role of the government has become such so as to see if the public

¹³ Green Vision Document Govt. of NCT Delhi, 2018

¹⁴ Green Vision Document Govt. of NCT Delhi, 2018

interest is getting adequately protected by ensuring quality and uninterrupted power supply to the consumers in Delhi at a reasonable cost and simultaneously that of a facilitator to help the new entities through execution and legislation of various rules/Acts/policies keeping in view the new Electricity Act, 2003 or any other Act.

The Govt. of India had enacted the Electricity Regulatory Commissions Act, 1998 (No.14 of 1998) on 2nd July, 1998 with the objective of providing for the establishment of a Central Electricity Regulatory Commission and State Electricity Regulatory Commissions, rationalization of electricity tariff, transparent policies regarding subsidies, promotion of efficient and environmentally benign policies and for matters connected therewith or incidental thereto. Thereafter, the Delhi Electricity Regulatory Commission was constituted by GNCTD vide Notification No. F. 11(28)/98-EB/341 dt. 03.03.1999 for discharge of the following functions:

- To determine the tariff for electricity, wholesale bulk, grid or retail, as the case maybe, in the manner provided in section 29 of the Electricity Regulatory Commission Act, 1998;
- To determine the tariff payable for the use of the transmission facilities in the manner provided in section 29 of the Electricity Regulatory Commission Act, 1998;
- To regulate power purchase and procurement process of the transmission utilities and distribution utilities including the price at which the power shall be procured from the generating companies, generating stations or from other sources for transmission, sale, distribution and supply in the National Capital Territory of Delhi.
- To promote competition, efficiency and economy in the activities of the electricity industry to achieve the objects and purposes of the Central Electricity Regulatory Commission Act, 1998.

Delhi Energy Development Agency, which was registered as society under Society Registration Act in 1986, was set up to promote Renewable Energy devices in Delhi. The main objective of agency was to implement various related projects of Ministry of New and Renewable Energy, Govt. of India and Delhi Government. Delhi Energy Development Agency was dissolved vide Cabinet Decision No. 892 dated 03.08.2004. Then, again in 2006, Energy Efficiency & Renewable Energy Management Center (EE&REMC) was set up in DTL under Department of Power and was designated as a State Designated Agency under Energy Conservation Act, 2006. In 2008, the center was transferred to Department of Environment, GNCTD. In the year 2014, EE&REMC has been transferred to the Department of Power, Government of National Capital Territory of Delhi (GNCTD). The EE & REM center works as:

- (i) State Designated Agency under Energy Conservation Act.
- (ii) State Nodal Agency to implement Renewable Energy project of Ministry of New and Renewable Energy, Govt. of India and Govt. of Delhi.
- (iii) State Agency to implement Renewable Energy Certificate framework.

9.1 Existing Status of Power Supply and demand

Delhi has the highest per capita power consumption of electricity among the states and union territories of India. The supply of electricity in Delhi periphery increased from 23,537 million units in 2005-06 to 37,484 million units in 2014-15. The state is highly dependent on the allocations from the Central Generating Station (CGS) and other states for fulfilling its power requirement. The peak demand of Delhi met in financial year 2012-13 was 5,642 MW, which has touched the level of 6,285 MW in Delhi during the financial year 2016-17. As most of the city's power plants are old, they generate way below their capacity at an overall plant load factor of 49.97% and load demand in the capital is estimated to grow approximately 7% per annum. The following table gives details of power generation plants in Delhi. However, three units of Badarpur Power Plant and Rajghat Power House are not under operation due to environmental concerns. A waste to energy plant with a capacity of 12 MW is also expected to be commissioned soon at Ghazipur.

Table 47: Power Generating Stations in Delhi¹⁵

Station	Gas Turbine Power Station	Pragati Power Station	Pragati Power Station II Bawana	NTPC Badarpur	Rithala Gas (TPDDL)	Timarpur Okhla Waste Management Ltd.
Station Capacity (MW)	270	330	1500(Nominal)	705	94.8	16
Units	6x30 (GT)+ 3X30 (STGs)	2x104(GT) + 1x122 (STGs)	4x250 (GT)+ 2x250 (STGs)	95x3+210x2	31.6x3	5.5MW each
Year of Commissioning	1986 & 1996	2002 -03	GT-1: 27.12.2011 GT-2: 16.07.2012 STG-1 14.12.2012	1973-75(95MW units)1980-81(210MW units)	2011-2012	2012
Coal Fields/Gas	GAIL HBJ Pipeline	GAIL HBJ Pipeline	GAIL Pipeline	Coal India	GAIL	MCD Waste
Water Sources	River Yamuna	Treated water from Sen Nursing Home and Delhi Gate Sewage Treatment Plants	Treated water from Rithala STP	River Yamuna	Sewage Water Treatment of DJB near Rithala	Sewage Treatment Plant of DJB, Okhla
Beneficiary Areas	BRPL, BYPL, TPDDL, NDMC, MES	BRPL, BYPL, TPDDL, NDMC	BRPL, BYPL, TPDDL, NDMC, MES, Haryana, Punjab	BRPL, BYPL, TPDDL, NDMC, MES	TPDDL	BRPL

¹⁵Department of Power, Government of NCT of Delhi

The consumption of total power supply available in Delhi in the year 2015-16 was 30559 MUs. Purchase of power from sources within Delhi was 5241 MUs and purchased from sources outside State was to the tune of 24618 MUs. The details of electrical energy purchases from sources within Delhi and outside sources are presented in table 48.

Table 48: Electricity Generation purchases from other sources (MU)¹⁶

Sources	2009-10	2010-11	2011-12	2012-13	2014-15	2015-16
Purchase from generating sources within Delhi	9,249	8,465	9,039	9,980	7,524	5,241
Purchases from sources outside the state	18,736	23,947	24,651	26,264	25,854	24,618
Total	27,385	32,412	33,690	36,244	33,378	29,859

9.2 Existing Concerns in Energy & Power Sector

The power reforms were undertaken in Delhi for improving the sector in the areas of supply side and making the sector viable by reducing AT&C losses which was about 50%. After unbundling on 01.07.2002, there is significant improvement. The AT&C losses have been brought down to around 15% in many of the areas. The load shedding during 2001-02 prior to the reforms was to the tune of 5% of the supply has been reduced to 0.13% in 2015-16. This factor is significant when the energy consumption has shown an increase of 29.8% from year 2009-10 to 2015-16. The total load shedding w.r.t. energy consumption is less than 1% which is evident from following table:

Table 49: Energy Consumption and Load Shedding in Delhi

Year	Consumption	Load shedding	Load shedding % to the consumption
2009-10	23543	185	0.784
2010-11	25582	74	0.290
2011-12	26613	83	0.312
2012-13	27335	138	0.507
2013-14	27127.12	77.04	0.28
2014-15	28965.50	116.87	0.40
2015-16	30559	42.05	0.13

(Source: Department of Power, GNCTD)

To meet the increase in demand for power, the generation capacity of Delhi has also been increased as indicated in table 50:

Table 50: Power Generation Capacity (MW)

Source	2002	2015
BTPS owned by NTPC	720	705
IP owned by Delhi Govt.	247.5	0
RPH owned by Delhi Govt.	135	135
GT owned by Delhi Govt.	282	270
Pragati owned by Delhi Govt.	0	330
Bawana CCGT owned by Delhi Govt.	0	1371

¹⁶Department of Power, Government of NCT of Delhi

Rithala owned by TPDDL	0	95
TOWMCL owned by Jindal Group	0	16
Total	1,369	2,922

(Source: Department of Power, GNCTD)

Key concern Areas regarding power availability and purchase concerning Discoms are as follows: Rising long term power purchase cost; Disposing off surplus power in economic manner; Surrender of power from costly long term power stations; Blending of costly imported coal in the power plant instead of Domestic coal; and Power is mainly sourced through long term PPAs, which was contracted by DVB and Discoms has no option for exit. Details of capacity addition post un-bundling: (Transmission System) are as follows;

Table 51: Delhi Power Transmissions System¹⁷

Particulars	At the time of un-bundling (2002)		In May 2015	
	400 kV	220 kV	400 kV	220 kV
No of sub-stations	2	21	4	33
Transformation Capacity (MVA)	1260	5300	5040	10680
Transmission Lines (Overhead Circuit km)	121.602	472.252	249.238	613.84
Transmission Cables (Underground Circuit km)	---	14.668	---	126.82

In the second phase of power reforms undertaken in Delhi, the power purchase responsibility lies with the Distribution companies from April 2007. To meet the rising demand, the plans executed/being executed by the successor Companies are as under:

Projects recently completed/commissioned ¹⁸	Projects under execution ¹⁹
(i) 220/66kV Wazirabad substation : 1x160MVA	(i) 220/33kV GIS at Lodhi Road
(ii) 220/66kV Gazipur substation : 1x160MVA	(ii) 220kV Transmission Line Bawana to Rohini-II
(iii) 220kV Peeragarhi substation	(iii) 220kV Cable Peeragarhi to Wazirpur
(iv) 220kV Cable Link from Mundka to Peeragarhi D/C (13.00 Ckt. km.)	(iv) 220kV LILO of Kanjhawala-Najafgarh at Mundka
(v) 220/ 33 KV GIS Sub Station at Peeragarhi: 2x100 MVA.	(v) Augmentation of 2X 220/66kV 100MVA TxS to 160MVA TxS at Pappankalan-I
(vi) 220kV Cable Link from Gazipur to Patparganj (4.90 Ckt. km.)	(vi) HTLS reconductoring of D/C 220kV Bamnauli – Naraina Ckts
(vii) HTLS conductoring of 220kV Wazirabad – Geeta Colony Ckt. I & II	(vii) HTLS reconductoring of D/C 220kV IP Power – Sarita Vihar Ckts
	(viii) Augmentation of 2X315MVA ICTs to 2X500MVA ICTs at Bamnauli.
	(ix) Additional 220/66kV 100MVA Tx at Sarita Vihar

¹⁷Delhi Transco Limited (<http://dtl.gov.in>)

¹⁸ Department of Power, Government of NCT of Delhi

¹⁹ Department of Power, Government of NCT of Delhi

	(x) Additional 220/66kV 160MVA Tx at DSIDC Bawana (xi) Additional 220/66kV 160MVA Tx at Pappankalan-II (xii) Additional 220/66kV 160MVA Tx at Kanjhawala along with 4Bays at 66kV level (xiii) Additional 220/33kV 1000MVA Tx at (vii) Masjid Moth
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Generation system: Power generation capacity of all power stations is mentioned below in table 52:

Table 52: Delhi Power Generation Capacity

S. No.	Plant	Capacity (MW)	Year
1	Pragati-I Power Station	330	2002-03
2	Pragati-III Power Station	1,500	2011-13
3	Rajghat Power Station	135	1989-90
4	Gas Turbine Power Station	270	1986&1996
5	NTPC Badarpur	705	1973-75 (95MW), 1980-81 (210 MW)
6	Rithala Gas (TPDDL)	94.8	2011-12
7	Timarpur Okhla Waste Management Ltd.	16	
8	Indira Gandhi STPP in Distt. Jhajjar Haryana (46.20 % Power Share)	1,500	2011-13

Details of important Power Projects (Generation Sector) in the pipeline or recently completed are as follows;

1500 MW (nominal) Pragati-III CCGT Power project at Bawana	This Power project was set up by Pragati Power Corporation Limited at Bawana in North-West Delhi. GT-1 on 27.12.11 GT-2 on 16.07.12 STG-1 on 01.04.12(with HRSG 1) STG-1 on 14.12.12 (with both HRSGs) GT-3 achieved full load on 27.06.2012 GT-4 achieved full load on 07.05.2013 STG-2 commissioned on 27.12.2013								
1500 MW Coal Based Indira Gandhi STPP in Distt. Jhajjar Haryana	1500 MW, Indira Gandhi STPP is set up in Distt. Jhajjar, Haryana by Aravali Power Company Pvt. Ltd. (A JV of NTPC Ltd., IPGCL & HPGCL) at an estimated cost of Rs. 7892.00 Cr. for sharing of power equally between Delhi and Haryana. All three units have been commissioned and declared for commercial operation as per details below: Date of Commercial Operation of STPP units <table border="1" style="margin-left: 20px;"> <thead> <tr> <th>Unit No.</th> <th>Date of Commercial Operation</th> </tr> </thead> <tbody> <tr> <td>Unit # 1</td> <td>05.03.2011</td> </tr> <tr> <td>Unit # 2</td> <td>21.04.2012</td> </tr> <tr> <td>Unit # 3</td> <td>26.04.2013</td> </tr> </tbody> </table>	Unit No.	Date of Commercial Operation	Unit # 1	05.03.2011	Unit # 2	21.04.2012	Unit # 3	26.04.2013
Unit No.	Date of Commercial Operation								
Unit # 1	05.03.2011								
Unit # 2	21.04.2012								
Unit # 3	26.04.2013								

750 MW Pragati-II CCGT Power Project at Bamnauli	Vide Cabinet of GNCTD decision in Sept. 2010; a 750 MW combined cycle Gas Turbine Power Project is to be setup in Bamnauli, Delhi. The Turnkey Contract for Supply, Erection and Commissioning has already been placed upon BHEL. However the work has not yet picked up steam due to non availability of gas.
Replacement of existing 270 MW Indraprastha Gas Turbine Power Station with 350-375 MW Advanced Class Machines.	A proposal to replace the 270 MW Gas Turbine Power station with 350-375 MW Advanced Class Machines has been approved by Board of Directors in Sept. 2011. A Consultancy Contract for Pre-Feasibility Study was awarded to M/s NTPC Ltd in May 2012. M/s NTPC has submitted the Pre-Feasibility Report on 02.07.2013.
Establishing a 350-375 MW Gas Based Power Plant at the site of Rajghat Power House, subsequent to its de-commissioning.	IPGCL Board, in September 2011, has accorded approval to set up a 350-375 MW Gas Based Power Project at the land of Rajghat Power House after its de-commissioning. A consultancy Contract for Pre-Feasibility Study has been awarded to M/s NTPC Ltd in May 2012. The pre-Feasibility Report is expected shortly.

(Source: Department of Power, GNCTD)

Distribution system: Three power distribution companies i.e BYPL, BRPL and TPDDL regulates in Delhi. The recent specific projects across all three distribution companies have been listed in table 53.

Table 53: Power Distribution System in Delhi

BYPL	BRPL	TPDDL
1. 2X25 MVA, 66/11kV Grid substation has been commissioned at Sonia Vihar in FY 2012-13	1. 66/11 kV Grid Gobind Singh University commissioned in the month of March 2012.	1. New 66/11 or 33/11 kV Grids with in feed Lines (90 MVA)
2. 2X 25 MVA, 33/11kV grid substation has been commissioned at New Kondli in FY 2013-14.	2. 66/11 kV Grid at Hastal commissioned in the month of March 2013.	2. New Power Transformers Added or Augmented (43 MVA)
3. 2X25 MVA, 33/11kV grid substation has been commissioned at DDU Marg in FY 2014-15	3. 66/11 kV Grid at DJB Najafgarh commissioned in the month of March 2015.	3. Evacuation of Power From 220 kV Wazir Pur Grid 220 kV DTL Sabzimundi Grid and 220 kV Piragrahi Grid

(Source: Department of Power, GNCTD)

The capacity additions of BYPL and BRPL power distribution companies is detailed out by highlighting comparative difference from the year 2002-03 and 2012-13 in table 54.

Table 54: Capacity Addition of Power Distribution Companies

S No	Particulars	BYPL			BRPL			TPDDL
		2002-03	2014-15	Capacity Addition	2002-03	2014-15	Capacity Addition	2014-15
		(a)	(b)	(b) – (a)	(c)	(d)	(d) - (c)	68
1	No. of Grids	40	52	12	63	82	19	168
2	No. of Power Transformers	98	145	47	146	224	78	3680
3	EHV Capacity(MVA)	1863	1302	1239	3036	5159	2123	675.76

S No	Particulars	BYPL			BRPL			TPDDL
		2002-03	2014-15	Capacity Addition	2002-03	2014-15	Capacity Addition	2014-15
4	EHV Cable/Line Length Laid (kM)	363	872	509	674	1143	469	220
5	No. of 66 & 33 kV Feeders	89	154	65	132	204	72	805
6	Shunt Capacitor (MVAR)	573	975	402	810	1492	682	
7	No. of Distribution Transformers Capacity (MVA)	2657	3594	937	4852	7162	2310	28693
8	Distribution Transformers Capacity (MVA)	1704	2620	916	2587	4301	1714	4891
9	No. of 11 kV Feeders	476	756	280	733	1240	507	944
10	11 kV Cables Laid (km)	1303	1793	490	1595	2215	620	1782.30
11	11 kV Lines Laid (km)	145	247.6	103	1566	1795	230	2180.98
12	Total No. of LT Feeders	10193	13635	3442	15219	21982	6763	23225
13	LT Lines Laid km	4589	5673	1084	5382	10506	5123	8350.63

(Source: Department of Power, GNCTD)

Impact of Reforms:

- (i) SBI Caps – As a result of power sector reforms, Delhi State Government has been able to save Rs. 30,000 crores over the past 10 years apart from saving 17% of the State Budget annually.
- (ii) The “Peoples’ Poll” of Times of India had identified power as one of the top 5 concerns but since 2009, power related issues no longer figure in the top-5 concerns of the public.
- (iii) According to draft 2nd Human Development Report of Delhi (perception survey) power sector is second only to DMRC in achieving customer satisfaction levels (65%)
- (iv) The Hon’ble Supreme Court vide its order dated 23.11.2012 has remarked that there is a tremendous improvement in power situation in Delhi.

9.3 Renewable Energy Initiatives

To harness the renewable energy sources, the Government is taking effective steps for increasing the generation from non-conventional sources like solar, biomass etc. As per the amended National Tariff Policy issued by the Govt. of India on 22.01.2011, all Distribution Companies have to purchase power from renewable sources upto 0.25% of its consumptions by end of 2012-13 and further upto 3% by the year 2022.

Apart from this the Distribution companies have started installation of solar panels in their areas to enhance the availability from renewable energy sources. At present (as on

31.3.2016) Delhi has 25.5 MW grid connected Installed Capacity of Renewable Power. Delhi Solar Roof Top Policy has been approved by cabinet. This has many innovative features like Group net Metering, Virtual net metering, Generation based Incentive, waiver of inspection by electrical inspector upto 200 kw capacity Solar power plant. Net metering regulations have already been notified in Delhi. And Delhi has 81.13 MW of installed capacity of solar power until February 2018.

Govt. is also promoting generation of non-solar power and setting up Waste to Energy Plants at various locations by using the municipal solid waste. Waste-to-Energy plants at Timarpur-Okhla & Ghazipur are functioning and a third at Narela-Bawana inaugurated in March 2017. The three municipal corporations, the New Delhi Municipal Council and the Delhi Cantonment Board send 8,370 tons of garbage to the three landfills at Bhalswa, Okhla and Ghazipur and 52 MW of electricity is generated from these waste-to-energy plants.²⁰

The TPDDL, BRPL and BYPL are setting up of various Grid Connected Solar Power Plants in their respective license area. The Delhi Metro Rail Corporation (DMRC) and the Solar Energy Corporation of India (SECI) signed a Memorandum of Understanding (MoU) in order to carry out projects for the production of renewable solar power in the Delhi Metro premises. As per the MoU, both the organizations will collaborate for the development of Solar PV (Photovoltaic) Projects (ground mounted, rooftop and other possible modes) at identified DMRC Sites for the production of solar energy. After signing of this MoU, a pilot project, of 500 kWp rooftop grid connected Solar PV Project has been installed at one of the identified rooftops of the Delhi Metro Stations. The two organizations will also explore the possibility of developing of another site where Solar PV Plant can be set-up. As on August 2017, DMRC has already commissioned 20 MWp solar plants in its premises. SPV plants are also being installed at various government buildings, schools and hospitals and the total capacity of renewable energy in Delhi until February 2018 was 133.13 MW.

Unnat Jyoti by Affordable LEDs for All (UJALA) programme

Domestic sector accounts for almost 50% of energy consumption in Delhi and lighting is a key component of the same. In order to promote the use of LEDs in household sector and reduce the energy consumption, EE&REM Centre in association with Energy Efficiency Services limited (EESL), BSES Rajdhani, BSES Yamuna and Tata Power Delhi Distribution Limited (TPDDL) has implemented the UJALA in Delhi.

UJALA promotes the usage of LEDs at a minimal cost and is designed to monetize the energy consumption reduction for the domestic consumers. The distribution of LEDs through this programme will reduce energy consumption by 88% (as compared to ordinary bulb) and 50% (as compared to CFLs). Also, 75.51 lakh numbers of LED Bulbs distributed in Delhi as on 27.12.2016.

²⁰ Budget 2018-19.

Street Light National Program (SLNP)

Under SLNP, it is proposed to replace conventional street lights using energy efficient LED lights. Around 1 lakh 36 thousand conventional street lights have already been changed to energy efficient LED lights in South Delhi Municipal Corporation area. EE & REM is pursuing with other Municipal bodies & PWD for replacing conventional street lights to energy efficient LED lights in their respective areas. This will lead to saving of electricity along with shaving of peak power demand.

EE & REM, Department of Power, GNCTD and United States Embassy, New Delhi agreed to have a common programme to promote the deployment of clean energy technologies (renewable energy and energy efficient technologies) to enhance energy security, improve access to energy, conserve energy and promote clean energy development. The Delhi Secretariat building has been identified as a scalable model for technical assistance under the bilateral initiative between US Embassy, the North India Office, Resource Conservation Unit and USAID, through its partnership to Advance Clean Energy Deployment (PACE-D) technical assistance programme (the PACE-D TA programme) and the EE&REM Centre, Department of Power, GNCTD.

Perform, Achieve and Trade Cycle (PAT)

Perform, Achieve and Trade (PAT) is a market based mechanism to enhance cost effectiveness of improvements in energy efficiency in energy intensive large industries and facilities, through certification on energy savings that could be traded. Designated Consumers are obligated to improve energy efficiency & under this scheme a target is given to every DC. Target under PAT scheme is defined as the % reduction of 'Specific Energy Consumption (SEC)' from Baseline value. Under PAT-I there are four Designated Consumers in Delhi namely Badarpur Thermal Power Station (BTPS), Rajghat Thermal Power Station (RTPS), Gas Turbine Power Station (GTPS) and Pragati Power Station. EE&REM Centre has successfully completed the monitoring and verification (M&V) of all DCs under PAT-I Cycle. Three new sectors have been added as DCs namely, Refineries, Railways, DISCOMS under PAT Cycle II.

Total Renewable Energy (Solar + Waste-to-Energy) installed capacity in the State of Delhi as on April'2018 = 140.86 MW (88.86 MW from Solar + 52 MW from WTE plants).

9.4 Institutions Involved in Energy & Power sector

- National Load Dispatch Center (NLDC)
- Northern Regional Load Dispatch Centre (NRLDC)
- Ministry of Power, Govt. of India (GoI)
- Department of Power (GNCTD)
- Central Electricity Authority (CEA)
- Central Electricity Regulatory Commission (CERC)
- Delhi Electricity Regulatory Commission (DERC)

- Delhi Power Company Ltd.(DPCL)
- State Load Dispatch Center (SLDC)
- Delhi Transco Ltd.(DTL)
- Indraprastha Power Generation Company Ltd.(IPGCL)
- Pragati Power Corporation Ltd.(PPCL)
- Energy Efficiency and Renewable Energy Management Centre (EE&REMC) – Department of Power, GNCTD
- BSES Rajdhani Power Ltd. (BRPL),
- BSES Yamuna Power Ltd.(BYPL)
- Tata Power Delhi Distribution Limited (TPDDL),
- Timarpur Okhla Waste Management Company Limited (TOWMCL)

9.5 Current Policies, Programmes and Projects of the government

To address the energy crisis, Delhi government is focusing more on renewable energy and energy efficiency measures. In this regard the government is coordinating with BEE and DISCOM to replace incandescent lamps and CFL with LED bulbs under UJALA scheme. Each household is being provided 4 LED lamps at a cost of Rs. 93 each payable in monthly installment of Rs. 10. It is also proposed to replace existing conventional street lights with energy efficient LED lights. The large buildings have been identified for taking up energy audits to reduce the energy consumption by almost 30 percent in the buildings. In the long run this alone will save nearly 100 MW of electricity per annum. As per notification (notified vide date 28/09/06) of GNCTD, it is mandatory to install solar water heater in the categories of Educational Institutions, Residential Buildings, Canteens, Corporate Buildings, Hotels/Motels/Banquet Halls, Hospitals/Nursing Homes, Industries, Govt. Buildings, Residential Schools and Jail Barracks at and above 500 sq m area.

Delhi's Rooftop solar policy has already been approved by Cabinet on 06.06.2016. As per the renewable purchase obligation (RPO) guidelines every obligated entity shall purchase electricity from renewable sources. In this regard, the power regulator has mandated that in the next five years, 9% of Delhi's power supply will come through renewable sources. Every obligated entity shall purchase electricity (in kWh) from renewable sources for fulfillment of a defined minimum percentage of the total quantum/consumption under the Renewable Purchase Obligation as specified below:

Table 55: Defined Minimum Quantum of Purchase (in% age) from Renewable Energy Source (In terms of energy equivalent in KWh) of Total Consumption

Year	Solar – RPO as per DERC	Solar RPO actually achieved	Total RPO as per DERC	Total RPO Actual achieved
2012-13	0.15%	0.0120	3.40%	0.234
2013-14	0.20%	0.0117	4.80%	0.3647
2014-15	0.25%	0.0133	6.20%	0.4093
2015-16	0.30%		7.60%	--
2016-17	0.35%		9.00%	--

(Source: F. 3(292) Tariff /DERC/ 2010-11/3026 dated 1st Oct, 2012)

Delhi Government has also planned to implement the “Solar Policy” that recommends installation in Delhi by the year 2020. The policy also entails tax breaks, benefits and subsidies. At present, there are about 37.28 lakh of domestic electricity consumers in Delhi, which is 82.84 percent of total domestic consumers, who are getting electricity at half of the applicable tariff compared to three years ago. During FY 2018-19, following is proposed under Green Budget:-

- Addition of 74 MW of solar power.
- Purchase of 1000 MW of Green Power i.e. from solar and wind-based generation in the coming year.
- Limited-time Generation Based Incentive (GBI) for existing and future net metered connections in the domestic/residential segment. A GBI of ₹ 2 per unit (kWh) of gross solar energy generated is being offered for 3 years on first come first serve basis under “Delhi Solar Policy-2016”.
- To bring out a Group Net Metering policy to enable utilisation of huge solar potentials in Govt Schools, Mandis and other Government buildings which can also turn into surplus generators. Pilot scheme named Agriculture-cum-Solar Farm scheme. The scheme will incentivise the installation of solar panels on raised structure on agricultural farms without affecting the normal farming activities that will continue below the solar panels.

The detailed list of renewable energy and energy efficiency projects that has been completed or under completion in Delhi city are given in below²¹.

- **Lighting & illumination through SPV plant at Safdurjung Tomb:** Solar Photovoltaic Power Plant capacity of 10.4 kWp has been installed at Safdarjung Tomb with the total cost of Rs. 24.72 Lakh under central finance assistance provided by MNRE, GOI. The system is sufficient for lighting and illumination for 5-6 hour daily. Safdurjung solar voltaic plant of 10.4 kWp will generate 156000 kWh unit of power collectively in next 10 years which have 126.88 tonnes emission reduction potential.

²¹ Energy Efficiency & Renewable Energy Management Centre, Department of Environment, Government of NCT of Delhi

- **Lighting & illumination through SPV plant at Jantar Mantar:** Solar Photovoltaic Power Plant capacity of 9.00 kWp has been installed at Jantar Mantar with the total cost of Rs. 25.00 Lakhs under Central Finance Assistance provided by MNRE, GOI. The system is sufficient for lighting and illumination for 5-6 hour daily. Jantar Mantar solar voltaic plant of 9 kWp will generate 135000 units of electricity; which have approx. 109.8 tonnes emission reduction potential in next 10 years.
- **Installation of Renewable Energy System/devices in Tihar Jail:** Solar Water Heater of 30,000 LPD has been installed. Biogas Plant & Improved Cook Stoves/ Gasifiers for reducing the consumption of Piped Natural gas (PNG) are under installation.
- **Installation of Grid Connected Solar PV Plants on rooftops:** Solar PV Power Plants of total capacity 9.35 MWp have been installed on rooftops of buildings. MNRE, Govt. of India has provided in principle approval for 30% of Central Financial Assistance. The buildings have been identified & Feasibility study had been conducted.
- **Installation of SPV power plant at Lotus Temple:** A solar PV Power plant of 120 kWp capacity has been installed for lighting and illumination of Lotus Temple. It will help in reducing 305 tonnes of emission and will generate 37500 units of power (electricity) cumulatively in next 10 years.
- **Solar City Program by MNRE:** The NDMC area has been selected for developing as solar City under the scheme of MNRE. RFP has been floated.
- **Vikas Bhavan-II:** SPV power plant of 100 kWp at Vikas bahvan-II of 100 kWp is installed. The Central Finance Assistance from MNRE is Rs.57.00 lakh under Off Grid Scheme.
- **Delhi Secretariat SPV power plant:** In order to make Delhi Secretariat the first Green, energy efficient secretariat in country operating completely on Solar Energy, EE & REM Centre, Department of Power, GNCTD has initiated the process of installing a 3MWp surface mounted SPV plant in association with MNRE and SECI on the vacant land of erstwhile Indraprastha Thermal Power Station (ITPS). Power generated from this 3MWp SPV plant will be dedicated to Delhi Secretariat for meeting out the total electricity requirement of the building. Out of total capacity of 3MWp SPV plant, 1 MWp capacity has already been commissioned & is operational since 24.10.2015.
- EE&REM Centre, Department of Power, GNCTD has got in-principle approval from the Ministry Of New and Renewable energy for installation of 92MWp Roof top Solar PV in Delhi. 2MW has already been installed and another 6 MW is under installation. The empanelment process of Solar Power Developers with GNCTD is under progress for balance 84 MW.
- Under Tail End Grid connected scheme of MNRE, projects of 335 kWp are awarded to BYPL (work completed).
- **SPV plant of 140KWp at 4 hospitals & at 4 schools:** Under off grid projects, SPV plants in 4 Govt. Schools (10 kWp each) and 4 Govt. Hospitals (25 kWp each) have been installed.

- **Street lighting project proposal on Energy Efficiency:** Street Lighting Project at JNU campus, Delhi is under process. The Central Finance assistance from BEE is Rs.25.00 lakhs.
- **Bio-fuel plant at Delhi Secretariat canteen:** A new waste to bio fuel plant has been commissioned in Delhi as an initiative to make Delhi an energy efficient city. The plant would consume up to 500 kg of kitchen waste and horticulture waste to produce 40 cubic meters of gas per day. The new plant is providing natural gas that is being used for cooking in the Delhi Secretariat canteen.
- **SPV plant of 130 kWp** has been installed at ISBT, Kashmere Gate at the cost of about Rs 1.2 crores.
- **SPV plant of 18 kWp and 12 kWp** are being installed at the official residence of Chief Minister and Dy. Chief Minister of Delhi respectively.
- **Awareness Programmes:** (i) EE & REM Centre in order to promote awareness about Renewable energy and energy efficiency among students and citizens of Delhi organizes various awareness programmes and campaigns. (ii) The Centre organizes Renewable Energy Fairs in different parts of Delhi in association with RWAs for demonstration of energy saving's systems to common man.

9.6 Strategies and Actions to address concerns due to Climate Change

Under NAPCC, the National Mission on Enhanced Energy Efficiency (NMEEE) seeks to strengthen the market for energy efficiency by creating conducive regulatory and policy regime, and National Solar Mission emphasis to promote ecologically sustainable growth while addressing the energy security challenge. The initiatives by the Delhi Government are consistent with those included in the missions.

Key Priorities

- Reducing transmission and distribution losses
- Promoting demand side management and energy efficiency
- Maximizing renewable (solar, biogas etc) power generation

The key department which are involved for implementation of proposed actions are as follows: EE&REMC of Department of Power - GNCTD, Delhi Transco Limited (DTL), IPGCL/PPCL, BSES Yamuna Power Ltd. (BYPL), BSES Rajdhani Power Ltd (BRPL) and Tata Power Delhi Distribution Ltd. (TPDDL)

Some of the key strategies that could be adopted to reduce the impact of climate change especially in Energy and Power sector are as follows:

Table 56: Action Plan for Energy & Power Sector for Challenges of Climate Change

1. Energy Efficiency

S. No.	Sub Sector	Target 2020	Target 2030	Remarks
E	(a) Building retro fitment for energy efficiency in existing buildings Implementation of Building Energy Efficiency Programme (BEEP)	Retrofit Projects for 50% existing SMEs, Commercial buildings through ESCO route, demonstration of “Net Zero Energy Building Concept”	Retrofit Projects for 100% existing SMEs, Commercial buildings through ESCO route, demonstration of “Net Zero Energy Building Concept”	Energy Efficiency & Renewable Energy Management Centre (EE & REMC), Department of Power, GNCTD is the nodal agency. Budgetary approval required for the implementation in SMEs, promotion & demonstration projects required.
	(b) Appliance replacement programme to promote star rated appliances for refrigerators & air conditioners	50% replacement by 5 star rated products Awareness programme to increase the penetration of BEE Certified STAR rated appliances Design and implement discount based DSM (Demand Side Management) scheme for the consumers in order to increase the replacement of the no star rated products with the 5 star rated products Setting up of energy benchmarking for government and other buildings	100% replacement by 5 star rated products Sensitization about the super efficient appliances, design & implementation of the DSM programme to increase the penetration of super efficient appliances	Financial incentives required for consumers to address the issue of high upfront cost of 5 star rated appliances. Energy Efficiency & Renewable Energy Management Centre (EE & REMC), Department of Power, GNCTD is the nodal agency.
	(c) Building construction to introduce green building technology and Enforcement of Energy Conservation Building Code (ECBC).	250 Green Buildings	500 Green Buildings	Energy Efficiency & Renewable Energy Management Centre (EE & REMC), Department of Power, GNCTD is the nodal agency.

S. No.	Sub Sector	Target 2020	Target 2030	Remarks
	(d) Replacement of conventional lighting system with energy efficient lighting system.	<ul style="list-style-type: none"> • 100% phase out of incandescent bulb • 50% penetration of LED in various lighting application • Addition of 25 lakhs bulbs to be replaced • To promote for star rating of all electrical equipments through a systematic campaign • LED promotion in 14 lakh households (for lighting), commercial (lighting / signage) and industrial (lighting / signage). 	<ul style="list-style-type: none"> • 100% penetration of LED in various lighting application • Based on the market development identification of energy efficient lighting alternatives • Addition of 50 lakhs bulbs to be replaced • To promote for star rating of all electrical equipments through a systematic campaign • LED promotion in 14 lakh households (for lighting), commercial (lighting / signage) and industrial (lighting / signage). 	<p>Financial incentives required for consumers to address the issues of high upfront cost of LEDs and promotional activities.</p> <p>‘No Tax’ on LED based product could be introduced by Government.</p> <p>Energy Efficiency & Renewable Energy Management Centre (EE & REMC), Department of Power, GNCTD is the nodal agency.</p>
	(e) Energy efficiency in existing buildings	<ul style="list-style-type: none"> • Make all DISCOMS building having load more than 50 KW as efficient, by adopting Efficient light (say LED), solar heating, AC upgradation and special coating and paint, to prevent extra heating of work area • 25% Implementation of PAT scheme in commercial buildings (hotels) having load more than or equal to 1000 TOE (nearly 500 kW) 	<p>100 % Implementation of PAT scheme in all commercial buildings having load more than or equal to 1000 TOE (nearly 500 kW)</p>	<p>Special budget is required to retrofit efficient product and make building efficient</p>

S. No.	Sub Sector	Target 2020	Target 2030	Remarks
		Educate and facilitate 200 consumers (load more than 100KW) about energy efficiency. Further facilitate them by providing services of good ESCOs	To frame a system to provide such service to all consumers.	
	(f) Create data base on energy consumption to promote energy efficiency and set up of State Energy Conservation Fund (SECF).	<ul style="list-style-type: none"> To study the load curve pattern and appliance usage pattern, of all types of consumers in Delhi. EC advice to 500 buildings 	EC advice to 1000 buildings	EE&REMC: Load research work already started by DISCOMS. Summer pattern is under study. Research will be completed soon. No budget is required.
		To enrol and train more than 1000 students	To enrol and train more than 5000 students	Budget will be required to provide some “kit” to enable “Urja Mitr” to do few measurements at site.

2	Renewable Energy			
(a) Adoption and Promotion of Renewable Energy		All DISCOMS divisional offices including Grid stations to have Solar UV films (PV) for windows and White roofing for UV cut-off wherever feasible and economically viable.	All DISCOMS divisional offices and quarters to have Solar UV films (PV) for windows and White roofing for UV cut-off wherever feasible and economically viable	<ul style="list-style-type: none"> Energy Efficiency & Renewable Energy Management Centre (EE & REMC), Department of Power, GNCTD Rural renewable and battery project subject to financial viability.
		Photo Voltaic (PV) assisted power system for 500 consumers	Photo Voltaic (PV) assisted power system for 1000 consumers	
		Renewable Energy use to be 5% of Delhi energy mix.	Renewable Energy use to be 7% of Delhi energy mix.	

The following additional strategies in planning and under consideration by power distribution companies to reduce the impact of climate change:-

- Demand Response Management

- E-Waste Management
- Solar Power Plant

The strategic focus of the XII FYP for Delhi Transco Limited (DTL) is to renovate and modernized the existing network using modern technology such as GIS and underground cables. Delhi is one of the first new utilities in India to operationalize SCADA and to introduce intrastate Availability Based Tarriff (ABT) metering. The concept of small grid is also being implemented to enhance the overall efficiency of the organization.

9.7 Budgetary Assessment of key priorities

A budget of 138 crore for the Energy and Power sector has been proposed by the Department of Power, GNCTD for the next five year. In addition to this budget, Department of Power has proposed some of the major infrastructure project of which details are as follows:

- GENCO with a total of 2,598 Lakh which includes 2500 Lakhs for 1500 MW Gas Based Combined Cycle Pragati-III Power Plant at Bawana and 98 Lakhs for 1500 MW coal based Indira Gandhi Super Thermal Power Plant at Jhajjar.
- TRANSCO with total of 5002 Lakh which includes 5000 lakh for Augmentation of 400 / 220 KV Transmission & Transformation Works and 2 lakh for Integrated Power Development Scheme (IPDS).
- Power Department of GNCTD has proposed 2,000 lakh for Payment towards land premium / land acquisition for subsequent leasing to DISCOMS. 3000 lakh for shifting of HT (11KV & 33KV) / LT (400V) Transmission Lines.

10. Water Resources

The River Yamuna, Western Jamuna Canal, the Upper Ganga Canal are the main sources of water supply in Delhi. Other sources of water supply include sub surface sources like Ranney wells & tube wells.

Table 57: Sources of Water in Delhi²²

S. No	Source of water	Quantity (MGD)
1	Yamuna River	375
2	Ganga River	240
3	Bhakhra Storage	218
4	Ground Water	80

There are 10 Water Treatment Plants (WTP) with total production capacity of about 906 MGD for drinking water supply. Delhi Jal Board has an installed capacity of treating 607 MGD of sewage. From the present water being supplied to the residents of Delhi (approximately 14914 LKLD), the generation of domestic sewage is approximately 455 MGD. The present sewage treatment capacity is 607 MGD and another 48 MGD sewage treatment capacity has been augmented by constructing 8 MGD STP at Delhi Cantt and 40 MGD STP at Coronation Pillar. This will augment the sewage treatment capacity to 732 MGD.

Table 58: Sewage treatment plants

Sewage generation	700 MGD
Installed Sewage treatment capacity	607 MGD
Sewage being treated	455 MGD
Capacity utilization	74.95%

There are 13 Common Effluent Treatment Plants (CETP) with total operational capacity of 212.3 MLD for the treatment of industrial effluents from 28 industrial areas.

With the present population, the current potable water demand in Delhi is 1080 Million Gallons per day (MGD). The Delhi Jal Board (DJB) is presently supplying about 880 MGD of potable water from its existing installations (800 MGD from surface water sources and 80 MGD from Groundwater sources). The source available is not sufficient to meet the demand and as such there is a shortfall of 200 MGD of water. The total water distribution network is of 14,000 km in Delhi. Below table 59, gives the details on installed capacity of WTPs in Delhi.

²² Green Vision Document Govt. of NCT Delhi, Year of publish-2018

Table 59: Water treatment plants and their production capacity

Sources of Raw Water	Water Treatment Plants	Production Capacity (MGD)
River Yamuna	Chandrawal	90
River Yamuna	Wazirabad	120
Bhakra Storage/Yamuna	Haiderpur	200
Bhakra Storage/Yamuna	Nangloi	40
CLC Munak Canal (increased availability of Yamuna / Ravi Beas water within the allocated water due to reduction in conveyance losses)	Okhla	20
	Dwarka	50
	Bawana	20
Uppar Ganga Canal	Bhagirathi	100
Uppar Ganga Canal	Sonia Vihar	140
Ground Water	Recycling Plants	45
Ground Water	R/Wells (9), T/Wells (3222)	80
Total production capacity		905
Total Demand		1080

Surface water contributes to over 86% of Delhi’s total water supply which is met largely by river Yamuna and partially by river Ganga. Other sources of water supply include sub surface sources like Ranney wells and tube wells. Though, the average water available to Delhi is approximately 225 lpcd, however total number of active consumers which were around 19.20 lakh as on 01.04.2015 has increased to 21.66 lakh. Due to the unequal distribution a large population remains without having an access to supply water and depends heavily on groundwater resources.

Groundwater contributes about 10% of total production. However, inadequate reserves and the increasing demand due to rapid urbanization have resulted in unsustainable exploitation of groundwater resources. The Central Ground Water Board (CGWB) assessed the total groundwater potential to be 280 million cubic meters (MCM) in 2008 as compared to 428.07 MCM in 1983 showing an overdraft and reduction of around 150 MCM over the past few years. Reduction in recharge of aquifers due to infrastructure development, demand by industrial and domestic sectors, runoff getting diverted into the sewers or storm water drains that convey the water into the river Yamuna and unplanned withdrawal from the sub soil aquifers have put tremendous stress on the groundwater resources.

With the city's population has gone up from 13.8 million in 2001 to 18 million in 2015, there is an ever-increasing pressure on the water resources. It is expected that the total demand for water would rise to 6,272 MLD in 2021²³.

10.1 Existing Water Related Concerns

Owing to this situation of escalating population without a commensurate increase in the availability of raw water, the ground water in Delhi has been over exploited. This has disturbed the hydrological balance leading to decline in the productivity of wells, increasing pumping costs and more energy requirement.

The groundwater table in Delhi has depleted to 20 –30 metres in various areas across the city. Compared to a level of 30 – 40 feet at the time of independence, the water table has dropped to 350 feet at certain places. It is said to be falling at the rate of 10 feet per year on an average. Groundwater levels have depleted by 2 – 6m in Alipur and Kanjhawla blocks, 10m in the Najafgarh block, and about 20 m in Mehrauliblock. In addition to the quantity, the quality of groundwater is also deteriorating and in several places it has been found to be unfit for human consumption. The salinity of groundwater is increasing in south-west and north-west Delhi while nitrate content is also found to be more than 1,000 mg/l.

Water Resources: Key Concerns
<ul style="list-style-type: none"> • Increasing water demand and supply gap • Depleting ground water resources • Deteriorating water quality in the city • Water Pollution: Point and Non-point Water Pollution • Non Uniform distribution • Water leakages • Improving water usage database via complete surface and ground water drawl metering

Along with the increasing demand for water, the highly non- uniform distribution of water supply add to the water woes in Delhi. Unplanned growth of the city had also upset the water supply distribution system. To meet the demand-supply gap, users depend on water sold through tankers by private companies whose source of water is groundwater. This imbalance is further exacerbated by the high level of Non-Revenue Water – including both technical and commercial losses which estimate to 40-50%. The ability to identify the losses is further constrained due to lack of bulk metering for transmission and distribution systems.

10.2 Institutions involved in Water Sector

Delhi Jal Board (DJB) is the sole government agency responsible for water supply in the city. It is responsible for the production and distribution of potable water after treating raw water from various sources. The Delhi Jal Board provides water in bulk to the NDMC and Cantonment areas. It is also responsible to collect, transmit, treat and dispose waste water

²³Green Vision Document Govt. of NCT Delhi, Year of publish-2018

and also for operation and maintenance of sewer system in local municipal bodies. The Yamuna river water quality is monitored by DPCC at 24 drains, 9 locations along River Yamuna, Water bodies/Ponds, STPs (22 locations), CETP, 10 WTPs, ground water (34 locations). River Yamuna water quality is jointly monitored by CPCB and DPCC.

10.3 Current Policies, Programmes and Projects of the Government

The GNCTD has recognized the need for comprehensive reforms in the water sector to ensure a significantly higher level of service provided in a sustainable manner by DJB. Major steps taken and future plans envisaged by Delhi Jal Board, Irrigation And Flood Control Department for sustainability of water resources and prevention of pollution in River Yamuna, in brief and not limited to these, are as under;

- **Augmentation and Sustainability of Water Resources and Conservation of Water:** Delhi Jal Board is working on various strategies for augmentation of water supply in the capital.
- **Prevention of Pollution in River Yamuna:** The Yamuna Action Plan (YAP), a bilateral project between the Government of India and Japan-one of the largest river restoration projects in India. The government of Japan, via the Japanese Bank for International Cooperation (JBIC), has provided financial aid of 17.7 billion yen to carry out the project, which has been executed by the National River Conservation Directorate, the Ministry of Environment and Forests, and the Government of India. During the first phase of the program it came out that the river water pollution cannot be lowered down without the active participation of the citizens. Therefore in YAP phase II a special component named as Public Participation & Awareness component has been brought in wherein NGOs are partnering to work at the community level on different identified themes. The works under YAP-II have been completed in this department. YAP-III phase, the objective this project is essentially to improve sewage conveyance system and wastewater treatment plant in the command of Okhla, Kondli & Rithala drainage zone so that the domestic wastewater can be treated to latest standards issued by CPCB/DPCC before being discharged in the river Yamuna thereby improving the quality of river water and have been taken up at a total cost of 32,571 million (₹1,656 crore). As per NGT order dated 13.1.2015 and clarificatory directions on 2.3.2015 in the matter of OA 6/2012 and 300/2013 relating to "Maily Se Nirmal Yamuna" Revitalization Plan 2017, several actionable points by various agencies was identified.

Existing Sewage Treatment Plants (STP) are not currently being utilized to their optimum capacities due to their renovations, blockage of sewers, settling of old and deteriorated sewers and extensive un-sewered area. Only around 55% of the population is connected to present sewerage network. Only part of total wastewater generation in Delhi is getting treated in the existing sewage treatment plants. The obvious manifestations are the increasing generation- treatment gap, inadequate sewage collection and sewerage network

resulting in low quality of water in river Yamuna. Hence Delhi government is further working on following initiatives for better sewerage facilities for the capital.

As per Groundwater Regulation & Management Notification F8(348)/EA/Env/09/2246 dated 12.07.2010 and as amended to date if the plot size of the building is more than 200 sq. meters, the permission to draw groundwater through borewell or tubewell (both new as well as existing and drawing groundwater without permission of Central Ground Water Authority) is subject to the condition that the occupier or owner of the said plot or building shall install rain water harvesting system in such building. The permission to draw ground water through borewell or tubewell (both new as well as existing and drawing ground water without permission of Central Ground Water Authority) for commercial and or industrial use is subject to the condition that the concerned person or authority shall install the rain water harvesting structure, and shall ensure reuse of the water in horticulture or cooling or toilet flushing, etc. after proper treatment of wastewater.

The annual rainwater harvesting potential has been assessed at 900 billion litres or 2,500 million litres per day. If even 25% of this could be harvested it would imply availability of 625 MLD, which would be nearly equivalent to the presently estimated deficiency. This is in addition to the potential for roof water harvesting assessed at around 27 MLD. For example, DMRC has installed Rain water harvesting systems at 151 stations having a pit capacity of 9,210 cum. In viaducts, 789 rain water harvesting pits have been installed with a capacity of 2,787 cum. Also, rain water harvesting has been installed at 11 depots and 7 staff quarters.

Further, as per various order of NGT in O.A. no. 94 of 2013 titled Vikrant Kumar Tongad Vs Delhi Metro Rail Corporation Limited, 8 committees comprising of officers from Delhi Jal Board, CGWA & DPCC have been inspecting various malls, hotels, hospitals etc for necessary rain water harvesting structures & report has already been filed before the tribunal. In another O.A. no. 72 of 2014 titled Vinod Kumar Jain Vs. NCT of Delhi & Ors, NGT has passed orders for construction and / or maintenance of the rain water harvesting system on all the flyovers and such other locations on and around the roads in Delhi.

With the growing importance of Delhi being capital city of India, there is heavy migration from different parts of the country and further contribution of rapidly changing land use pattern within the city has resulted in increased load on existing drainage system. Due to increase in urbanization and reduction of rural areas, run off increased considerably thereby necessitating review of existing drainage system. To overcome Water logging problems, to revive water bodies, recharge ground water storage and design for proper drainage system in the city the job was entrusted to this department. Delhi Drainage Master Plan has been prepared by IIT Delhi and has made following recommendations:-

- No encroachments on storm drains.
- No sewage in storm drains. (Use of Supper suckers is suggested in place of puncturing in case of blockage)

- No Solid Waste or Construction and Demolition Waste (C&D) waste be allowed into storm drains.
- Record of Weight/ volume of silt after street sweep should be maintained, C&D wasted should be lifted and dumped at C&D processing sites by Govt. appointed contractors
- Effectiveness of De-silting of the Storm Drains (Public display of desilting schedule)
- No storm water should be drained into sewer systems (Public awareness)
- No construction should be allowed inside any storm drains (Utilities and pillars of elevated road/ Metros should not be allowed inside storm water drains)
- Design of new storm drains should not be done in isolation.
- Rejuvenation of water bodies for retention and recharge (Prohibition of solid waste dumping, regular desilting and encroachment removal)

There are 61 number drains in the jurisdiction of I&FC department and approximately 4 lakh tonnes silt is removed from the bed of the drains annually. As on today the silt is either dumped in local depressions along drains or disposed of in sanitary landfill sites managed by respective Municipal Corporations, it is an old age method and with the passage of time all the sanitary land fill sites have already been saturated and no more scope for further disposal left. To redress this serious problem, department of Environment, Govt. of Delhi has engaged Central Building Research Institute, Roorkee for exploring and suggesting recycling option for this type of waste into useful product with or without suitable additions based upon the physical and technical characteristics of silt. The solution resulting from the study would prove techno-commercial viability of the product. I&FC Department is in liaisoning with CBRI and the inputs whatever required shall be provided to them. This technology is in initial stage and the implementation/adoption shall be based on results of the study. An innovative projects have been conceptualized for development of Rajokari Water body adopting wet land system based on SWAB technology, however the project could be taken up after NGT clearance regarding use of construction material. The landscape of water bodies is proposed so as to ensure its maximum utility for the public benefit.

Similarly at two different location of old abandoned Bawana Escape drain for treating waste water of drain No. 6 & PWD drain discharge into the abandoned portion of Bawana Escape Drain and thereafter treated water shall be utilized for increasing water table of the area through ground water recharge.

I. No.	Activities	Type
1.	Augmentation and Sustainability of Water Resources and Conservation of Water	
	A. Surface Water Resources:	
	(i) DJB is pursuing for construction of 3 upstream storage dam projects viz; Renuka, Kishau and Lakhwarvyasi, on tributaries of River Yamuna. Of these the Renuka dam project has been prioritized, which will provide about 275 MGD of water for drinking purposes to Delhi as per 1994 MoU. All the 3 projects have been declared National Projects by the Government of India.	Infrastructure
	(ii) Central Water Commission (CWC) has submitted a pre-feasibility report (PFR) for additional barrage on River Yamuna at Palla. But due to submergence in Delhi, UP & Haryan due to stoppage of rain water, the proposal has been dropped	Infrastructure
	(iii) Recycling plants to reclaim raw water which is utilized in process of back wash of treatment units in the water treatment plants have been commissioned at Haiderpur, Wazirabad, Chandrawal and Bhagirathi with total capacity of 45 MGD.	Infrastructure
	(iv) DJB has funded construction of parallel lined Canal from Munak to Haiderpur water treatment plant (102kms), which is being constructed by Irrigation Department, Government of Haryana at a cost of Rs. 545cr (as projected by Haryana). After intervention of the Hon'ble High Court, the Munak Canal has been commissioned to its full capacity. Consequently the water treatment plant at Bawana WTP (20 MGD), Dwarka WTP (50 MGD) and Okhla WTP (20 MGD) have been commissioned.	Infrastructure
	B. Ground Water Resources:	
	(i) Central Ground Water Authority (CGWA) had declared whole of South and South West districts of NCT Delhi as "Notified Areas" in August, 2000 and imposed prohibition and restriction in these districts on the construction and installation of any new structure for extraction of ground water resources to avoid further depletion and deterioration in water quality in the said districts.	Policy
	(ii) CGWA through its public notices issued between 3/2001 and 8/2004 has directed Group Housing Societies/ Institutions/ Schools/Hotels/industrial establishments/Farm Houses in South and South –West Districts and group housing societies located outside notified areas of NCT Delhi (where ground water levels are more than 5 meters below the ground surface) to adopt Roof top Rain water Harvesting systems in their premises.	Policy
	(iii) Ministry of Urban Development & Poverty Alleviation (Delhi Division), Govt. of India by its notification dated 28.7.2001 had made modification / additions in the building Bye laws 1983 for promotion of water harvesting.	Policy
	(iv) Orders of Lt Governor of Delhi under EPA Act-1986 have been issued from the office of Secretary (Environment), Department of Environment, GNCTD, making prior permission necessary for installation of bore wells for	Policy

	<p>use of ground water for domestic, industrial, agricultural and commercial purposes in all the eleven revenue districts of Delhi.</p> <p>(i) Delhi Jal Board has made provisions under Delhi Water & Sewer (Tariff and Metering) Regulations, 2012 to incentivise rain water harvesting and water recycling systems. These regulations provide rebate in tariff for plot/properties which are having area of 2000 square meter or more for having installed functional rain water harvesting system or waste recycling system. A rebate of 10% in total bill amount was allowed as per Delhi Water & Sewer (Tariff & Metering) Regulations, 2012 in Plot/Properties of 2000sqm and above having installed functional RWH system. This rebate scheme has been extended for plots of 500sqm and above.</p> <p>(ii) The consumer of the Delhi Jal Board having a plot / property of size 500 sq.mtr or more shall make provision for Rain Water Harvesting covering the entire plot area within one year, in case of commercial / industrial property and within 3 years of for residential property from the date of coming into force of these regulations. In case the consumer fails to comply the above provisions within the time limit. The tariff as applicable for the consumer respective category will be increased by 1.5 times till the provision is installed.</p>	Revenue.
C. Leakage Management	<p>(i) DJB has installed 320 bulk meters on raw water inflow conveyance systems to all its Water Treatment Plants (WTP) and on water transmission mains emanating from the WTPs. It is envisaged to install more bulk flow meters at strategic locations in transmission mains and survey conducted for remaining bulk meters from carrying out water audit at micro level. Further, district meter areas (DMA's) are being formed to assess the inflow and outflow of water from a particular area. 39 DMA's have been selected for water auditing at micro level and 61 DMA's more have been identified. This will also help in an accurate real time assessment of water flows and better control over leakages and theft would be possible.</p>	Infrastructure & Policy
	<p>(ii) A Pilot Project through distribution management contract in the Command areas of Nangloi Water Treatment Plant, Malviya Nagar UGR, Vansant Vihar and adjoining colonies is being implemented.</p>	
	<p>(iii) DJB, through JICA Technical study, is framing Master plan for water supply based on various raw water scenarios, GIS mapping and water demand of all areas. Under this, various reports on water supply, water availability and rehabilitation of network, DDA Master Plan, Zonal plans and water demand at zonal level have been analysed</p>	Planning
	<p>(iv) Delhi Jal Board has initiated the project in Chandrawal WTP command area through JICA funding. The main components proposed in the project are construction of new WTP (105 MGD), installation of SCADA, new transmission main as well as replacement of old one, creation of DMA's, replacement of pipes within DMA, consumer meters and service pipe connection.</p>	

	<p>Further, it has also been proposed to carry out renovation / reconstruction of Wazirabad Water Treatment Plant command area project through ADB funding. The main components proposed in the project are renovation of existing 120 MGD WTP, installation of SCADA, new transmission main as well as replacement of old one, creation of DMA's, replacement of pipes within DMA, consumer meters and service pipe connection.</p>	
	<p>(iii) DJB has 21.40 lakh sanctioned water connections. DJB is emphasizing on full domestic consumer metering for all the consumer water connections and streamlining of internal revenue processes. DJB had installed 4 lakh new water meters meeting the international standards with a warranty of 5 years. This has resulted in efficient water accounting and awareness to avoid wastage of water. For remaining unmetered connections DJB will be permitting the consumer to install their meter from market based on specifications prescribed by this department.</p>	
	<p>(iv) Special thrust has been given for improvement of the existing transmission and distribution system by replacement of old water lines. About 2120 KM of old/damaged water lines were replaced during the period from 2004-2015. Of the 700 km of transmission network, critical leak prone portions, especially of pre stressed concrete (PSC), are being replaced in phased manner.</p>	Infrastructure
	<p>(v) The existing water supply, transmission and distribution network under Nangloi Water Treatment Plant is being revamped for enhanced service standards, reduction in non-revenue water, energy conservation, improved water quality, better collection efficiency of revenue, and extension of water supply in un-served areas.</p>	Planning
	<p>(viii) Three special courts have been made functional under Delhi Water Board Act 1998 to take action for violations under this Act.</p>	Revenue.
D. Waste Water Recycling :	<p>(iv) About 142 MGD of treated effluent from DJB sewage treatment plants is being provided for horticulture and industrial purposes. Another 67 MGD of treated effluent will be provided for PPCL Bannoli, DTC, PWD, NDMC etc. Treated effluent from 1 MGD STP for CWG Village will also be recycled for horticulture and other purposes. To facilitate the consumers, the water network is being laid within 2-3 Km periphery of the STP so that treated water is supplied at their door step.</p>	Policy
	<p>(v) Under "Jan Jal Prabandhan Yojna" (JJPY) a pilot project in six colonies will be implemented where decentralized water and waste water recycling system will be provided. The various components of the project are provision of UGR along with network for drinking water decentralized sewage treatment plant along with sewerage network for sewerage collection and distribution network for treated effluent.</p>	

	(iii) A Comprehensive plan is being prepared for use of treated effluent within Delhi of each STP command area after assessing the potential users of treated effluent for non-potable purposes.	
	(iv) MCD may consider for giving rebate in property tax for the institutional category in the year of implementation of waste water recycling system and then subsequently on yearly basis depending on functionality of the system.	Institutional
	(v) A financial assistance scheme for reimbursement of part of the implementation cost of waste water recycling system may be initiated by the DJB/GNCTD.	Institutional
	(vi) Mandatory provision of installation of on-site decentralized waste water treatment systems (STP/ETP) by industries, hotels, shopping malls, hospitals, other big construction projects etc with treated waste water reuse in flushing, cooling, horticulture etc. More than 1500 STPs/ETPs have been installed so far.	Policy
E. Water Tariff Structure	(i) Presently water tariff are charged broadly under two categories i.e. domestic (Category-I) and Commercial/Industrial (Category-II). Water Tariff for monthly consumption up to 20 Kilolitres in Category-I is free and 6 Kilolitre in Category-II is subsidized. Calibrated/differential water tariff structure, depending on social and financial status of the consumers, can be effectively implemented on accurate assessment through proper metering of the consumer water connections.	Revenue.
2. Prevention of Pollution in River Yamuna		
A. Augmentation of Sewage Treatment Capacity	DJB has augmented its sewage treatment capacity to 684 MGD and another 2 STPs 40 MGD at Coronation Pillar and 8 MGD at Delhi Cantt. Are proposed to be constructed which will thereby increased the total sewage treatment capacity to 732 MGD by 2017.	Infrastructure
B. Treatment of Industrial Wastewater	(i) Proper networking of all industrial areas with CETPs. (ii) New CETP has been constructed at Bawana to cater for the treatment of industrial wastewater from Bawana industrial area. (vi) For reducing the load on CETPs, industrial areas have been directed for mandatory installation of on-site ETPs before discharging.	Infrastructure and Policy
C. Modernization & Refurbishment of Sewage Treatment Plants (STP)/ Sewage Pumping Stations (SPS)	(i) Refurbishment & modernization of existing sewers network, sewage treatment plants and pumping stations for improving conveyance efficiency of sewer network and for enhancing treatment effectiveness and quality is being proposed in 3 sewerage zones of Kondli, Okhla and Rithala under Yamuna Action Plan (YAP) -III. (ii) STPs are being monitored on quarterly basis for compliance of standards. Recently data of STPs shows the most of the	Planning

		STPs are meeting the standards. Efforts are being made for continuous and tamper proof online monitoring system. (vii) All new STPs are being designed on the out put parameters of BOD less than 10 mg per liter and SS less than 10 mg per liter as prescribed by CPCB.	
	D. Rehabilitation of Peripheral Sewers:	(i) 168 Kms of peripheral sewer has been identified for rehabilitation in various parts of Delhi and the work of rehabilitation of these sewers is being taken up in a phased manner.	Infrastructure
	E. Interceptor Sewer Project	(i) This involves laying of interceptor sewers along the three major drains of Delhi, viz; Najafgarh Drain, Supplementary Drain and Shahdara Drain (total length 59 kms). The interceptor sewers is being laid along these drains below the bed level of the drains and all the drains carrying wastewater from un-sewered areas will be trapped and conveyed to the existing STPs. The project has been designed in such a way that the interceptor sewers work as the trunk sewers for the presently un-sewered areas in long term. The work has been completed.	Infrastructure
	F. Sewerage Facilities in Un-Sewered Areas	(i) An international consultant has prepared “Master Plan for Sewerage System of Delhi for 2031.” The Master Plan shall also include sewerage plan for unsewered areas such as authorized colonies rural villages, urban villages, extended abadi, lal dora, resettlement colonies etc. These are approximately 26 unauthorized/regularized colonies. 6 urban villages, 147 rural villages and 1700 unauthorized colonies which are yet to be provided with sewerage facilities. In 212 unauthorised colonies sewerage facilities have been provided & in 297 colonies work are in progress. (ii) The expert committee constituted by Hon’ble National Green Tribunal has recommended installation of 32 STP’s on major and minor drain in an effort to prevent the flow of sewage in the naturals drains. Hon’ble NCT in its judgement has directed the installation of 32 STPs with the requisite capacity ranging from 0.6 to 10 MGD at the site specified in the report.	Infrastructure
	G. Utilization of Sludge	Sludge management for all STP’s is being taken up for proper treatment and usage using different technologies in the field.	Research
	H. Curtailing Non-point sources of pollution	(i) Public awareness on water pollution through media, campaigns. (ii) Provision for designated enclosures for idol immersion during Durga Puja festival	Public relation
3	Ground Water Regulation and Management	Voluntary Disclosure Scheme for bore well/tube well data collation was started for certain period.	Policy
		Groundwater withdrawal metering and pricing.	Policy

10.4 Strategies and Actions to address concerns due to Climate Change

The National Water Mission under National Action Plan on Climate Change proposes enacting a water policy to combat, mitigate and adapt to water scarcity scenarios that may arise out of climate change. The Mission seeks to ensure integrated water resource management to conserve water, minimize wastage and ensure more equitable distribution both across and within states. The initiatives by the Delhi Government are consistent with those included in the National Water Mission.

Table 60 briefly describes the action plan identified by the Delhi Government as short term, medium term and long term goals to be achieved by the year 2020 and 2030 respectively.

Water Resources: Key Priorities

- Increasing water use efficiency
- Enhancing water availability
- Enhancing wastewater treatment through interceptor sewers and mandating decentralized wastewater treatment at local level.
- Mandatory water assessments and audits
- Mandating rain water harvesting and artificial recharge
- Restoring and rejuvenating natural water bodies
- Reuse of wastewater
- Groundwater Regulation and Management

Table 60: Action Plan for Water Sector for Challenges of Climate Change

Sector	Target 2020 and 2030	Objective and Strategy to be adopted	Departments
Water Use Efficiency	<ul style="list-style-type: none"> • By 2020: In the command area of existing WTPs • By 2030: In the command areas of all the upcoming new WTPs 	<ul style="list-style-type: none"> • Recycling plants to reclaim raw water which is utilized in process of back wash of treatment units in the water treatment plants have been commissioned at Haiderpur, Wazirabad, Chandrawal and Bhagirathi with total capacity of 45 MGD. • A Pilot Project through distribution management contract in the Command areas of Malviya Nagar UGR, Vasant Vihar and adjoining colonies is being implemented. • The existing water supply, transmission and distribution network under Nangloi Water Treatment Plant is being revamped for enhanced service standards, reduction in non-revenue water, energy conservation, improved water quality, better collection efficiency of revenue, and extension of water supply in un-served areas. • Leakages to be checked and high users to be encouraged to use recycled water for toilet, gardens, washing and cooling, detailed plan to be drawn up by DJB to achieve 20% efficiency of use by 2020/2030, since national action plan has a target of 20% efficiency of use and this is achievable. • There is a need to strengthen water supply network by utilizing the latest technology (water efficient fixtures) with respect to upgradation of water supply system so that the leakages and wastage of water could be reduced upto 10-20%. • Encroachment of Floodplains of River Yamuna to be removed. 	Delhi Jal Board (DJB), Delhi Municipal Bodies
Water recharge system	25% of all existing institutional buildings and 50% & 100% of institutional buildings RWH, depending on technical feasibilities by 2020/2030 respectively.	<ul style="list-style-type: none"> • All concerned departments to identify and implements to identify and implement/enforce implementation of RWH systems for buildings under their direct/indirect control. For technical assistance on RWH systems, they may approach DJB, who will provide the same in time bound manner. Rain Centers have been started in 3 zones to provide free technical know how about simplified structure of RWH. • MCD may consider rebate in property tax for implementing and proper maintenance of RWH systems for institutional as well as individual categories. 	DDA, MCD, CPWD, PWD, DJB and other concerned government departments.

Sector	Target 2020 and 2030	Objective and Strategy to be adopted	Departments
Waste water reuse	50% & 100% of institutional buildings to adopt waste water recycling systems, depending on technical feasibilities by 2020 & 2030 respectively.	<ul style="list-style-type: none"> • This requires a policy framework which needs to be created to incentivize the reuse of waste water with technical input including double piping in some buildings and changes in bye laws. This is a complex process and needs to be started for water conservation. • All concerned departments to identify and implement/enforce implementation of waste water recycling systems for buildings under their direct/indirect control depending on technical feasibilities. • MCD may consider rebate in property tax for implementing and proper maintenance of the systems for institutional category. • Brackish groundwater available could be processed for converting it into potable water by installation of water softener plants so that this resource of water could also put to use and the dependent on the supply water could be reduced in some of the areas where un-planned development took place. 	Delhi Municipal Bodies
Waste water treatment through interceptor sewers	2020: 50% completion of the project. 2030: 100% completion of the project.	The interceptor sewer is being implemented by EIL for DJB.	Delhi Jal Board (DJB)
Waste water treatment by connecting all houses to existing sewer systems	2020: 90% 2030 : 100%	<ul style="list-style-type: none"> • In many cases residents do not connect houses to sewer lines and discharge into drains and this needs to be stopped. • To ensure 100% connections to sewer lines wherever existing. 	Delhi Jal Board (DJB)
100% treatment of Sewage/industrial effluent	2020: 100%	Delhi Jal Board and DSIIDC to achieve 100% treatment of Sewage/industrial effluent within 3 years to ensure that no untreated sewage/industrial effluent enters the River Yamuna.	Delhi Jal Board and DSIIDC
Ground Water Recharge	2020: 100%	Ground Water drawl metering and charge on same	DJB/DPCC
Rejuvenation of River Yamuna and	2020: 100%	Encroachment on Floodplains of River Yamuna to be removed	DDA and MCDs

Sector	Target 2020 and 2030	Objective and Strategy to be adopted	Departments
Encroachment on Floodplains of River Yamuna		Rejuvenation of River Yamuna Development of mini off-river reservoirs to store flood waters. Restoration of catchment wetlands to store flood waters and recharge ground water.	DDA, DJB, UD Dept. Delhi Parks and Garden Society (DPGS)

Table 61 below briefs the other recommended propositions along with policy prescription for improving water quality with respective agencies involved.

Table 61: Policy prescription for improving water quality

Actions / Policies	Agencies Responsible
Mandatory Decentralized wastewater Treatment – Recycle and Reuse Waste Water (Grey & Black) at Local Level	DDA, MCD, DJB, NDMC, DPCC, Indian Railways, DMRC
Revive, restore and stringently preserve Natural Water Systems of the City i.e., Water bodies, lakes, nallahs and river	DPCC, DJB, DPGS
Decentralize and mandate Natural Storm water Management in roads, parks, large developments etc.	PWD, MCD
Quantification of available/ surplus treated wastewater at STPs	DJB
Groundwater Regulation and Management	Dept. of Env., DJB, NDMC, DCs
Zone “O” Development for recreational purposes	DDA
Create City Level Watershed Management Plan and Urban Drainage Master plan based on natural treatment, conveyance, capture, and infiltration systems. Structured systems may be used only for overflow capture.	I&FC, UD
Increase public awareness of the importance of safe, high-quality drinking water. All the 12 DJB water laboratories (including 6 zonal laboratories) have been upgraded and are fully geared up for intensive checking of water samples on daily basis to ensure adequate surveillance of potable water supplied to citizens.	DJB, NDMC

10.5 Budgetary Assessment of key priorities

The budget requirement for the implementation of key priorities in water resource (including sewerage) sector for the next five years is mentioned below in table 62.

Table 62: Budgetary assessment of key priorities in water sector

Key Priorities	Department/Organization	Budget (Rs. Crore)		
		State Source	Other Source	Total
Water use efficiency	Delhi Jal Board	585	2115	2700
Waste water reuse to be started	Delhi Jal Board	185	NA	185
Waste water treatment through interceptor sewer	Delhi Jal Board	1239	118	1357
Waste water treatment by connecting all houses to existing sewer system.	Delhi Jal Board YAP –III	298	783	1081
Treatment of all the waste water by setting up STP's sewer network in villages/unsewered areas	Delhi Jal Board	-----	700	700
Total		2307	3716	6023

(Source: Delhi Jal Board, GNCTD)

State Interventions to Improve Water Supply & Sanitation

- ₹676 crore is proposed to provide piped water supply in 300 unauthorized colonies. While currently water tankers are being used with stainless steel containers and fitted with GPS and 407 MS mounted tankers are being used to deployed for supplying potable water to far-flung areas, JJ Clusters, rural villages; re-settlement Colonies, unauthorized colonies and deficit prone areas.
- Other programmes for improving urban water supply, replacement of old distribution lines and transmission works etc. are taken-up regularly by Delhi Jal Board, for which, around 1200 crore has been allocated for various urban sanitation programmes.
- Major programmes are for improving sewerage facilities in unauthorized colonies, sewerage treatment plant and for improving sanitary condition in Katras, squatter re-settlement colonies, laying/ replacement of Trunk sewer and for sewerage capacity. All the municipal corporations are responsible for solid waste management, sweeping of roads and lanes in Delhi, for which, ₹580 crore has been allocated to three agencies.
- Atal Mission for Rejuvenation & Urban Transformation (AMRUT) programme launched on 25th June, 2015 as a mission mode project by the Ministry of Urban Development, Govt. of India, with the priority to provide water & sewerage connection to each household. This scheme has components: Storm Water Drainage, Developing Greenery & Parks, Urban Transportation, including construction of pathways, cycle track, footpath, foot over bridge, non-motorized transport, multilevel parking, etc.

11. Forest and Biodiversity

Climate change, in particular, is expected to impact on forest and biodiversity and the ability of forests to provide soil and water protection, habitat for species and other ecosystem services. It is also quite evident that climate change has negative impact on agricultural productivity.

The GNCTD has been undertaking green initiatives in the form of establishment of city forests, biodiversity parks and recreation parks, and species enrichment of ridge forests, restoration of water bodies and the green belt development around them, flood plain forest and grasslands along riverfront plantation along railway lines, canals, roadsides, institutions, gram sabha lands etc. as mitigative and adaptive features to anticipated climate change.

11.1 Status of Biodiversity and Forests in Delhi

The State of Forest Report 2017 has shown an increase in forest cover in Delhi compared to 2015. The forest cover of Delhi has increased by 3.41 sq km to 192.41 sq km from 189 sq km in 2015. After having achieved unprecedented success in increasing the green cover, efforts have been sustained to plant more and more trees on vacant lands through active involvement of greening agencies and community participation. This also includes free distribution of saplings to schools, RWAs, NGOs and other citizen groups through Forest Department's nurseries, petrol pumps, CNG Stations, mother dairy booths etc during monsoon season and financial assistance to RWAs for maintenance of parks and gardens.

Today, Delhi has nearly 20,000 small/medium/big recreation parks and gardens, 42 city forests, 4 ridge areas, 6 bio-diversity parks and other green belts. Department of Forests and Wildlife along with 20 greening agencies including horticulture wings of civic agencies like NDMC, North MCD, South MCD, East MCD, New Delhi Municipal Corporation, Delhi Cantonment Board, PWD, CPWD, DDA and others takes up a million tree plantation campaign since 2011. A total of 20 lakhs saplings have been planted by various organizations/agencies in 2018-19. A target of tree plantation of 10 lakh saplings and 5 lakh shrubs have been fixed annually keeping in view that small avenue trees are required to be planted on either side of roads and vacant areas of parks and gardens. The Forest department is striving to increase the forest and tree cover in Delhi up to 25% of the geographical area of Delhi within the next five years to 371 sq.km. Parks and gardens in Delhi are being maintained and developed through horticultural units under various civic agencies like MCD, DDA, NDMC, PWD, CPWD, etc as well as by RWAs & registered societies through Delhi Parks and Garden Society (DPGS), an autonomous body under Department of Environment, which also provide financial assistance to RWAs / NGOs for maintaining parks / gardens. Also, DMRC has a policy to plant 10 saplings for every tree that is required to be felled. In order to ensure that the correct type of saplings are planted and maintained.

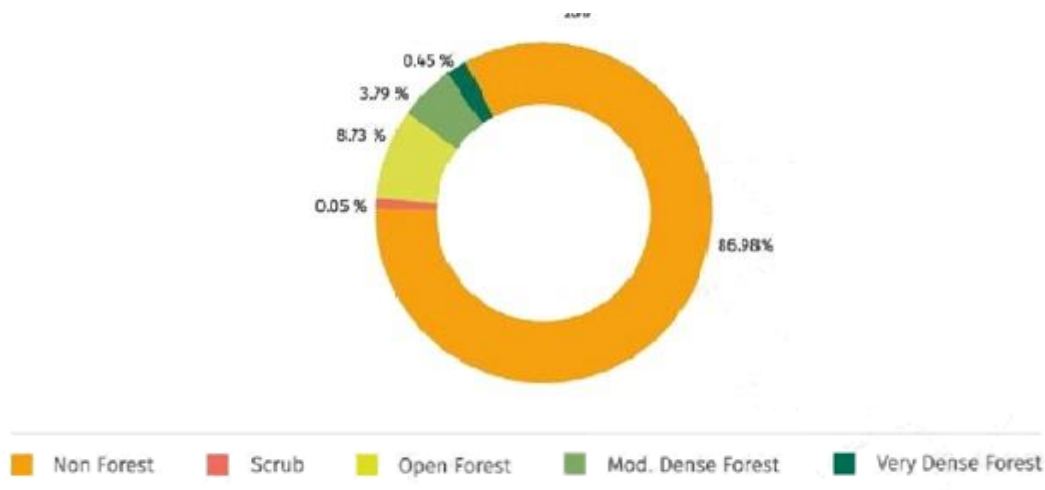
Table 63: Tree Plantation Data for DMRC Construction Phase 1, 2 & 3

Felled	Transplanted	Planted
31,855	6,636	344,251

11.2 Existing Concerns in Forest and Biodiversity Sector

The forest cover of Delhi has increased by 3.41 sq km to 192.41 sq km in 2017 from 189 sq km in 2015. The highest increase in forest cover, an increase by 2.50 sq km, was in South-West Delhi. The area under “Very Dense Forest” increased by 0.18 sq. km, “Moderately Dense Forest” increased by 7.77 sq. km, from 49.38 sq. km to 57.15 sq km. From 2009 onwards, Department of Forest, GNCTD has been focusing on plantations in areas like Garhi Mandu and Bhatti near Badarpur planting the slopes of former sand quarries with saplings.

In terms of forest canopy density classes, Delhi has 6.72 sq km of very dense forest, 56.24 sq.km of moderately dense forest and 129.45 sq.km of open forest. The distribution of forest cover is shown in Figure 19.

Figure 19: Forest Cover Types in Delhi

(Source: Forest Survey of India, 2017)

The extent of district-wise forest cover of Delhi as per the India State of Forest Report, 2017 is tabulated below:

Table 64: District wise Forest Cover of Delhi (2015)

District	Geographical Area (sq. kms)	Forest Cover (sq. kms)	Percent of GA
Central Delhi	25	5.14	20.56
East Delhi	64	3.28	5.13
North- East Delhi	60	3.97	6.62
North West Delhi	440	17.04	3.87
New Delhi	35	17.25	49.29
North Delhi	59	4.53	7.68

South West Delhi	421	48.60	11.54
South Delhi	250	82.14	32.86
West Delhi	129	6.82	5.29
Grand Total	1,483	188.77	12.73

(Source: Delhi Statistical Handbook 2017)

In order to improve the quality of forests, Department of Forests and Wildlife has developed 42 City Forests and woodlots. Gradually these areas are being opened for the public to ensure better management and creation of awareness for environmental values.

Recorded Forest (Notified Forest Areas in Delhi)

About 305.41 sq. km. of Delhi is covered with forest and trees which is 20.59% of the total area.²⁴ The total recorded forest area in Delhi is 102 sq. km i.e. 6.88% of the geographic area of which the Reserved and Protected Forests constitute 76.48% and 23.52% of the total forest area respectively.

Reserved Forest

“Ridge” which is the rocky outcrop of Aravali hills in Delhi, has been notified as Reserved Forests under Section 4 of the Indian Forest Act, 1927 vide Notification No.F.10 (42)-1/PA/DCF/93/2012-17(I) dated 24th May, 1994. The Hon’ble Supreme Court, through various orders passed in Writ Petition (Civil) No. 4677/1985 (MC Mehta vs. UOI & Ors.) has directed that ridge should be maintained in its pristine glory. The Ridge in Delhi is comprised of the following, break up of which is given in the table below:

Table 65: Area covered in different Ridge Forest

Ridge Forest	Approximate Area in Ha. (to be demarcated/reconciled)	Proportion of different parts of Ridge (in %)
Northern Ridge Forest	87	1.13
Central Ridge Forest	864	11.09
South-Central Ridge Forest	626	8.04
Southern Ridge Forest	6,200	79.65
Nanakpura South Central Ridge	7	0.09
Total	7,784	100.00

The position of different parts of the Ridge and their present status of management is given below:-

- i. Northern Ridge: Northern Ridge, located near Delhi University, has an area of 87 ha and is under the control and management of various agencies, which are mentioned below.

Table 66: Agencies Responsible for Managing Northern Ridge

Managing Agency	Area
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²⁴ State Forest Report, 2017

DDA	73.00 ha.
MCD (Hindu Rao Hospital)	11.00 ha.
Forest (KNR Nursery)	3.00 ha.
Total	87.00 ha.

ii. Central Ridge: Central Ridge has an area of 864 ha area and is under the control and management of various agencies which are mentioned below.

Table 67: Agencies Responsible for Managing Central Ridge

Managing Agency	Area (Ha.)
Forest Department	423.00
Army (Signal Regiment) B/W	202.00
DDA (Bhuli Bhatiyari Park, R Block Rajender Nagar)	85.00
CPWD(Buddha Jayanti Park, Mahavir Vanasthali)	37.00
NDMC (Talkatora Garden)	25.00
MHA (Wireless Stn.)	6.00
MCD (Nursery)	3.00
Railways (Sardar Patel Rs)	11.00
Areas Allotted By L&DO	70.00
Total	864.00

iii. South-Central Ridge: South Central Ridge has an area of 626 ha including Sanjay Van and is located near Mehrauli. The whole of this ridge is under the control & management of Delhi Development Authority.

iv. Southern Ridge: The Southern Ridge has an area of approximately 6,200 ha. and the agency-wise details of which are as under:

Table 68: Agencies Responsible for Managing Southern Ridge

Managing Agency	Area
Forest Department	1938.00 Ha.
Delhi Development Authority	120.00 Ha
Sports Authority of India	32.00 Ha
Gaon Sabha & Ors.	4207.00 Ha
Total	6200.00 Ha.

Uncultivated surplus gaon sabha lands in the Southern Ridge have been excluded from vesting in the gaon sabha and transferred to the Forest Department for afforestation vide notification dated 02.04.1996 under Section 154 of the Delhi Land Reforms Act,1954. Out of the total 4,207 ha of Gaon Sabha lands so notified, approximately 3,200 ha have already been handed over to the Forest Department which is maintained as forests.

Protected Areas (Asola- Bhatti Wildlife Sanctuary)

Gaon Sabha land in village Sahurpur, Asola, Maidan Garhi measuring 2,679.29 Acres (1,084.27 ha Ha.) and 2,166.28 Acres (876.66 ha.) of village Bhatti in the Southern Ridge has

been notified on 09.10.1989 and 15.04.1991 as Asola and Bhatti Wildlife Sanctuaries respectively under the Wildlife (Protection) Act, 1972.

Protected Forests

The following areas in Delhi have been notified as Protected Forests under Section 29 of the Indian Forest Act, 1927.

Table 69: Protected Forests and Agencies Involved in Delhi

S. No.	Name of the Protected Forests and Agency	Area (in acre)
1	Mitraon (Forest)	105
2	Sultanpur (Forest)	120
3	Mukhmelpur (Forest)	133
4	Rajokhari (Forest)	600
5	Tughlakabad (Forest)	
6	Distt. Park I/c Hauzkhas picnic Hut, lake, garden etc. (DDA)	400
7	City Forest (DDA)	800
8	Basant Nagar, Moradabad Pahari Area (DDA)	200
9	Vasant Vihar Distt. Park (DDA)	20
10	Dhaura Kuan Complex (DDA)	200
11	Nehru University Afforestation (DDA)	200
12	Distt. Park Gokulpuri (DDA)	7.50
13	Distt. Park Jhilmil Taharpur (DDA)	20
14	Zonal Green Area Kalyanpuri, Trilokpuri, Khichripur, Ghazipur etc. (DDA)	373
15	Orchard between Sindhora Kalan, Nimri, Gulabi Bagh & Darbar Khan Nursery and Other Area (DDA)	100
16	Area between Hill Road & Ludlow Castle Road (DDA/ L&DO)	17
17	Orchard in Wazirpur near Bharat Nagar and Nimri Colony (DDA)	120
18	Mayapuri Green Belt (DDA)	5
19	Hastal Afforestation (DDA)	40
20	Area between Inderpura Narayana JJ Colony (DDA)	32
21	Afforestation MP Green area Tagor Garden (DDA)	55.26
22	Orchard Nangloi Sayed (DDA)	257.56
23	Distt. Park Rohtak Road Co-operative Society (DDA)	35
24	Afforestation MP Green G 8 Tihar	65
25	Afforestation MP Green Area Najafgarh Drain (DDA)	54.58
26	Distt. Park in between Pitampura Co-operative Society (DDA)	185
Total		4,144.90 (1,658 Ha.)

(Source: GNCTD)

Biodiversity Parks

Realising the importance of sustaining environmental quality which in turn determines the quality of life in Delhi, the DDA has been establishing a network of 6 Biodiversity Parks

covering an area of about 1,300 hectares apart from 52 km stretch of riverfront and its flood plains encompassing more than 9,000 hectares. The Concept of Biodiversity Park was first developed in Delhi and was implemented for the first time in the world by DDA in joint collaboration with Centre for Environmental Management of Degraded Ecosystems (CEMDE), University of Delhi. The 6 Biodiversity Parks notified by DDA are: Yamuna, Aravalli, Northern Ridge, Neela Hauz, Tilpath Valley, and Riverfront.

The 7th Biodiversity Park is Tughlakabad. Except riverfront, all other Biodiversity are being developed. The Yamuna and Aravalli Biodiversity Parks are fully functional and have become Nature Reserves of Delhi having some 3,000 species living in 40 to 50 biological communities. Biodiversity Parks are not only preserve natural heritage of the area but also have educational, conservation and cultural values. These Biodiversity Parks have been rendering a wide range of ecological services ranging from storage of flood water, recharging of ground water, cleaning air, buffering environment and imparting resilience to climate change, besides serving as tool to create environmental awareness through education. The Biodiversity Parks are owned and managed by DDA under Delhi Biodiversity Foundation.

Forests, by acting as a sink for greenhouse gases, help mitigate the effects of climate change. However, forest biological diversity is also directly and indirectly impacted by changing climatic conditions. These changes question the degree to which forests will be able to continue sequestering greenhouse gases in the future.

Ecosystem and climate models suggest that climate change will have a variety of impacts on the distribution of forest organisms and populations as well as impact ecosystem function and composition. It is expected that forest biodiversity will be forced to adapt and as a result species compositions in forests is likely to change and those species and populations which are already vulnerable will potentially become extinct. The impacts of climate change on the forest and agriculture include:

- Drastic alterations in the structure and organization of biological communities
- Marked changes in the flora and fauna
- Loss of species (plants, animals and microbes)
- Many species with low ecological amplitude may be restricted in their distribution ranges
- Many of the avenue trees and species in parks will be lost.
- Rapid decline in the primary productivity which in turn lead to the decline in the dependent animal species.
- Soils loose their life supporting potentials due to alteration in the physical, chemical and biological properties.
- There will be less CO₂ sequestration through biological processes.
- There will be increase in the pest pathogenic loads and also increase in the incidence of diseases leading to epidemics.
- Shifting of species distribution from high elevation to low lying area under Scenario I and vice-versa under scenario II will occur.

11.3 Institutions Involved in managing Forest and Biodiversity

The institutions involved in maintaining the forests and bio diversity of Delhi are:

- Department of Forests and Wildlife, GNCTD
- 132 Eco-Task Force
- Delhi Development Authority
- Delhi Parks and Garden Society (DPGS)
- East Delhi Municipal Corporation
- South Delhi Municipal Corporation
- North Delhi Municipal Corporation
- Delhi State Industrial and Infrastructural Development Corporation (DSIIDC)
- New Delhi Municipal Council
- Central Public Works Department (CPWD)
- Delhi Cantonment Board
- Delhi Development Authority

11.4 Current Policies and Programmes of the GNCTD

The National Forest Policy, 1988 provides that a minimum of 1-3rd of the total land area of the country should be under forest or tree cover. Taking the above strategy in view, the GNCTD is making all endeavors to meet the national goal as set by the Central Govt. and is constantly adding to the Green Cover of the State which is reflected in the change in Forest and Tree Cover given below:

(i) Afforestation/Plantation Scheme

Besides undertaking plantation on forest and gram sabha land available with the Department, it is also monitoring the implementation of the Green Delhi Action Plan by 20 other Greening Agencies in Delhi for increasing the forest and tree cover of the territory. The Department also distributed around 5 lakh saplings every year through the 2,000 Eco Club Schools and 3,000 Resident Welfare Associations, NGOs and other citizen groups etc. More than 500 retail centers of Mother Dairy, CNG and Petrol Pumps were also utilized for this purpose, apart from distribution through various exhibitions and festival organized by different departments of the GNCTD. NDMC is maintaining public greens of 43 sq. km area comprising mainly of New Delhi district. They have taken several steps for biodiversity conservation in the recent years. Some of these include:

- Herbal gardens have been created in all major parks, few colony parks and school for creating public awareness
- A tree ambulance facility has been started for proper management of trees
- Peacock conservation programme has been taken up at Lodhi Garden. In last 3 years 10 peachicks were reared in the garden and released after initial care
- A butterfly conservatory has been developed at Lodhi Garden for providing habitat to

butterflies, which are indicator of health of environment

The plantations undertaken by the Greening Agencies and free distribution of saplings made by the Department over the last three years is as below:

Table 70: Plantation Activities of Department of Forest and Wildlife, Delhi

Years	Target (Lakh)	Achievement (Lakh)			
		Total Achievement	Plantation by Forest Department	Plantation by Other Department	Free Distribution of Seedlings
2007-08	13.88	17.62	3.93	8.67	5.02
2008-09	13.43	16.38	3.15	8.18	5.05
2009-10	10.35	21.38	3.65	10.01	7.72
2010-11	11.34	11.23	3.99	7.49	5.46
2011-12	99.64	95.69	2.81	6.76	7.77
2012-13	8.20	9.15	4.63	4.53	8.01
2013-14	8.19	5.51	1.42	4.08	4.59
2014-15	12.84	9.66	3.64	6.01	6.47
2015-16	13.17	9.74	3.54	6.20	6.77
2016-17	10.56	8.72	2.96	5.76	3.71
2017-18	10.00	6.89	1.29	5.60	3.74

(Source: Forest Department, Government of National Capital Territory of Delhi)

Role of DPTA (1994)

In order to increase the green cover of Delhi, the Government tries to preserve the existing tree stock and ensure plantation of 10 saplings for felling of a tree as per the provisions of the Delhi (Preservation) of Trees Act, 1994. In order to ensure densification of existing forest cover, the forest department has been asked to plant and maintain at least 5 tree saplings against permission granted for felling of a tree. The remaining 5 saplings are to be planted and maintained by the User Agency.

The Department of Forests and Wildlife, GNCTD is also implementing the project of rehabilitation of degraded forests and abandoned mine pits of Bhatti covering an area of 2,100 acres and the southern ridge in Delhi through afforestation by Eco-Task Force from 16th December, 1999 with the following objectives:

- Reclamation of degraded Bhatti area through afforestation and grassland development
- Restoration of habitat for wildlife indigenous to Delhi
- Improving groundwater regime of the area
- Improving the soil quality and fertility of soil in the area and adjoining areas as well

It has been reported that ETF has planted approximately 24 lakh saplings up to March, 2018 and is continuing with the eco-restoration and protection works of the Bhatti and Dera mandi area in the southern ridge.

(ii) Greening of water bodies

The Department of Forest and Wild Life carries out plantation around water bodies that are rehabilitated by the Land Owning Agencies. The Department has planted saplings around 85 water bodies with 12434 saplings. The saplings are planted and maintained with the support of Delhi International Airport Limited as compensatory plantation.

Department was assigned the responsibility of creation of plantation along road sides and central verge of NH1 from Wazirabad Bridge to Mukarba Chowk (8km) and creation of urban forest on 30 acres land and ITO Chungi Inter-section in North Forest Division for the Commonwealth Games and meeting the much needed requirement of green cover in the area.

(iii) Consolidation of Forests

Forest Department has taken up the matter of notification of old established city forests as Protected Forest under IFA'27. The proposals in respect of Alipur, Hauzrani, Ghoga, Shahpur Garhi, Mamurpur, Jindpur, Garhi Mandu, Hindan Cut, Harewali, Sultanpur Dabas etc. are being examined by the revenue department for their notification by the Forest Department.

(iv) Awareness Activities

The GNCTD has set up Conservation Education Centre, Delhi in collaboration with Bombay Natural History Society (BNHS) to educate people of Delhi about conservation of nature. From its inception in 2004, it has reached out to different target groups by conducting conservation education programmes through nature trails, poster displays, audio- visual presentations, interactive sessions and thematic workshops. Besides, the Department has been successful to a great extent in enlisting the support of the masses through Bhagidari and Eco-clubs, Health Melas, observance of Wildlife Week, World Environment Day, International Day of Bio-diversity, World Forestry Day etc. and awareness campaigns namely “Greening Delhi”, “Say Yes to Eco Friendly Bags”, “Save Yamuna”, “Anti Fire Crackers”, “Waste Minimization”, “Play Holi with Safe and Natural Colours” etc in creating awareness about the importance of trees and forests by educating public in general & different segments of the city such as school students, residential associations, women groups etc. as also the role played by them in improving the environment including protection of wildlife in Delhi.

26 separate programmes and projects were proposed by four departments of Delhi Government – Environment, Transport, Power and Public Works Department, and Govt. of Delhi attempted to bring them together in the form of a concerted initiative to control pollution. Delhi Govt. collaborated with a global think-tank “World Resource Institute”, working towards sustainable development, to understand the impact of Delhi Government’s Green Budget for 2018-19 on

pollution in Delhi. All these initiatives will make a long-term impact on reduction of carbon emissions and air pollutants under Green Budget. Following plan schemes are being implemented in NCT of Delhi:

- Public Environmental Awareness and other related activities
- Environmental Data Generation Survey Research Projects and Other activities
- Eco Clubs in schools & colleges
- Climate change and other activities
- Science Technology Awareness Programme
- Delhi Parks and Garden Society
- Assistance to the NGOs in the promotion, conservation and preservation of Environment,
- Development of Forest including Consolidation
- Development of Wild Life Sanctuary & Stg. of Wild Life Section
- Creation & Maintenance of Urban Forest
- Monitoring of Greening Activities in Delhi
- Eco Clubs in schools & colleges
- Intensification of forest management-CSS

In addition to the above activities, presently Environment Department, GNCTD provides grant to the Eco-Clubs of an annual amount of Rs. 20,000/- per school/ college under the Outlay scheme “Eco-Clubs in Schools/ Colleges”. Up to the year 2011-12, yearly grant of Rs. 10,000/- was given to each eco-club in schools/ colleges which has been enhanced to Rs. 20,000/- p.a. from the year 2012-13. Also Additional grant of Rs. 2,500/- is given to only schools from Ministry of Environment & Forest, GOI as NGC (National Green Corps). The scheme was started with 100 schools during 1998-99 and now more than 2,000 Eco clubs are established in Delhi Govt. schools/ Aided/ Public/ Private schools, NDMC school, KV/JNV and colleges of Delhi. The schools having class XI onwards are enrolled as Eco-Clubs. The various activities of the Eco-Clubs basically about the Environment awareness and to preserve, conserve and protect the Environment etc.

11.5 Strategies to Address Associated Climate Change

The report of the Working Group on Forests for the 11th Five-Year Plan puts the annual rate of planting to 3.3 million hectares to achieve the final target of one-third of the geographic area of India under forest cover.

The existing greens of the City in the form of Parks, Gardens, Avenue trees, besides city forests, urban woodlands, green cover on the ridge and two biodiversity Parks, countryside/gram sabha, plantation along with roadside and railway lines, may not be enough to mitigate greenhouse gas emission. To implement the mitigative and adaptive measures and also to collect the baseline data, it is important to develop institutional capacity. As a part of the Institutional

capacity, a proposal has already been moved for the establishment of the Institute of Ecosystem Research and Management in Delhi. This Institute will not only collect the baseline data and build scenarios based on the baseline data, but will also assess the risks and vulnerability and evolve mitigation and adaptive measures. The Institute will also work on policies to adapt to the anticipated climate change.

As per direction of Hon'ble High Court in WPC -1346 and NGT in OA-58/2013 for consolidation of the ridge forest land through survey and demarcation of Southern Ridge Area and construction of boundary wall around forest area.

GNCTD also plans to increase the activities of environment awareness including construction of compost pits, tree census, biodiversity index in various schools and colleges, apart from inviting innovative ideas in environment protection through participation of children of school.

Forest and Biodiversity: Key Priorities

- Increase in the green cover
- Water conservation measures
- Improving tree planting and forest management to integrate with watersheds and water resources management
- Selection of flood tolerant and drought tolerant species for plantation
- Adaptation of ecosystem approach to evolve mitigative measures and adaptive responses
- Biodiversity enrichment of Ridge, Urban Woodlands, Parks and Gardens
- Creation of embankments and check dams in low lying areas
- Monitoring carbon stock and biodiversity at regular intervals

Table 71: Action Plan for Forestry Sector for Challenges of Climate Change

Sub Sector	Category of Interventions for implementation by 2020 and 2030	Proposed activities/projects	Department Concerned
Scaling Down Vulnerability	Enhancing afforestation and plantation activities	Identify barren and degraded land area especially along the Yamuna River and Ridge is for intensive greening.	Involve all departments like DDA, PWD, CPWD, DMRC, DJB, NDMC, Parks & Garden Society, MCD and RWAs.
	Promotion of Natural Regeneration and mixed species planting	Increase the green cover to 33% of land area of Delhi as per the NAPCC.	

Sub Sector	Category of Interventions for implementation by 2020 and 2030	Proposed activities/projects	Department Concerned
	Mitigation programmes/ projects under Green India Mission (GIM)	(Annexure-6 contains the list of common indigenous tree species of Delhi)	
Carbon Sink enhancement	Enhancing the quality of forest cover and improving ecosystem services Increase in Green Cover of Delhi to 25% by 2030	Greening the Delhi Ridge area of South Delhi through Eco Task Force with an agenda to cover an area of 1,000 hectares for Afforestation	Forest Department, Environment Department of GNCTD Delhi Development Authority (DDA)
	Afforestation, enrichment and maintenance of existing forest areas under the management of forest department	More city forests to be opened by Forest Department and Bio-diversity Park by DDA. To open nine more city forests and 1 bio-diversity park in Delhi to add to the carbon sinks.	
		Plantation on vacant forest/non-forest land available/to be made available (2.5 lakh saplings)	
		Construction of 6 kms boundary wall & providing fencing and protection of forest areas	
		Eco Restoration of riparian ecosystem at Garhi Mandu	
Awareness Generation and Capacity Building	Develop incentives for responsible for greening practices and market linkages	Formation of Eco Clubs in Schools and Colleges of Delhi and motivating RWAs and NGOs.	Forest Department, Environment Department of GNCTD
	Create awareness among people about importance of ridge and forest in general through various means of publicity and capacity building on sustainable forestry	Creation of nature interpretation or Knowledge Dissemination centres at Botanical Garden.	
		Creation of GIS Cell and appointment of Consultants and Experts	
	Awareness programs for farmers and stakeholders to avoid crop-burning instances in and around Delhi's agricultural fields.		
	Grant will be provided to 2,000 Eco clubs in Delhi Govt. schools/ Aided/ Public/ Private schools, NDMC School, KV/JNV and colleges of Delhi. 600,000 number of students will be reached through Eco-clubs.		

Sub Sector	Category of Interventions for implementation by 2020 and 2030	Proposed activities/projects	Department Concerned
Tree Plantation: Plantation of 10 lakh tree saplings and 5 lakh shrubs every year	Consolidation of forest land & mapping, development of water bodies in forest areas, construction of Boundary Wall & providing fencing of forest area, construction of Watch Tower for protection. Replacement of Keekar (Vilayati babool) by indigenous saplings in Central Ridge area.	Development of Forests through plantation and saplings will be distributed free of cost to encourage plantation on vacant lands. Maintenance and development of existing Nurseries, Existing City Forests, development of new city forests. 1 lakh saplings will be planted in schools through Eco-clubs. 8 lakh number of Saplings in nurseries will be raised for plantation. 20 number of new plantation sites to be evaluated.	All greening agencies
Training / Awareness Programs	To increase the activities of environment awareness including construction of compost pits, tree census, biodiversity index in various schools and colleges, apart from inviting innovative ideas in environment protection through participation of children of school.	26 training Programme / workshop to be organized for Teachers / Professors & college / university & ITIs Students and RWA's. 2 number of awareness program/workshop on climate change to be organized. About 4,000 number of people to be trained in these training programmes / workshops on various issues related to combating climate change.	
Prohibition of crop-burning	Implementation of NGT order (in OA21/2014) on prohibition of crop-burning.		Forest Department, Environment Department of GNCTD

11.6 Budgetary Assessment of key priorities

The Department of Forest, GNCTD has proposed a budget requirement of Rs. 109.95 crore for the next five years for the implementation of all of the proposed activities under the forest and biodiversity sector in Delhi's SAPCC.

12. Health

Much of the ill-health is due to poor public health that is, unsafe water, contaminated soil, inappropriate disposal of human excreta and refuse, poor housing, insects and rodents. The high death rate, infant mortality rate, sickness rate and poor standards of health are in fact largely due to neglect of environmental sanitation. Improvement of environment is therefore crucial for the prevention of disease and promotion of health of individuals and communities. All the above mentioned environmental factors greatly affect the human health directly or indirectly. Therefore, the first step in any health programme is the elimination of major public health risks through environmental control of those factors which are harmful to health.

Climate change also brings new challenges to the control of infectious diseases. Many of the major killers are highly climate sensitive as regards temperature and rainfall, including cholera and the diarrhea diseases, as well as diseases including malaria, dengue and other infections carried by vectors. In sum, climate change threatens to slow, halt or reverse the progress that the global public health community is now making against many of these diseases. Environmental health is a key discipline to understand the complex issues of environment and climate change by the Doctors, Scientists and Researchers. Cancer is a leading cause of death worldwide. Globally 19% of all cancers are attributable to the environment.

Most of the diseases attributed to climate conditions are also influenced by the socio economic parameters driven by different developmental paradigms resulting in creating conducive environment for the occurrence and spread of the disease. Therefore, along with the interventions of the advancing medical science and pharmacology, though diseases are being controlled, but the trends of the diseases over the years when seen in totality do not seem to be exclusively driven by climate. However, it is known that with climate change some of the diseases may spread to newer areas and there might be emergence of new diseases as well.

As per National Health Profile 2015 prepared by Central Bureau of Health Intelligence, Directorate General of Health Services, Ministry of Health and Family Welfare, Govt. of India, the number of cases and deaths reported in the year 2014 in Delhi were as follows: 557 cases of Malaria (while no deaths were reported), 08 cases of Chikunguniya, 995 cases of Dengue (03 deaths reported), 113,677 cases of Acute Diarrhoeal Diseases (73 deaths reported), 25,131 cases of Enteric Fever (Typhoid) (14 deaths reported), 339,506 cases of Acute Respiratory Infection (104 deaths reported), 6,425 cases of Viral Hepatitis (95 deaths reported), 25,640 cases of Pneumonia (402 deaths reported) and 1,118 new cases of Leprosy (April to Oct.14). And as per Office of Chief Registrar, Births & Deaths, GNCTD the number of deaths reported in the year 2016 in Delhi were as follows: 247 of Cholera, 208 of Dysentery and Diarrhea, 9,149 of Respiratory diseases, 128,458 of other causes, total of 141,632.

In year 2015, the number of suspects of Pulmonary Tuberculosis recorded was 184,400, out of which, 55,582 numbers of patients were declared and registered for treatment (DOTS). The

total number of cases registered for all Population Based Cancer Registries in Delhi during 2006-2015 was 66,492.²⁵

Delhi has the highest population density in the country. This phenomenal population growth is predominantly a result of large scale migration which is estimated to be nearly 2 lakh per year as per Census 2012. As per Registrar General of India 7,663,955 people migrated to Delhi by the year 2011. This rapid population growth has put the urban infrastructure namely land, health services, education and administration under tremendous pressure.

12.1 Existing Status of Health Sector in Delhi

The total bed capacity of government and private medical institutions (allopathic homeopathic, PHC and ayurvedic) in Delhi was 49,969 as on 31st December 2015. Delhi Government has created robust health infrastructure with 36 mutispeciality hospitals including six spuer speciality hospitals, 10 hospitals having blood banks and blood storage facilities. The number of beds from private registered hospitals constitutes highest percentage in Delhi and the same was recorded at 48.39 percent. While number of beds from Delhi government incl. autonomous constituted at 21.91 percent. In addition to the world renowned government as well as private hospitals, Delhi has also showed the highest private sectors participation in health sector. More than two fifth of total available beds in Delhi are in private sector.

There are 242 Allopathic Dispensaries, 107 Aam Aadmi Mohalla Clinics (Pilot+Regular), 23 Polyclinics, 59 Seed Primary Urban Health Centers (PUHC), 39 Ayurvedic, 19 Unani and 101 Homeopathic Dispensaries, 43 Mobile Clinics and 70 School Health Clinics.

To strengthen the maternal and child health care, Government of India with the assistance of World Bank has implemented India Population Programme IPP - VIII in the slum population of four metropolitan cities viz. Bangalore, Delhi, Hyderabad and Kolkata in 1993 for a period of seven years.

Under this project the MCD has opened 6 Maternity Homes, 21 Health Centers and 90 Health Posts to improve maternal and child healthcare, as well as family planning services and a total of 3,797 beds has been sanctioned for MCD in 2015-16. The funding for this project from the World Bank has ceased and the facilities created under the programme are now being managed by the MCD. By 2015 the number of beds per thousand population reached 2.73, which earlier was 2.25 in 2004. According to the recommendations of the World Health Organization (WHO), the recommended bed population ratio is 5 beds per thousand population. But the bed population ratio in Delhi during 2015 was almost half of the prescribed level.

As on 31st July 2016, there are 1,151 hospitals including 1,057 private registered nursing homes with total of 49,969 beds. As on 31st December 2016, Delhi's bed-population ratio was 2.55 beds per 1,000 population which is better as compared to the national average of one per 1,000.

²⁵ Report on MCCD Delhi, 2015 by DES Delhi

The agency wise information regarding number of medical institutions and bed capacity in Delhi as on 31st December 2016 as presented in table.

Table 72: Medical Facilities in Delhi (as on 31 Dec. 2016)

Name of the Organization	Allopathic in Nos.		Ayurvedic / Unani in Nos.		Homeopathic In Nos.		Primary Health Centre		Total	
	Hosp.	Beds sanctioned	Hosp.	Beds	Hosp.	Beds	Nos.	Beds	Nos.	Beds
Delhi Government	34	10,160	2	510	2	150	-	-	38	10,820
MCD	53	3,598	8	199	-	-	2	10	63	3,807
NDMC	2	215	-	-	-	-	-	-	2	2,215
CGHS	2	41	1	25					3	66
DGHS	4	3,848	-	-	-	-	3	10	7	3,858
ESIC (Min of Labour)	4	1,416	-	-	-	-	-	-	4	1,416
Railways	3	479	-	-	-	-	-	-	3	479
Ministry of Defence/ Delhi Cantt.	3	2,148	-	-	-	-	-	-	3	2,148
Autonomous (Govt. + State)	3	2,842	-	-	-	-	-	-	3	22,842
Pvt. Reg. Nursing homes/Voluntary Org.	1,057	24,180	-	-	-	-	-	-	81057	124,180
Total	1,165	48,927	11	734	2	150	5	10	1,168	4,6421

Railways include 17 beds in 1 TB clinic

MoD includes Delhi Cantonment Board General Hospital

(Source: Delhi Statistical Handbook 2017)

Delhi generates approximate 14 tons of bio-medical waste per day from various hospitals, clinics, and clinical laboratories. There are 109 hospitals (including Ayurvedic Hospitals, Maternity/Home, IPP VIII) in the Govt. sector, 1,050 (approx) registered Nursing Homes in Private Sector and large number of Hospitals, Health Centers run by Government as well as Non-Government Organization. The Govt. Hospital and some private hospitals have their own arrangement for treatment of biomedical waste. The treatment of bio-medical waste and their disposal has paramount importance for prevention of environmental pollution and hazardous diseases arising out of these substances. Biomedical Waste is Management in Delhi under Biomedical Waste Management Rules, 2016. In order to facilitate the proper treatment of the biomedical waste generated from dispensaries, smaller Nursing Home/Clinics Blood

Bank/Diagnostic Laboratories etc., the Government has taken initiatives to establish centralized waste treatment facilities.²⁶

There are about 4,743 Health Care Establishments/Health Centres in Delhi from where an average of 22.8 tons/per day of Bio-Medical Waste are collected by the two Common Bio-Medical Waste Treatment Facilities (CBWTF) i.e. SMS Water Grace BMW Pvt. Ltd. and M/s Biotic Waste Solutions Pvt. Ltd. which are operational in Delhi.

12.2 Existing Concerns in Health Sector

Number of medical institution in Delhi has increased at low rate in terms of number of institutions and special clinics. There are number of reasons for the slow pace of extension of new health outlets such as non-availability of land, shortage of manpower and multiplicity of agencies etc. Moreover all the hospitals especially major hospitals in Delhi are overcrowded because of heavy patient load.

Delhi's bed-population ratio is 2.73 beds per 1,000 population which is better as compared to the national average of one per 1,000. Though the situation of health services in Delhi is much better than in other states, there are certain areas which require attention. This includes provision of health services to the large and rapidly growing urban poor habitations in the city which include JJ clusters, unauthorized colonies, resettlement colonies and pavement dwellers which have very poor access to health services. The hospitals in Delhi also cater to a large number of patients from other states. It is estimated that nearly 33 per cent of the load in secondary facilities in

Health: Key Concerns

- Quality of services and users satisfaction
- Health sector reform
- Decentralizing Health Care System
- Strengthening of the Healthcare Governance framework
- Inadequate early warning systems regarding epidemic/endemics
- Inadequate public sector medical facilities. Lack of quick response medical teams
- Low levels of research in developing low cost vaccination, rapid diagnostic tests
- Proper biomedical waste disposal

Delhi is from neighboring states. This leads to further strain on the existing infrastructure in the city. Further, while some facilities and schemes are managed by the Govt. of Delhi, some are managed by the Urban Local Bodies. Therefore, there is a need to have an integrated and coordinated approach to regulate and strengthen the health sector in Delhi through the realignment of existing structure and procedures for better synergisation of available resources.

There is need for inter sectoral coordination between the environment department, health department, civic authorities, food and civil supplies and urban development departments for the success of the programme. This requires lot of capacity building, training, and sensitization, identifying priorities and responding to emergencies in appropriate manner.

²⁶ Annual report 2015-16, Directorate General Of Health Services, Govt. of NCT of Delhi

12.3 Institution involved in Health Sector

Urban Local Bodies and Delhi Government are responsible for the health care in the form of preventive, promotional and curative services, medical education and other services including the registration of births and deaths. In addition, there are large numbers of private health-care service providers.

Directorate of Health Services (DHS) of Government NCT of Delhi is the major agency related to health care delivery. The DHS is also the largest department under Department of Health and Family Welfare, GNCTD providing health care facilities at primary and secondary level to the citizens of Delhi through various types of health outlets, spread all over Delhi viz. Dispensaries and Health Centres, School Health Clinics and Mobile Health Clinics. The key institutions involved in Health sector are as follows:

- Ministry of Health and Family Welfare, Govt. of India
 - Department of Ayurveda, Yoga & Naturopathy, Unani, Siddha and Homeopathy (AYUSH)
 - Department of Health and Family Welfare
 - Directorate General of Health Services
 - Central Government Health Scheme
 - National Rural Health Mission
 - Department of Health Research
 - Indian Council of Medical Research
 - Department of AIDS Control
 - National AIDS Control Organization
- Employees' State Insurance Corporation
- Department of Health and Family Welfare, GNCTD
 - Directorate of Health Services, GNCTD
 - Directorate of Family Welfare, GNCTD
- Department of Social Welfare, GNCTD
- Department of Women and Child Development, GNCTD
- Delhi Pollution Control Committee
- Local municipal bodies of Delhi.
- All Government, Government undertaking and private hospitals, nursing homes and primary health centers in Delhi

12.4 Current Policies, Programme and Projects of the government

A number of programs impacting upon health status of the urban poor are in operation though their coverage is far from being adequate. These include Public Distribution System, Mid-Day meal scheme, Nutrition Program, Integrated Child Development Schemes (ICDS) and National Creche Fund Scheme. Though Delhi appears to have adequate health care facilities, this does

not extend to most slum communities which have limited access to primary health care services.

- The National Rural Health Mission (NRHM) envisages the integration of all vertical health programmes under one umbrella in the form of a single integrated health society. The Delhi State Health Mission has been formed which would act as this unified umbrella institution to integrate the various vertical programmes being implemented by the different departments in Delhi Govt., Urban local bodies etc and the introduction of the Accredited Social Health Activist (ASHA). Improving the health and nutritional status of women and children, monitoring of quality of health, communicable disease control etc will be the areas of concern for the Mission. The Delhi State Health Mission would function under the chairmanship of the Chief Minister.
- In May 2007, the Cabinet of the Delhi Government approved the deployment of 5,450 ASHAs to cover 109 lakh residents of slums, JJ cluster, resettlement colonies, unauthorized colonies and rural villages. Under this scheme, women who volunteer from local community will be selected and trained to reinforce community action for universal immunization, safe delivery, and new-born care, prevention of water-borne and communicable diseases, improved nutrition and promotion of household / community toilets. The activists will inform, mobilize and facilitate improved access to preventive healthcare and also provide basic curative care through the drug kit. Under ASHA Scheme-Revised target for 2018-19 there are 6,077 ASHAs.
- Janani Suraksha Yojana (JSY) is a safe motherhood intervention under the National Rural Health Mission (NRHM) being implemented with the objective of reducing maternal and neo-natal mortality by promoting institutional delivery among the poor pregnant women. JSY is a 100 % centrally sponsored scheme and it integrates cash assistance with delivery and post-delivery care. The success of the scheme would be determined by the increase in institutional delivery among the poor families. In Delhi, all mothers below the poverty line above 19 years of age and all mothers belonging SC and STs are eligible under this scheme. A cash assistance of Rs. 600/- for urban areas and Rs. 700/- for rural areas is provided to the mother delivering in a health institution upto a maximum of two live births. In Delhi unlike some other states, no compensation is available under this scheme for the ASHA.
- The Delhi Government has taken a number of policy initiatives to improve the health and living conditions in the city.

Health programme / schemes / Projects under Directorate of Health Services

1. Chacha Nehru Sehat Yojna:

Launched in 2011 to provide comprehensive health care to cover primary, secondary and Sr. Secondary school students in Delhi. This is one of the major public health interventions and is still at early stage of major breakthrough, About 4 lakhs students have been screened till date.

2. Diabetes and Hypertension screening of urban slums of Delhi:

Delhi is the first state to start and successfully complete the diabetes and hypertension campaign in urban slum population. About 4.5 lakh population of slum were screened for diabetes and hypertension between November 2011 to June 2012.

3. Integrated Disease surveillance project: Integrated Disease surveillance project is being successfully implemented for early detection and containment of outbreak prone communicable disease. DHS has successfully coordinated with different urban local bodies for control of infections/ vector borne diseases such as dengue, Malaria, Cholera etc.

4. Revised national Tuberculosis Control programme: Delhi is having 100% coverage for tuberculosis DOTs treatment with 732 DOTs centers and 200 microscopy centers up from 51 each ten years back. 112,378 lives have been saved from death due to the interventions under the programme. Due to sustained efforts, it has been possible to decrease the defaulter rate from 9% in 2002 to 4.4 % now. Due to interventions under the programme 6,085,717 number of new tuberculosis infections have been prevented.

5. Tobacco Control programme: 391,708 raids have been carried out under the antitobacco programme and 61,929 persons and 6,514 vendors have been penalized with a total final collection of Rs. 542,966 since 2007. Eight raiding squads have been constituted in various districts of delhi. Guthka and other pan masalas having tobacco/nicotine as ingredients have been banned in 2012.

6. Leprosy Control programme: The prevalence rate of leprosy has declined from 4.27 per 10,000 population in 2003 to 0.78 per thousand in 2011. The leprosy eliminations rate of below 1/10,000 population was achieved way back in 2007. During the last 10 years, 25,938 new cases of leprosy have been diagnosed and treated under the programme. Under the programme special foot wear (Micro cellular rubber (MCR) footwear) is being provided to leprosy patients with disabilities needing the footwear and around 4,000 such footwear have been provided to deserving patients.

7. Bio-medical waste management: Two centralized treatment facilities have been established for the treatment of Bio-medical waste generated by government as well as private health care centres.

8. Silicosis & Flourosis Mitigation programme-In a recent judgement, the honourable Supreme Court has directed selected states to work towards identification of silicosis victims, compensate them and work towards its prevention and elimination. Delhi in one of the states that has been directed to address the problem of silicosis.

9. Environment Health Cell: A dedicated environment health cell in all govt. hospitals having 100 beds and above, headed by the medical superintendent/Medical Director of the hospital and consisting of other members e.s Nodal Officer (BMW), concerned engineers from PWD/Engineering division, paramedical staff etc have been formed. The mandate of EMG is to look after the matters concerning implementation of the requirements under pollution control laws including BMW management rules; Air & water act; The E Waste (management & handling) rules 2018; the Hazardous Waste (Management, handling and transboundary movement) rules, 2018; the Noise Pollution (regulation and control rules 2000) etc. To monitor

the environmental groups in govt. hospitals, GNCTD, Environmental Management Cell has been constituted at the level of Directorate of Health Services, GNCTD.

10. Cancer Control Cell

Directorate of Health Services, GNCT Delhi: First Tier Services

- **Dispensaries / Mohalla Clinics/Poly Clinic**

Delhi is divided into eleven districts and there are about 242 dispensaries including 59 Seed PUHC , 106 Mohalla Clinics and 23 Poly Clinics which frontline health outlets are providing primary health care.

- **School Health Scheme**

This scheme was started in 1981 to provide basic medical services to the students in the age group of 10-18 years studying in various government schools of Delhi. Screening for common diseases, deworming program and Iodine Deficiency Disease Control Program are the key components of the program.

- **Mobile Health Scheme**

The Mobile Health Scheme is being implemented with the aim of providing primary health care outreach services to the residents of JJ clusters. In order to provide primary health care to the most vulnerable slum population of Delhi which do not have access to primary health care services, the Delhi government provides services through the mobile health scheme. This takes the health care to the door step of the people and reduces the work load on the hospitals. During the year 2015-16 a total of 480,346 patients were covered by the 43 Mobile Health Clinics in 31 JJ Clusters.

An Expert Committee under the Chairmanship of Dean, MAMC has been constituted by Department of Health and Family Welfare to conduct evidence based study of the likely impact on public health of various levels of atmospheric / air pollution in Delhi. The committee comprises of Environment / air pollution experts.

In Delhi, the Delhi Pollution Control Committee (DPCC) is the prescribed authority for implementation of Bio-Medical Waste Management Rules. Over the years Hospitals /Health Care Facilities has become a major source of waste generation particularly infectious waste known as Bio Medical Waste. With the explosion of diseases like HIV/ AIDS / Hepatitis etc the tendencies to use disposables have increased many folds, which in turn increases the quantum of waste generated. During the period of January 2013 to December 2013, 13.9 TPD of Bio-Medical Waste was generated in Delhi.

Realizing the impacts of the Bio Medical Waste, the Govt. of India formulated "Bio-Medical Waste (Management & Handling) Rules, 1998" under the Environment (Protection) Act, 1986. These rules have been implemented all over India and being followed by all states and UTs.

In Delhi, the Delhi Pollution Control Committee (DPCC) is the prescribed authority for implementation of these Rules. The Health Care Units (HCUs) generating bio-medical waste, have been categorized on the basis of bed strength. Bio Medical Waste Management Cell has been created in Delhi Pollution Control Committee for the implementation of the various provisions of the Bio- Medical Waste (Management & Handling) Rules, 1998 in health care units. Inspections are carried out to check the compliance of the BMW Rules and deficiencies observed if any are communicated by way of Show Cause Notices /Letters to the Health Care Establishments for rectification of the deficiencies.

To introduce the Green Building Concept/ ensure control of pollution, for efficient waste management, energy & water conservation, Delhi Pollution Control Committee has issued directions to hospitals having 50 beds or more to install: Solar Water heating system, Rain Water harvesting system, Replace ordinary bulbs with Light Emitting Diode (LED) Bulbs, install Effluent Treatment Plant (ETP)/Sewage Treatment Plants (STPs) for recycling of treated effluent for use in horticulture, air conditioning/cooling plants and flushing of toilets etc and plant trees along side of the periphery of the hospitals building.

Initiatives of DPCC have led to ISO 14001 accreditation of 12 major hospitals in the City, which ensures proper environmental management system in place within the hospital. Further to this, in order to control mercury pollution, DPCC has initiated the drive for minimization/elimination of use of mercury containing equipment's in health care establishments and for safe disposal plan for collected mercury waste in hospitals, DPCC has identified two industrial units for recycle and reuse of mercury stored in the HCUs. Various public notices are issued and workshops/training are organized by DPCC in leading newspapers highlighting the need for proper implementation of Bio-medical (management & Handling) rules.

12.5 Impact of climate change on health

Climate change presents risks for human health. Projected increases in temperature may increase the frequency of heat waves and thermal stress leading to heat related disorders such as heat cramps, dehydration, leading to heat stroke, influenza, cardio-vascular and respiratory diseases. Flood or drought by contrast would affect the agriculture sector and reduce crop productivity. This in turn could reduce food availability resulting in malnutrition or inadequate nutrition as well as nutrition related diseases. While on one hand, malnutrition would reduce resistance to infections by weakening hosts' immune response, infectious diseases decrease the nutrient absorption capacity resulting in nutrition deficits. Several studies have established a link between deficiencies in micronutrients (vitamin A, zinc, iron etc.) and significant incidents of malaria morbidity and mortality. Heavy rain as projected in certain areas would adversely affect crop production, causing soil erosion and increasingly limit employment in the sector with negative implications on livelihoods. Floods could directly contaminate drinking water and cause outbursts of water borne diseases such as diarrhea. Warming trends will favour the spread of vector borne diseases (malaria, kala azar, and dengue) into new areas by shortening the development duration of vectors (mainly mosquitoes). *Bhattacharya et al (2006)* pointed

out that the malaria transmission window with respect to temperature lies between 15°C and 40°C while the period for completing a life cycle varies with the prevalence of a particular temperature range of and humidity. Martens *et al* (1995) found that with a rise in temperatures the rate of blood meal digestion in mosquitoes increases. This in turn accelerates the ovarian development and reduces the duration of the gonotrophic cycle, leading to higher frequency of feeding on hosts and consequent enhanced probability of transmission.

Table 73: Health vulnerabilities vis-à-vis climate change

Health concern	Vulnerability due to climate change
Temperature related morbidity	<ul style="list-style-type: none"> • Heat and cold related illness • Cardio-vascular illness
Vector borne diseases	<ul style="list-style-type: none"> • Changed pattern of diseases • Malaria, filarial, kala azar, Japanese encephalitis and dengue caused by bacteria, viruses and other pathogens carried by mosquitoes, ticks and other vectors
Health effects of extreme weather & water borne diseases	<ul style="list-style-type: none"> • Diarrhea, cholera and poisoning caused by biological and chemical contaminants in the water (even toda about 70% of the epidemic emergencies in India are water-borne) • Damaged public health infrastructure due to cyclones/floods • Injuries and illness • Social and mental health stress due to disasters and displacement.
Health effects due to insecurity in food production	<ul style="list-style-type: none"> • Malnutrition and hunger, especially in children.

12.6 Strategies and Actions to address concerns due to Climate Change Issues

The National Mission on Sustainable Habitat aims to promote sustainability of habitats through improvements in the energy efficiency of buildings, urban planning, improved waste management systems, and promoting public transport by making appropriate changes in the legal and regulatory framework. It also aims at improving the ability of habitats to adapt to climate change through improved resilience of infrastructure, community-based disaster management and advance warning systems for extreme weather events. Initiatives by the Delhi Government are consistent with those included in the National Mission on Sustainable Habitat.

Health Sector: Key Priorities

- Develop early warning systems for disease outbreaks. Disseminate information on appropriate individual behavior to avoid exposure to vectors.

- PHC concerned constituting medical teams and mobile teams should be supplied with required drugs and equipment with instructions to rush to the affected areas without waiting for further instructions.
- Sponsor research and development on vaccines and other preventive measures.
- Provide low-cost vaccinations to those likely to be exposed.
- System for detection of contagious diseases and potential epidemics.
- Improving the reach of drugs to people on time.
- Health education and awareness
- Environment based Health Advisory

National Vector-Borne Disease Control Programme (NVBDCP) is the umbrella programme initiated by Government of India for vector borne diseases (VBDs) such as malaria, dengue and chikungunya. Specific programmes and guidelines have been established for different diseases, detailing prevention, detection and case management. In case of an extreme heat event, as per the heat action plan, the DPCC will issue heat alerts, based on thresholds determined by the DPCC, as an additional means of communication by using the following colour signal system:

Yellow Alert	Hot Day Advisory	41.1Day Advis
Orange Alert	Heat Alert Day	43.1 Alert Dayr
Red Alert	Extreme Heat Alert Day	≥xtrem

Public Awareness and Community Outreach programmes are essential to communicate with the public about climate change and its affects. Following actions can be taken for effective outreach of the programmes:

- Frequent use of print, electronic media and FM radio to increase general awareness among public over heat waves and its health-related issues.
- Use of Social Media Platform like Facebook, Twitter and WhatsApp in reaching larger masses of people.
- School Children Awareness programs.
- Reaching out to targeted communities at higher risk with the help of locally working NGOs for generating awareness.
- Building awareness among various vulnerable occupational groups.
- Early Warning Systems and Inter-Agency Coordination can also be done, example Press advisory to be issued of heatwave alerts on Heat Alert Days (Orange Alert) in print media and on Extreme Heat Alert Days (Red Alert) in both print and electronic media.
- A feedback mechanism on heatwave alerts to be established among Inter-Agencies.
- Social Media Platform also to be used in issuing heatwave alerts.

- New potential key agencies to be identified and added in the early warning and coordination system.
- Capacity building can be done among health professionals to hold sensitization workshops for various associations of private healthcare providers.
- Daily death reporting and 108 calls data to be used to keep watch on mortalities and morbidities with rise in temperatures.
- To strengthen surveillance of heat wave related morbidity and mortality through engaging private healthcare providers in reporting system.
- Medical officers of UHCs located around Industrial zones to be trained for specific occupational heat health hazards in consequence to rising temperature and work in hot environments.
- All healthcare facilities to be strengthened with equipment, staff and medicinal supply to handle potential increases in patient demand specifically during heat wave days.
- Reducing heat exposure and promoting adaptive measures- Locations for provision of safe drinking water at public places to be increased over 2015 levels.
- Night shelters to be mapped and made functional.
- Ensure sufficient water supply in whole city, specifically on heat wave days.
- Ensure no power cuts in whole city, specifically on heat wave days.
- To arrange for rest during peak hot hours of the day for various government and nongovernment vulnerable occupational groups.

Table 74 briefly describes the health sector strategies & action plan identified by the Delhi Government as short term, medium term and long term goals to be achieved by the year 2020 and 2030 respectively.

Table 74: Action Plan for Health Sector for Challenges of Climate Change

Strategies and Actions	Target for 2020 and 2030	Objective and Strategy to be adopted	Departments
Vector borne diseases including managing out breaks	As per National Health Programme	Prevention and control of Vector Borne Diseases	Department of Health - GNCTD, Directorate General of Health Services – PH-IV, IDSP; North Delhi Municipal Corporation (NDMC), South Delhi Municipal Corporation (SDMC), East Delhi Municipal Corporation (EDMC)

Strategies and Actions	Target for 2020 and 2030	Objective and Strategy to be adopted	Departments
Water borne diseases including managing outbreaks	Prevention & Treatment by 2030	<ul style="list-style-type: none"> • Safe Water Supply. • Upkeep of existing system • Health Education 	Delhi Jal Board (DJB), North Delhi Municipal Corporation (NDMC), South Delhi Municipal Corporation (SDMC), East Delhi Municipal Corporation (EDMC)
Extreme Events including Physical and psychological impacts	As per Delhi disaster Management plan	<ul style="list-style-type: none"> • IEC; • Skill Development Programmes for Doctors and Paramedical Staff • Training 	Directorate of Health Services, Delhi Disaster Management Authority (DDMA), All Hospitals, Department of Social Welfare.
Preparation of State Action Plan on Climate Change and Human Health (SAPCCHH)	Preparation and Implementaion by 2020	• Adaptaion strategies to counter health impacts due to climate change	Directorate of Health Services, Delhi
Food security and malnutrition	Introduction of mid-day meals in all of the schools, anganwadi systems to provide rations to pregnant and lactating mothers, and subsidised grain for those living below the poverty line through a public distribution system	<ul style="list-style-type: none"> • IEC • Regular medical checkup of school children • Training 	Integrated Child Development Services (ICDS), School Health Scheme, Women and Child Development Department, Directorate of Health Services(DHS), Dispensaries, FASSAI

Strategies and Actions	Target for 2020 and 2030	Objective and Strategy to be adopted	Departments
Disaster preparedness (extreme precipitation leading to flooding)	As per Delhi Disaster Management plan	Medical support & counseling	-Other Departments to be involved for preparing modules as per training needs. -Inputs from DDMA, DJB, DDA, North Delhi Municipal Corporation (NDMC), South Delhi Municipal Corporation (SDMC), East Delhi Municipal Corporation (EDMC) etc.
Capacity building: 1. Identification of training needs	100% by 2020 through stakeholder meeting and rapid survey	<ul style="list-style-type: none"> • IEC • Group Discussion • Presentation • Audio-visuals • Field visits • Visit to other developed countries where the systems are in place. 	Other departments to be involved for preparing modules as per training needs such as DPCC, Deptt. Of Environment, COEH, CPCB etc. Dte. General of Health Services; PSM Deptt., MAMC; TERI; DMA/IMA; Association of Health Providers; PHD Chamber; CII, University of Delhi, IP University, NHM, Disaster Management Authority, Delhi, Public Health Foundation of India, Climate & Development Knowledge Network (CDKN), India Meteorological Department (IMD), etc.
2. Preparation of modules	100% by 2020		
3. Training of Trainers	50% by 2020 and 100% 2030		
4. Cascading training upto field level staff	50% by 2020 and 100% by 2030		
5. Identification of vulnerable groups and their specific problems	100% by 2020		
6. Capacity building of the community	50% by 2020 and 100% by 2030		

The above action plan would be reviewed every three years by the Advisory Committee. Public health is the practice of preventing disease and promoting good health and is of prime importance in the health care management system. The focus of public health intervention is to improve health and quality of life through the prevention and treatment of disease and other physical and mental health conditions, through surveillance of cases and health indicators, and through the promotion of healthy behaviours.

12.7 Budgetary Assessment of key priorities

The Department of Health, GNCTD has proposed a total budget requirement of 976 crores for the next five years for the public health sector under the SAPCC. The activities under the SAPCC will be implemented by the joint collaboration of directorate of health services, directorate of family welfare, forensic science laboratory and all of the municipal local bodies including NDMC, SDMC and EDMC.

13. Transportation

Delhi has the highest number of registered vehicles (approx 97.05 lakhs) in this country. In addition approximately 11 lakh vehicles enter or leave in Delhi every day. The city has 21% of its land area under roads and it is among the highest in the world. It is not possible to add additional road length to handle the growing number of registered vehicles. Delhi's rapid rate of economic development and population growth has resulted in an increasing demand for transport, creating excessive pressure on the city transport infrastructure. Delhi being the nodal point for five national highways and intercity rail corridors, it carries large volumes of heterogeneous passenger and goods traffic. Table 75 presents the total registered vehicles in Delhi during the years from 2007-08 to 2016-17.

Table 75: Total Registered vehicles in Delhi as on 31st March²⁷

Vehicle Type	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Cars and Jeeps	1,729,695	1,859,370	2,013,680	2,173,323	2,343,113	2,474,087	2,629,343	2,790,566	2,920,547	3,152,710
Motor Cycles and Scooters	3,578,199	3,797,943	4,055,229	4,342,403	4,644,146	4,962,507	5,297,697	5,681,265	5,831,491	6,707,891
Auto Rickshaws	75,297	83,948	86,482	88,181	88,197	86,838	91,840	81,633	100,471	174,000
Taxis	30,704	40,072	45,240	57,958	69,780	70,335	78,686	79,606	85,630	148,434
Buses	52,763	55,148	58,047	61,471	64,033	39,694	40,947	32,540	34,472	38,265
Goods Vehicles	160,726	175,250	193,205	209,370	228,886	140,942	154,654	161,821	284,219	231,767
E-Rickshaws	-	-	-	-	-	-	-	-	-	29,690
Total	5,627,384	6,011,731	6,451,883	6,932,706	7,438,155	7,774,403	8,293,167	8,827,431	9,256,830	10,482,757

13.1 Existing Status of Transportation System in Delhi

The transport system of Delhi consists of a well-developed transport network based on ring and radial pattern, large fleet of buses and a suburban rail system including Mass Rapid Transit System (MRTS). MRTS aims to provide a non-polluting, useful and affordable rail-based mass rapid transit system for Delhi, integrated with other modes of transport. The majority share of travel needs of commuters is met by road based transport system.

²⁷ Source: Delhi Statistical Handbook 2017

In order to meet the transport demand, the State and Union Government constructed a mass rapid transit system, including the Delhi Metro, which is undergoing a rapid modernization and expansion. The Metro started commercial operations on 25th December, 2002. It has set many performance and efficiency standards ever since and is continuously expanding at a very rapid pace. As on date, the metro operates on 8 lines (including airport line) with 202 stations and a total length of 187.41 Km length of Metro line has been completed under Phase-I & Phase-II in Delhi and 117.620 Km of Metro rail in Phase III has been added expect for Mayur Vihar to Trilokpuri on Mukund Pur to Shiv Vihar line (about 1.5 km), Dwarka to Najafgarh (4.295 km) and Najafgarh to Dhansa Bus Stand (1.18 km). Length of Operational corridors of Delhi Metro is mentioned below in table.

Table 76: Operational length of Delhi Metro Rail project

Line	Length (Kms)
Line No.1- Dilshad Garden-Rithala	25.09
Line No.2- Samaypur Badli – Huda City Centre	49.43
Line No.3- Noida City Centre – Dwarka Sec. 21	49.94
Line No. 4 - Yamuna Bank – Vaishali	8.74
Line No. 5 - Inderlok – Kirti Nagar –Mundka	18.46
Line No. 6 - ITO – Escorts Mujesar	38.16
Orange Line (Airport Express Line)	22.70
Line No. 8 - Majlis Park - Yamuna Vihar (Gokulpuri) - Shiv Vihar	58.59
Total	212.52

In 1998, the Supreme Court of India ordered that all public transport vehicles in Delhi must be fuelled by compressed natural gas (CNG). Buses cater for about 60% of the total demand. DTC continue to play pivotal role in the multi -modal transit system of public transport apart from metro-rail. It has existing infrastructure of 40 depots, fleet size of 3,944 buses compressing 1,275 AC low floor buses, 2,506 Non-AC low floor buses and 163 Standard buses.

The state-owned Delhi Transport Corporation (DTC) is a major bus service provider which operates the world's largest fleet of CNG-fuelled buses. Current Modal Share of the City is as follows:

Mode	% of Person Trips without walk trips (2007-08)
Cycle	6.82
Cycle Rickshaw	7.9
Auto Rickshaw	3.61
Bus	41.5
Metro	4.07
Rail	0.65
Car / Taxis	13.92
2 Wheeler	21.54
Total	100

(Source: Transport Demand Forecast Study and Development of an Integrated Road cum Multi-modal Public Transport Network for NCT of Delhi, 2008)

13.2 Existing Concerns in Transport Sector

The population of Delhi is expected to grow from 167 lakh in 2011 to 230 lakh by year 2021. This situation is likely to worsen due to increasing population and economic growth. However the daily transport demand is expected to grow from 139 lakh in 2001 to 279 lakh passenger trips by the year 2021. To cater to this demand, the mass transport system will need to be augmented substantially and the road infrastructure, traffic management and associated amenities improved substantively.

There are several factors responsible for the prevailing road congestion, pollution and lack of road safety. The basic cause, however, is the imbalance in the modal mix of passenger traffic carried by various modes of transport. There is a preponderance of low capacity vehicles such as two wheelers and cars. This is induced by increasing inadequacy of mass transport to cater to travel demand both in quantity and quality. Some of the key issues in transport sector that Delhi city is facing are:

- High growth rate of vehicles and heavy vehicular volumes on road causing congestion, delay and pollution
- Non- intensive land utilization with respect to major transport corridors
- Parking mix. Inadequate parking at major commercial areas and work centers and lack of proper parking policy
- Lack of user system interface and transport information
- It is estimated that nearly 1.2 million vehicles enter and exit Delhi on a daily basis. The large influx of vehicles from outside and especially the transit truck traffic cause enormous pollution and negate the effect of local pollution control efforts. The night time pollution is also very high in Delhi because of movement of truck traffic.
- The travel characteristics and modal share of Delhi is unfortunately not reflected in either the allocation of road space to the different users or the design of the Roads themselves. There is an immediate need to reclaim road space rightfully for active use by pedestrians, cyclists, Intermediate Public Transport and Mass Transit.
- Delhi's extensive road infrastructure of 28,508 km unfortunately does not provide the optimum level connectivity desired within the city. Very large block sizes and limited permeability, particularly at the tertiary level, have, in turn, resulted in an overdependence on the City's Arterial network for all mobility needs, both local and otherwise. This not only results in limited route options for the commuter but also greater travel time and increased congestion on the roads.
- The multi-modal public transport system of the city is not integrated. While modal options may be available in near proximity, the physical infrastructure does not cater to seamless

Key Concerns
● Traffic Congestion
● Vehicular Pollution
● Increasing number of private vehicles
● Inadequate Parking Space
● Lack of Parking Policy
● Interstate Traffic Movement within the City

transfers between modes neither through the design of the systems (including that of terminal buildings) or that of the public realm of our transit hubs. System integration improvement and augmentation of infrastructure on the following Ring Rail stations: Shivaji Bridge, Bhairon Marg, Kasturba Nagar (Sewa Nagar), Lajpat Nagar, Kirti Nagar, Shakur Basti.

13.3 Institutions Involved in Transport Sector

Since the transportation system is multidisciplinary and multidimensional it requires integration and coordination among the various agencies. The agencies involved in this sector are:

- State Transport Authority
- Public Works Department
- Delhi Transport Corporation
- Delhi Development Authority
- National Highways Authority of India
- Delhi Metro Rail Corporation
- Delhi Integrated Multi-Modal Transit System (DIMTS) Ltd
- Urban Local Bodies
- Traffic Police
- Unified Traffic And Transportation Infrastructure (Planning & Engineering) Centre (UTTIPEC)

13.4 Current Policies, Programmes and Projects of the Government

With the objective of achieving a balanced modal mix and to discourage personalized transport, Delhi Govt. Transport Policy²⁸, proposes to augment mass transport by massive investments accompanied by institutional improvements. The focus, therefore, will be on increasing mass transport options by providing adequate, accessible and affordable modes like buses, mini-buses, electric trolley buses complemented by a network of a rail based mass rapid transit systems like metro and commuter rail. Para transit modes like autos and taxis are envisaged to provide feeder services in designated areas catering to work and leisure trips. Non-motorized transport like bicycles and cycle rickshaws will be accommodated. To tackle the present urban transport problems in Delhi is by creating sustainable multi-modal transport such as High Capacity Bus System (HCBS), Monorail and LRT to supplement the Metro Rail and the present DTC and other bus services. Accordingly a plan known as the Integrated Multi-Modal Transit Systems has been approved by the Delhi Govt. for implementation by 2021. A number of initiatives have been taken by the authorities; these responses can be classified under three major categories:

²⁸Tackling Urban Transport – Operating Plan for Delhi <http://delhigovt.nic.in/trans-pol.asp#1>
[Accessed 5th May 2018]

- Managing Travel Demand (MTD)
- Improving Transport Supply (ITS), and
- Reducing Vehicle Pollution Emissions

For efficient management of travel demand, rail based Mass Rapid Transport Systems (MRTS) has been planned in Delhi and adjoining areas of NCR for a total route length of 484.24 km to be executed in four phases. The project is being executed in four phases. This would comprise of 395.72 km route in Delhi and balance in adjoining NCR region. Phase I of 65.10 route km has been completed and put to operation in 2006. Phase II of 124.93 km has also been completed and put to operation in 2010. Phase IV of 103.93 km length is in planning stage to be completed by 2021. There is a need to plan and implement High Capacity Bus Corridor, to strengthen the public transport operations. The planning should be based on moving people and not cars. The Bus corridor should be integrated with the existing, under construction, planned metro lines along with transport hubs and Ring Rail stations.

To avoid non-destined commercial vehicle load in the City, Supreme Court has directed IA No. 345 in Writ Petition (Civil) No. 13029 of 1985 in the matter of M.C. Mehta vs Union of India & Ors, to levy Environment Compensation Charge on the commercial goods vehicles entering the City.

The GNCTD initiated a scheme in 2011-12 for Corporatization of Private Stage Carriage Service to substitute the Blue line private stage carriage system under Public Private Partnership (PPP) model. Under this scheme, 457 stage carriage bus routes of Delhi have been divided into 17 distinct clusters. Presently approximately 1,600 cluster buses are operational in 09 clusters.

Currently DTC is the largest public transport entity in the NCR with daily average passengers about 35.37 Lakh during 2015-16. DTC has planned to augment its fleet to 6,900 buses. To accommodate new buses being purchased by DTC, six new bus depots at Gumanhera, Mundela Kalan, Rohini Sector-37, East Vinod Nagar, Bawana Sector-5 and VIU Burari will also be constructed in 2018-19. In the Low Floor Buses it is pertinent to mention here that low floor buses are fitted with Engine Electronic Controls - AL ULE is fitted with CUMMINS B-gas plus engine which is an electronic engine controlled by a microprocessor called "Engine Control Module (ECM)". ECM continuously monitors and analyzes exhaust gases composition based on feedback received from "heated oxygen sensor" which is fitted with after exhaust manifold. In case exhaust gases specification are out of limit, oxygen sensor will provide feedback to ECM which will take corrective actions through a number of electronic actuator e.g. Fuel Control Valve, throttle actuator, etc. There are 2,506 Non AC and 1,275 AC Low Floor Buses for which pollution checking is mandatory after every year. DTC is regularly getting pollution check of all the buses not only as per CMVR i.e. after every three months but even twice a month as per recent directions of NGT. The Delhi Transport Corporation is also planning to use recycled water for washing of buses and installation of ETP in all of depots.

Table 77: Recommended Integrated Public Transport Network and System

S. No.	System Type			
Metro				
(A)	Phase III of DMRC			
		CORRIDOR	Max PHPDT(2021)	LENGTH (km)
1	III	Majilis Park-Shiv Vihar	35,447	58.596
2	III	Central Secretariat-kashmere Gate	43,613	9.256
3	III	Janakpuri West-Botanical Garden	33,442	38.23
4	III	Dwarka-Nazafgarh	7,869	4.295
5	III	Mundka-Bahadurgarh	21,168	11.182
6	III	Badarpur-Bahadurgarh	18,824	17.075
7.	III	Jahangirpuri- Badli	4,519	4.489
8.	III	Dilsgad garden-Gaziabad Bus Adda	13,955	9.410
9.	III	Noida City Centre – Sector 62 Noida	16,873	6.675
10.	III	Noida Ext/Noida-Greater Noida	10,463	29.567
		TOTAL		188.894
(B)	New Metro Corridor(Proposed in Phase IV)			
1	IV	Rithala-Narela	16,519	21.73
2	IV	Janakpuri West-R.K. Ashram	18,953	28.92
3	IV	Tuglakabad-Aerocity(NH-8)	16,617	20.20
4	IV	Inderlok-Indraprastha	11,797	12.58
5	IV	Lajpatnagar-Saket G-Block	8,951	7.96
6	IV	Mukundpur-Maujpur	13,454	12.54
		TOTAL		103.93

The Delhi Metro Rail Corporation (DMRC) has taken a number of measures for protecting the environment and conserving the resources. Some of DMRCs Green initiatives are water management, Waste management, Use of Renewable energy, Tree plantation, CDM & Gold Standard Projects. The details of the activities carried out by the DMRC are as follows;

(i) Installation of low GHG emitting rolling stock in metro system: This was the very 1st CDM project to be registered by DMRC. DMRC cars are equipped with regenerative braking system which enables the trains to ‘generate’ electricity when brakes are applied. The electricity regenerated by trains in braking mode is used by trains in other modes of operation. This translates into reduction of load on the grid equivalent to the amount of electricity regenerated and thereby reduction in CO₂ emission. For a ten year crediting period (2007 to 2017), the estimated emission reductions are 41,160 tonnes of CO₂ (e) average per year.

(ii) Metro Delhi, India: The essence of this project is that the carbon footprint of people travelling by metro is much lesser than that of the same journeys performed by other modes of transport i.e. private vehicles. Over a seven year crediting period, commencing June 2011, the estimated annual average emission reductions are 5, 29,043 tCO₂ (e).

(iii) Energy Efficiency measures in DMRC Phase-II under the Gold Standard: The title of this micro scale Project Activity is 'Energy Efficiency measures in DMRC Phase II stations'. The total annual energy consumption is approximately 70 KWh/sqm for phase-I stations while for phase II stations it is 46.6 KWh/sqm, thus resulting in a total reduction of 23.4 KWh/sq m. So Phase II has resulted into reduction of 12195 tonne of CO₂ equivalent for a period of 2 years. Such benefits of emission reduction will be available for next 10 years.

(iv) The MRTS PoA: The MRTS PoA (Programme of Activities) will consist of a series of MRTS projects (like Metro Rail, LRT, Monorail etc) implemented across India. Delhi Metro Rail Corporation Ltd (DMRC) will act as a Coordinating / Managing Entity (CME) for the PoA. The emission reductions under this programme will be calculated. Delhi Metro Project has potential to generate more than 6 lakhs CERS annually just from Phase-3 operations. Project has potential to generate more than 6 lakhs CERS annually just from phase-3 operations. Furthermore, upcoming Metro projects across India can avail benefits of CDM through DMRC's MRTS PoA. DMRC will act as umbrella for all other upcoming MRTS projects interested to join MRTS PoA. Already, MEGA, Mumbai & Chennai Metro have joined hands with DMRC to register their CDM projects under this PoA program.

(v) DMRC SOLAR PV Project: DMRC's initiative on Solar PV roof-top installations became the first CDM project to be registered with UNFCCC for any metro or railways. The project will generate approx 18,506 CERs (carbon credits).

(vi) Cycle Sharing Services from Delhi Metro Stations: With a view to provide last mile connectivity to the metro commuters, decongest the road traffic and to propagate environment friendly mode of transportation, DMRC has allotted Cycle Stands at 19 metro stations.

Furthermore, to promote the Multi Modal Transit System in Delhi, the Transport Department, GNCTD conceived Monorail project in Delhi in the year 2004. The network of Monorail is an alternative to the Bus Rapid Transit System or Metro Rail System. Monorail is a light Metro System to run on short interval as intermediate Transit System between Metro and BRTs.

The estimated completion cost of the project with taxes and duties would be Rs. 2,235 Crores, out of which proposed equity of GNCTD would be Rs. 444.5 Crores and Subordinate Debt of Rs. 132 Crores. The Monorail Corridor from Shastri Park to Trilokpuri is recommended for implementation as per SPV model funding pattern of DMRC, which will be the SPV for the purpose of implementation of Monorail project in Delhi. It is expected to connect densely populated Delhi areas where Metro could not reach. The corridor starts from Shastri Park Metro Station and terminates at Trilokpuri near Sanjay Lake parallel to proposed Trilokpuri Metro Station of Metro Phase-III with 12 stations. The passenger interchange facilities between both the systems have been planned at the proposed Metro Station at Trilokpuri. The maintenance

depot has been proposed on land at Sanjay Lake where 8 hectares of land will be required. Other lines which are being proposed in addition to Phase I are:

- From Badarpur to Mehrauli.
- From QutabMinar to Dwarka via VasantKunj - IGI airport.
- From Saket to IG Stadium via Siri Fort - South Extension - JLN Stadium - New Delhi Railway Station.

Table 78: Recommended Integrated Public Transport Network and System²⁹

S.No	System Type	Corridor	Max PHPDT(2021)	Length (Km)
1	Metro			
a	<i>Extension of Metro Corridors</i>			
	I	Rithala to Barwala	5,990	6.4
	II	Jhangirpuri to Narela	28,447	15.3
	III	DwarkaMor to Najafgarh	5,780	2.7
	IV	Dwarka Sector 21 to Delhi Border (to be extended to Gurgaon)	9,574	3.8
	V	Central Secretariat to ISBT Kashmere Gate	11,988	7.5
	VI	Mundka to Delhi Border (to be extended to Bahadurgarh)	13,066	6.3
			Total (a)	42.0
b	<i>New Metro Corridors</i>			
	I	Mukundpur to Gokalpuri (via Ring Road, NH24 bypass, Swami DayanandMarg, Jaffrabad Road)	21,055	54.24
	II	Sailing Club Okhla to Mukundpur (along Outer Ring Road)	17,771	52.1
	III	ITO to SukhdevVihar	5,541	8.6
			Total (b)	114.9
		Total Metro Length (a+b)		156.9
2	Light Metro			
	I	Kondli to Delhi Gate to Rohini Sector 21	21,098	40.7
		Total		40.7
3	BRT			
a	<i>Extension of BRT Corridor</i>			
	I	Delhi Gate to ISBT Kashmere Gate	4,519	4.0
	II	For two lane each side with grade separation at junctions	Up to 20,000	
			Total (a)	4.0
b	<i>New BRT Corridors</i>			
	I.	Karawal Nagar to Chilla	8,942	18.8

²⁹Transport Demand Forecast Study and Development of an Integrated Road cum Multi-modal public Transport Network for NCT of Delhi, RITES Ltd, MVA Asia ltd and TERI, April 2010.

S.No	System Type	Corridor	Max PHPDT(2021)	Length (Km)
	II.	Mukundpur to Kondli	14,842	26
	III.	GulabiBagh to Bakhtawarpur	7,513	18.8
	IV.	ISBT Kashmere Gate to Kapeshera Border	9,819	26.8
	V.	Central Secretariat to VasantKunj	4046	12.5
	VI.	IGI Airport to Badarpur	15,327	26
	VII.	DhauraKuan to Dabri More to Chawala/Dwarka Sector 21	6,149	25.5
	VIII.	I.G Stadium to Mehrauli	5,269	15
	IX.	Rajokri to Dhansa Border	9,336	33.8
	X.	Najafgarh to Narela	9,451	34.7
	XI.	Mundka to NH1 (Alipur)	6,820	18.9
	XII.	Khaira to Nazafgarh to Ibrahimpur	10,076	42.3
	XIII.	Khanjawala to Bawana	6,821	21.1
	XIV.	Rajokri to Badarpur	6,971	26.5
	XV.	Rohini Sector 21 to Khanjawala	5,836	7
	XVI.	Tilak Nagar to KirbyPlace	2,693	4.3
			Total (b)	358
4	Mono Rail³⁰			
	I	From Rohini Sector 21 to Red Fort via WazirPur - Shakti Nagar - Anand Parbat - Ajmeri Gate - Delhi Gate (Delhi)		28.54
	II	From Kalyanpuri to PulMithai via Scope Minar - Geeta Colony - Shanti Van - Red Fort - Old Delhi Railway Station.		15.45
	III	From GulabiBagh to Delhi University via Shakti Nagar - Kamla Nagar - Guru TegBahadur Road.		3.83
			Total	47.82
		Total BRT Length (a+b)		362
		Total Length (Km) (Metro + Light Metro + BRT+Monorail)		606.82

Apart from above Mass Transit corridors, the redevelopment of existing railway stations and ring rail station needs to be planned. The capacity of handling rail and passenger traffic needs to be augmented of the existing ring rail station to distribute the load and decongest Old Delhi and New Delhi railway stations. The ring rail network needs to be integrated with bus and metro network. Upgradation is required to develop ring rail as rail passenger network.

Odd and Even Scheme: Hon'ble Supreme Court of India, Hon'ble High Court of Delhi and Hon'ble National Green Tribunal had passed various directions from time to time to take action to control the alarming level of vehicular pollution in Delhi and therefore, the Lieutenant

³⁰Monorail Corridor (Transport Department, Government of NCT of Delhi)

Governor of the National Capital Territory of Delhi, on being satisfied that further steps are required to control vehicular pollution caused by non-transport four wheeled vehicles (motor cars etc.), ordered in the interest of public safety that proper measures must be taken in Delhi, and Odd Even scheme was initiated with details as:

- The plying of non-transport four wheeled vehicles (Motor Cars etc.) having registration number ending with odd digit (1,3,5,7,9) shall be prohibited on even dates of the month (i.e.2nd,4th ,6th ,8th, 10th, 12th day and so on) and plying of the non-transport Vehicles having registration number ending with even digit (0,2,4,6,8) shall be prohibited on odd dates of the month (i.e. 1st, 3rd, 5th, 7th, 9th, 11th day and so on). These restrictions shall also apply to the non-transport four wheeled vehicles bearing registration number of other states.
- These restrictions shall be applicable from 8 AM to 8 PM of such dates.
- These restrictions shall not be applicable on Sundays.
- Violation of these orders shall attract a fine of Rs. 2,000/- in accordance with the provisions of sub- section (1) of section 194 of the Motor Vehicles Act, 1988.
- This order was into force with effect from 01.01.2016 till 15.01.2016 and another time the Odd even scheme was into force with effect from 15.04.2016 till 30.04.2016.

Several countries have implemented odd and even formula as an emergency action to reduce peak pollution levels. Many of those programmes are more stringent in terms of duration, penalty and minimal exemptions. There are evidences of impact on air quality in those global cities. With this programme several cities have reported a wide range of benefits including reduction in air quality, reduced congestion, improvement in public transport ridership etc. Lowering of pollution levels have been reported in in different cities. In Paris for instance that has implemented this programme in March 2014 and repeated in March 2015, saw 18 % reduction in traffic volume and 6% in pollution levels. But Beijing that has a longer and a more stringent programme has shown 38% reduction in PM10.

Delhi is piloted its first ever-emergency action to reduce peak pollution levels. This was consistent with global best practice. Vehicles that are second highest emitters in the city were responsible for very high exposure and health impacts. The first few days of the programme demonstrated that the peak pollution levels lowered than the normal smog peaks of the season – despite the adverse weather conditions. **The fuel efficiency norms for passenger cars have been notified by Bureau of Energy Efficiency (BEE) in April 2015 and the fuel efficiency norms for Heavy Duty Vehicles for Gross Vehicle Weight greater than 12 Tonne has been notified in August 2017.**

A study on traffic volume and speed survey carried out by School of Planning and Architecture, New Delhi, at 11 locations during the first few days of odd and even scheme in Delhi found that due to lowering of traffic volume the travel time has reduced by 35%. This bought out the importance of reducing traffic volume. Delhi Government will continue with odd-even vehicle-rationing scheme if adverse weather conditions continued.

Furthermore, the GNCTD has inacted Delhi Electric Vehicle Policy 2018 for promotion of Electric Vehicles for road transport. It aimed at improving the better air quality, reduced noise pollution, enhanced energy security and in combination with a low carbon power generation mix, reduced greenhouse gas emissions. With vehicular pollution being a consistent source of air pollution in the National Capital Territory of Delhi ('Delhi') and contributing up to 30% of particulate pollution, rapid adoption of zero emission electric vehicles is of great importance to the city.

India is a member of the Electric Vehicles Initiative (EVI), a multi-governmental policy forum dedicated to accelerating the deployment of EVs. The EV@30 campaign, launched in 2017, sets a collective aspirational goal for all EVI members to have EVs contribute to 30% of all vehicle sales by 2030. This policy will apply exclusively to Battery Electric Vehicles (as defined in 'FAME India', which was launched in March 2015). Mild Hybrid, Strong Hybrid and Plug-in Hybrid Electric Vehicles will not be targeted by this policy. 'FAME India' in this policy refers to the Scheme for Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India as notified in March, 2015 by the Govt. of India.

The primary objective of the Delhi EV Policy 2018 is to bring about a material improvement in Delhi's air quality by bringing down emissions from transport sector. To do so, this policy will seek to drive rapid adoption of Battery Electric Vehicles (BEVs) in a manner where they contribute to 25% of all new vehicle registrations by 2023. This policy will also seek to put in place measures to support the creation of jobs in driving, selling, financing, servicing and charging of EVs.

Delhi is well on its way to become the largest user of CNG vehicles in the world. **Euro VI norms are being implemented by the vehicles running within the City.** Low sulphur diesel (up to 5 ppm) has been made available in the City. Other actions taken to reduce the overall vehicle pollution loads include phasing out of 15 year old commercial vehicles, adopting new vehicle technology and matching emission standards,) improving the performance of existing vehicles through better inspection and maintenance, promotion of emission less battery operated vehicles by the government by providing concessions up to 29.5% (15% base price, 2% road tax and registration expense and 12.5 % VAT refund). Other initiatives taken by government include widening of Ring Road from 6 lanes to 8 lanes; conversion of road from Delhi to Gurgaon to eight lane express way, bypass road from Kalindi Colony to Badarpur; and construction of signal free flyovers and under passes for traffic decongestion. Government has also banned the manufacturing of BSLV III engines, and implemented policy to ensure that only eco-friendly BSLV VI engine is manufactured. There has also been tightening of mass emission standards for new vehicles. The quality of the fuel being supplied in Delhi has been significantly improved over the years by the ban of selling leaded petrol, introduction of low sulphur diesel, reduction of sulphur and benzene content in petrol.

Delhi Government as per the recommendation of High Power Committee under Chief Secretary, Delhi and in consultation with all concerned departments has prepared an air pollution control Action plan with immediate, short term and long term actions to be taken by various departments. Further to this, National Green Tribunal (NGT) has passed various orders

in O.A. 21 of 2014 titled “Vardhman Kaushik Kaushik Vs. UOI & Ors” for air pollution control, which are being implemented by the concerned departments. Delhi Government also launched its first Car-Free-Day on 22nd October 2015 with Chief Minister Arvind Kejriwal leading the Cycle Rally with over 1,000 cyclists took part in the event which encouraged people to use public transport.

A number of additional measures have been undertaken to reduce vehicular pollution by providing CNG buses, strengthening the Pollution under Control (PUC) system by online networking, introduction of strict Inspection and Certification Systems and promotion of advanced technologies. Special focus is on safety certification and stringent inspection of all transport vehicles. A Safety Council to set standards for vehicle safety and fitness is being set up shortly. Below table 79 briefs the Delhi government’s proposed policy prescriptions in transport sector under SPD 2021:

Table 79: Proposed policy prescription for Transport sector

S. No.	Actions/Policies	Agencies Responsible
1	<ul style="list-style-type: none"> ● Air Quality Monitoring: Transport sector is one of the major contributor affecting ambient air quality. Delhi has set the target of meeting the National Ambient Air Quality Standards in the time frame 2017-2020 to protect public health. This requires robust and effective air quality monitoring system. Its air quality-monitoring network is operated by Central Pollution Control Board (CPCB), Delhi Pollution Control Committee (DPCC), National Environmental Engineering Research Institute (NEERI), and Ministry of Earth Sciences (MOES). Monitoring capacity to be expanded to meet the needs of the standards PM2.5, Ozone and the key air toxics. ● Need inventorization of all sources of pollution. ● Mandatory source monitoring specially from industries and power plants. ● Coordinate with research agencies for health impact assessment of pollution. ● Expand online continuous air quality monitoring grid network. ● Institute public information on air quality along with health advisory. 	CPCB, DPCC, NEERI, MoES
2	<p>Implementation of stringent emission standards for vehicle</p> <ul style="list-style-type: none"> ● The Government of India has set a deadline for implementation of Bharat stage VI norms by 1st of April, 2020. (MORTH) ● In use vehicle emission standards and test procedures should be tightened. (MORTH) ● Pollution Checking/Testing of vehicles and its management should be improved. ● Then in use emission standards, testing and management should be improved ● The current PUC norms and its enforcement system need further 	Transport Department, GNCTD and Ministry of Road Transport & Highways (MORTH)

S. No.	Actions/Policies	Agencies Responsible
	<p>strengthening. (MORTH and Transport Deptt.)</p> <ul style="list-style-type: none"> ● Need centralized and well equipped vehicle inspection centers. (Transport Deptt.) ● Upgrade Vehicle inspection system for more advanced Bharat stage vehicles, there should be on board diagnostic systems and advanced emission control systems. (MORTH) ● More advanced in use monitoring strategies are needed to enable more sophisticated and advanced testing for the new generation vehicles. Both technical as well as organizational parameters of the programme will have to be improved significantly. (MORTH) ● The annual fitness and emissions checking system for private vehicles should be introduced. There should be planning infrastructure and identification of workshops for fitness tests of private vehicles. The annual fitness of 4-wheeler private vehicles should be linked with insurance for vehicles for 100 per cent compliance. (MORTH) ● There is a need of stringent enforcement at inter-state borders to check overloading of vehicles under motor vehicle act. Cancel permit / deloading / sending back the vehicles on the spot etc. (Transport Department, GNCTD, NHAI) ● Regular enforcement drives and strict penal action against vehicles violating pollution norms. (Transport Department, GNCTD) ● Strict and legal enforcement of targets of action plan for air quality control. (Environment Department, GNCTD) ● Enforce truck bypass and expedite the western and eastern peripheral bypass. (Traffic Police & PWD) ● Improve inter-state bus connectivity to reduce the load of NCR traffic and pollution. (Transport Department of Delhi, UP and Haryana) ● Introduction of sealed trucks and containers for transport of goods and check overloading may be included in the specifications of truck bodies. Reference may be made to damage to property act (Central Act) to address overloading. (MORTH, NHAI and Transport Department) ● Retrofit petrol pumps with vapour recovery system to reduce evaporative emissions. (MOPNG and Food & Civil Supply Department, GNCTD) 	
3	<p>Strengthening public transport, zero emitting non-motorized transport (B) and improving urban infrastructure.</p> <ul style="list-style-type: none"> ● Induce and monitor drastic modal shift to public transport through smart land-use planning and TDM measures. Increases efficiency and service and service level of public transport and intermediate para- 	Transport Department, Delhi Transport Corporation, DIMTS,

S. No.	Actions/Policies	Agencies Responsible
	<p>transit and keep them affordable. (DTC and Transport Department, GNCTD)</p> <ul style="list-style-type: none"> ● Increase and report conventional bus service (DTC and clusters). Meet the targets of 10000 buses that was set for 2011 and projected demand for next 5 years and use that for continuous monitoring DTC and cluster buses. (DTC and Transport Department, GNCTD) ● Reduce taxes on buses, Identify other tax revenue measures to create the urban transport fund. (Transport Department, GNCTD) ● Implement 230 km of BRT Network throughout city to decongest bus movement. (Transport Department, GNCTD) ● The National Urban Transport Policy has additionally recommended expansion of non-motorized transport, travel demand management measures and promotion of alternatives. This is urgently needed to reduce pollution, congestion and energy impacts of motorization and ensure equity. Scaling up in public transport ridership will also require massive expansion in walking and cycling to improve last mile connectivity. (Department of UD and PWD, GNCTD) ● Implement cycling and pedestrian network throughout Delhi for making cycling and walking safe and convenient. (Department of UD and PWD, GNCTD) ● Implement public bike sharing for non-motorized public transport (NMT-PT) integration. Prepare and implement area network plan for NMT implementation for NMT tracks and traffic calming strategies in local neighborhood etc. Also provision of penal actions against violation in usage of NMT tracks. ● All new road developments to follow the street design guidelines and the reformed IRC guidelines. ● Necessary for all road construction agencies to include designated areas for pavement, greenery, cycle tracks, recharge zones etc. Provide safe at grade pedestrian/NMT crossing at required interval as per street guidelines. ● Implement integration plan for bus metro IPT and NMT design integration of interchange points along with common ticketing systems etc reorganize IPT system. ● Create a metropolitan/regional plan for PT network and integration. ● Proper traffic impact assessment to be done for all new construction and development in Delhi. 	<p>Department of environment, DMRC, Department of UD and PWD</p> <p>Department of UD, PWD, DMRC, Local Urban Bodies, DDA and UTTIPEC</p>
4	<p>Parking policy as a travel demand management tool to control air pollution</p> <ul style="list-style-type: none"> ● There is a need to implement parking policy as a demand management 	<p>EPCA, Department of Environment,</p>

S. No.	Actions/Policies	Agencies Responsible
	<p>strategy to reduce personal vehicle usage and to cut congestion and pollution.</p> <ul style="list-style-type: none"> ● Implement parking policy as a transportation demand management (TDM) measure in city, prioritizing congested areas. ● Demarcation of legal parking areas, metering system, proper designates, IT for information on parking availability to reduce cruising time and pollution, prevent illegal parking etc. ● All structured parking lots must have an integrated local area management plan for both surface as well as structured parking areas. 	DDA, Urban Local Bodies, UTTIPEC, Traffic Police
5	<p>Discourage Private vehicles</p> <ul style="list-style-type: none"> ● Levy higher taxes/fees, parking charges on personal vehicles and diesel vehicles ● Control entry and thoroughfare of private vehicles through NCT ● Prohibiting non-destined vehicles to enter Delhi 	Urban Local Bodies, Transport Department, UD, Traffic Police and PWD

13.5 Strategies and Actions to Address Concern due to Climate Change Issues

Under NAPCC, the National Mission on Sustainable Habitat suggests a future focus on strengthening the enforcement of vehicle economy standards and using pricing measures to encourage the purchase of efficient vehicles and incentives for the use of public transportation. Similarly, the National Urban Transport Policy emphasizes the development and usage of extensive public transport facilities. The initiatives by the Delhi Government are consistent with those included in the mission. Table 80 briefly describes the action plan identified by the Delhi Government for transport sector.

Transport: Key Priorities
<ul style="list-style-type: none"> ● Integrating Urban Land use and Transport Planning ● Enhancing the use of public transport ● Low Carbon Fuel ● Vehicle Pollution Control ● Develop Parking Policy ● Promoting Non-Motorized Transport ● Promoting emission less vehicles ● Improving Road Infrastructure

Table 80: Action Plan for Transport Sector

Actions	Actions details and Target for 2020 and 2030	Departments
Augmentation of integrated Public Transport Network	<ul style="list-style-type: none"> • Inclusion in the Modal share bus 73% in favour of public transport and intermediate transport trips by 2021, which is currently only 53% • BRT corridor between Ambedkar Nagar to Moolchand (Delhi Gate) is being dismantled by PWD vide cabinet decision No.2240 dated 03.11.2015 and cabinet decision No.2182 dated 21.07.2015. DPRs have been prepared of 6 corridors for 112.65 KM by DIMTS ltd. on behalf of Transport Department, GNCTD. • Augmentation of CNG buses: As on date, there is a fleet of 6,900 number of city buses. DTC is operating 4,169 CNG buses at present which include 3,781 CNG Low Floor Buses. Government is committed to augment the bus fleets to enhance the share of public transport trips. • Expansion of Metro Network: The government is committed to expand the Metro network in NCT of Delhi and NCR towns. The proposed expansion is likely to increase the metro ridership to 44.74 lakhs per day from the present 27 lakhs in the year 2015, under Phase IV additional 103.9 kms will be included, which is expected to complete by 2021. 	Transport Department, Delhi Transport Corporation, Delhi Metro Rail Corporation Delhi Integrated Multi-Modal Transit System (DIMTS) Ltd Urban Local Bodies
Improving the accessibility of public transport	<ul style="list-style-type: none"> • Passenger Information System (PIS) with Global Positioning System (Transport Department, GNCTD) • Proper Interchange Infrastructure between various public transport systems (Multi-Modal Integration) for seamless interchange. • As per proposed new Multimodal Integration norms in MPD 2021 and UTTIPEC Street Design Guidelines. • Retrofit Terminal Railway Stations Areas (500 m zone from all exit points) (DMRC) -Anand Vihar and Hazrat Nizamuddin metro stations of Phase-III, presently under construction, are being constructed as per UTTIPEC approved plans. • Retrofit all Phase I and Phase II Metro Station Areas (DMRC) • Design and implement all Phase III Metro Station Areas (300m zone from all exit points) (DMRC) – 37 stations of Phase-III have been designed and implemented under UTTIPEC Street Design guidelines. The balance stations are under 	MHA, Delhi Traffic Police, DTIDC, DMRC, and Transport Department

Actions	Actions details and Target for 2020 and 2030	Departments
	<p>development with DDA-UTTIPEC and are at various stages of approval.</p> <ul style="list-style-type: none"> • Retrofit all Roads greater than 18M ROW as per UTTIPEC Street Guidelines to provide adequate IPT and NMT facilities for last mile connectivity. In doing so, ensure that pedestrians, cyclists, cycle-rickshaws (for passenger & goods), Autos and Taxis get a rightful and equitable place within the transport system • Modernization of all Bus Queue shelters (DTIDC) • Development of Inter-state bus terminals as inter modal transit modal transit centre (DTIDC) • Intelligent transport signaling system • Data based management practices for effective regulation of traffic discipline: Government plans to take up the creation of the above infrastructure on priority. • Automatic fare collection system (AFCS) (Transport Department, GNCTD) • Plan, design and implement infrastructure to enable feeder services to become a meaningful and legal mobility option. • On priority, retrofit all arterial roads along Metro Phase III alignment to: (PWD) • Provide dedicated stops / stands in addition to other drop-off / pick-up bays within the Multi-Functional Zones within ROWs designed as per UTTIPEC Street Guidelines. • Amenities including seating / resting areas, hawker zones, toilets etc. must be provided at the stands. These could be clubbed with the provision for bus stops, designed as a small hub. 	
<p>Promoting Non-motorized vehicles movement</p>	<ul style="list-style-type: none"> • Promoting NMT Movement • Plan and deliver a finer network of streets for NMT access by creating new connections and retrofitting existing streets and junctions (including those along signal free corridors) to ensure network augmentation and safe mobility options for NMT. • Provide fully segregated cycle tracks with provision for safe NMT parking facilities and at-grade crossings as per the UTTIPEC Street Design Guidelines on all roads. • Dedicated stands and parking areas to be located within Multi-Functional Zones within ROWs designed as per UTTIPEC Street Design Guidelines. 	<p>Urban Local Bodies, PWD, DIMTS, Transport Department and UTTIPEC</p>

Actions	Actions details and Target for 2020 and 2030	Departments
	<ul style="list-style-type: none"> • Amenities including seating / resting areas, hawker zones, toilets etc. could be clubbed with the provision for bus stops, designed as a small hub. • Plan and implement a City wide, affordable and accessible bike sharing / rental schemes. (Note: It is important to not club such schemes with other PPP model incentives such as advertisement, which has known to has attracted zero cycle sharing demand, mainly because it is often in the commercial interest of such vendors to suppress demand, to ensure profitability from the primary income source such as advertisement) • Policy level change are planned to enhance Pedestrian Movement • Implementation of Delhi Non-Motorized Vehicles Bill, 2011 • Integration of motorized and non-motorized vehicles on the road from Lothian bridge to MCD headquarters on Shyma Prasad Mukherjee Marg by MCD • For last mile connectivity, PWD has planned walking and cycling track within One Km range of Metro Stations. Within this range, pedestrian, cycling/ NMV, Public transport etc. will be promoted. PWD has already being designed 10 stretches which will be completed in next 6 months. For 1,260 KM of PWD roads, about four years time will be required for such last mile connectivity. • Taking up real time projects/studies to study to study NMV impact. 	
<p>Parking Regulation</p>	<ul style="list-style-type: none"> • Introduction of modern system based on parking meters and internet based parking • Digitization of Parking sites • Modernization of parking systems • To implement a comprehensive planning, design, pricing and management strategy across the city as per the EPCA recommendations • Prohibiting non-destined vehicles to enter Delhi • Parking facilities to be provided as part of the overall Parking Management Districts (PMD) plan incorporating all modes, with a clear cut community benefit strategy as per MPD-2021. • Municipalities and/or planning bodies should develop detailed parking management plans for 	<p>Transport Department, Department of Urban Development, UTTIPEC, Urban Local Bodies, PWD and M/s Geo Spatial Delhi ltd.</p>

Actions	Actions details and Target for 2020 and 2030	Departments
	such PMD, with physical design and demarcation of spaces on ground and strict enforcement.	
Expansion of Bus Rapid Transit System	<ul style="list-style-type: none"> • Retrofitting existing road infrastructure including junctions along the 14 BRT corridors to allow for easily accessible bus stops at regular intervals with all necessary design and safety features as per standards 	Transport Department
Reinforcement of Ring Railways	<ul style="list-style-type: none"> • Reinforce the Ring Rail as an important Mass Transit System for Delhi, one that is affordable and provides the critical ‘circular’ connectivity across major business / employment districts and residential quarters of the city. • Planned expansion and upgradation of the system should include safe, active, convenient and comfortable connectivity to the Stations for all, which is critical for the success of the system. In order to improve the rider-ship on Ring Rail, Provide additional Halt Stations at the following locations: MotiBagh, Bhairon Road, Hans Bhawan (ITO), Ganesh Nagar, PreetVihar, Shyam Lal College • As a priority undertake, accessibility improvement and augmentation of infrastructure on the following Ring Rail stations: Shivaji Bridge, Bhairon Marg, Kasturba Nagar (Sewa Nagar), Lajpat Nagar, Kirti Nagar and Shakur Basti 	Ministry of Railways
Development of Regional Rapid Transit System	<ul style="list-style-type: none"> • Constitute eight rail corridors to connect Delhi and cities in NCR with high speed commuter trains to enable safer, high speed and high-frequency services. • Construction of two semicircular expressways, which will form a third ring road around Delhi, to decongest Delhi from traffic entering and bypassing the city through National highways. • For implementation of RRTS corridors: <ul style="list-style-type: none"> ○ RRTS terminal stations must be integrated with existing and proposed Metropolitan Passenger Terminals (MPT). ○ Non-terminal RRTS stations within the NCT must be integrated with Metro and / or Ring Rail stations and / or ISBTs to ensure effective multi-modal integration. ○ In particular, seamless transfers between the MRTS and RRTS is critical. 	Ministry of Urban Development, Railway Ministry, NCR planning board, GNCTD , Haryana, Uttar Pradesh, and Rajasthan.

Actions	Actions details and Target for 2020 and 2030	Departments
Vehicular Pollution Control	<ul style="list-style-type: none"> • Development & implementation of vehicle emission standard for GHGs (presently standard are only for CO and Hydrocarbons)Effective implementation and tightening of PUC norms for all vehicles; Software for issuing of the PUC Certificates in ‘Real Time’ and ‘on-line’ mode is operational at all PUC centers 828 in Delhi. • Mobile enforcement teams being deployed at various locations for monitoring polluting vehicles and vehicles not having PUC certificates. • Amendment sought from Govt. of India in CMV Rules <ul style="list-style-type: none"> (a) Intensify challaning the visibility polluting vehicles and non-PUC holders. (b) PUC Centers need to made more efficient and the pollution check data generated be made reliable by minimizing scope of human interference. (c) PUC norms to be made more stringent for old vehicles. • BIS have approved and MOPNG has notified use of 5% blended Ethanol Gasoline fuel, to reduce VAT on proportionate basis on blended fuels • Introduction of emission on tax on vehicles manufacture by creating financing Mechanism for Public Transport. There are 687 BS-IV Low Floor Buses for which pollution checking is mandatory after every year. • DTC is planning to use recycled water for washing for buses and installation of ETP in all the depots. • Implementation of Euro-VI norms • Restriction of vehicles – Odd/Even formula • Mass awareness campaigns. • Levy of Environment Compensation Charge on commercial vehicles entering Delhi. • Ban on 15 years old commercial vehicles in compliance of Hon’ble Supreme Court order is already in place. • Ban on 15 years old private vehicles in compliance of Hon’ble NGT order is already in place. • Ban on 10 years old diesel vehicles is already in place in compliance of Hon’ble NGT order. • Ban on entry of Transport vehicles registered before 2006 in compliance of Hon’ble Supreme Court order dated 16.12.15 is in place. 	Traffic Police, Transport Department, MORTH, Finance Department and Trade & Taxes

Actions	Actions details and Target for 2020 and 2030	Departments
	<ul style="list-style-type: none"> • Ban on registration in NCR of private cars/ SUVs of the capacity of 2,000 cc and above using diesel as fuel up to 31 March, 2016 in compliance of Hon'ble Supreme Court order. • Delaying entry of Trucks into NCT of Delhi: A notification no. F.No.19 (96)/ Tpt./Sectt./2010/16 dated 05.02.2016 has been issued to restricted entry of Trucks. 	

Actions	Actions details and Target for 2020 and 2030	Departments
Vehicle Ownership and Use Restraint	<ul style="list-style-type: none"> Rates of tax on (for the private vehicles registered in the name of companies and firms) vehicle have been increased by an additional amount of 25 % of the existing rates/ amount Undertake feasibility study for road pricing / Congestion charging for specific areas as well as possible Regulatory Strategies 	Transport Department, Department of Urban Development, UTTIPEC, Urban Local Bodies
Network Improvement	<ul style="list-style-type: none"> Prioritize of network planning & augmentation/enhanced connectivity over piecemeal road infrastructure improvements. Propose a methodology for project identification, prioritization and budget allocation based on the network needs of an area - both macro and micro – as well as mobility needs of a locality based local site conditions. Prepare network plans on priority to assess the need for augmentation of street networks, incorporating all proposals for new linkages, changes to existing roads. Damage to natural features including covering of drains for provision of new links/infrastructure must be avoided unconditionally. 	Transport Department, Department of Urban Development, UTTIPEC, Urban Local Bodies

13.6 Budgetary Assessment of key priorities

The Department of Transport, GNCTD has proposed a budget of 2,568 crores for transport sector for the next five years to implement the priority measures under the Delhi SAPCC. The activities proposed to be implemented by the Department of Transport, PWD, and all of the municipal local bodies.

14. Urban Planning

As the national capital, Delhi's urban development has been subjected to many planning interventions. The Delhi Development Authority (DDA) is responsible for urban planning and land management such as preparation of master plans and their implementation in coordination with other organizations. One of the main aims of these plans is to deal with the rapid population increase and its associated problems.

Along with planning of new urbanization, the master plan also focuses on dealing with existing urban environments through various redevelopment strategies like conservation, rehabilitation and slum clearance. The current master plan of Delhi, the third one, covers the period from 2001 to 2021 and came into effect in 2007. The current master plan focuses on issues like promoting market competition in land and housing, encouraging tourism and increasing revenues. Despite the existence of several master plans and the authority given to the DDA to acquire the entire land within the city, a significant part of urbanization in Delhi has taken place in an unplanned way. This chapter mainly deals with the Land Use, Infrastructure and Solid Waste Management facilities of Delhi which constitute its Urban Planning.

14.1 Existing Status of Urban Planning in Delhi

Delhi's urban population has grown from 1.4 million in 1951 to 16.3 million in 2011. In any urban area, population growth takes place through natural growth, net in-migration and expansion of physical boundary. The estimated annual population growth in Delhi showed that population growth by net in-migration is slightly more than the natural growth. For instance, average annual population growth by natural growth and net in-migration was 2.2% and 2.4% respectively between 1995 and 2006 (NCTD, 2009).

In spatial terms, the pattern of land use in Delhi was influenced considerably by the implementation of the Delhi Development Authority's 20-year (1962–81) master plan. Broadly, public and semi-public land use was concentrated in the central secretariat area of New Delhi and in the old secretariat area in the civil lines, with subsidiary centres developing in the Indraprastha Estate (an office complex) in the east and in Ramakrishnapuram (an office-cum-residence complex) in the south. A large number of small manufacturing establishments have entrenched themselves in almost every part of old Delhi, but the main industrial areas have gravitated toward Najafgarh Road in the west and the large planned okhla industrial estate in the south. Refer table 81 for Delhi land use statistics.

Table 81: Delhi Area Statistics

S.No	Field	Area (Sq. kms)
1	Total Area	1483
2	Urban Area	924.68
3	Natural Features to be Conserved**	195.05
4	Balance Area Available for Urbanisation	363.27
5	Addl. Area Proposed for Urbanisation (2021)***	276.29

6	Proposed Urban Area (2021)	977.91 (66%)
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(** Including. Forests, ridge, rivers, wildlife sanctuaries, other water bodies and drains;
*** Preliminary estimate, MPD 2021)

Delhi’s power demand has increased continuously and the dependence on the power from outside has been increasing simultaneously. Though, the power corporations have earned sufficient surpluses during the winter season when Delhi has power-surplus, the summer peaks are way high above the total arranged capacity which leads to load shedding. The peak electricity demand has touched the level of 5,150 MW in Delhi in May, 2012³¹. At present Delhi has 25.5 MW grid connected Installed Capacity of Renewable Power. The CEA estimates indicate that electricity demand may reach to around 8700 MW in Delhi by the end of the 12th Five Year Plan. The position of total power supply in Delhi from different sources- 24,638 MUs, Power from Own Generation - 18.52% (4565 MUs), Power from BTPS- 16.86% (4,154.923 MUs) and Power from other bilateral and sources including CPSU- 64.61% (15,918 MUs). As far as the transportation sector is concerned, the steep increase in growth of traffic, and other factors, the road network is unable to meet the requirements of Delhi and due to the very heavy traffic and congestion; it is grossly inadequate and requires huge inputs to make it effective. This is despite of Delhi not lacking road infrastructure. As per the latest data (March 2017), the availability of roads in Delhi is 22,963 Kms. The existing road network in Delhi is shown in table 82.

Table 82: Existing Road Network in Delhi (In Lane Kilometer)

Agency		2012
MCD (EDMC, SDMC, NDMC)		13,026
New Delhi Municipal Council		1,290
Public Works Department (Delhi Govt.)	National Highway	430
	Other Roads	6,308*
DSIIDC		1,434
I&FC		40
DDA		435**
Total		22,963

*including 3208 lane km taken over from MCD

** as on 31.03.2013 (Source: Delhi Statistical handbook-2017)

As far as the Solid waste management of Delhi is concerned, 80% of the municipal solid waste generated is collected, and the rest remains unattended on streets or in small dumps. About 90% of the collected MSW is disposed in landfills, and the remainder is composted.

To date 17 landfill sites have been filled and closed. At present Delhi's garbage is being dumped at four landfill sites landfill sites viz. Bhalswa, Gazipur, Okhla and Narela bawana. Landfill sites at Bhalswa, Gazipur and Okhla have already reached their saturation points and are being over-utilized due to lack of availability of new site, they have more than 30-meter-high piles

³¹ An Approach to 12th Five Year Plan (2012-17), Government of NCT of Delhi.

of garbage as against the permissible limit of 20 meters. Narela-bawana is the first scientific landfill site and it is expected that almost half of the garbage generated daily can be used in this plant. The three municipal corporations, the New Delhi Municipal Council and the Delhi Cantonment Board send 8,370 tons of garbage to the three landfills at Bhalswa, Okhla and Ghazipur.

14.2 Existing Concerns in Urban Planning

a) Land Use:

Some of the major issues faced by Delhi are as follows:

- **Increasing gap between demand and supply of housing and infrastructure:** The growth of unauthorized colonies and Jhuggi-Jhopri clusters clearly indicate the housing status of the city. Consistently, targets for housing provision have not been met. Moreover, the poor have borne the brunt of the shortfall. Overall, Around 5 lakh houses are to be constructed to fulfill past back logs, over and above the future demand of 20 lakh houses by 2021.

Key Concerns

- Overcrowding
- Haphazard development
- Need for sustainable development
- Encroachment
- Unauthorized development leading to exploitation of land.
- Lack of cost effective physical planning strategies.
- Increasing the green cover for better environment

- **Overcrowding, haphazard development without basic services:** There are 728 JJ clusters; 1,700 unauthorized colonies and 165 urban villages accommodating around 60 lakh population. Of these, barely 25% of the population has access to physical infrastructure.
- **Encroachments on agricultural land and urban villages:** The urbanization area is expanding in an adhoc manner, often into the green area. Due to ineffective development regulations and control, rural areas are falling prey to unauthorized development. Original land owners have parceled their holdings and sold these at high prices to builders/developers. Urban villages have been over-run with haphazard developments.
- **Exploitation of Land for unauthorized development:** Large portion of urban land in NCT is owned by government generally for public, community and government uses. Without programmed use and efforts for protection, these lands get easily encroached by both marginal groups and unregistered land speculators. This is further aggravated by insufficient official provision of land for various uses – be it residential, commercial or industrial.
- **Non-Conforming Land uses:** Around 1 lakh industries are located in nonconforming areas as per MPD. Efforts for relocation have failed due to the inaccessibility to work-centre of the relocation site; lack of infrastructure; security of tenure & assets and affordability of the owner.

- **Lack of Linkage of Physical Planning Strategy with Financial Planning:** Successful physical planning should respond to economic realities; and support broader financial goals and strategies for the city. The link between these aspects, while strong in the first Master Plan, seems to have weakened substantially in subsequent plans. Failure of implementation has aggravated the situation further.
- **Environment Services Zone:** The objective for environment management is to reduce, reuse and recycle all resources. Planning resource management to incentivize local and decentralized solutions will enable decisions that both minimize use and enable treatment and reuse.

b) Infrastructure:

i) Power:

The two main issues of the power sector in Delhi increasing demand and supply gap, especially during the transitional period, and the continuing tariff issue. A consequent third issue of the sector is the fact that the public-private partnership on which the reforms were premised has come under strain. The regulatory concerns that have been referred to have, in some cases, put Transco and the DISCOMs in opposite camps. DISCOM managements have been slow or remiss at times in making payments to Transco and DPCL in terms of the reform package (though payments for power purchase have been timely). While DISCOM managements may have felt at times that they were not getting sufficient cooperation in various matters, they too may need to appreciate that public and political support for them is bound to weaken unless all three DISCOMs are able to create a strong feeling of satisfaction among their consumers.

Key Concerns
● Widening demand & Supply gap
● Issues pertaining to tariff
● Strained public-private partnership
● Energy insecurity
● Adopting renewable energy sources

Further, Delhi’s energy security in regard to the power sector remains a question mark, neither has any project to enhance local generation been launched, nor has the opportunity of benefiting from private sector participation in generation in Delhi yet been availed of.

ii) Roads & Railways:

The road network in Delhi can be categorised on the basis of a hierarchy of roads, ranging from “Arterial Roads” designed to carry fast through traffic, to “Feeder Roads” and “Residential roads”.

However, the lack of transport choices results in a pedestrian presence on all roads, regardless of the hierarchy and designated functions. The existing road design does not appear to have considered the needs of pedestrians, cyclists, or other slow

Key Concerns
● Traffic Congestion
● Unsafe Conditions for pedestrian
● Absence of safe crossing points
● Poorly Maintained Footpaths
● 50% of road space encroached by NMT resulting in lower transit speed.
● Improved public transport with last mile connectivity

moving traffic. Service roads, if present, are not well maintained. Footpaths are either not present or are poorly maintained. Furthermore, there are no specific facilities, other than passenger waiting shelters, provided for buses.

Approaches to bus shelters, dedicated bus priority lanes, continuous pedestrian paths, and separate lanes for slow vehicles like bicycles and rickshaws have not been included in the road network designs. As a result, consequently, all road users have to share the carriageway. This often leads to unsafe conditions for pedestrians and slow moving vehicles and congested conditions for motor vehicles. Not surprisingly, government surveys find 50 per cent of the road space in Delhi ‘encroached on’ by non-traffic activities. This disrupts traffic in all lanes and makes walking and cycling even more hazardous. Motor traffic does not use the kerb-side lane even when pedestrian and bicycle densities are low. The absence of safe crossing points for pedestrians leads to their trying to run across busy roads between traffic flows, slowing down the motorised traffic besides causing accidents and casualties. Even where zebra crossings have been provided, drivers of motor vehicles do not stop clear of them as a result of which pedestrians have to jay walk through a maze of parked mixed vehicles waiting at the red light in a jumbled manner.

c) Waste Management

Solid Waste: MoEF&CC, GoI has notified the revised Solid Waste management Rules, 2016. As per these rules “Solid Waste” means and includes solid or semi-solid domestic waste, sanitary waste, commercial waste, institutional waste, catering & market waste and other non-residential waste, street sweeping, silt removed or collected from surface drains, horticulture waste, agriculture and dairy waste, treated bio-medical waste excluding industrial waste, bio-medical waste and e-waste, battery waste, radio-active waste generated in the area under local authorities etc. As per these rules the responsibility of waste management has been entrusted with the Urban Development Department and the Urban local authorities. As per the data available with DPCC records, solid waste generation in Delhi was around 8,370 TPD. This is slated to increase due to economic and population growth. 455 MGD sewage is also treated, which generates organic sludge. Municipal waste of Delhi is disposed in three landfill sites namely Bhalswa GT Road, Gazipur and Okhla. The technical problems relate to municipal solid waste storage, collection and transportation. But the major problem is in the area of processing and disposal.

Key Concerns

- Collection, Transportation and Disposal of Refuse and Solid Waste
- Overloading of Existing landfills
- Major reception of garbage by open “dhalao”
- Adoption of Decentralized waste management
- Present extraction/ recycling of E-waste is being done in an unscientific way, though it adds to economic activity
- Air pollution control devices and water pollution control device are not installed.
- Lack of safety equipments for the workers.

DPCC has granted temporary permission to operate M/s Timarpur Okhla Waste Management Pvt. Ltd. for process of waste/ waste disposal facility of waste to energy at Okhla site upto

31/12/16. Another two plants for generation of energy from municipal waste have been set up at Gazipur & Bawana. Both the plants are under trail run.

Open 'dhalao' (masonry built dust bin) is still the major receptacle for municipal solid waste in Delhi. These lead to two-fold problems – exposure of the waste to the environment and multiple handling (from depositing of the garbage to its loading on to the waiting collection vehicle – whether manually or by a frontend loader and again un-loading at the landfill unless the transporting vehicle is tipping type).

The private operators are using smaller bins with lids (plastics or FRP made) and dumper placer containers, where the above mentioned problems are under control. However most of the dumper containers are not covered, leading to environmental pollution. Open vehicles are being used for transporting the waste across busy roads in majority of the cases, which needs to be controlled in a planned way. Putting a dangling tarpaulin over the open truck of garbage is no solution.

Processing and disposal of municipal garbage is the most crucial issue. The existing landfills (dump-sites) are almost full. They need to be closed immediately in a scientific manner to the extent possible and new sanitary landfill (SLF) sites need to be developed and commissioned at the earliest possible. The major constraints in this are:

- Provision of adequate land for building new sanitary landfills
- To make arrangement for disposal of the waste in the intervening period before the new SLFs can receive waste
- UD Department is in the process of finalizing the bye-laws and Solid Waste Management Action Plan for Delhi.

Bio Medical Waste: Bio-medical waste means any waste, which generated during the diagnosis, treatment or immunization of human being or animals or in research activities and is governed by the Bio-Medical Waste Management Rules, 2016. The prescribed authority for implementation of these rules is DPCC. Department of Health & Family Welfare, Department of Animal Husbandary and the Urban Local Bodies as per schedule III of the rules. GNCTD in its notification dated 6th July, 1999 has authorized Delhi Pollution Control Committee (DPCC) to grant authorization for collection, reception, storage, treatment and disposal of bio medical waste. To implement the Bio Medical Waste Management Rules, 1998, GNCTD has also constituted an Advisory Committee and an Appellate Authority, in exercise of powers conferred under Bio Medical Rules. With the increase in the number of hospitals and nursing homes in Delhi, hospital waste has become another area of concern. In-house waste treatment facilities in terms of autoclave/ incinerators / shredders are available in major hospitals. While in small nursing homes, clinics and dispensaries are disposing off the waste through 'Operator of facility' who collects, treat, transport and dispose of the waste.

There are about 2,070 Health Care establishment in Delhi as of March, 2018. At present, two common bio-medical waste treatment facilities (CBWTF) are operational in Delhi for the collection, treatment & disposal of the Bio-Medical waste;

- M/s Biotic Waste Solutions Pvt. Ltd.
- M/s SMS Water Grace BMW Pvt. Ltd.

Presently, 07 incinerators are in operation (including 3 incinerators with 2 CBWTFs). DPCC/CPCB also carries monitoring of the CBWTFs in Delhi from time to time. Other treatment systems installed for Bio-Medical Waste in HCEs included 16 Autoclaves, 2 Microwaves and 17 Shredders.

Hazardous Waste: Hazardous waste means any waste which by reason of any of its physical, chemical, reactive, toxic, flammable, explosive or corrosive characteristics causes danger or is likely to cause danger to health or environment, and is governed by the Hazardous and Other Wastes (Management and Trans boundary Movement) Rules, 2016 issued by MoEF & CC, GOI. Approximately 2,400 hazardous waste generating units have been listed in Delhi. Quantity of hazardous waste generated in Delhi is 5,281 tones / annum. The hazardous wastes and other wastes as specified in these rules shall have to be managed as per the provisions laid down in these rules. Presently. a TSDF for disposal of hazardous waste of Delhi is being developed at Bawana.

Electronic Waste: Electronic Waste, means any waste, which is generated due to product obsolescence and discarded electronic items, and may include data processing, telecommunications or entertainment in private households and businesses. In a present scenario, Delhi generates 30,000 T/annum of e-waste. The Ministry of Environment and Forest, Government of India has issued E-Waste (Management) Rules 2016 for handling electronic waste. The implementing agency for these rules in Delhi is DPCC. Central Pollution Control Board has issued authorization for Extended Producer Responsibility (EPR) to 48 producers located in NCR of Delhi.

Awareness/collection drive on e-waste is conducted in 200 Eco-club schools with regards to handling and disposal of e-waste in collaboration with Nokia and GIZ. However, now MoEF, GoI has issued revised E-waste (Management) Rules, 2016 which have come into force on 1st October, 2016.

Plastic Waste: According to the present scenario about 690 TPD of plastic waste is generated in Delhi. Plastic waste especially carry bags has been creating nuisance in Delhi despite over 12 years of massive awareness campaign “Say No To Plastic Bags”. Hon’ble High Court of Delhi had passed a judgment in August 2008 for imposing ban on plastic carry bags in main markets, local shopping centers, etc. subsequent to which GNCTD had issued a notification on 07.01.2009.

Since even 2 years after the issue of 07.01.2009 Notification, the results were not encouraging. Delhi Govt. decided to put a blanket ban on plastic carry bags in NCT of Delhi. Consequently, a Notification imposing ban on manufacture, sale, storage, usage, import and transport of all kinds of plastic carry bags in the NCT of Delhi was issued on 23.10.2012. The Notification

was challenged in the Hon'ble High Court of Delhi and on 05.12.2016 Hon'ble High Court has transferred the matter to Hon'ble NGT with direction to respondent not to take any coercive action till 8 Weeks or further order by NGT. On 10.08.2017, NGT had prohibited use of less than 50 microns non-compostable plastic carry bags in Delhi and also directed defaulters to pay Rs. 5,000/- as Environment Compensation per default. MoEF&CC, GoI has notified new Plastic Waste Management Rules, 2016, which entrust the responsibility with respect to Plastic waste Management with Urban Development Department & Urban local bodies.

Construction & Demolition Waste: A Construction & Demolition waste processing plant of capacity 2,000 tons per day has been installed by M/s IL & FS and is operational at Jahangirpuri for processing of constructional and demolition waste in Delhi. A C&D Waste Processing Plant of capacity 500MTD at Shastri park, Delhi operational and is run by M/s IL & FS. Processed C & D material is used for tiles/pavement blocks and also ready mix concrete, aggregated etc. MoEF & CC, GoI has notified the Construction & Demolition Waste Management Rules, 2016. As per the rules, the Secretary, In-charge of Development shall prepare their policy document with respect to management of construction & demolition of waste in accordance with the provisions of these rules within one year from the date of final notification of these rules. The concerned Department in the State Government dealing with land shall be responsible for providing suitable sites for setting up of the storage, processing and recycling facilities for construction and demolition waste. The town and country planning Department shall incorporate the site in the approved land use plan so that there is no disturbance to the processing facility on a long term basis. Procurement of materials made from construction and demolition waste shall be made mandatory to a certain percentage (say 10-20%) in Municipal and government contracts subject to strict quality control as per these rules.

14.3 Institutions Involved in Urban Planning

a) Land Use

Following are the central and state government agencies involved in land management in Delhi:

- Delhi Development Authority (DDA)
- Land and Building Department/Revenue Department
- L&E Department of MCD
- Land & Development Office(L&DO) GoI, UDPA

b) Infrastructure:

i) Power:

The institutions involved in the Power Sector of Delhi are:

- Delhi Power Supply Company Limited (DPCL)- Holding Company;
- Delhi Transco Limited (DTL) – TRANSCO;
- Indraprastha Power Generation Company Limited (IPGCL) – GENCO;

- BSES Rajdhani Power Limited (BRPL) – DISCOM;
- BSES Yamuna Power Limited (BYPL) – DISCOM;
- North Delhi Power Limited (NDPL) – DISCOM.
- Delhi Electricity Regulatory Commission (DERC)

ii) Roads & Railways:

At present the following agencies are responsible for construction and maintenance of roads, bridges and flyovers in Delhi:

- Public Works Department of GNCTD
- Municipal Corporation of Delhi
- New Delhi Municipal Council
- The Delhi Cantonment Board
- Delhi Development Authority
- Delhi Tourism and Travel Corporation
- Central Public Works Department
- National Highways Authority of India

Other authorities are also involved in different aspects of road administration in Delhi.

iii) Water Supply:

- Delhi Jal Board
- New Delhi Municipal Council
- Delhi Cantonment Board

c) Waste Management:

- **Urban Development Department**
- **Industries Department (w.r.t hazardous waste)**
- East Delhi Municipal Corporation
- South Delhi Municipal Corporation
- North Delhi Municipal Corporation
- Delhi Cantonment Board (DCB)
- Private Companies for Waste Collection & transportation
- Delhi Pollution Control Board (DPCC)

14.4 Current Policies, Programmes and Projects of the Government

a) Land Use

In order to encourage planned development in the city, the DDA prepared master plans for the NCTD Area. Various plans prepared for Delhi over the years include:-

- (i) Lutyen's Plan for the New Delhi (the imperial capital) now NDMC area-1,911;
- (ii) Interim General Plan for Delhi prepared by the Town Planning Organisation (TPO) in 1956;
- (iii) Master Plan for Delhi (MPD) with perspective of 1981 (based on Land use inventory TPO, 1958) prepared by DDA in 1962;
- (iv) Master Plan for Delhi with perspective of 2001 prepared by DDA in 1990;
- (v) National Capital Regional Plan (NCRP) with perspective of 2001 prepared in 1989;
- (vi) Master Plan for Delhi 2021 Prepared by Delhi Development Authority, notified on 7th February 2007 by Central Government (presently under revision); and
- (vii) National Capital Regional Plan (NCRP) with perspective of 2021 prepared in 2005.

b) Infrastructure

i) Power

Delhi Government gives a power subsidy to agricultural consumers and to the consumers who consume less than 150 units of power per month during non-peak months. It has been decided to give the subsidies at Re.1 per unit during both peak and non-peak seasons.

The cross-subsidy i.e. different industrial and residential rate per unit is also in place thereby stressing the industrial users. The Delhi Electricity Regulatory Commission (DERC) has decided to reduce this cross-subsidy gradually and level the two rates.

To attract private investments in generation and distribution in villages, tax exemptions are offered to these investors. In rural areas Rural Electrification Corporation is responsible for helping set-up small power plants under the Rajiv Gandhi Grameen Viduyutikaran Yojana. This central scheme is being implemented by the Delhi government. According to the 2001 census the number of un-electrified rural households stand at 24,580 i.e. 14.5% of the rural households. In Delhi the rural population account for just 2.50% of the total population of 167.88 Lakh which is not significant. These areas are distributed over Delhi and initiating rural power scheme to set-up an independent power plant for these areas seems economically unfeasible at the moment.

Delhi was the first State/UT to introduce kVAh billing for bulk consumers, to motivate them to maintain the power factor, and it is DERC's policy to gradually expand the coverage of consumers under kVAh billing. The current (FY 2006) tariff specifies the tariff for non-domestic and industrial consumers at LT level above 10kw in both kwh and kVAh terms, the former continuing to be applicable wherever meters supporting the latter are yet to be installed.

ii) Roads & Railways:

Provided below is the list of schemes introduced by Delhi government for development of infrastructure in the region of NCT-Delhi:-

- Digital Mapping Project in Collaboration with NIC
- Augmentation of Infrastructure i.e Roads, Streets, Local Parks Street lights in each Assembly Constituency.
- Beautification of Entry Points of Delhi
- Renovation/improvement of Chaupals and Development of Urban Villages
- Trans Yamuna Area Dev. Board
- JNNURM Projects - BSUP
- Unidentified Projects - CWG

c) Waste management:

- The Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016
- The Bio- Medical Waste Management rules, 2016
- The Solid Waste Management Rules, 2016
- The Construction and Demolition Waste Management Rules, 2016
- The Plastic Waste Management Rules, 2016
- The E- Waste (management) Rules, 2016
- The Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989.
- Ban on Plastic carry Bags: Delhi government has imposed ban on manufacture, sale, storage, usage, import and transport of plastic carry bags in the NCT of Delhi vide notification dated 23.10.2012. However, the implementation has been stayed by the Hon'ble High Court of Delhi.

The GNCTD is committed to provide better living conditions in unauthorised colonies by providing basic civic amenities like construction of roads and drains, water supply, sewerage, sanitation and street lights etc. The funds are provided mainly to the executing agencies DSIIDC, I&FC & DJB. During 2018-19, 1,500 crore has been proposed for infrastructure development in the unauthorised colonies as against 840 crore in RE 2017-18. Delhi Urban Shelter Improvement Board DUSIB has been consistently making efforts to give good sanitation facilities to jhuggi dwellers by giving access to well maintained and safe toilets in the neighbourhood. During the past few years, around 16,000 toilet seats were renovated / constructed. From 1st January 2018 these toilets complexes have been made available 24x7 to slum dwellers “free of charge”.

14.5 Strategies and Actions to Address Concern due to Climate Change Issues

Under NAPCC, the National Mission on Sustainable Habitat suggests a future focus on water and solid waste management, reduced need for pumping of water, proper treatment of waste water and use of better designed toilets, conversion of solid waste into energy and integrated

sustainable urban planning. The initiatives by the Delhi Government are consistent with those included in the mission. Table 84 briefly describes the action plan identified by the Delhi Government for transport sector for the target year of 2020 and 2030 respectively.

Table 83: Action Plan for Urban Planning

Sector	Strategies & Actions 2020 and 2030
Land Use	<ol style="list-style-type: none"> 1. Building materials waste to be used by setting up C & D waste recycling facilities. 2. Green Delhi in schools by growing vegetable in school lands 3. Study and create data base for mercury waste handling 4. Treatment of Electronic waste facility 5. Industrial waste and hazardous waste treatment facility 6. Increasing green cover 7. Ensuring environmental sustainability which is the basis for sustainable development that ensures wise use of natural resources so that the commons are not depleted.
Infrastructure	<ol style="list-style-type: none"> 1. Five-year tariff package: The ongoing multi-year tariff exercises, and the tariff decision for the current year, need to be expedited by DERC. They are already overdue. 2. Master Plan/Zonal Development Plan provides for environmental services under Land Use category utilities. Each zonal plan will incorporate supply of water to households from local water sources and will provide land for sewage treatment in the environmental services zones and the Environmental services zones will provide land for management of waste from each zone, including its recycling and disposal. All zonal plans and areas included in land pooling policy will (a) Mandatorily include Environment Services Zones for management of Water sources, Sewage and Solid Waste. (b) Comprehensive Environment Services Assessment Plans. (c) All plans for new growth, including Urban Extension Areas, will be based on the principle of local resource use. There will be mandatory provisions for resource management and treatment of waste, before the plans are finalized. 3. Focus on consumer satisfaction: DERC needs to be proactive in dealing not only with individual consumer grievances but with overall utility performance. The existing Metering & Billing Regulations establish norms for processing individual matters and penalties for individual failure. DERC has now taken steps to monitor the performance of Discoms in the field. It should also take steps to implement the well-known objective, overall norms and standards for the quality of service provided by Discoms (especially SAIDI39 and SAIFI40) with effective penalties for failure to achieve them. 4. Sourcing of power: Immediate steps should be taken to expedite the allotment of the Bawana site for a power generation project and for expanding the capacity of Genco.

5. **Energy audits for new buildings** will be introduced in a phased manner to improve energy efficiency and reduce consumption (by encouraging conservation/management measures, use of star rated appliances, renewable etc.). All non-residential buildings to comply with BEE energy star ratings.
6. **Water audits will be introduced in a phased manner** to improve water efficiency and reduce consumption (by encouraging conservation / management measures, use of water efficient fixtures, rainwater harvesting, wastewater treatment and reuse, encouraging native plants/less water intensive plants in landscape to water use etc.)
7. **Scientific and proper dismantling of buildings** with proper segregation, collection and transport of various construction & demolition waste must be mandated. In addition ensure maximum onsite reuse and recycle of the waste and minimal disposal to the designated C&D waste handling sites/units. **The incentive programme for Green Buildings** will be based on specific performance benchmark and linked with stringent requirement. It will specify the authorized agencies and certifiers who will be made responsible for verifying and certifying compliance periodically. Based on this the fiscal **incentives will be granted. This will make** the system more accountable and transparent.
8. **Efforts will be made to provide financial assistance for use of Renewable Sources of Energy** such as solar water heating proportionate to daily hot water requirement. Delhi Electricity Regulatory Commission (DERC) has regulated Renewable Purchase Obligations (RPO) and Renewable Energy Certificate framework implementation in the State of Delhi NCT, has also issued statutory advice for preparing an action plan for installation of 50 MW Solar Roof-top capacity in the city over the next 5 years. Energy Efficiency & Renewable Energy Management Centre (EE & REMC) has been designated as the “State Agency” by DERC for Accreditation & recommending the Renewable Energy projects for registration under Renewable Energy Certificate (REC) framework. Solar policy for the city has been approved.
9. **Environmental Impact Assessment (EIA) for large buildings** (built-up area more than 150,000 square meter) and development projects in the city need will be implemented with rigor and stringency. These are Category B projects that are appraised by the State level Expert Appraisal Committee (SEAC) and State level Environment Impact Assessment Authority (SEIAA) of NCT Delhi, which operates through Delhi Pollution Control Committee (DPCC). Approval for buildings with built up area from 5,000 to 150,000/-built-up area is covered under building plan sanction.
10. The environmental guidelines for the EIA clearance will be fully aligned with the relevant regulatory requirements related to land, energy conservation building code, water and waste regulations, ground water rules, and transit oriented development norms.

Sector	Strategies & Actions 2020 and 2030	
	11. There is a need to build capacity for enforcement and monitoring. The projects require to submit six monthly compliance reports, this should be strictly monitored and information available in public domain.	
	Roads & Railways	Please refer Transportation chapter
	Water Supply	Please refer Water chapter
Waste	<ul style="list-style-type: none"> ▪ Implementation of ban on open burning. ▪ Three waste to Energy Plants have been installed. Need to install more waste to Energy Plants. ▪ Scientific landfill sites need to be installed. ▪ C & D waste processing facility to process the C & D generated need to be installed. ▪ Renting Plants to be installed. ▪ De –Centralized waste processing facility for new project with built-up area above 20,000 sq mt. ▪ Environment Services Zone in Zonal plans ▪ To ensure environmental sustainability, a massive development of greens and creation and restoration waterbodies, reuse of wastes generated are planned 	

14.6 Budgetary Assessment of key priorities

The GNCTD has proposed 2,984 cores for urban planning and development sector under the Delhi SAPCC. The proposed activities to be implemented by the Delhi Urban Shelter Improvement Board (DUSIB), Urban Development department, PWD and all of the municipal local bodies.

15. Vulnerability Assessment of Delhi

The state action plan for climate change for the state of Delhi offers a unique opportunity in that Delhi is the only city/state in the country, with 97.5 percent of its population living in urban areas. The vulnerability assessment and the climate action plan that is designed for the state can therefore serve as a model for other mega-cities in the country. In this vulnerability assessment therefore, fragile urban systems in the form of sectors are considered. This will ensure that the city/state (urban) nature of Delhi is well highlighted throughout this study.

Delhi is a non-coastal city and therefore is not particularly affected by sea-level rise. It is however affected by the increasing number of hot days and the increase in intensity of rainfall that is projected for northern India as part of the PRECIS model that has been adopted for this study. These projections have shown that the annual temperature of Delhi is slated to increase by 1-4 degrees Celsius along with the intensity of rainfall by 2050. These changes in climate can lead to large scale damage to life and property in the years to come.

Delhi is the capital of India and a state with one of India's highest (of any other state) rate of growth of GDP. The formulation and implementation of a comprehensive climate change action plan is crucial to maintain this growth in GDP and the rising standards of living in the city. This climate change action plan can also serve to define a plan for sustainable development of the state of Delhi, through demand and supply side management of resource intensive activities. This would help Delhi maintain its economic robustness in the decades to come and help improve living conditions for large populations currently living in informal settlements, without adequate access to basic amenities.

The actions recommended as part of this vulnerability assessment need to be well integrated into the city's development strategy. This would help ensure efficient implementation of the climate action plan and that adequate funding is appropriated for these activities. Additionally, the plan can also be implemented in congruence with the eight missions described under the National Action Plan for Climate Change. This will help better integration of national and state level policies for combating the impacts of climate change.

15.1 Methodology

The Delhi vulnerability assessment was prepared for the Delhi government as part of Delhi's State Action Plan for Climate Change. The vulnerability assessment for the Delhi National Capital Territory included the following three steps:

- Identification of fragile sectors
- Identification of climate change impacts on the fragile sectors of the city
- Identification of the vulnerable groups affected by these sectors and the impacts of climate change on these groups

Given that such an assessment would entail understanding both current and future vulnerabilities, as a first step the existing fragile sectors were initially identified. The fragile sectors were identified through several consultations with various government departments (as part of the larger exercise of developing and revising the SAPCC for Delhi) and the assessment was undertaken using available validated information and data, along with a few stakeholder consultations. The following steps were followed to perform this vulnerability assessment:

Six sectors that are currently fragile and expected to be vulnerable to the impacts of climate change were identified for the state of Delhi, including:

- (a) Health,
- (b) Energy,
- (c) Water Resources,
- (d) Urban Planning (infrastructure, waste management and land use),
- (e) Transport, and
- (f) Agriculture, Forest & Biodiversity.

The exposure, sensitivity and adaptive capacity of each fragile sector to the various impacts of climate change were analyzed. Exposure generally relates to the sector/urban system as whole, while sensitivity relates to social groups and specific areas within the sector/urban system in question. These were analyzed with the help of available published literature, in the form of published articles in scientific journals and reports published by the Government of India and Delhi.

Adaptive capacity is the available capacity of a given population/area/system to adapt to the projected impacts of climate change. This can be in the form of social, human, physical, natural and financial capital. These also included the policies and other institutional mechanisms in place to combat the impacts of climate change. This was also undertaken with the help of a secondary literature review.

The vulnerability of the sectors to projected climate impacts has been defined as a function of exposure, sensitivity and adaptive capacity with separate sections for each. These are then synthesized at the end, leading to the adaptation strategies (infrastructure and institutional) that complement the existing adaptive capacity to combat the impacts of climate change. Here various climate change action plans were studied to identify the relevant adaptation actions for the sectors in question in Delhi.

15.2 Vulnerability Assessment of Fragile Sectors

The vulnerability of the sectors to projected climate impacts has been defined as a function of exposure, sensitivity and adaptive capacity with separate sections for each. These are then synthesized at the end, leading to the adaptation strategies.

15.2.1 Health

Every year approximately 2.5 million Daily Adjusted Life Years (DALYs) are lost in the South Asia region (more than 80% of the population of South Asia lives in India) as a consequence

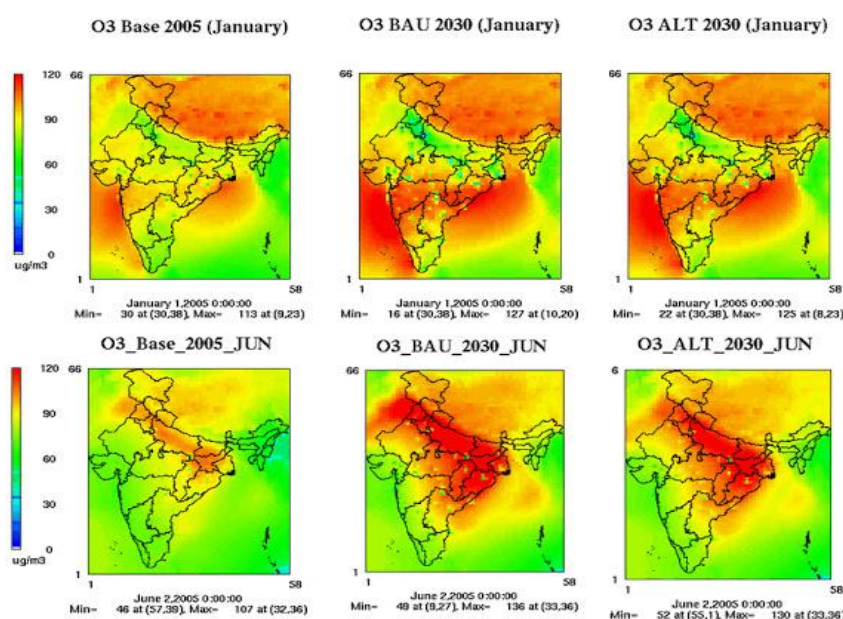
of climate change (Singh, 2012). In Delhi, the projected increase in temperature and intensity of monsoons (refer to background) can lead to an increase in heat stress related disorders and in the incidence of infectious diseases.

Exposure: Citizens of Delhi are prone to heat stress related disorders due to the harsh summers, such as heat strokes, increase in eye diseases like cataract, dry eyes, respiratory disorders and skin diseases. In recent years, Delhi has experienced an increase in maximum summer temperatures, with 2006 reporting a maximum temperature of 44.5 °C and leading to death of 53 people in Delhi (Mehrotra, et al., 2007). It is estimated that for every one degree rise in temperature above 29 °C there will be a four percent increase in risk of mortality (Hajat, et.al 2005).

In addition to heat stress, the changes in climate can also lead to an increased occurrence of vector borne diseases like Dengue and Malaria. The lifecycle of these vectors are dependent on the prevalent temperature and humidity. GCM studies estimate increases of 5 – 15 percent in risk of these diseases due to climate change by 2100 globally. In addition, lack of adequate drainage and changing rainfall patterns may cause increased water logging, creating favorable conditions for the spread of such diseases. This was experienced in Delhi when in 2010 high rainfall led to a dramatic rise (6,259 in 2010; 1,154 in 2009 and 1,216 in 2008) in Dengue and malaria cases (Telle, 2012).

This increase in transmission, would affect urban areas like Delhi more due to high density of population (11, 297 persons per sq. km) and therefore a large number of people being affected (Bhattacharya, et al., 2006). Delhi also has about half its population living in informal settlements like JJ (Jhoogi-Jhopdi) clusters, slum designated area, unauthorized colonies and resettled colonies. (Delhi Government, 2010), which may be disproportionately vulnerable to the impacts of health on climate change. This may be due to lack of basic social amenities and the general trend of low socio-economic status of the population residing in these settlements.

High temperature has also been found to lead to an increase in ozone concentration of the atmosphere with oxides of nitrogen and other hydrocarbon pollutants reacting in the atmosphere to form ozone (Centre for Science and Environment, 2009). In recent times, this trend has been observed in Delhi. This increase in ozone levels may lead to adverse health effects. Ozone worsens symptoms of



asthma, leads to lung function impairment and damages lung tissues. Chest pain, coughing, nausea, headaches and chest congestion are common symptoms. It can even worsen heart disease, bronchitis and emphysema. These impacts can be expected to further stress the public health system in the State. Ozone can also damage leaves and impede plant growth. This figure clearly indicates a growing trend of temperature and ozone concentration in summer months in North India (including Delhi) (TERI, 2008).

Sensitivity: Heat stress in Delhi is amplified due to urban heat island effect. Mohan, et.al, 2011 show that urban heat island effect is most concentrated in commercial areas of Delhi, namely Connaught Place (Central Delhi), Sitaram Bazar (Old Delhi). These are followed by residential/mixed areas like Noida (NCR-South East Delhi), Dwarka (South-West Delhi), Janakpuri (West Delhi), Kaushambi (East Delhi), Adarsh Nagar (North Delhi). These areas are densely populated which also serves to increase surface temperature. The lowest urban heat island effect was found in Sanjay Van-HauzKhasDistt Park zone (South Delhi) and Buddha Jayanti Park-Moti Nagar zone (North Delhi) due to the existing greenery and open spaces in these areas (Mohan, et al., 2009).

Vector borne diseases like Dengue have been found to disproportionately affect densely populated parts of Delhi like Shahadra (Centre for Infectious Diseases, 2012) Areas like Shahadra clearly require greater allocation of resources towards mosquito eradication. Additionally, low lying areas near the Yamuna river bed, are at disproportionate risk of water logging and therefore increased intensity of disease outbreak (Bhattacharya, et al, 2006). South Delhi has about 30 percent of Delhi's slum population and may therefore be more susceptible these disease outbreaks (Istyak and Kumar, 2010).

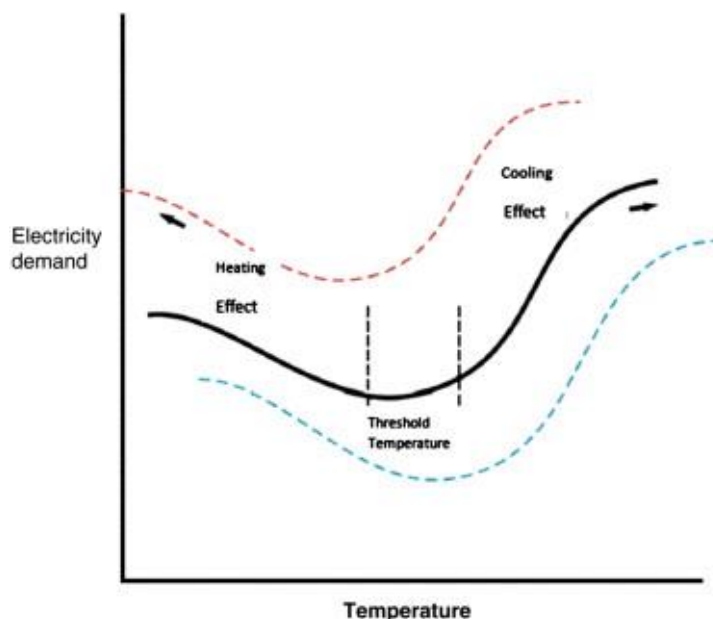
As can be expected, the concentration of Ozone is higher at busy traffic junctions. However as Ozone generally drifts towards periphery from city centre, the outskirts of Delhi may also be adversely impacted. This may hurt agricultural yield (concentrated in the periphery of Delhi), as ozone retards plant growth (CSE, 2009).

Adaptive Capacity: Mohan, et al. found that green spaces are more effective in reducing temperatures than water bodies. There are 7,784 hectares of forests in Delhi, with about 8,500 hectares earmarked for urban green spaces (parks, etc.) under the Delhi Master Plan 2021. (GNCTD, 2013)

There are legally binding guidelines to ensure hygienic non-mosquito genic conditions in Delhi. Municipal corporations in Delhi also have a large mosquito eradication initiative. Additionally there are various awareness campaigns in schools, college and mass media on protection from these vector borne diseases. There are several measures being undertaken to reduce vehicle load on Delhi's roads through incentivization of public transport, non-motorized transport, energy efficiency and cleaner fuel initiatives (National Urban Transport Policy, City Development Plan - Delhi).

There are about 5,185 medical institutions in Delhi, with about 44,995 beds. The doctor to population ratio in Delhi is 1:1,700 (Delhi Statistical Handbook, 2012), which is much lower than 1:1,000 recommended by the WHO (Mayor, 2008).

The expected change in climatic patterns will lead to a corresponding increase in expenditure in the public health sector. The health impacts of climate change would disproportionately affect low income families and populations living in low lying areas. There is an apparent lack of adequate public health, drainage and pollution control services, which may lead to a low adaptive capacity to these impacts. Planned improvements of the aforementioned services would be required in order to adapt to these impacts on health.



15.2.2 Energy

About 60% of India's power is generated through fossil fuels, leading to a large amount of carbon emissions and thus climate change. The generation is slated to increase with increased demand due to rise in temperature, thus leading to increase in long term climate change and shortage of electricity in the short term.

The annual per capita consumption of electricity in Delhi is around 1,615 units. The residential sector accounts for 45 percent of total electricity consumption in Delhi. A large majority of this is used to maintain thermal and visual comfort. Increasing temperatures may lead to increasing demand for maintenance of thermal comfort, which may lead to a shortage of electricity in Delhi (Gupta, 2011).

Exposure: This demand is slated to increase, with demand for maintaining thermal comfort due to projected rise in temperature. This may therefore lead to shortage of power supply and increased power cuts. A study (for Delhi) performed at the Indian Statistical Institute shows that a 1°C rise in temperature at 30°C (Gupta, 2011) is expected to increase annual electricity demand by over 5 Million KWh by 2015, 6MKWh by 2020, 7 MKWh by 2025 and 8 MKWh by 2030 (Gupta, 2011). This trend indicates an incremental increase in the demand for electricity in Delhi with rising temperatures. This means that a projected rise of 1.5-4 degrees Celsius can lead to enormous rise in electricity demand.

Sensitivity: According to the National Sample Survey Organization (NSSO) surveys, number of households owning an air cooler or an air conditioner doubled from 32.9% in 1993 to 60%

in 2009 in urban Delhi (which represents 97.5% of the total Delhi population as per Census 2011) while it increased from 20.6% to 26% in rural Delhi. In the case of refrigerators, this upward trend was even more impressive, with penetration increasing from 29% in 1993 to 61.3% in 2009 in urban Delhi and from 17.7% to 38% in rural areas. In the 2004–05 NSSO survey (which provides data on the ownership of air coolers and air conditioners separately unlike in the previous rounds) only 9% have access to air conditioners and only 58% to air coolers in Delhi. However, with increasing incomes, there is a very high probability that the total air conditioning electricity demand could increase substantially (Gupta, 2011).

These patterns imply that the growing middle class of Delhi would be most sensitive to increase in demand and a resultant shortage of electricity as they may not be able to afford expensive power back-up infrastructure. The shortage in power may lead to load shedding, causing discomfort and increasing the need for DG sets for those who can afford them. These may increase greenhouse gases, thus contributing to climate change (Gupta, 2012). The residents of affluent areas in Delhi, may be able to reduce their vulnerability to these changes due to their high adaptive capacity (access to power back-up). The lower rungs (about 52 percent of Delhi's population live in informal settlements with little to no access to electricity and other basic amenities) of society would therefore be most vulnerable to increase in temperatures and shortage of electricity.

Adaptive Capacity: There are efforts by the Indian government to encourage use of BEE star rated energy efficient appliances and lighting systems to reduce demand for electricity. There are also guidelines being put in place by the Delhi government to curtail energy use in the commercial sector during off-peak hours, these include recent plans to have differential pricing for peak and off peak hours for commercial enterprises that will incentivize energy conservation and reduce power cuts. There are also guidelines put in place by Energy Conservation Building Code (ECBC) to improve energy efficiency of building. Compliance with ECBC is slated to be compulsory for all new commercial building constructions. These measures if optimally implemented can reduce energy consumption by 40-60 percent. Buildings are also given tax and other incentives to use solar powered systems (water heater, etc), in terms of capital subsidy and property tax rebates. Additionally, awareness campaigns for energy conservation are being undertaken in Delhi (GNCTD, 2012). There are also a large number of renewable energy initiatives being undertaken by the Delhi government under the National Solar Mission and JNNURM. These include initiatives to promote the use of rooftop solar installations in order to supplement the supply of electricity from the grid. These policies and incentives can reduce the burden on fossil fuel generated electricity.

15.2.3 Water Resources

Fresh water is one of the most valuable natural resources in the world today. With supplies dwindling, the shortage of water is going to be a serious problem in coming decades. India has only ten percent of the worlds freshwater with about 17 percent of the world's population (Jackson, et al., 2001). This shortage of water will be particularly pronounced in urban India, with increasing strain on resources through population increase and rising temperatures.

Exposure: Delhi's water supply infrastructure has been studied as part of service level benchmarking carried out by the Ministry of Urban Development, Government of India. Water requirements in Delhi are 927 million gallons per day (MGD). The Delhi Jal Board (DJB) supplies 815 MGD (including around 100 MGD from groundwater). The deficit in drinking water supply is 112 MGD. The coverage of water supply was 71.6 percent of the population (Service Level Benchmarking Data book, 2010).

Availability of both ground and surface water sources in Delhi are also fast depleting. Depth to groundwater in Delhi varies from 1.2 meters (in the Yamuna flood plain) to more than 64 meters (in the southern part of the Delhi ridge). Groundwater levels in Delhi are declining with an average rate of decline as high as ten feet per year (south and south west Delhi) (Delhi Jal Board, 2010). Surface water comprises 86 percent of the drinking water in Delhi. The primary source of surface water is the River Yamuna along with other Himalayan rivers through several interstate arrangements and sub-surface sources of water (Delhi CDP, 2010). As temperatures rise, demand for water in Delhi will increase. This along with increased population will lead to depletion of reservoirs of water sources and increased economic and environmental costs of transporting water from sources at a greater distance from Delhi.

Increased intensity of rainfall may increase water run-off, which would lead to reduced infiltration and spring recharge (Delhi Jal Board, 2010). Shortage of power may also impede water supply in Delhi. Shortage in supply of water in Delhi is further complicated with leakage of 40 percent reported by Delhi Jal Board. On average, Delhi's households have access to tap water for only 13.5 hours a day (Service Level Benchmarking Data book, 2010).

Groundwater in Delhi was found to contain high amounts of nitrates and fluorides in addition to heavy metals in a recent study performed by NEERI. Increase in intensity of the monsoon may lead to increased runoff and therefore a reduction in water quality supplied in Delhi. Parts of the city are also susceptible to flash floods in periods of high intensity rainfall. This problem is compounded by low coverage of water treatment infrastructure and poor drainage facilities in most parts of Delhi. Water treatment plants currently in operation in Delhi are also severely affected during floods, which may lead to low water supply due to extreme deterioration in water quality and subsequent reduction in operational capacity of these plants. In addition, freshwater lines, which often run close to drains, are affected by "siphon effect" (intake of wastewater into freshwater system) due to low water pressure. This deterioration in water quality can also lead to an increase in spread of water borne diseases like Cholera (Kraus, 2009).

Sensitivity: Delhi's large slum population would be particularly affected by decreasing water availability because of limited access to basic services. Other areas of Delhi dependent solely on supply of groundwater are susceptible to declining groundwater levels throughout the city. Socio-economically backward areas of Delhi would be most affected by the shortage of water as they may not have enough water for basic daily domestic needs. The agricultural sector in Delhi would be severely affected as water scarcity may lead to a reduction in productivity and loss of livelihood. Dependence of water supply on power supply also complicates the issue of water scarcity in Delhi. Kraus, et al. 2009 has shown that informal settlements in Delhi are

most exposed to poor drainage systems. This is due to low coverage of freshwater lines in these areas and proximity of available lines to waste water sources. Populations living in such settlements are also largely socially and economically disadvantaged and therefore cannot seek to augment or improve their water supply through bureaucratic lobbying. More affluent areas of Delhi, South and Central Delhi for example have better, well-organized water supply as they have the social and economic means to augment their water supply in periods of shortage (summers).

Adaptive Capacity: There are currently programs being implemented to improve efficiency of water supply, increased wastewater treatment and methane capture (from sewage treatment plants) as part of the city development plan. These initiatives are aimed at optimizing use of water in Delhi to ensure availability of water for decades to come. The Delhi government has also mandated rainwater harvesting for all constructions of more than 200 sq. yards (GNCTD).

There are also demand side management practices, aimed at incentivizing conservation of water through awareness initiatives and differential pricing of water across different sectors of Delhi. Water pricing is a major issue currently being addressed by the Indian government. An efficient water pricing mechanism, perhaps managed through public-private partnership would help ensure efficient use of water and curtail wastage (CDP, 2010).

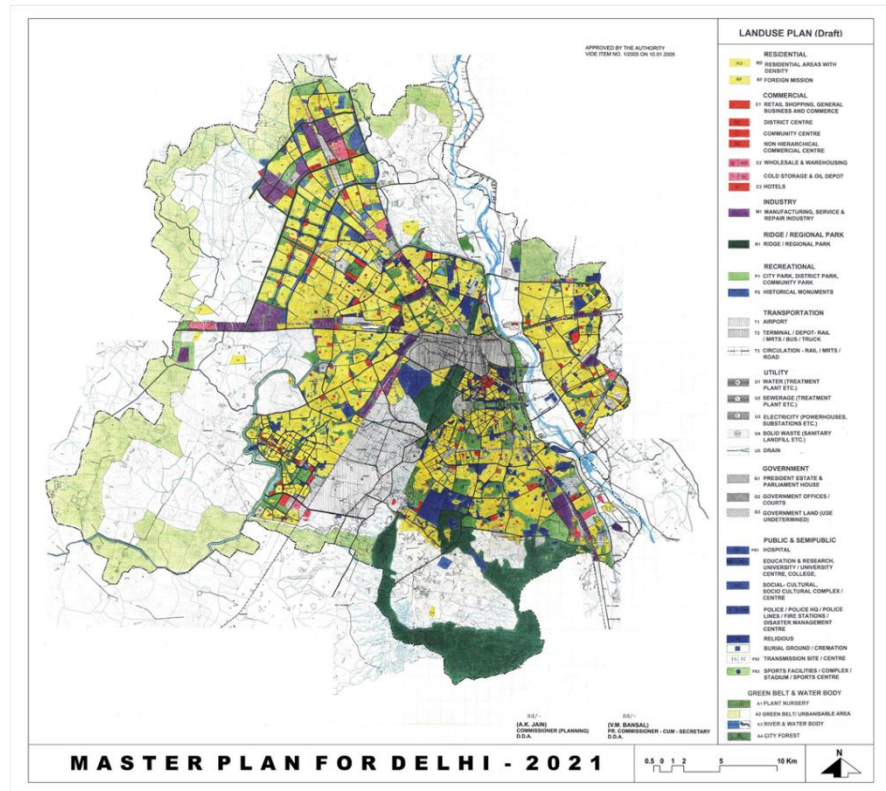
Delhi government has planned to upgrade treatment facilities that have become highly inefficient. Service level benchmarking initiative of the government of India also requires higher penetration of water supply and sanitation services provided by local bodies. The National Water Mission and National Mission on Sustainable Habitat, aim at optimizing water supply and quality. Climate change may result in reduced water availability and deteriorate water quality. This would disproportionately affect low-income families and informal settlements. The government has planned optimization and improvement of available water supply and treatment services. This is in addition to incentivisation of conservation efforts like rainwater harvesting. The implementation of the above interventions along with demand side management of water is essential for adapting to the above impacts.

15.2.4 Urban Planning

Three urban systems that have been taken into consideration as part of urban planning, these include: (a) Land Use, (b) Infrastructure, and (c) Solid Waste Management.

(i) Land Use: Over the last 50 years there has been large-scale urbanization in most mega cities in India. This trend is likely to continue with the economy growing and with most of the growth in cities, rural-urban migration is set to increase population and therefore leads to further urbanization. The figure below (Delhi Master Plan, 2021) illustrates the land use plan for Delhi, which has been designed to optimize the inter relationship between the urban activities, environment and the image of the city.

Exposure: Delhi is perhaps the most affected by rapid urbanization, with its population growing at 4.1 percent every year, the highest of any megacity in India (Taubenbock, et al., 2008). This can mostly be attributed to the rural-urban migration that has led to changes in Delhi's land use pattern. With Delhi's economy growing at over ten percent per annum this trend is likely to continue the



increase in urbanization has led to a corresponding decrease in space available for other land use like agriculture. Climate change may further exaggerate the trend of land use change with temperatures rising that might lead to degradation of forests and decrease in productivity of agriculture. Thus incentivizing further urbanization (National Climate Centre, 2011).

Sensitivity: Forest and agricultural land would be the most sensitive to changes in climate and land use, which may lead to a decrease in the moisture available for growth of plants and may therefore lead to degradation of these lands. This may lead to the use of this land for the purposes of building urban housing (National Climate Centre, 2011).

Adaptive Capacity: Several initiatives have been undertaken by the GNCTD to spread awareness about the importance of planting trees. These campaigns have been widely supported by corporate social responsibility initiatives by Indian corporate enterprises. Agricultural activities taking place in the rural outskirts of the city have also been incentivized through the use of sustainable agricultural practices and other incentives. This would help sustain agriculture as a source of livelihood and reduce rural-urban migration.

Land use changes due to rapid urbanization may be exaggerated by climate change. Change in land use would disproportionately affect agricultural and forest land. The government, under

the National Green India Mission is incentivizing the increase of green cover in Indian cities. This is in addition to crop varieties suited to the changing climate. These measures, if implemented as part of a well-defined urban planning strategy may help adapt to the aforementioned impacts of climate change.

(ii) Infrastructure: To keep up growing pace of GDP growth as mentioned in the eleventh five-year plan and to cope with the rate of population increase, studies estimate that investments in physical infrastructure are slated to grow at 20 percent per annum. In 2011-12 there were INR 6 trillion spent on infrastructure development. The most critical infrastructure include telecommunications, electric power, gas and oil storage and transportation, water supply, banking and financial services, emergency-service institutions, including hospitals, police stations, fire & rescue departments and government institutions (Planning Commission Working Group on Infrastructure, 2011).

Exposure: A large majority of infrastructure is in urban areas where majority of the population resides. Delhi has one of the highest per capita expenditure on infrastructure of all states in India, with INR 700 billion being spent for preparations for commonwealth games alone (GNCTD). The annual plan outlay for 2012-13 in Delhi was about INR 150 billion (Delhi Budget, 2013). A large chunk (22%) of this money was spent on physical infrastructure like transportation. This physical infrastructure may be susceptible to increased wear tear from high intensity rainfall that may reduce the lifetime of infrastructure (Mellilo, et al., 2010).

Sensitivity: Damage to infrastructure will affect Delhi as a whole, as it would serve to slow the rate of economic and social growth. The transport sector would be particularly impacted as most of the investments in physical infrastructure are in this sector. Roads and bridges being constructed as part of the development plan of Delhi may be susceptible to increased intensity of rainfall (CICERO, 2011).

Adaptive Capacity: The government is incentivizing the construction of green buildings, which encourages resource efficiency, and the use of locally sourced materials (GNCTD, 2012). There are however, no guidelines implemented to ensure long term resilience to impacts of climate on buildings.

Changing climate patterns would serve to reduce lifespan of existing infrastructure and delay the growth of incremental infrastructure. Old infrastructure and infrastructure dependent on external raw materials would be disproportionately affected by these impacts. The rate of infrastructure development may be slowed down due to rising prices of materials involved in construction of these infrastructure services (Mellilo, et al., 2010). More widespread implementation of sustainable supply chain practices and construction of climate resilient infrastructure would help adapt to these impacts of climate change.

(iii) Solid Waste Management– 69 million tons of solid waste is generated every year in Indian cities. In most cities across India infrastructure available for SWM is lacking, leading to problems like increased spread of diseases, deterioration of water quality and reduction in aesthetic quality of the cities.

Exposure: There is a large amount of uncovered exposed waste in the city. According to the service level benchmarking data book, about 20 percent of the waste generated in the city remains uncollected. The collection and transport of waste may be hurt further with climate change induced fuel price rises. The waste management systems may also be susceptible to high intensity rainfall, as the uncollected waste may clog uncovered drains as well as contaminate groundwater (US EPA, 2013). This could cause an increase in incidences of vector borne diseases in addition to degradation of aesthetic quality of the city of Delhi. Treatment of waste through bacteria may also be affected with increasing temperatures and humidity in the atmosphere. This may cause sub-optimal results in composting and bio-methanation units throughout the city (Patel, 2002)

Sensitivity: Low-lying areas that are more vulnerable to flash floods may be more vulnerable to failures in solid waste management systems. These areas would be at higher risk of increased incidence of infectious diseases. The waste treatment facilities in these areas may also get flooded and therefore cause breakdown of the solid waste management services (Talyan, et al., 2008).

Adaptive Capacity: There have been efforts to streamline collection and transportation of solid waste, through privatization of these services in Delhi. There are now two functioning waste to energy plants in the city of Delhi. These help augment energy supply and reduce waste in the landfill. The privatization programs also include awareness campaigns for waste segregation and suitable waste management practices in the capital. There are also national policies like the National Sustainable Habitat Mission in place that aim at increasing the spread of sustainable solid waste management practices.

Solid waste management services would be impacted by climate change. Low income households and low lying areas would be disproportionately impacted by these changes. The government plans to implement integrated solid waste management services, including basic services and promotion of waste to energy projects in all cities across India as per the National Mission on Sustainable Habitat. Widespread implementation of the aforementioned interventions in a climate resilient manner would help better adapt to these impacts.

15.2.5 Transport

The transport sector in Delhi is responsible for 30.05 percent of all greenhouse gas emissions. The rate of increase in the number of vehicles exceeds the rate of population growth by four times. This number is set to increase with the increase in population and the standards of living.

Exposure: The increase in the number of vehicles has led to the construction of transport infrastructure, including public transport. Delhi also has the most extensive transport network of any Indian city with about 21 % of its geographical area covered by motorways (City Development Plan, 2010). The change in climate, i.e. rise in temperature and increased intensity of rainfall can lead to a reduction in the lifespan of these systems. High temperature and rainfall can affect sensitive materials that may lose its stability rendering the systems unsafe for use. This can lead to huge losses in public expenditure. There is therefore a need to plan for the

impacts of climate change on the transportation infrastructure. This includes rails, roads, waterways and airport/aircrafts (CICERO, 2011).

Sensitivity: This includes roads and bridges that would be severely affected by the increase in rainfall intensity (increasing traffic congestion and wear and tear). This may lead to increased travel time and increased expenditure for repair of traffic infrastructure (CICERO, 2011). The rising greenhouse gas emissions are also known to be corrosive and may damage existing infrastructure (Kumar, et al., 2012). It has also been found that extreme rainfall events can lead to increase in the number of road accidents (Millelo, et al., 2010)

The old infrastructure (roads and bridges) in the city would be disproportionately vulnerable to increasing temperature and high intensity rainfall. The busier roads in the city, with inadequate drainage infrastructure would be at risk of submersion from the high intensity rainfall, this may disproportionately affect low lying areas in the city (US EPA, 2012). The high traffic flows may also lead to increased accidents during intense rainfall due to reduced visibility (US EPA, 2012).

Adaptive Capacity: There are several efforts being made to incentivize non-motorized transport in various small and medium sized cities across the country. In Delhi these efforts include a massive mass transit system in the form of the Delhi Metro, changing fuel input in buses from diesel to CNG, other measures to incentivize public transport like Bus Rapid Transport systems. This is in addition to subsidies provided by the government for the use of electric vehicles. These efforts will serve to optimize land use in transportation, lower emissions and reduce traffic congestion. The national mission on sustainable habitat aims to improve storm drainage in Indian cities. There is however a need to integrate the impacts of climate change into transport planning.

There are currently very few measures being undertaken by the government to adapt to these changes. To adapt to these changes, transport infrastructure needs to be designed in a climate resilient manner, so as to reduce traffic disruption and make travel safer.

15.2.6 Forest, Biodiversity and Agriculture

The area of Delhi under agriculture has declined steadily to 23 percent of the total geographical area in 2010 from more than 30 percent about a decade ago. The crop intensity of the state has also seen a decline in the past few years (Delhi Economic Survey).

Although there has been an increase in the forest area in Delhi, this forested land may be at risk from changes in temperature and rainfall patterns. These may serve to cause degradation of the forests in question. The changing pattern of green spaces and built up area in the city of Delhi has led to a change in the biodiversity. These changes may be further exacerbated with the increasing rate of urbanization and population increase that is projected for the city-state of Delhi. Changes in weather patterns would also serve to intensify loss in biodiversity (National Climate Centre, 2011).

Impacts on Agriculture: Exposure: Agriculture accounts for a very small proportion of Delhi's economy, however about a fourth of Delhi's area is covered by agricultural land. This land has continuously diminished in the past decade largely due to urbanization. The major crops grown in the Delhi area are wheat, barley, jowar, bajra, maize, paddy, gram, potato, sugarcane. The growth and productivity of these crops is vulnerable to the changes in temperature and rainfall intensity as projected for Delhi (Haris, et al., 2013). The table (Delhi Statistical handbook, 2012) below illustrates the land share of the various crops grown in Delhi.

Sensitivity: A large majority of the agricultural land in Delhi is in the Yamuna flood plains that will be particularly vulnerable to flash floods as discussed, which will make this part of Delhi more vulnerable to impacts of climate change on agriculture. The change in weather patterns may also serve to reduce productivity of the land in Delhi. The productivity of land already shows a declining trend. This trend may be exacerbated due to increases in temperature and more intense rainfall. The reduction in productivity in Delhi's agriculture would also mean an increase in expenditure in transportation of food products to the capital. This is in turn a source of greenhouse gas emissions.

Adaptive Capacity: IARI located in Delhi is working on crop varieties that are resistant to change in climatic patterns (IARI, 2012). This is in addition to the spread of kitchen/terrace gardens in the city of Delhi, which contributes to sustainable organic food sources for the citizens of Delhi (GNCTD, 2012).

Impacts on Forests & Biodiversity

Exposure: The changing land-use patterns due to rapid urbanisation in Delhi will impact the biodiversity severely in Delhi. This may lead to the degradation of ridge and loss of native biodiversity, both of which may be further influenced by changing climate patterns. All these may lead to ecological instability and environmental deterioration which in turn results in loss of resilience (Khera et al., 2009).

Sensitivity: A study performed by National Climate Centre in 2011 has shown a decrease in the moisture index in Delhi. This means that Delhi's land is becoming increasingly more arid. This trend may serve to change plant growth patterns and therefore affect biodiversity. Climate change has been found to increase the incidences of ecological disturbances like wild fires and insect outbreaks (Dhote, 2012).

Adaptive Capacity: The forest area in Delhi has continuously increased in the past ten years and more green spaces are planned as per Delhi's City Development Plan. This would add to the recently developed biodiversity parks in the city of Delhi (CDP, 2010). The green spaces are also being designed to encourage floral and faunal biodiversity, which would aid in improving the ecological health of the city-state of Delhi (Khera, et al., 2009). The table (Delhi Statistical Handbook, 2012) below provides a description of the forest areas present in the various parts of Delhi. The table illustrates that a large majority of forested land in Delhi is concentrated in South Delhi, with low concentrations in North and East Delhi. These parts of

Delhi (North and East) may be more vulnerable to the impacts of climate change and are in need of public and private interventions for afforestation initiatives.

Biodiversity Parks and flood plain forests and grasslands interspersed with wetlands and greenway along 52 km stretch of river Yamuna and Biodiversity enrichment of Ridge will not only be mitigative and adaptive to climate change but also climate resilient.

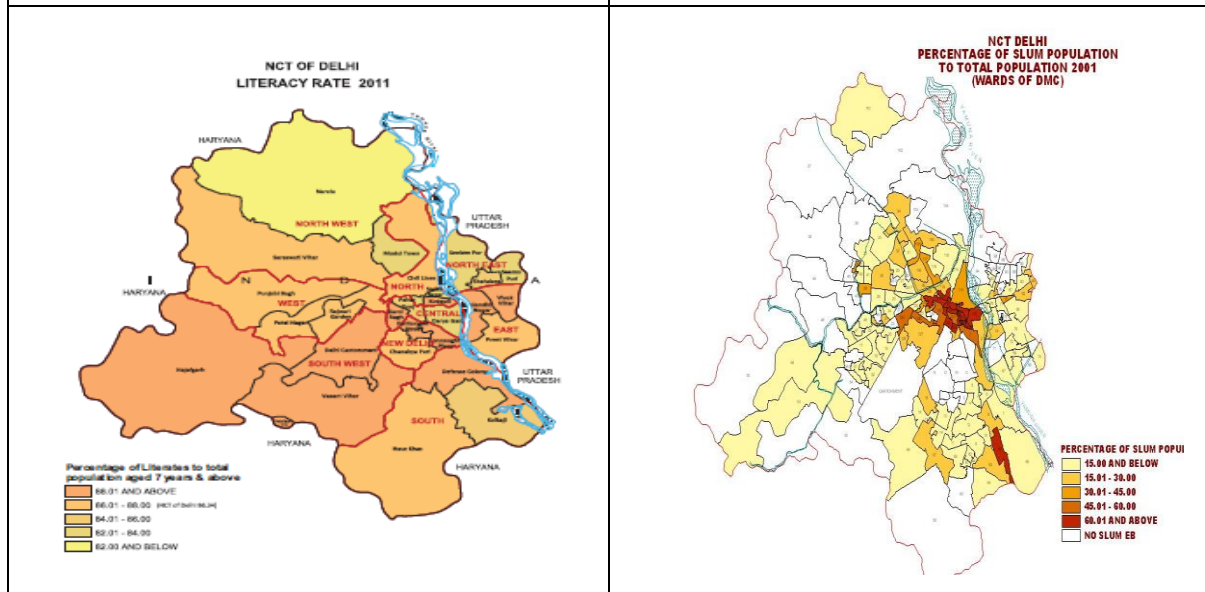
Table 84: Distribution of Forests in Delhi

District	Geographical Area	Very Dense Forest	Moderately Dense Forest	Open Forest	Total
Central Delhi	25	0	2.23	2.82	5.05
East Delhi	64	0	1.14	1.85	2.99
North-East Delhi	60	0	1.12	2.98	4.1
North-West Delhi	440	0.11	7.33	9.05	16.49
New Delhi	35	1.67	5.53	9.11	16.31
North Delhi	59	0	2.99	1.82	4.81
South-West Delhi	421	2.37	12.7	26.73	41.8
South Delhi	250	2.61	13.62	62.09	78.32
West Delhi	129	0	2.82	3.51	6.33
Total	1483	6.76	49.48	119.96	176.2

Figure 20: Vulnerability Maps: An intersection of the following data is used to construct this map

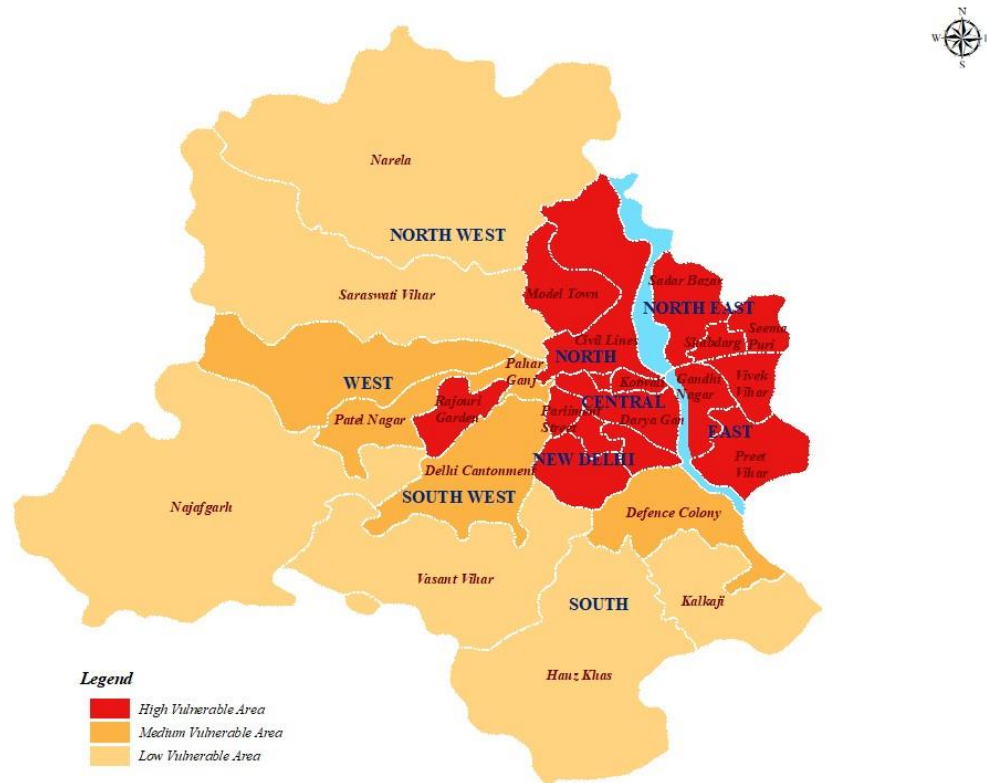
<p>Density of Population – The Density of population lends a fair approximation of the exposed population in a given area (Census, 2011)</p>	<p>Decadal Growth of Population – The trend of population growth provides an estimation of future population densities of a given area, thus exposure of the area (Census, 2011)</p>
<p>Literacy Rate – The distribution of literacy rate would provide an indirect indicator of adaptive</p>	<p>Distribution of Slum Population (Census, 2001). The 2011 census shows similar trends of slum population concentration in Delhi (Census, 2011)</p>

capacity to the impacts of climate change (Census, 2011)



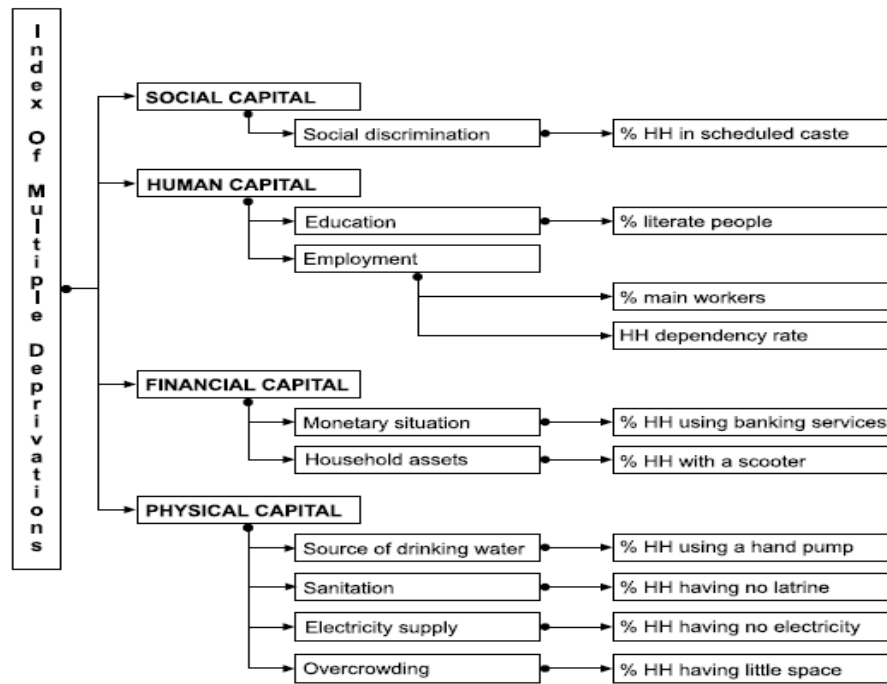
Flood Prone Areas – Propensity to flood may serve to increase the vulnerability of a given area to impacts of climate change. According to the Delhi flood control order, Delhi has been divided into four flood sectors. These include Shahadra, Wazirabad – Babrapur, Alipur and Nangloi – Najafgarh (Census, 2011).

The intersection of the highly sensitive areas, i.e. high population density, high decadal growth of population, low literacy rate and high slum population concentration was used to design the map given below. The map below however does not include any ground truthing (primary data collection) therefore is only an indicative representation of the sensitive areas of Delhi.



These parameters serve to provide a fair interpretation of the highly vulnerable areas in Delhi. The areas marked in the map above are sub-administrative districts. A common feature for all of these areas is their proximity to the River Yamuna. As mentioned in the sections above, these low lying areas are disproportionately sensitive to most of the impacts. This map could be improved significantly with the help of more detailed/current data, especially about the urban infrastructure (drainage/embankments) present in the low lying areas of Delhi. In addition to more detailed socio economic data, the study below attempts at drawing more detailed inferences.

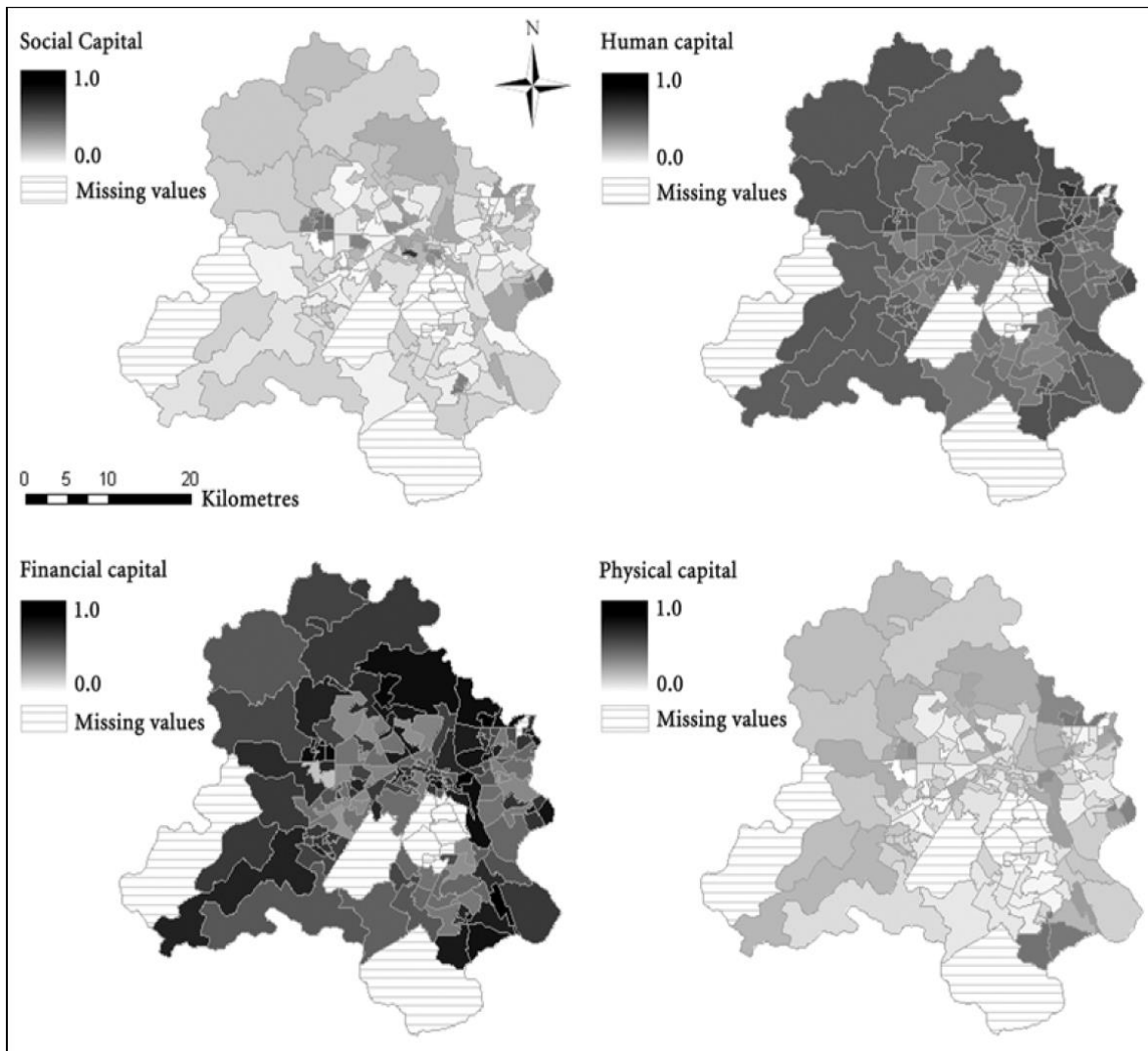
As stated in the methodology, a combination of social capital, human capital, financial capital and physical capital is used to assess the adaptive capacity of the city of Delhi. These four are analyzed together to form the index of multiple depravity. The figure below describes the method of quantification for the four phenomena.



- a) Social capital is defined as a function of social discrimination (defined by the percentage of scheduled caste households in Delhi).
- b) Physical capital is defined by sources of drinking water (percentage of households with hand pumps), Sanitation (percentage not having latrines), Electricity supply (percentage having no electricity) and overcrowding (percentage living in little space).
- c) Human capital is defined by Education (percentage of literate people) and Employment (percentage of main workers and household dependency rate).
- d) Financial capital is defined by monetary situation (percentage of household using banking services) and household assets (percentage of households having at least a scooter)

The study by Baud, et al, 2009 has attempted to quantify these measures of adaptive capacity, the results are given below. Although there are areas of Delhi where the data is not available, the map below gives an indicative assessment of the adaptive capacity in the various administrative sub- districts (wards) of Delhi.

According to these maps, Delhi is most deprived in financial and physical capital, with deprivation higher in areas with higher slum population concentration. These areas of high informal settlement are also the ones affected by high multiple deprivations. The areas affected the most by multiple deprivations of adaptive capacity include – Mangolpuri North, Mangolpuri South, Gokulpuri and Kondli (Baud, et al, 2009). Kondli and Mangolpuri are administrative wards are low lying areas, in the vicinity of the Yamuna River, this is consistent with the first vulnerability map. Mangolpuri and Gokulpuri are resettlement colonies comprising mostly of former slum dwellers which can explain the multiple deprivations in these areas.



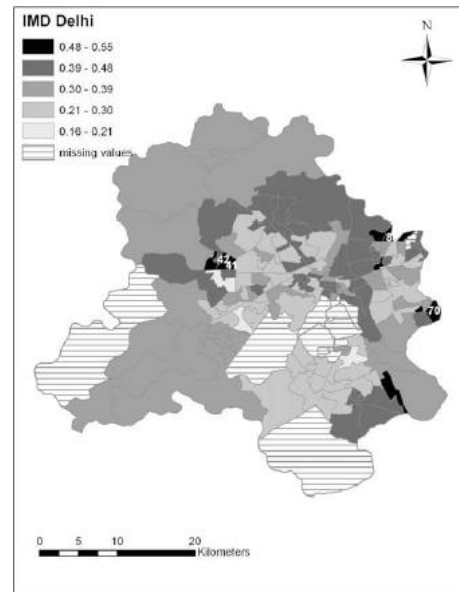
The deprivations are rated from zero to one, with one being the most deprived. The figure below illustrates the index of multiple deprivities (IMD) in Delhi (Baud, et al, 2009).

This study can therefore be used as a quantitative (indicative) assessment of adaptive capacity in Delhi that can be helpful in efficient appropriation of funds for climate change adaptation.

Climate-resilient Ecological System in Delhi

It has been demonstrated that biodiversity rich (species rich) ecosystems are climate resilient. For example, some of the temperate grasslands are climate resilient³². Preservation of species rich ecosystems, restoration of degraded ecosystems, biodiversity enrichment of depauperated forests and recreation of lost natural heritage in urban centres not only provide mitigation and adaptation to climate change but also ensure climate resilience.

Delhi city has a network of species rich Biodiversity Parks which are unique landscapes, where 100s of plants, microbes and animals live together in the form of biological communities. These Biodiversity Parks provide a wide range of ecological services and goods to the citizens of Delhi ranging from storage and recharge of flood waters, clean air, regulate storm water and combat desertification ad others. The Biodiversity Parks have also conservation, cultural and educational values. Presently the network of Biodiversity Parks spreads over 1500 acres. There is a proposal to develop 26250 acres of Riverfront of Yamuna river and its flood plains into a mosaic of wetlands, floodplain forests and greenways. This will be also a part of network of Biodiversity Parks.



The six Biodiversity Parks of DDA are:

- (i) the Yamuna,
- (ii) the Aravalli,
- (iii) Neela Hauz,
- (iv) the Tilpath Valley,
- (v) the Northern Ridge
- (vi) Tughlakabad;

Of these 6 Biodiversity Parks, Yamuna and Aravalli Biodiversity Parks are fully functional and become Nature Reserves of Delhi and simulate National Parks/ Wildlife Sanctuaries/ Wilderness. The protected forests of Ridge and city forests constitute major greens that can also be made climate resilient through biodiversity enrichment. The Asola and Bhatti Wildlife Sanctuaries of Government of NCT Delhi are also highly degraded and can be made climate resilient through habitat improvement and biodiversity enrichment.

DDA's greens, particularly urban parks can be made climate resilient through re-designing, restoration and biodiversity enrichment. Similarly the greens of Municipal Corporation

³² Zwicke M, Picon-Cochard C, Morvan-Bertrand A., Prud'homme M.P. Volaire F.(2015) What functional strategies drive drought survival and recovery of perennial species from upland grassland? *Annals of Botany*, 116: 1001-1015.

particularly large Parks/ Gardens can also be made climate resilient through biodiversity enrichment.

Action plan proposed for development of climate resilient ecological systems in Delhi State:

- Integrating the existing green spaces into large landscape units by linking them through greenways/ green corridors. Such ecologically integrating landscape units are known as Green Circuits. A Report on Green Circuit is being finalized and will be submitted to DDA for implementation. This will act as protective shield against desertification, and mitigate and adaptive to climate change.
- Greenways with 3-tier vegetation all along 52 km stretch of Yamuna river front will be undertaken, to enhance the green cover that buffer temperature and ameliorate environment.
- Floodplain forests and its wetlands will be restored to regulate floods and enhance availability of water resources.
- Restoration and biodiversity enrichment of Ridge protected forests, city forests and woodlands and urban parks will be carried out to ensure that the urban ecosystem will be resilient to climate change.
- More degraded areas will be brought under Biodiversity Parks for enhancing climate resilience of urban ecosystems.

Short term strategies include Protection of existing notified forest from encroachment; Increased Green cover; Involvement of Civic Agencies for enhancement of tree cover; free distribution of seedlings to public for planting; Involvement of all stake holders in raising awareness; Eradication of invasive species of weeds. Whereas, Long term strategies includes, Bringing at least 25% geographical area under green cover; Manipulation of species composition to increase tree cover of indigenous tree species; Creation of more urban greens as carbon sinks; Habitat restoration by plantation of indigenous hardy species; Protection of catchment areas of water bodies.

Delhi is a non-coastal city and is not affected by sea level rise, it is however affected by changes in temperature and rainfall patterns, along with extreme weather events. The effect of these impacts is amplified due to the rapid increase in high range of population size and resource utilization in the city of Delhi. Utility services like water resources and energy would be most affected by local and global climate change, due to the high dependence of the population on these resources and the scarcity that follows. The government should therefore take planned measures for demand and supply side management of resources. This is in addition to planned increases in adaptive capacity and development of technological and institutional infrastructure to better deal with the impacts of climate change.

Table 85: Sectoral Policy and Infrastructure Oriented actions

Sector	Institutional/Policy Actions	Infrastructure Actions
Health	<ul style="list-style-type: none"> ● Increased penetration of awareness campaigns on hygiene, healthy practices, sanitation & spread of communicable diseases ● Incentivizing/supporting on-going research on Dengue/Malaria vaccine ● Better enforcement of command and control mechanism for polluters ● Alert system against viral infections and water pollution ● More efficient air pollution monitoring and warning systems 	<ul style="list-style-type: none"> ● Increasing number of hospitals and improving facilities in existing hospitals, especially for the poor and citizens living in slum areas ● Setting up of Mohalla Clinics ● Improve/supplement water and drainage/supply/treatment infrastructure in the city in order to reduce water stagnation and incidence of water borne diseases ● Increase the coverage of green spaces in Delhi in a planned manner, so as to reduce urban heat island effect
Energy	<ul style="list-style-type: none"> ● Increasing intensity of awareness campaigns on the importance and methods of energy conservation - demand side management in Delhi ● Organize larger number of training initiatives and academic courses for energy audits and energy efficient practices ● Provide subsidies and incentives for conducting energy audits in residential and commercial buildings all over the city ● Creation of resource centers to improve the implementation efficiency of subsidies/incentives for renewable energy like solar, biomass, small hydro and wind energy technologies to ensure large-scale impact of these technological interventions. ● Reduce subsidies on fossil fuels in order to incentivize the use of energy efficiency/renewable energy measures and reduce dependence on such inputs. 	<ul style="list-style-type: none"> ● Increase the proportion of power generation through waste to energy technologies ● Transmission and Distribution losses should be minimized. ● Increase dependency on non-fossil fuels i., solar energy than on fossil fuels,
Water Resource	<ul style="list-style-type: none"> ● Intensification of awareness campaigns about demand side management of water resources through conservation practices ● Organizing larger number of training initiatives to train professionals in the use of water efficient technologies, this will help in building capacity for the sector 	<ul style="list-style-type: none"> ● Planned improvement of drainage facilities all over the city to avoid water logging. ● Protection of water bodies around the city. ● Construction of rainwater

	<ul style="list-style-type: none"> ● Incentivizing the use of water efficient technologies in commercial and residential buildings in Delhi ● Proper design of sewerage and freshwater pipelines to avoid “siphon effect” ● Re-balance rights between irrigation needs and urban consumer needs, to optimize water supply. ● Early warning systems to be established in the event of flash floods, which affect water infrastructure and therefore water quality and availability. ● Use of STPs coupled with bioremediation technologies for reuse of waste water ● Flood plain restoration and protection ● Wetlands protection and restoration 	<p>catchment ponds.</p> <ul style="list-style-type: none"> ● Mandatory rain water harvesting in plots about 500 sq mt with rebate in water bill. ● Groundwater regulation and management with metering and pricing ● Mandatory decentralized wastewater treatment and reuse of treated waste water. ● Imposition of Penalty on waste disposal in the river and on its banks ● Action plan for restoration and protection of flood plains of river Yamuna ● Action plan for restoration and protection of wetlands
<p>Urban Planning</p>	<ul style="list-style-type: none"> ● Reduced dependency on foreign markets for raw materials and energy needs (Infrastructure) through renewable energy initiatives and incentivization and awareness/capacity building for the use of sustainable procurement methods. ● Better planning and maintenance of green spaces throughout the city (Land Use) ● Spread awareness about waste management practices – collection, disposal, segregation, etc (SWM) ● Incentivize research in waste to energy technologies more suited to characteristics of Indian waste (un-segregated, low calorific value) ● Considering the impacts of climate change on waste treatment/collection/disposal, etc while designing a strategy for solid waste management ● Encourage/incentivize sustainable agricultural practices (Land Use) 	<ul style="list-style-type: none"> ● Open source GIS resources should be available for planner/developers/researchers to optimize urban planning ● SWM also offers opportunities to secure energy sufficiency in the coming decades through waste to energy and bio-methanation initiatives, which can be implemented with the help of a sustainable integrated solid waste management plan ● Designing climate resilient infrastructure (keeping in mind possible impacts of climate change) – roads, bridges, buildings, etc. (Infrastructure) ● Integrated solid waste management– that would optimize solid waste management and provide room for constructive use of municipal solid waste (SWM) ● Environment service zones at

	<ul style="list-style-type: none"> ● Uniform development of adjacent areas to dis-incentivize migration (Land Use) 	zonal level.
Transport	<ul style="list-style-type: none"> ● Integrating transport in urban planning ● More stringent enforcement of traffic laws, including pollution control legislations ● Incentivizing fuel efficient public and private transport ● Incentives for the development of new cleaner transport technologies (R&D grants, technology transfer, etc) ● Increased intensity of awareness and capacity building initiatives for the use of non-motorized and public transport ● Build sustainable transport infrastructure with the help of locally sourced/climate resilient materials. ● Parking provisions in new construction, to reduce congestion 	<ul style="list-style-type: none"> ● Better road signage and lighting to aid visibility and avoid accidents ● Intelligent transport system to inform travelers about delays and diversions before hand ● Improve maintenance/coverage of drainage system for discharge of storm water in case of high precipitation to avoid traffic congestion.
Agriculture and horticulture	<ul style="list-style-type: none"> ● Promotion of organic farming reducing dependence on chemical fertilizers and pesticides through government mandated decentralized/centralized waste composting facilities. ● Increasing awareness and training dissemination of sustainable practices in agriculture ● Providing insurance for crop failure ● Initiating review of subsidies to pesticides and fertilizers and subsidies to organic agriculture ● Promotion of less water intensive hybrid crops ● Awareness programs for farmers and stakeholders to avoid crop-burning instances in and around Delhi's agricultural fields. ● Implementation of NGT order on prohibition of crop-burning. ● Organizing awareness campaigns for sustainable use of organic fertilizers and insecticides/pesticides 	<ul style="list-style-type: none"> ● Development of temperature resistant, flood and drought resistant varieties of crops ● Research and training centers for producing natural/ organic fertilizers and pesticides

<p>Forest, and Biodiversity</p>	<ul style="list-style-type: none"> ● Promoting recycling of paper ● Enhancing public participation in afforestation activities. ● Green spaces can be designed in a manner that will optimize biodiversity conservation. ● Replenishment Policy for mature trees. ● Demarcation and protection of ridges areas Enhancement of green cover and development of green circuits (greening at central verges, urban landscaping, development of vertical gardens at metro pillars, flyover pillars, and other public places). 	<ul style="list-style-type: none"> ● Promoting afforestation in urban areas with public participation. ● Demarcation of ridges areas as per PERT Chart ● Creation of more city forests. ● Replenishment Policy for mature trees. ● Better Monitoring infrastructure to help plan for biodiversity conservation activities ● Biodiversity enrichment of Ridge, development of greenways along 52 km stretch of river Yamuna, open spaces and vacant lands, and development and management of additional Biodiversity Parks.
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16. Agriculture and Horticulture

The Delhi is primarily a city State having geographical area of 1483 Sq. Km, out of which the area under Agriculture and Horticulture activities is 45,000 Hectare as per the Agriculture Census 2010-11. The 85% area under agriculture is irrigated and 15% area is under rain-fed.

There are 20,000 nos. farming family in Delhi comprising of small, marginal, medium and semi-medium and large farmers. The contribution of agriculture in the State GDP is about 1%. The major challenge posed before the entire world today is the climate change or global warming. Several countries have initiated various measures to counter global warming. It has been estimated that due to continued human modification of the atmosphere the rate of future global warming over the period 1990-2100 would be about 0.20 degree celcius per decade, which stands some five times the mean rate of warming over the past hundred years. During the early nineties, the Intergovernmental Panel on Climate Change (IPCC) had forecasted a worldwide negative impact of climate change on agriculture sector with less adverse effects on crop yields in mind and high latitude regions than such effects in low latitude regions. The warmer areas would witness decline in potential yields due shortening of crop growing period, decrease in water availability owing to higher rate of evapotranspiration, and poor vernalisation of temperate cereal crops.

16.1 Current Status of Agriculture and Horticulture

The Delhi comes in northern plains of India. The season wise crop pattern/major crops of Delhi are as under:-

Table 86: Season wise crop details

Sr. No.	Season	Name of Agri-Horicultural Crops
1.	Kharif (May to October)	Paddy, Bajra, Arhar, Kharif Vegetables
2.	Rabi (October to April)	Wheat, Mustard, Vegetables, Flowers
3.	Summer (March to June)	Summer Pulses, Fodder, Vegetables

About 20,000 families consisting of 90% small and marginal farmers are cultivating about 45,000 hectare land in rural area of Delhi. The aim of the unit is to provide Hi-tech/technical knowhow for increasing production and productivity of agriculture crops by supply of sludge, organic manure, compost and wormicompost etc. Many countries in the World are utilising each drop of water from sewage treatment plants, as its saves potable water for drinking. But, Delhi is not able to do so because large treatment plants installed.

The development department of GNCTD is looking after Agriculture division. Utilization of land in Delhi is mixed use. Below table 90 provides the different land use patter over the years.

Table 87: Utilization of Land in Delhi (In Hectares)

S. No.	Classification	2009-10	2010-2011	2011-2012	2012-2013	2013-14	2014-15	2015-16	2016-17
1	Area according to Village papers (Excluding forest area)	147,488	147,488	147,488	147,488	147,488	147,488	147,488	147,488
2	Area not available for cultivation	91,425	92,700	90,875	91,058	92,701	92,701	92,701	92,701
(a)	Land put to Non-agricultural uses	75,361	76,218	74,855	75,054	76,218	76,218	76,218	76,218
(b)	Barren Uncultivated Land	16,064	16,982	16,064	16,004	16,482	16,482	16,482	16,482
3	Other Uncultivated Land excluding fallow land	11,144	11,144	11,144	11,144	11,124	11,124	11,124	11,124
(a)	Permanent Pastures and other grazing land	61	61	61	61	61	61	61	61
(b)	Land under Misc. Tree crops and groves not included in net area sown	1,190	1,177	1,190	1,190	1,170	1,170	1,170	1,170
(c)	Cultivable waste land	9,893	9,913	9,893	9,893	9,893	9,893	9,893	9,893
4.	Fallow Land	19,227	20,043	19,234	19,230	19,225	19,225	19,225	19,225
5.	Net Area sown	23,575	22,124	22,885	23,118	23,150	23,150	23,150	23,150
6.	Area sown more than once	10,125	9,223	13,560	12,060	11,590	11,590	11,590	11,600
7.	Total Cropped Area	33,700	31,366	36,445	35,178	34,312	34,312	34,312	34,750
8.	Forest								
(a)	Forest Area under DDA	1,281	1,281	1,281	1,281	1,281	1,281	1,281	1,281
(b)	Notified Ridges Area	7,784	7,784	7,784	7,784	7,784	7,784	7,784	7,784
(c)	Under Forest Deptt. Forest	388	388	388	388	388	388	388	388

	Area, Except Ridge Area								
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(Source: Delhi Statistical Handbook 2017)

16.2 Existing Concerns in Agriculture and Horticulture

Agriculture and climate change are inextricably linked, the changing climate affect the following directly i.e. Crop yield, Crop Biodiversity, Water use and Soil health. Climate change, which is largely a result of burning fossil fuels, is already affecting the Earth’s temperature, precipitation, and hydrological cycles. Continued changes in the frequency and intensity of precipitation, heat waves, and other extreme events are likely, all which will impact agricultural production. Furthermore, compounded climate factors can decrease plant productivity, resulting in price increases for many important agricultural crops. Wheat, paddy and mustard are the major growing crops in Delhi, if the temperature of atmosphere goes up / high due to climate change, in that case the yield of cereal crops decreases slightly, the price will rise for the most important agricultural crops, the infestation of insect/pest incidences increased, soil fertility affected, crop growth affected, crop development affected to cope-up with such situations the following measures may be adopted to mitigate climate change in agriculture.

Mitigation of Climate Change in Agriculture: Sustainable practices such as organic farming, natural farming can help farmers adapt to the changing climate. Integrated farming systems based on locally available resources by including trees, livestock, and water management can help mitigate climate change to a large extent and improve the quality of life of the farmers. Although Delhi continues to emit greater and greater amounts of GHGs due to accelerated industrialization process, almost 20 per cent of its GHG emissions actually come from agriculture. Methane (CH₄) emissions from irrigated rice production, nitrous oxide (N₂O) from the use of nitrogenous fertilizers, and the release of carbon dioxide (CO₂) from energy sources used to pump groundwater for irrigation are the primary culprits. Generally, mitigation includes reducing emissions of carbon dioxides, methane and nitrous oxides, sequestering carbon, clean development mechanism, etc. Emissions of carbon dioxide from changes in agricultural land use can be reduced by slowing deforestation. The other appropriate approaches of mitigation include changes in agricultural land management viz. conservation tillage, agroforestry, and rehabilitation of degraded crop and pasture land, overall improvement of nutrition and genetics of ruminant livestock, storage and capture technologies for manure, and conversions of emissions into biogas. Most of these approaches have positive outcomes in terms of higher productivity, better management of natural resources, or the production of valuable by-products, such as bioenergy.

The distribution of wild crop relatives, an increasingly important genetic resource for the breeding of crops, will be severely affected due to climate change, we as individuals do to help slow the loss of biodiversity, since consumption of resources is a root cause of biodiversity loss, we can consume less and be more mindful about what we consume. We need to leverage our purchasing power to help protect biodiversity by consuming products that do not harm the environment.

16.3 Current Policies, Programmes and Projects of the government

Delhi's economy has a predominant service sector with its share of contribution to GSVA (Gross State Value Added) at 85.92 percent during 2017-18 followed by contribution of Industries (12.04 percent) and Agriculture (2.04 percent) sectors. The contribution of agriculture sector has been reduced in NCT of Delhi, because of growing urbanization and the growth of trade and industry sector. Also, fast growth of services sector is making agriculture and rural economic activities less attractive. As a result, the contribution of agriculture and allied activities in the GSVA of Delhi at current prices has declined year after year. More clearly, the percentage contribution of agriculture sector to GSVA of Delhi at current prices reduced from 0.94 per cent in 2011-12 to 0.47 per cent in 2017-18.

The GNCTD will be implementing a new scheme – “Smart Krishi Yojana” with the objective to develop High Tech Demonstration Farms in rural areas of Delhi. The farmers will learn and adopt newly developed techniques and crop varieties to enhance their crop production. GNCTD has proposed an outlay of 10 crore for this scheme in 2018-19. An Agriculture Policy will also be prepared for overall development of agriculture and horticulture in Delhi.

Integrated agriculture development scheme including ext. education programme, a component of vermi compost – SCSP. Its objective is to promote organic farming through awareness programs and production of vermi compost by awareness programmes for farmers, training being imparted by technical staff and encouragement of vermi composting. The following activities/ parameters achieved during 2017-18 against the targets as mentioned below under the scheme:

Table 88: Agriculture Sector Activities Target and Achievements, 2017-18

S. No.	Activity	Target 2017-18	Achievement
1	Production of Vermi Compost	5,000 Kg	10,060 Kg
2	Farmer training cum demonstration camp	55 Nos	0
3	Farmers study tours	4 Nos	0
4	Providing assistance to SC/ST farmers up to Rs. 5,000 per beneficiary under SCP component	100 Nos	100
5	Animal husbandry training-cum-treatment camps for farmer village level	50 Nos	0

The National Mission for Sustainable Agriculture (NMSA) derives its mandate from National Action on Climate Change (NAPCC, 2008) and envisages multi-pronged, long term and integrated strategy achieving country's key developmental goals while negotiating impacts of

climate change. Mission Document of NMSA has been approved ‘in principle’ by Prime Minister Council on Climate Change (PMCCC). NMSA strategizes transformation of Indian Agriculture into a sustainable and climate resilient production system by mainstreaming / embedding appropriate climate change adaptation measures onto ongoing and future programmatic / schematic interventions. Accordingly, this restructured Mission of DAC along with Rashtriya Krishi Vikas Yojana (RKVY) will address various key dimensions as outlined in NMSA Mission Document, besides catering to diverse needs of Indian Agriculture.

During the 6th Five year plan, four plan schemes (namely- Floriculture production programme (plan), Development of community parks and gardens (plan), integrated hort. & veg. development programme (plan), Horticulture training school and landscaping (plan)) were launched/initiated by horticulture unit of Environment Department of GNCTD. Latter on all these four schemes were merged into one plan namely- Floriculture production programme, under which the various activities like Departmental Floriculture/horticulture nurseries, Govt. seed farms cum horticulture nursery at patparganj, dwarka, masoodabad etc are being carried out / maintained under the scheme. The budget of salary portion of above all plan scheme were converted into non-plan and other expenditure were merged into one Head of Account i.e., Material and Supplies (Non Plan). However, budget under the plan and non-plan schemes has been merged under Outcome budget and those schemes are:

- Intensive vegetable Crash Programme (Non-Plan), only pay to staff, Sale Centres.
- Integrated Horticulture Vegetable Development cum Training Programme (Non-Plan), only pay to staff (Farms & Extension).
- Development of Community Parks & Garden (Non-Plan), only pay of labours.
- Floriculture Production Programme (Non Plan) pay and maintenance of flower demonstration nurseries and extension of floriculture.

Kisan Gosthis as well as training are organized to provide technical known how about latest technologies as well as latest verities for growing/production of vegetable crops, floriculture crops, fruit/orchard crop, medicinal plants, mushroom production, etc to the farmers of Rural/sub-urban areas as well as kitchen gardeners/trainees/youth of urban areas of NCT of Delhi. The awareness is also given to the trainees about soil health to use chemical fertilizers after their soil testing of micronutrients. Details of trainings/kissan gosthies arranged/conducted, during the last five years are given below:

Table 89: Training/Kissan gosthis details

S. No.	Year	No. of Trainings / Kissan Gosthies		No. of Farmers / Kitchen Gardeners / Youth	
		Target	Achievements	Target	Achievements
1	2011-12	25	20	625	500
2	2012-13	25	25	625	625
3	2013-14	25	30	625	750
4	2014-15	50	65	1250	1625
5	2015-16	60	74	1500	1913
6	2016-17	100	91	2500	2250

7	2017-18	100	89	2500	2225
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- Mushroom production and demonstration at Dwarka, Hauzrani and Patparganj Nurseries.
- Block plantations and drain side plantations.
- Park development & maintenance at Saidulajaib, veterinary hospitals & nasirpur village in South West District.
- Input sale centre- for sale of inputs i.e. seeds of vegetables & flowers, organic & inorganic manures, garden tools, insecticides / pesticides etc., to farmers as well as kitchen gardeners at krishi bhawan, patparganj, moti bagh, hauzrani, dwarka, kharkhari nahar, and Delhi Secretariat.
- City forest has been created and is being maintained at hiranki on 16 acers Gaon sabha land.
- Organic manures / wormi compost production and demonstration at hauzrani.
- Samriti vatika at moti bagh to plant a tree as memory plant by near and dear ones.
- Survey and estimation of farm land/farmer for vegetable/fruit/flower crops.

The GNCTD will pilot an innovative scheme named Agriculture-cum-Solar Farm scheme. The scheme will incentivise the installation of solar panels on raised structure on agricultural farms without affecting the normal farming activities that will continue below the solar panels. This initiative has high-potential of enhancing the income of farmers. New scheme ‘Smart Krishi Yojana’, the farmers will be provided technology to adopt high yielding, high quality varieties of agriculture and horticulture crops, so that the farmers to enhance their income double. The scheme is to be implemented by the Development Department, GNCTD through NGOs which are engaged in agricultural and horticultural development activities in other States/ UTs and registered by the GOI/ State Govt. having subject expertise..

The details of departmental horticulture nurseries, farms, parks, being maintained is as follows:

Table 90: Delhi’s Nursery/Farm and Parks details

S. No.	Name of Nursery / Farm/ Park	Area (in acre)	Activities
1	Khar Khari Nahar	(Total) 35 (Cultivated) 25	Fruit plants, vegetables, demonstrations to farmers.
2	Masoodabad	4	Amla plants, demonstrations and production of vegetables seeds and seedlings.
3	Patparganj	5	Ornamental, flower plants / crops and demonstrations on vermi compost, mushroom, sale centre of inputs.
4	Hauzrani	4	-do-
5	Dwarka	2	Demonstrations of vegetables, flowers, mushrooms etc.

6	Libaspur Nursery – I	2.5	Fruit plant nursery
7	Libaspur Nursery – II	1.5	Floriculture nursery
8	Chilla	1	Medicinal plants nursery
Parks / City Forest:			
1	Community parks, saidulazaib (south distt.)	5	Community park and tree plants are being maintained
2	Smriti vatika, moti bagh, new delhi	7.5	786 tree plants of different species have been planted by the individuals in memory of their dear ones as commemorative trees against onetime payment.
3	City Forest Hiranki (Tihiri Daulatpur)	16	10,000 tree plants of Jamu, Arjun, Shishum, Pilkhan etc are being maintained.
4	Nasirpur village in south west district (pocket-A)	03	Park is being maintained.
5	Nasirpur Village in South West District (Pocket-B)	02	Park is being developed.

16.4 Strategies and Actions to address concerns due to Climate Change

The strategies and actions pertaining to the agriculture and horticulture for the year 2020 and 2030 are as follows;

S. No.	Priority measures	Additional details	Time	Remarks /Concerned agency
1.	Providing extension education for cultivation of high yielding agri-horticultural crops with a view to promote the cultivation of low volume and high value crops through organising: Training for extension staff, Convening of workshop, Arranging Kisan Gosthies at block levels, at IARI along with staff study tour to different agricultural universities in adjoining states.	Through extension staff at block	Every year	Block In-Charge/extension staff / District training officer / Office of the JD(A), Mori Gate, Delhi.

2.	Supply of wormi compost to the farmers / users at cheaper rates to promote organic farming and also arranging awareness campaigns by organising meetings, seminars / workshops and Kisan Gosthies on the subject and by imparting training to the interested users It also provides for setting up of wormi compost units demonstrating at farmers field	Krishi Bhawan, Green Park MCD office, Hauz Rani farm, Saket, Punjabi Bagh club, Khyber Pass, Civil Lines and JD(A) office on cash payment @ Rs. 5/- per kg.	Every year	In-charge sale centres / Scheme in-charge at JD(A) office
3.	Providing 30% subsidy on purchase of fertilizers to the small and marginal farmers	Identification and selection of beneficiaries by the extension staff at each block and issue of permit after receiving the allocation of funds from Project Officer (Multiple cropping) / Registering authority / Controller of fertilizers, JD(A) office	After soliciting the approval of the Finance Deptt. and allocation of budget to each block against permits to be issued by the BDO offices	BDO office / PO(MC) at Tel. 398 4475 / JD(A) office
4.	Enforcement of Fertilizer Control Order 1957/1985 Appellate Authority: Development Commissioner Controller of Fertilizers: Jt. Director (Agr.) Registering Authority: Project Officer(MC)Fertilizers Inspectors: Notified officials		Every year	

5	Promotion of less water intensive hybrid crops and integrated farming systems and agro-forestry	As per the National Mission for Sustainable Agriculture (2019-2030)	Every year	Development department
6	Awareness programs for farmers and stakeholders to avoid crop-burning instances in and around Delhi's agricultural fields.		Every year	Development department
7	Implementation of NGT order on prohibition of crop-burning.		Every year	Development department
8	Development of temperature resistant, flood and drought resistant varieties of crops		Every year	Development department
9	Promotion of organic farming reducing dependence on chemical fertilizers and pesticides through government mandated decentralized/centralized waste composting facilities.	Following an national and international best practices	Every year	Development department
10	Increasing awareness and training dissemination of sustainable practices in agriculture	Across all Municipal bodies	Every year	Development department
11	Research and training centers for producing natural/ organic fertilizers and pesticides	Across Delhi	Every year	Development department
12	Promotion of balance diet and availability of green fodder for livestock to control carbon emission	Across Delhi	Every year	Development department

16.5 Budgetary assessment of of key priorities

The Development Department of GNCTD has proposed total budget requirement of INR 84 crore for Agriculture & horticulture sector under Delhi's SAPCC.

17. Strategic Knowledge on Climate Change

Knowledge is one of the key determinants for design of suitable interventions to respond to climate change. Further, the abundance and diversity of existing knowledge, which is often conflicting, inconsistent or outdated, may pose challenges on its usefulness. The situation is compounded by the low capacity of many stakeholders to assess the credibility and relevance of available knowledge. Additionally, enhanced local research capacity is essential if evidence – based policy to address climate change is to be realised. In this context, the state mission on Strategic Knowledge on Climate Change intends to create a knowledge system that would help take actions to reduce vulnerabilities as well as take advantage of the mitigation opportunities. Strategic Knowledge on Climate change is therefore, the system of knowledge that is required by various stakeholders to respond to climate change. Information and knowledge requirements of the stakeholder groups are as diverse as the groups themselves. Consequently, the mission is cross cutting in nature and is intended to serve as a support mission for generating and providing strategic knowledge to all other thematic missions under the Delhi’s SAPCC, in consonance with the National Mission on Strategic Knowledge for Climate Change. The mission not only focuses on key knowledge requirements but also on knowledge management and application. The State Government established a ‘Climate Change Cell’ in the Department of Environment to act as a nodal agency to deal with all the issues related with Climate Change in the State. The Cell had been constituted in the year 2018 and will be the nodal agency for the Mission on Strategic Knowledge on Climate Change.

17.1 Knowledge creation

Creation of knowledge can stem from theory, observations, experiments and or modelling assessments. While there is plethora of information that is available in various domains, it often offers incomplete or conflicting knowledge that often does suffice for targeted action on climate change. Further there are crucial knowledge and data gaps in some research domains. Additionally, the assessments of impacts and vulnerabilities are often at the national level but not at state and district levels. A significant amount of conceptual and empirical work is required to better understand local climate impacts. Such an understanding is necessary to provide a better background for developing differentiated but linked responses to the different types of impacts. From a mitigation perspective, it is widely acknowledged that an alternative development model is necessary to embark on a low carbon development path. However, other than increasing efforts to promote energy efficiency and renewable energy there is a lack of understanding of the diverse opportunities towards a low carbon development pathway. Many existing options and opportunities are under utilized due to absence of research and analysis especially tailored to state specific social, ecological, political circumstances. In order to link experiential knowledge from policy side to scientific knowledge in the context of vulnerability assessments and to enhance the knowledge base in the state on climate risks, vulnerabilities and opportunities for adaptation and mitigation.

With regards to knowledge creation, it is not only important to emphasize on data requirements but also identify which data is already collected, what is missing, at what scales they should be collected, in what format these need to be collected and what their use will be. Table below presents an indicative list of some key data requirements for climate modelling, impact assessments, and adaptation and mitigation assessments.

Table 91: Key knowledge requirements

Database	Components	Rationale
Meteorology	Precipitation (Daily), maximum and minimum temperature (Daily), solar radiation, Wind speed, Relative humidity, Evaporation data etc are and also for	Essential input to sectoral impact assessment models such as DSSAT, SWAT or CROPWAT Extreme event analyses This information is critical for various early warning systems and decision support systems.
Land Surface	Land surface data at appropriate scales. Hydro-geological maps inclusive of: contour, drainage, Digital Elevation Models (DEM), soil type, depth, texture and physical, characteristics (composition of silt, sand, clay, rocks), drainage network, watershed boundary, Hydraulic conductivity, LRDP (land resource development plan) Time series remote sensing data on land use land cover (decadal or five year interval data)	Essential for various sectoral impact assessment models of agriculture, surface water, and ground water etc. Extreme event assessments Land use plans Disaster planning and management Important input for assessments pertaining to forestry, water resources, and urban systems amongst others
Hydrological	Stream gauge stations, water level and discharge, river cross section, reservoir/water bodies characteristics etc. Aquifer-type, depth, extent, lithological variation, information, transmissivity, hydraulic conductivity, specific yield, storage coefficient, well-location, well type, well depth, water table data, groundwater consumption	Feed into surface water runoff models such as MODFlow, SWAT Feed into ground water assessment methods such as the GALDIT. Hydrological data is an important input to agricultural models

<p>Agriculture and Livestock</p>	<p>A detailed ACZ wise inventory on cultivar name, planting date/method/distribution, crop management practices, crop level diseases, incidence of livestock diseases, invasive species inventory, fertility factor percentage organic carbon and nitrogen content, area under cultivation (for different crops and on the basis of land holdings) yield (farm and crop level) and types of crops cultivated is important. Socio economic data relevant to agriculture like irrigation infrastructure, details on land holdings (cereals, pulses, fodder, commercial, etc.) alternative livelihood sources, tenancy, access to market, utilization of agricultural credit and insurance as well as information on traditional crop varieties and indigenous animal breeds and their special features.</p>	<p>This inventory could help understand the impact of climate change on various crops. Critical to assess the adaptive capacity of the sector and design appropriate interventions.</p>
<p>Socio Economic data</p>	<p>Socio economic information inclusive of information on the institutions and governance. Vital Statistics (Total population, male female ratio, adult dependency ratio, crude death rate, crude birth rate, average life expectancy at birth, etc.), Education information, Occupational Structure – formal and informal, State Govt. spending on credit and insurance support including rural banking density, Number of non-financial, spread and activities of such institutions and livestock insurance participation level of industrialization and urbanization are important. Rehabilitation and</p>	<p>Essential for vulnerability assessments and also for socio economic scenario building both of which are critical for responding to climate change. For designing efficient interventions for climate change adaptation</p> <p>This is essential for not just to plan for water scarcity but also for interventions in the health sector.</p>

	relief measures as well as direct economic losses, indirect losses, etc. due to extreme events are equally important. Coverage of and access to drinking water source, Coverage of sanitation facilities data	
Forests and bio diversity	Geographical distribution of vulnerable habitats and species, information about invasive species.	Important to understand the impacts of climate change on the forestry sector.
Health Related data	Health statistics including morbidity/mortality data, distribution/Risk maps for climate sensitive diseases like diarrhoea and malaria, health infrastructure, prevalence of malnutrition etc.	For understanding health sector vulnerability to climate change.
Energy	Energy information on consumption patterns and conservation potential. It should include information on urban infrastructure like transport and buildings. Composition, quantum, and sources of waste	Help the state to take advantages of the low carbon development opportunities under the CDM mechanisms of the UNFCCC. Help in design of waste to energy projects

17.2 Knowledge Management

While, there is an abundance of information available on climate change issues at coarser scales relevant information at local level is not accessible. This information and knowledge could be ranging from climate science and impacts to; mitigation and low carbon development paths. A strategic knowledge system should be able to integrate and organize information and assessments from multiple sources at various scales and present it to stakeholders in a useful form. The focus should also be to adapt existing knowledge and systematically organize knowledge products. A careful synthesis of existing knowledge is necessary through the use of information and communication technology (ICT) amongst other relevant technologies. Further, an arrangement for real time data sharing among various data sources is necessary for building strategic actions based on knowledge-led paths. In the following section we present some important initiatives in the state of Delhi that are intended to collate, present and manage knowledge relevant for action on climate change.

Table 92: Existing initiatives for knowledge management

Emergency Operation Centers (EOC)	A GIS based Emergency Operation Centers – Delhi Disaster Management Authority (DDMA) has set up a 24x7 disaster helpline (1077) to coordinate disaster response efforts. At present 12 Emergency Operation Centers (in 11 Districts of Revenue Department of Govt. of Delhi & 1 in HQ) are operational in Delhi. Also, in Financial Year 2018-19, GNCTD has also proposed to institute GIS set-up in all 11 districts.
Solar Roof	A comprehensive Roof top solar policy has been approved by the GNCTD to make Delhi a Solar City through promotion of renewable alternate sources of energy. In the new Solar Policy, there is a provision to incentivize installation of Solar Plant by the domestic consumers giving them generation based incentive of ₹2 per unit for three years.
Greenery & Landscaping	The 93 water bodies are being taken over by DJB. Apart from this, Supplementary drain has been taken up for cleaning & greening.
Street Lights	As on date 31st March 2018, 5472 LED lights are installed and energised. Work was executed by PWD for MCDs and the works executed has been handed over to MCDs for maintenance.
Waste-to-Energy	Total Waste-to-Energy Installed Capacity in the State of Delhi as on April'2018 = 52 MW from three WTE Plants at- Timarpur – Okhla, Ghazipur (East Delhi) and Narela – Bawana.
Groundwater Rehabilitation	About 80 MGD of ground water is being explored through Ranney Wells and Tube Wells by Delhi Jal Board. For augmentation of ground water, the work of rehabilitation and automation of tube wells and Ranney wells at Palla has been taken up.

17.3 Knowledge Application

In terms of application of knowledge, there should be an emphasis on co-synthesis of relevant knowledge related to climate change. Timely dissemination of information and capacity building efforts are critical to aid practical application of knowledge. Application of knowledge Communication of knowledge helps bridge information asymmetry that is critical for any action on climate change. Timely dissemination of information could help enhance the adaptive capacities of vulnerable communities, it could help government to better mobilize resources and money during a climatic extreme. However, low capacity of many stakeholders to assess the credibility and relevance of the available knowledge has been a barrier to respond appropriately to challenges of climate change. Therefore training and capacity building activities are equally critical for the strategic mission. These activities could range from short term training, mentoring and coaching assistance to enhance the capacity of various government officials, research institutions, policy makers and corporates; or a longer term strategy to create manpower for undertaking climate change research.

17.4 Gaps

Knowledge gaps: There is an inadequate knowledge on the impacts of climate change in different sectors of the state. Insufficient observational and scientific information database discourages attempts to assess the climate change implications for the state. Further there is a lack of clear understanding of important processes like desertification, which requires the monitoring of various parameters such as changes in water quality & quantity, biomass, biodiversity, soil salinity etc. No specific studies have been conducted to monitor this process in the state.

Scale and spatial distribution of the data: Meteorological data has to be available at adequate scales for models to provide outputs that are policy relevant. There is little or no meteorological data available at the district level. A high number of observations network is essential for validating the modelling outputs.

Digitization of information: Socio economic information containing in district statistical handbook is not available in digital format for all years as well as the GIS and remotely sensed data. There is no digitized database at the state level, and no databases at the district level for socio economic data.

Fragmented knowledge base: Existing data and information is fragmented at multiple sources. There is a lack of systemic institutional mechanism for collating, synthesizing and delivering knowledge products for decision making on climate change. Poor connectivity between diverse knowledge generation communities is a hindering knowledge exchange process.

Inventorize traditional knowledge: While the benefits of traditional knowledge to enhance resilience of communities to climate change are acknowledged, there have been limited efforts to inventorize and scale up traditional knowledge. It is important to assimilate the traditional knowledge systems and reference them to the social contexts of the region.

Capacity building: Capacity building at various levels, including strengthening the base, creating centres of excellence in priority areas in existing institutions; and setting up new institutions in gap areas that allows a for leveraging the global and national knowledge base is important.

17.5 Strategies for State Mission on Strategic Knowledge on Climate Change

Key Strategy 1: Knowledge creation

Action 1: Facilitate studies related to climate change vulnerability and impact assessments for better preparedness - The overall aim will be to develop a cross-sectoral adaptation strategy based on the analysis of the projected climate change impacts and the assessment of vulnerability in the following key sectors: Hydrology and water resources Agriculture and animal husbandry, Desertification, Forestry and biodiversity, Livelihoods, Human health.

Action 2: Study on Climate projections using scientific Models- There is need to assess likely future growth scenarios in the state using an optimization energy environment modelling

framework. This will facilitate in long-term planning in identifying technological and policy choices today.

Key Strategy 2: Knowledge Management

Action 1: Peoples biodiversity register- The best way of making people aware of science is to get them to practice it. The practice of science right down to the grass-roots can be done with Biological Diversity Act. This Act provides for the establishment of Biodiversity Management Committees in all local bodies, whether Panchayats or Municipalities throughout the country.

Action 2: Understanding low carbon development pathways which aims to point out ways how to combine both: climate protection and sustainable development. By understanding and exploring sustainable low carbon development pathways in Delhi could serve as regional and international example as well.

Key Strategy 3: Knowledge Application

Action 1: Periodic development of knowledge products on climate change. The objective of this action point is to synthesize existing knowledge base in the state to form knowledge products for decision-making, addressing climate risks and opportunities. These products can be in the form of working papers, technical reports, peer-reviewed articles and policy briefs to aid evidence-based policy making. The focus in this will be on integration of perceptions and practices of people with scientific analysis to validate, standardize and scaling up of these traditional knowledge systems.

Action 2: Environment and Climate Change museum could catalyze a cultural transformation around climate, inviting people from all walks of life into the conversation and building community around solutions. Transcending traditional disciplinary and societal boundaries, the Museums bring people together to learn about the problem, grieve what has been lost, actively engage with solutions, and join the fight for a brighter future.

Action 3: Resource centre on Climate Change provides information about climate change impacts on forests and other ecosystems, and approaches to adaptation and mitigation in the state. The website based resource centre compile and create educational resources, climate change and carbon tools, video presentations, literature, and briefings on management-relevant topics, ranging from basic climate change information to details on specific management responses.

Action 4: Mainstreaming of climate change concerns into developmental programmes and policies. Mainstreaming climate concerns into ongoing developmental initiatives can offer opportunities for adaptation and mitigation in the state. For example, while development is essential for adaptation, adaptation is imperative to safeguard developmental investments. Similarly it is essential to embark on a low-carbon pathway to aid adaptation efforts. This action can facilitate policymakers and vulnerable communities deploy findings of research into practice and identify potential entry points with the scope of current and planned developmental programmes and policies for reducing risks or tapping opportunities posed by climate change.

Action 5: Facilitate capacity building for the advancement of research on climate change. This action point will focus on facilitating capacity building initiatives to further the skillsets of government officials in the state, on application of climate science, GIS and remote sensing applications, Hydrological modelling etc. through the network of national and international knowledge institutes. This would also include orientation sessions and workshops on climate change for government officials to better understand climate change dynamics and impacts, along with opportunities and issues related to adaptation and mitigation.

17.6 Budgetary Assessment of key priorities

The Climate Change Cell and MGICCC has proposed a total budget requirement of 52 Cr for the implementation of proposed activities under the Strategic knowledge on Climate Change under Delhi’s SAPCC. The budget requirement for the priorities measure under the strategic knowledge on climate change for Delhi are as follows.

Table 93: Key Priorities and Actions identified for “Strategic Knowledge on Climate Change” along with budget requirement

S. No.	Targets (Short term and Medium term)	Financial requirements (Cr)
1	Facilitate studies related to climate change vulnerability and impact assessments for better preparedness in the state of Delhi by 2020	10
2	Study on Climate projections using scientific Models by 2020	5
3	Peoples biodiversity Register by 2030	1
4	Understanding low carbon development pathways by 2020	1
5	Development of knowledge products on climate change by 2020	10
6	Environment and Climate Change museum by 2030	5
7	Resource centre on Climate Change by 2030	5
8	Mainstreaming of climate change concerns into developmental programmes and policies by 2020	5
9	Capacity building for the advancement of research on climate change by 2030	10
	Total	52

18. Design of Monitoring & Evaluation System and Implementation of the Plan

The proposed institutional structure for the implementation of the Delhi Action Plan on Climate Change is under the Chairmanship of the Chief Secretary under whom the Steering Committee would directly operate. Steering Committee is headed by the Chief Secretary himself. The Nodal Department for monitoring and overall management of SAPCC related activities is the Department of Environment, GNCTD, headed by the Secretary (Environment). The nodal department has an advisory, supervisory and coordinating role on Climate Change issues. Different working group's task forces operated under the vigilance of the department.

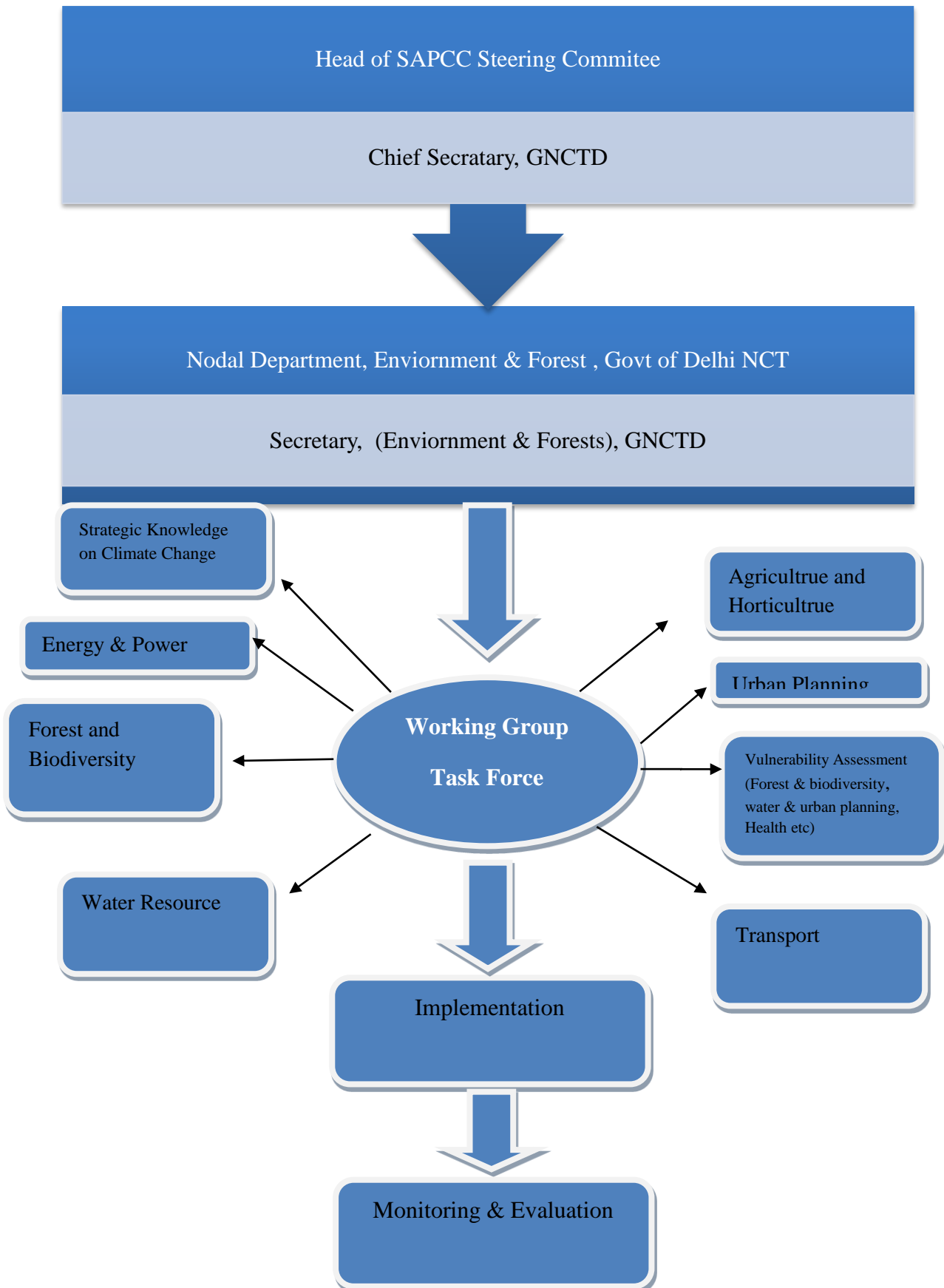
A crucial part of a climate change action plan has to be **(a)** The monitoring of impacts of climate change and of progress in achieving key targets. **(b)** The evaluation of programs undertaken to mitigate climate change as well as to adapt to its consequences. Monitoring and evaluation is critical to take corrective action in the case of **(a)** Impacts being more or less severe than originally anticipated. **(b)** Key targets not being attained in a timely manner, and **(c)** Programme underperforming.

To be able to implement the various strategies and actions within the proposed SAPCC, implementing agencies would be needed. These could be in the form of academic institutes, research institutes, universities in case of R&D, private sector in case of technology implementation, government department in case of creating fiscal structures and community based organizations, scientific organizations & NGOs for raising awareness and capacity building.

Delhi Government has identified the Mahatma Gandhi Institute of Climate Change Centre in Bakoli as the field level institution which will pioneer efforts in creating strategic knowledge about climate change. The Centre will partner with the leading institutions in creating awareness and conducting research in this area. The Climate Change Cell has been placed under the Department of Environment to coordinate the activities of Climate Change management in a holistic manner.

Below is the institutional structure for implementation of the Delhi's SAPCC:

Figure 21: Institutional Structure for Implementation of Delhi State Action Plan on Climate Change



18.1 Financial Budgets

Each department has put together a budget for the initiatives proposed to meet the key priorities in each sector. The additional resources required in each sector will be sourced from the Government of India or external multilateral and bilateral funding agencies. The following table gives the estimated budget for the Plan:

Table 94: Budget for Delhi Action Plan for Climate Change

S. No.	Particulars	Approx. Amount (INR Crores)
A	Sectors	
1	Energy & Power	138
2	Water Resources & Sanitation	6,023
3	Forest & Biodiversity	110
4	Urban Planning	2,984
5	Agriculture & Horticulture	84
6	Strategic Knowledge on Climate Change	52
7	Transportation	2,568
8	Health	976
	Sub Total:	12,935
B	Institutional Arrangements	
	Independent external Monitoring & Evaluation (10% of the total budget)	1,293
	Grand Total	14,228

Source: Finance Department, GNCTD

18.2 Monitoring and Evaluation Framework

A monitoring and evaluation framework needs to be prepared to study the effectiveness in the implementation of the SAPCC document over a time period. Following table gives the list of impact to be monitored over a period of time.

Table 95: Delhi Climate Change Action Plan Monitoring and Evaluation Framework

Sector	Monitoring and Implementation Plan	Benchmark	Frequency	Responsible Agency
Energy & Power	<ul style="list-style-type: none"> - GHG Emission - Emissions Intensity - Renewable Technologies Deployment - Green Building - Clean Energy - PAT Scheme - UJALA Scheme 	GHG emissions reduction	Every 5 year	<ul style="list-style-type: none"> •BSES Rajdhani Power Ltd. (BRPL), •BSES Yamuna Power Ltd.(BYPL)

Sector	Monitoring and Implementation Plan	Benchmark	Frequency	Responsible Agency
				<ul style="list-style-type: none"> •North Delhi Power Ltd.(NDPL), •Indra Prastha Gas Company Ltd.(IPGCL) •Pragati Power Company Ltd.(PPCL)³³
Water Resources	<ul style="list-style-type: none"> • Online Real time monitoring system at WTPS and STPs • High quality and accredited laboratories to monitor water quality etc. • Management and Monitoring plan for storm water management on all roads above 18 m • Ground water monitoring to asses RWH measures adopted and check excessive ground water exploitation • Mandate periodic water audits • Identify water thefts and illegal connections • Adopt universal metering for consumers, bulk supply and transfer etc of water for enabling measurement of system input and output • Develop management tools/formats for 	<ul style="list-style-type: none"> •Reduced per capita water demand •Run-off rates for new developments •Run off rates of all road projects •Ratification of a storm water management manual •Set targets for providing decentralized sewage treatment and water recovery/recycling/harvesting system within next 5 years. •Set targets for next 5 years for KMs of pipes to be replaced to minimize 	Every year	DJB, MCD, DDA, NDMC, PWD, I&FCD, CWC, UD, Env. Deptt., DPCC

³³ Other includes; Delhi Transmission Company Ltd.(DTL), Delhi Power Company Ltd.(DPCL), Central Electricity Regulatory Commission (CERC), Department of Power (Government of NCT of Delhi), Delhi Electricity Regulatory Commission (DERC), Energy Efficiency and Renewable Energy Management Centre (EE&REMC)

Sector	Monitoring and Implementation Plan	Benchmark	Frequency	Responsible Agency
	<p>assessment of water balance for each source/system/zone using data of water supply and delivery</p> <ul style="list-style-type: none"> • Map for frequent check and validation of the infrastructure • Rejuvenation of River Yamuna • Revival and protection of Water bodies 	<p>leakage and water loss during transmission.</p> <ul style="list-style-type: none"> • Set target for next 5 years for KMs of roads retrofitted to be Zero run off • Implement Decentralized sewage treatment systems in all Government building by 2021. • Adopt Bioremediation technology • Restore water bodies 		
Transport	<ul style="list-style-type: none"> • Regular enforcement drives and strict penal action against vehicles violating pollution norms • Include other penal action to protect NMT tracks and users • Air quality monitoring station in NCR Promotion of battery operated vehicle • Implementation of EURO-VI norms • Setting up of air quality monitoring stations in NCR • Prohibiting non-destined vehicles to enter Delhi • Effective implementation and tightening of PUC norms for all vehicles 	<ul style="list-style-type: none"> • Meet air quality standards by the end of 12th five year plan • periodic monitoring of bus/PT/NMT/p performance, service quality and user satisfaction • Modal share 80:20 in favor of public transport • Generate data base to assess 	Every year	<ul style="list-style-type: none"> • State Transport Authority • Public Works Department • Delhi Transport Corporation • Delhi Development Authority • National Highways Authority of India • Delhi Metro Rail Corporation

Sector	Monitoring and Implementation Plan	Benchmark	Frequency	Responsible Agency
	Amendment of CMV Rules Setting up Trans-shipment zone	trend in modal shift • Prepare city specific service level benchmarks		<ul style="list-style-type: none"> • Delhi Integrated Multi-Modal Transit System (DIMTS) Ltd • Urban Local Bodies • Traffic Police • MORTH
Forest and Biodiversity	<ul style="list-style-type: none"> • Forest area demarcation and protection • Replenishment of existing trees • Create new City Forests • Biodiversity enrichment of existing forests and urban parks • Greening of parks and gardens • Greenery of wasteland • Action plan to Green Delhi • Develop additional Biodiversity Parks • Develop greenways in open spaces leading green circuit (greening at central verges, urban landscaping, development of vertical gardens at metro pillars, flyover pillars, and other public places). 	Increase in green cover percentage of total land use	Every 5 year	<ul style="list-style-type: none"> • Department of Forests and Wildlife, GNCTD • Eco-Task Force • Delhi Parks and Garden Society • East Delhi Municipal Corporation • South Delhi Municipal Corporation • North Delhi Municipal Corporation • Delhi State Industrial and Infrastructural Development Corporation • New Delhi Municipal Council • CPWD • Delhi Development Authority (DDA)

Sector	Monitoring and Implementation Plan	Benchmark	Frequency	Responsible Agency
Urban Planning	<ul style="list-style-type: none"> • Environment Service Zone at zonal level • Waste management and its disposal • Green Building Concept • Water conservation, waste water treatment & its reuse • Regular monitoring drives through GIS based data on open spaces and strict penal action against violators of natural heritage guidelines. 		Every year	<p>Land Use:</p> <ul style="list-style-type: none"> • Delhi Development Authority (DDA) • Land and Building Department/Revenue Department • L&E Department of MCD • Land & Development Office(L&DO) GoI, UDPA <p>Waste:</p> <ul style="list-style-type: none"> • East Delhi Municipal Corporation • South Delhi Municipal Corporation • New Delhi Municipal Council • Delhi Cantonment Board (DCB) • North Delhi Municipal Corporation <p>Water: Delhi Jab Board</p>
Waste	<ul style="list-style-type: none"> • Inbuilt weighing and GPS monitoring system in trucks: The system enables tracking of the distance 	GHG emission (methane) reduction from integrated waste management	Every year	<p>Waste:</p> <ul style="list-style-type: none"> • East Delhi Municipal Corporation

Sector	Monitoring and Implementation Plan	Benchmark	Frequency	Responsible Agency
	<p>traveled by each vehicle. When the vehicle enters the weighbridge, the system can calculate the weight of the garbage brought in and thereby the total quantity of waste generated can be worked out. Dumping garbage elsewhere can be detected, so can non-picking of garbage. This system will eliminate vehicles from dumping garbage at places other than the predetermined site. It will also help in reducing cases of uncleared garbage and door to door waste collection</p> <p>(i) door to door collection of waste</p> <p>(ii) Mandate decentralized segregation and waste management at project/community level</p> <ul style="list-style-type: none"> • Off site real time (OSRT) technology for monitoring cleaning of bins: OSRT system uses a combination of Global Positioning System (GPS) and general packate radio services (GPRS) technologies through cell phones for managing civic amenities in a transparent and efficient manner. 			<ul style="list-style-type: none"> • South Delhi Municipal Corporation • New Delhi Municipal Council • Delhi Cantonment Board (DCB) • North Delhi Municipal Corporation

Sector	Monitoring and Implementation Plan	Benchmark	Frequency	Responsible Agency
	<p>The GPRS technology allows cell phones to capture real time images of public officials at work or work sites under inspection with the date and time of the picture as well as the stamp of latitude and longitude alongside the image, superimposed on a google map layer. These images are instantly transmitted to a central server.</p> <p>(iii) Mandate vacuum based waste collection/processing units for all new development with a density grater.</p> <p>(iv) Upgrade existing facilities used for collection, segregation and processing</p> <p>(v) Mandate waste management strategies for development projects greater.</p>			
Health	<ul style="list-style-type: none"> • Prevention of vector borne diseases and water borne disease • Implementation of SAPCCHH • Food security and malnutrition • Capacity building and training event • Disaster preparedness 	Combating health impacts due to climate change	Every year	<ul style="list-style-type: none"> • Directorate of Health Services, Government of NCT of Delhi
Agriculture	<ul style="list-style-type: none"> • Production of vermi compost 	Mitigation of GHG emission	Every year	<ul style="list-style-type: none"> • Development department, GNCTD

Sector	Monitoring and Implementation Plan	Benchmark	Frequency	Responsible Agency
horticulture	<ul style="list-style-type: none"> • Training of agriculture sector stakeholder on crop production and stop burning of crop residues etc • Integrated farming practices • Promotion of balanced diet for livestock and availability of green fodder 	from the agriculture sector		<ul style="list-style-type: none"> • Horticulture departments of Delhi municipal bodies
Strategic knowledge on climate change	<ul style="list-style-type: none"> Knowledge creation Knowledge management Knowledge application 	Building in adaptive capacity and informed decision by the policy planners	Every year	<ul style="list-style-type: none"> • Climate Change cell, • MGICCC

References

1. Mehrotra S, Natanzon C.E., Omojola A, Folorunsho R, Gilbride J, Rosenzweig C, “Framework for City Risk Assessment”, **World Bank Commission Research, 2009**
2. Singh P.K. & Dhiman R.C., “ Climate and Health: Indian Context”, **J Vector Borne Dis 49, June 2012, pp. 55–60**
3. Bhattacharya I S, Sharma C, Dhiman R. C., Mitra A.P., “Climate Change and Malaria in India”, **CURRENT SCIENCE, VOL. 90, NO. 3, 10 FEBRUARY 2006**
4. Mayor S, “Doctor-population ratio grows in UK but is still short of that in France and Germany”, **BMJ. 2008 February 16; 336(7640): 353.**
5. Hajat S, Armstrong B, Gouveia N, Wilkinson P “Comparison of Mortality Displacement of Heat- Related Deaths in Delhi, Sao Paulo and London” **Epidemiology , Volume 15, Number 4, July 2004**
6. <http://www.cseindia.org/node/64>, 20 March, 2013
7. http://www.teriin.org/index.php?option=com_ongoing&task=about_project&pcode=2008EE08, 20 March, 2013
8. http://www.isid.ac.in/~pu/conference/dec_12_conf/Papers/DeeptiGoel.pdf, 20 March, 2013
9. Mohan M, Kikegawa Y, Gurjar B.R., Bhati S, Kandya A, Ogawa K, “Assessment of Urban Heat Island over Delhi”, **The seventh International Conference on Urban Climate, 29 June - 3 July 2009, Yokohama, Japan**
10. *Service Level Benchmarking Data book, 2010*
11. Delhi Jal Board, 2011
12. Delhi Statistical Handbook, 2012

13. Gupta E, “Global warming and electricity demand in the rapidly growing city of Delhi: A semi-parametric variable coefficient approach”, **Energy Economic, Volume 34, Issue 5, September 2012, Pages 1407–1421**
14. City Development Plan, Delhi, 2010
15. <http://delhi.gov.in>, 20 March, 2013
16. National Mission on Sustainable Habitat, 2011
17. National “Green India” Mission, 2011
18. INCAA, National GHG inventory, 2011
19. Delhi Master Plan 2021
20. State Gross Domestic Product, Government of Delhi, 2012
21. Delhi Economic Survey
22. <http://www.epa.gov/climatechange/impacts-adaptation>, 20 March, 2013
23. Patel H, Madamwar D, “ Effects of Temperature and Organic Loading on Biomethanation of Acidic Petrochemical Waste Water using an Anaerobic Up flow Reactor”, **Bioresource Technology 82 (2002) 65-71**
24. Solid Waste Management Factbook, US EPA, 2002
25. Haris A.V.A, Biswas S, Chhabra V, Elanchezhian R and Bhatt B.P., “Impact of climate change on wheat and winter maize over a sub-humid climatic environment”, **CURRENT SCIENCE, VOL. 104, NO. 2, 25 JANUARY 2013**
26. Sygna L, Eriksen S, O’Brien K and Naess L.O., “Climate change in Norway: Analysis of economic and social impacts and adaptations”, **CICERO report 2004:12**
27. Karl TR, Melillo JM, and Peterson TC, “Global Climate Change Impacts in the United States”, (eds.). **Cambridge University Press, 2009**
28. Jackson R.B., Carpenter S.R., Dahm C.N., McKnight D.M., Naiman R.J., Postel S.L., and Running S.W., “Water in a Changing World”, **Issues in Ecology, 2001**
29. Dhote M, “Land Use Strategy for Conservation of Biodiversity” **Delhi School of Planning and Architecture, 2009**
30. Kraus F, Kraft T, Wang W, “Global Change Urbanization and Health”, **China Meteorological Press, 2006**
31. “Climate Change Impacts on Industry in India”, **CII, 2011**
32. Garg A, “Climate Change and Indian Industry”, **DFID 2012**
33. Gore P, Roy B, Hatwar H, “Impact of Climate Change on Land Degradation in India” National Centre for Climate, 2011
34. H. Taubenböck, M. Wegmann, C. Berger, M. Breunig, A. Roth, H. Mehl “SPATIOTEMPORAL ANALYSIS OF INDIAN MEGA CITIES”, **The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences. Vol. XXXVII. Part B2. Beijing 2008**
35. Kumar P, Imam B, “Footprints of air pollution and changing environment on the sustainability of built infrastructure”, **Science of the Total Environment 444 (2013) 85–101**
36. Khera N, Mehta V, Sabata B, “Interrelationship of birds and habitat features in urban greenspaces in Delhi, India”, **Urban Forestry & Urban Greening 8 (2009) 187–196**
37. Muller N and Werner P, “Urban Biodiversity and the Case for Implementing the Convention on Biological Diversity in Towns and Cities” **Urban Biodiversity and**

Design, 1st edition, 2010

38. *V Talyan, R.P. Dahiya, T.R. Sreekrishnan*“State of municipal solid waste management in Delhi, the capital of India”**Waste Management 28 (2008) 1276–1287**
39. *White P, Golden J.S., Biligiri K.P, Kaloush K*, “Modeling climate change impacts of pavement production and construction”, **Resources, Conservation and Recycling 54 (2010) 776–782**

Annexures1: List of Working Groups Chairpersons, Convenors and Members

GOVERNMENT OF N.C.T. OF DELHI
DEPARTMENT OF ENVIRONMENT
'C' WING, 6TH FLOOR, DELHI SECRETARIAT,
NEW DELHI-110002

Telefax: 23392029

F..12(197)/Env./NAPCC/11

13898 to 13902

Date:04.03.2011

ORDER

Sub:- Constitution of Working Group on Water

Secretary (Environment) is pleased to constitute a Working Group on Water for preparation of sectoral working papers for the State Action Plan for Climate Change (SAPCC). The Working Group will constitute the following officers:

- ✓ (i) Representative from Delhi Jal Board - Member
- ✓ (ii) Representative from Delhi Pollution Control Committee - Member
- ✓ (iii) Director, Environment Dept., Govt. of Delhi – Member
- ✓ (iv) Dr. Chetna Harjai, Scientist, Environment Dept., Govt. of Delhi – Member
Convener

Draft TOR for the Working Group is enclosed.

The first meeting of the Working Group will be held on **15.03.2011 at 3.00 PM** in the Conference Room of the Secretary (Env.), 6th Level, 'C' Wing, Delhi Secretariat, New Delhi.

Anil Kumar
(Dr. Anil Kumar)
Director (Env.)

All Concerned

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Date:04.03.2011

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Sub:- Constitution of Working Group on Forestry and Bio-Diversity

Secretary (Environment) is pleased to constitute a Working Group on Forestry & Bio-Diversity for preparation of sectoral working papers for the State Action Plan for Climate Change (SAPCC). The Working Group will constitute the following officers:

- ✓ (i) Chief Conservator of Forest, Department of Forests & Wild Life, Govt. of Delhi - Member
- ✓ (ii) Prof. C.R. Babu, Delhi University- Member
- ✓ (iii) Dr. B.C. Sabata, SSO (Env.) Environment Dept., Govt. of Delhi – Member
- ✓ (iv) Ms. Nigam Agarwal, Scientist, Environment Dept., Govt. of Delhi – Member Convener.

Draft TOR for the Working Group is enclosed.

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Director (Env.)

To

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NEW DELHI-110002

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F..12(197)/Env./NAPCC/11

139036 13907

Date:04.03.2011

ORDER

Sub:- **Constitution of Working Group on Transport**

Secretary (Environment) is pleased to constitute a Working Group on Transport for preparation of sectoral working papers for the State Action Plan for Climate Change (SAPCC). The Working Group will constitute the following officers:

- ✓ i) Representative of Commissioner (Transport), Govt. of Delhi - Member
- ✓ ii) Representative of DIMTS - Member
- ✓ iii) Shri. M. Dwarakanath, SSO, Environment Dept., Govt. of Delhi – Member
- ✓ iv) Dr. Chetna Harjai, Scientist, Environment Dept., Govt. of Delhi – Member
Convener

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The first meeting of the Working Group will be held on **15.03.2011 at 3.30 PM** in the Conference Room of the Secretary (Env.), 6th Level, 'C' Wing, Delhi Secretariat, New Delhi.

Anil Kumar
(Dr. Anil Kumar)
Director (Env.)

To

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NEW DELHI-110002

Telefax: 23392029

F..12(197)/Env./NAPCC/11

13908 to 13912

Date:04.03.2011

ORDER

Sub:- Constitution of Working Group on Energy & Power

Secretary (Environment) is pleased to constitute a Working Group on Energy & Power for preparation of sectoral working papers for the State Action Plan for Climate Change (SAPCC). The Working Group will constitute the following officers:

- ✓(i) Executive Officer, EE&REM Centre - Member
- ✓(ii) Representative of Power Department, Govt. of Delhi - Member
- ✓(iii) Director (Env.) Environment Dept., Govt. of Delhi - Member
- ✓(iv) Ms. Nigam Agarwal, Scientist, Environment Dept., Govt. of Delhi - Member Convener.

Draft TOR for the Working Group is enclosed.

The first meeting of the Working Group will be held on **15.03.2011 at 5.00 PM** in the Conference Room of the Secretary (Env.), 6th Level, 'C' Wing, Delhi Secretariat, New Delhi.

Anil Kumar
(Dr. Anil Kumar)
Director (Env.)

To

All Concerned

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F..12(197)/Env./NAPCC/11

13913 To 13919

Date:04.03.2011

ORDER


Sub:- **Constitution of Working Group on Industry & Urban Planning**

Secretary (Environment) is pleased to constitute a Working Group on Industry & Urban Planning for preparation of sectoral working papers for the State Action Plan for Climate Change (SAPCC). The Working Group will constitute the following officers:

- ✓ (i) Representative from DDA - Member
- ✓ (ii) Representative from Industries Dept., Govt. of Delhi - Member
- ✓ (iii) Representative from UD Dept., Govt. of Delhi - Member
- ✓ (iv) Representative from Planning Dept. Govt. of Delhi - Member
- ✓ (v) Shri M. Dwarakanath, Scientist, Department of Environment, Govt. of Delhi. - Member Convener.

Draft TOR for the Working Group is enclosed.

The first meeting of the Working Group will be held on **15.03.2011 at 5.30 PM** in the Conference Room of the Secretary (Env.), 6th Level, 'C' Wing, Delhi Secretariat, New Delhi.


(Dr. Anil Kumar)
Director (Env.)

To

All Concerned

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NEW DELHI-110002

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F..12(197)/Env./NAPCC/11

13893 to 13897

Date:04.03.2011

ORDER

Sub:- Constitution of Working Group on Disaster Management.

Secretary (Environment) is pleased to constitute a Working Group on Disaster Management for preparation of sectoral working papers for the State Action Plan for Climate Change (SAPCC). The Working Group will constitute the following officers:

- ✓(i) Representative from DDMA - Member
- ✓(ii) Representative from Centre for Disaster Management Studies, I.P. University - Member
- ✓(iii) Director, Environment Dept., Govt. of Delhi – Member
- ✓(iv) Dr. B.C. Sabata, SSO, Environment Dept., Govt. of Delhi – Member Convener.

Draft TOR for the Working Group is enclosed.

The first meeting of the Working Group will be held on **15.03.2011 at 4.30 PM** in the Conference Room of the Secretary (Env.), 6th Level, 'C' Wing, Delhi Secretariat, New Delhi.

Anil Kumar
(Dr. Anil Kumar)
Director (Env.)

To

All Concerned

Copy for information to:- PS to Secretary (Env.)

Annexure 2: Minutes of the Fifth Meeting of the Expert Committee on Climate Change (ECCC), Ministry of Environment and Forest, Government of India for the State Action Plan on Climate Change

The fifth meeting of the Expert Committee on Climate Change (ECCC) was held on September 18, 2012 under the Chairmanship of Dr. Subodh Kumar Sharma, Adviser (Climate Change), Ministry of Environment and Forests at 2:30 P.M. in Room No. 402, Paryavaran Bhawan, CGO Complex, Lodhi Road, New Delhi. The expert committee considered following SAPCC proposals: West Bengal, Andhra Pradesh, Mizoram, Manipur, Punjab, Karnataka, and Delhi.

Agenda Item No. 1: Introduction

At the outset, Dr. Subodh Kumar Sharma, Adviser (CC), Chairman, while welcoming all the participants, briefly outlined the objective of the Meeting. He emphasized that the main purpose of the meeting is to examine SAPCCs on an inter-ministerial basis for checking its adequacy for the following issues:

- Alignment of the SAPCCs with the National Action Plan on Climate Change (NAPCC)
- Planned Strategy by the State to combat Climate Change
- Role of various departments proposed to be involved in the various activities

He also highlighted the two stage procedure this Ministry is following to consider SAPCC. He mentioned that the SAPCC documents could be revised to incorporate comments/recommendations of the ECCC, if any, to be considered in the National Steering Committee on Climate Change (NSCCC). This was followed by a brief round of introduction by all the members.

Agenda Item No. 2: Action taken on the decisions of the four Meetings of the Expert Committee on Climate Change

Dr. S. Satapathy, Member Secretary of ECCC, Director, Climate Change Division, Ministry of Environment and Forests, briefly mentioned the status of the SAPCC documents considered in the last four meetings of ECCC held in September, 2011 and April, 2012 and follow up actions taken by the State Governments and MoEF to the decisions of the ECCC. The Committee took note of the status of the SAPCCs.

The representative of Delhi Government made a presentation highlighting the climate sensitivity of the state, contents of the SAPCC, key actions in the vulnerable sectors and monitoring and evaluation framework.

Comments/ observations:

Taking note of the information provided in the presentation, following were suggested to the State government representative:

- Health and Agriculture sectors should be included as thrust areas in the SAPCC
- The report should focus more on the adaption options to Climate Change
- The report needs to be revised in consultation with various nodal departments

Recommendation:

Based on the information provided in the presentation and taking note of the suggestions made by the experts, it was recommended that the State would revise the document and would submitted in 6 months time preferably by April 2012 after incorporating the suggestions made by the ECCC.

Annexure I: List of participants

1. Dr. Subodh Kumar Sharma, Adviser, Climate Change Division, Chairman of Expert Committee on Climate Change, MoEF
2. Dr. S. Satapathy, Director, Climate Change Division, Member Secretary of Expert Committee on Climate Change, MoEF
3. Dr. J. C. Dagar, ADG (Agriculture and Agro-forestry), ICAR
4. Dr. R.S. Sharma, Additional Director, Ministry of Health and Family Welfare
5. Shri A.K. Kharya, Director, Climate Change, Central Water Commission, Ministry of Water Resources
6. Dr. Mohan Lal, Deputy Inspector General of Forests, NEAB, MoEF
7. Dr. Preeti Soni, Advisor, Climate Change, UNDP
8. Shri R.P.S. Kamon, Principal Secretary, Department of Environment, Government of West Bengal
9. Shri Debal Ray, Chief Environment Officer, Department of Environment, Government of West Bengal
10. Shri A.K. Parida, Director General, EPTRI, Hyderabad, Government of Andhra Pradesh
11. Shri G. Surayanarayana, Head (Environment and Management Division), EPTRI, Hyderabad
12. Shri P. Prasada Rao, Head (ESD Division), EPTRI, Hyderabad, Government of Andhra Pradesh
13. Dr. Vanlal Zara, Chief Scientific Officer, Department of Environment, Government of Mizoram
14. Dr. H. Homeshwor, Director, Department of Environment, Government of Manipur
15. Dr. Brajakumar, Research Officer, Department of Environment, Government of Manipur
16. Dr. Satnam Singh Ladhar, Joint Director, Punjab State Council for Science and Technology, Government of Punjab
17. Dr. H.K. Parwana, Expert, Punjab State Council for Science and Technology, Government of Punjab
18. Shri Kanwar Pal, Secretary (Ecology and Environment), Government of Karnataka
19. Dr. Anil Kumar, Director, Department of Environment, GNCTD
20. Dr. B.C. Sabata, Senior Scientific Officer, Department of Environment, GNCTD

21. Dr. Chetna, Scientist, Department of Environment, GNCTD
22. Ms. Kavita Singh, Manager (Energy and Environment), ICLEI, New Delhi
23. Shri Kirtiman Awasthi, Project Officer, MoEF/UNDP
24. Ms. Nidhi Madan, Project Officer, MoEF/ GIZ

Annexure 3: Highlights of the Working Group Meetings, held in the Chairmanship of Additional Secretary (Environment) at Department of Environment, (Room No. C-604), 6th Level, C-Wing, Delhi Secretariat, I.P. Estate, New Delhi- 110002

S. No.	Sector	Date of Meeting	Participants	Key highlighted Comments
1	Urban Planning	07.11.2013 <i>Letter reference number No.E-in-C/W/ELC/2-13/5430 on 14.10.2013</i>	(1) Ravi Mathur, Director (Works), PWD (2) Director, Urban Development Department, Govt. of NCT Delhi, 9th Level, C-Wing, Delhi Secretariat (3) Director (Plg.), MPR&TC, Delhi Development Authority (4) Additional Secretary, Department of Environment (5) Dr. Anil Kumar, Director, Environment Department (6) Dr. Chetna Anand, Scientist, Environment Department (7) Mr. Keshav Jha, Project Officer, ICLEI South Asia	<ul style="list-style-type: none"> Housing Sector need special attention as there is a wide gap in demand & supply of Residential accommodations for which land availability is to be identified; & the land – use is to be put to optimum level of utilization so as to suffice the need of future demand even beyond 2021. This changing scenario requires construction technology to be in commensuration with the climate change & this has to be as per “Green Building norms” which envisages various concepts like site selection & planning, health & well being, Building & construction planning including water management, energy saving, waste management etc. Road sector needs to be further improved by providing facilities to all modes of transport i.s the traditional as well as modern means by widening of existing roads & construction of new flyovers which may lead to reduction in travel time thus less consumption of fossil based fuel. Plantation for increasing green cover needs to be paid much more attention by planting suitable plants alongside the roads & on central verge/medians of roads as well as in the building areas. Rainwater harvesting in buildings as well as alongside road network needs to be executed for proper recharge of ground water to the maximum extend possible.
2	Health	07.11.2013	Dr.Ravindra Aggarwal, Addl.Director (BMW),(Antiquackery),(Human Organ Transplantation Cell),(CME), Health & Family Welfare Department of GNCTD (7) Mr. Keshav Jha, Project Officer, ICLEI South Asia	<ul style="list-style-type: none"> Action plan to combat Communication diseases need specific attention. Disaster preparedness and risk reduction should be priority. Rest of the chapter is well drafted.

S. No.	Sector	Date of Meeting	Participants	Key highlighted Comments
3	Energy	23.09.2013	(1) Additional Secretary, Department of Environment (2)Dr. Anil Kumar, Director, Environment Department (3) Dr. Chetna Anand, Scientist, Environment Department (4)Department of Power, The Tata Power Company Limited (TPDL) (5) Ms. Kavita Singh, Manager, ICLEI South Asia (6) Mr. Keshav Jha, Project Officer (Energy & Climate), ICLEI South Asia	<ul style="list-style-type: none"> • Key priorities for Delhi Energy Sector should be updated. Reducing transmission and distribution losses is the major issues. • EE& REM ongoing initiatives and projects need to be updated. • All three power distribution companies i.e BYPL, BRPL and TPDDL recent specific projects and achievements need to be highlighted and mentioned in detail.
4	Transportation	03.10.2013	(1) Additional Secretary, Department of Environment (2)Dr. Anil Kumar, Director, Environment Department (3) Dr. Chetna Anand, Scientist, Environment Department (4) Delhi Development Authority (DDA) (5) DIMTS (6) Ar. Iram Aziz, Consultant- Urban Planner & Architect UTTIPEC, DDA (5) Mr. Keshav Jha, Project Officer (Energy & Climate), ICLEI South Asia	<ul style="list-style-type: none"> • The Current Modal Share of the City should be mentioned in the chapter, could be sourced from the RITES Ltd., MVA • Asia Ltd. and TERI study titled “Transport Demand Forecast Study and Development of an Integrated Road cum Multi-modal Public Transport Network for NCT of Delhi”. • Multiplicity of Agencies and lack of integration & coordination is one of the major bottlenecks. • Inequitable distribution of Road Space, Lack of connectivity and network limitations, and Lack of system integration. • To reduce the consumption of fuel & emission of carbon through traffic, it is required to plan for the finer network for city mobility. Such network planning should integrate well with the city's landuse planning to avoid excessive generation of vehicles. • Monorail initiative should be mentioned along with the pilot phase details.

S. No.	Sector	Date of Meeting	Participants	Key highlighted Comments
5	Water	23.09.2013	(1) Additional Secretary, Department of Environment (2) Dr. Anil Kumar, Director, Environment Department (3) Dr. Chetna Anand, Scientist, Environment Department (4) Mr. R S Negi, Delhi Jal Board (DJB) (5) Mr. Keshav Jha, Project Officer (Energy & Climate), ICLEI South Asia	<ul style="list-style-type: none"> • Rainwater Harvesting potential has to be realized. • Various preventive, adaptive and coping measures for water related stress need to be mentioned. • Institutional capacity building should be the first priority.
6	Forestry & Biodiversity and Agriculture	23.09.2013	(1) Additional Secretary, Department of Environment (2) Dr. Anil Kumar, Director, Environment Department (3) Dr. Chetna Anand, Scientist, Environment Department (4) Mr. Rajesh Kumar, Forest Department, GNCTD (5) Dr. C.R. Babu, Emeritus Scientist, University of Delhi (6) Mr. Keshav Jha, Project Officer (Energy & Climate), ICLEI South Asia	<ul style="list-style-type: none"> • Action plan for Agriculture sector need to identified and discussed among concerned stakeholders. • Green Action Plan of Delhi, to be developed under Green India Mission, should be integrated with the SAPCC.
7	Vulnerability Assessment		(1) Additional Secretary, Department of Environment (2) Dr. Anil Kumar, Director, Environment Department (3) Dr. Chetna Anand, Scientist, Environment Department (4) Prof. S.K.Dash, IIT Delhi (5) Mr. Keshav Jha, Project Officer (Energy & Climate), ICLEI South Asia	<ul style="list-style-type: none"> • Research done by Prof. SK Dash on Delhi city climate projection and assessment should be incorporated. • Delhi Vulnerability sectors and areas maps need to be added. • Chapter need little bit revision. • Climate projection and scenarios should be included in the chapter.

Annexure 4: Minutes of the Meeting / Workshop for stakeholder consultation to finalize Delhi State Action Plan on Climate Change (SAPCC) held on 28.05.2015 at Delhi Secretariat

Minutes of Meeting /Workshop for stakeholder consultation to finalize Delhi State Action Plan on Climate Change (SAPCC) held on 28.05.2015 at Delhi Secretariat.

Meeting/workshop for stakeholder consultation to finalize on Delhi State Action Plan on Climate Change (SAPCC) was held on May 28th, 2015 under the Chairmanship of Chief Secretary, GNCTD in hall no. 3, level 2, Delhi Secretariat, New Delhi.

List of participants is at Annexure-I.

Secretary (Environment), GNCTD at the outset welcomed all the senior officers from DDA, New Delhi Municipal Council, Power Department, I&FCD, Department of Industries, , DJB, Transport Department, DTC, DSIIDC, MCDs, Traffic Police, Forests department, UTTIPEC, DMRC, DHS, DPGS, DPCC. No one was represented from following departments: Urban Development department, DIVCOM, PWD, DDMA, DIMTS, CPWD and Cantonment Board.

Shri. Sanjiv Kumar, Secretary, Environment & Forests, GNCTD briefly outlined the objective of the meeting and informed the participants about the second draft SAPCC report (already emailed to all the concerned departments) prepared with help of ICLEI South Asia organization. The report also contains inputs received from all the concerned departments. He further emphasized that the main purpose of the meeting is to examine actions proposed to combat /mitigate climate change impacts, alongwith allocation of budget and finalization on an inter-departmental basis.

Shri. Emani Kumar, Executive Director of ICLEI South Asia gave a presentation on the basic intent of the SAPCC and the broad sectoral outcomes in terms of key priorities.

Dr. Anil Kumar, Director, Environment Department, GNCTD mentioned that the SAPCC document needs to incorporate comments/ recommendations of the concerned department. He has also briefly mentioned the process involved in preparation and the current status of the SAPCC document and the follow up actions.

Taking note of the information provided in the document and subsequent discussion among the departmental representatives, following directions were given by Chief Secretary:

- i. All the departments to focus on sectoral actionable points with the close consultation with the Environment department.
- ii. Need for comprehensive planned strategy & action to combat Climate Change and the requisite active role of concerned departments viz Transport, Power and Urban development etc in the process.
- iii. Budget component for the envisaged activities of each sector should be incorporated after consulting all nodal State departments.
- iv. Recent NGT order with respect of different service management may be highlighted clearly in the SAPCC report.
- v. Year wise target of all the department on proposed actions to be shared with Environment department on regular basis.
- vi. Review the leading global cities action plan on climate change like for instance New York, London and Seoul and incorporate actionable components in the Delhi's plan.

The Chief Secretary stressed on the need for approval of the heads of all concerned Departments for finalization of Action Points proposed as many of which require policy decisions.

Considering the direction from the Government of India, it was decided that all the concerned departments shall review the proposed actions with matching budgets and send it to the Environment department before 10th of June, 2015 positively which will be further incorporated in the document and subsequently a high level meeting of heads of the concerned department will be convened under Chairmanship of Chief Secretary to finalize the document before sending to Ministry or Environment, Forests and Climate Change, Govt. of India.

Non submission of the comments by 10th of June, 2015 will be presumed that the information contained in the SAPCC draft report (soft copy already emailed to officers as per details contained in the Annexure I) is acceptable to the concerned department.

Meeting ended with vote of thanks to the Chair.


Kulwant Joshi
Adp- Secretary (Environment)
08.6.15

Attendance Sheet

A meeting/ workshop for stakeholder consultation has been organized in Hall No. 3, 2nd Level, Delhi Secretariat regarding Delhi State Action Plan on Climate Change (SAPCC).

Date & Time : 28.05.2015 & 02:30 PM to 06:30 PM

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27.	R.K. Srinivasan	E.O. EELREM Centre	9999533500 rajneesh@delhi.gov.in	[Signature]

Sl. No.	Name	Designation/ Organization	Telephone No./ Email Id	Signature
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36.	Nigam Agarwal	SSO (Env. Dept.)	nigam.agarwal@ gov.in	
37.	Dr B. C. Sabot	SSO (Env. Dept.)	PCW	
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45.	Dr Chitra Arav	Secretary (Env)	23392029	
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Annexure 5: Minutes of meeting to finalize Delhi State Action Plan on Climate Change (SAPCC) held on 23.09.2016 at Delhi Secretariat

Minutes of Meeting/Workshop for Stakeholder Consultation to finalize Delhi State Action Plan on Climate Change (SAPCC) held on 23rd Sep, 2016 at Delhi Secretariat

Meeting/workshop for stakeholder consultation to finalize on Delhi State Action Plan on Climate Change (SAPCC) was held on September, 23rd, 2016 under the chairmanship of Secretary, Environment, Government of NCT of Delhi

List of Participants is at Annexure-I

Secretary (Environment), GNCTD at the outset welcomed the participants. Thereafter, participants from DDA, New Delhi Municipal Council, South Delhi Municipal Corporation, Delhi Jal Board, DTC, DSIIDC, MCDs, Forest Department, DMRC, DHS, DPCC etc. introduced themselves. No one was represented from following department; Revenue, Industries, DDMA and Cantonment Board.

Dr. Anil kumar, Director, Environment, GNCTD briefly outlined the objective of the meeting and informed the participants about the latest draft SAPCC report – the copy of which had already been emailed to all the concerned departments.

Mr. Keshav Jha, Sr. Project Officer, ICLEI South Asia gave a presentation on the background and progress happened so far on Delhi SAPCC preparation. He informed about the status of all key chapters of Delhi SAPCC and communicated the gaps in terms of specific year wise targets and budgetary requirement for Health and Forest sectors.

Dr. Anil Kumar, Director, Environment Department, GNCTD mentioned that Delhi is already very late already in its submission of SAPCC to Government of India. Several rounds of consultations have been held with various departments on the thematic sections/chapters however there are still some gaps which are supposed to be collectively worked upon. He informed that they now have the final opportunity to deeply review of respective concerned sections and further refine and update it.

The following points were discussed and deliberated upon during the meeting;

(1) Health chapter needs to be improved and short, medium and long terms targets for combating Climate Change impacts on Health Sector need to be clearly identified. Health is a very important sector for Delhi to give attention as city has witnessed havoc created by water-borne, vector-borne diseases such as Dengue, chikungunya etc.

(2) Prof Babu, Delhi University noted that it is important for Delhi to focus on climate resilience strategies and build the adaptive capacity of its fragile urban systems and vulnerable sectors. He has stated that he will submit one pager note on his observations on Delhi's climate resilience which could be considered for its incorporation in Delhi SAPCC.

Contd..

Anil Kumar

(3) Smt. Poonam Dewan, DDA raised point on the accuracy of Delhi's Protected/ Reserve forest areas figures mentioned in the forest chapter of Delhi SAPCC. Prof. Babu mentioned that the Delhi's forest areas demarcation is a long ever pending issues which require significant time to resolve it and arrive on the definite area demarcated under the forest. Therefore, he suggested Forest and DDA representative to jointly review the forest and urban planning chapter and a foot note may be added describing the current status of the matter.

(4) Dr. Chetna, Scientist, Environment, GNCTD informed that all of the chapters include existing baselines situation of the particular sector and at the end of each chapter, there is a Table which includes draft actions with target years and name of concerned department and budgetary requirement.

(4) Secretary, Environment reiterated the urgency of completion of SAPCC report and communicated that there are multiple opportunities for financing the potential actions enlisted in the SAPCC. Thus, he requested all the department to give due attention while framing and identifying actions and submit it at the earliest.

(5) Secretary, Environment further requested all the **departments to review their sections and send comments and further addition by Friday 30th Sep, 2016.** He also requested the participants to communicate about the same to all the departments who did not gave their feedback so far such as Industries, Cantonment board, etc

(6) It was also requested that all the departments will review the existing chapters and provide comments in track change mode so that it becomes easily recognizable and assist the officials in its incorporation to the base document. Subsequently the SAPCC will be submitted to Government of India for its approval and further sanctioning of funds to implement the priority actions and strategies.

Meeting ended with vote of thanks to the chair



ATTENDANCE SHEET

A meeting for stakeholder consultation regarding Delhi State Action Plan on Climate Change (DSAPCC).

Date & Time : 23.09.2016 at 11:30 AM
 Venue: Hall No. 3, 2nd Level, Delhi Secretariat

Sl. No.	Name	Designation/ Organization	Telephone No./ Email Id	Signature
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27	S.M.ALI	Sp. Secy (E&F) + MS, DPCC		
28	Dr Chetna Anand	Scientist, Dept of Env.	dr.chetnaand@gov.in	
29	Kishor Jha	ICLET Deptt. Env	9860406072	
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31	Dr S D S	CEO DPCC	9910035158	

Annexure 6: List of Common Indigenous Tress Species of Delhi

List of Common Indigenous Tress Species of Delhi			
S.No.	Name of the species	S.No.	Name of the species
1	Amaltas (Cassia fistula)	41	Kaniar (Bauhinia purpurea)
2	Amla (Phyllanthus emblica)	42	Karonda (Carissa karonda)
3	Anar (Punica granatum)	43	Kassod (Senna siamea)
4	Anjan (Hardwickia binata)	44	Katahal Artocarpus integrifolia)
5	Arjun (Terminalia arjuna)	45	Khair Acacia katech)
6	Ashok (Polyalthia longifolia)	46	Khairi Acacia senegal)
7	Ashok (Polyalthia pendula)	47	Khajur (Phoenix sylvestris)
8	Babool (Acacia nilotica)	48	Khezari (Prosopis cineraria)
9	Bael Patra (degle marmelos)	49	Khirmi Manilkara hexandra)
10	Baheda (Terminalia bellirica)	50	Lagestromla speciosa
11	Bakain (Melia azederach)	51	Lasora (Cordia dichotoma)
12	Balam Kheera (Kigelia pinnata)	52	Lesu (Cordia dichotoma)
13	Bargad (Ficus benghalensis)	53	Toon (Toona cililata)
14	Ber (Zizyphus jujuba)	54	Maharukh (Ailanthus excelsa)
15	Bistendu (Diospyros cordifolia)	55	Mahula (Madhuca longifolia var la)
16	Champa (Plumeria obtusa)	56	Makkhan katora (Ficus benghalensis)
17	Desi papdi (Ehretia laevis)	57	Mango (Mangifera indica)
18	Dhak (Butea monosperma)	58	Mulsari (musops eleng)
19	Dhuak (Annogeissus pendula)	59	Mulbery (Monus alba)
20	Goolar (Ficus racemosa)	60	Neel gulmobar (Jacuranda mimosifolia)
21	Guava (Psidium guajava)	61	Neem (Azadirachta indica)
22	Gulmohar (Delonix regia)	62	Pahadi Papri (Holoptelia integrefolia)
23	Gundani (Cordia ghara)	63	Pasendu (Diospyros Montana)
24	Harad (Terminalia chebula)	64	Peepal (Ficus religiosa)
25	Anjan (Hardwickia binnata)	65	Phalsa (Grewia asiatica)
26	Harshingar (Nyctanthes arbor-tristis)	66	Pilkhan (Ficus vire)
27	Imli (Tamarindus indica)	67	Putranjiva (Droptetes rauburghi)
28	Indian coral tree (Erythrina vari)	68	Rohida (Tecomela undulata)
29	Israeli babool (Acacia tortills)	69	Ronjh (Acacia leucocephala)
30	Jamun (Syzigium cumi)	70	Sagwan (Tectona grandis)
31	Jangli arand (Jatropha curcas)	71	Semur (Bombox ceiba)
32	Jhaar (Kigelia Africana)	72	Shahtoot (Morus alba)
33	Jhand (Prosopis cineraria)	73	Sharifa (Annona squomosa)
34	Jhinjheri (Bauhinia racemosa)	74	Shisham (Dalbergia sissoo)
35	Jungle jalebi (Pithecellobium dul)	75	Siras (Aibizia lebbeck)
36	Kachnar (Bauhinia variegata)	76	. Sonjna (Moringa oleifera)
37	Kadamb (Acacia auriculiformis) (Ea)	77	Thor (Euphorbia neriifolia)
38	Kadamb (Neolamarckia cadamba)	78	Tuma (Millettia peguensis)
39	Kadi patta (Bergera koenigii)		
40	Kanak (Pterospermum acerifolium)		