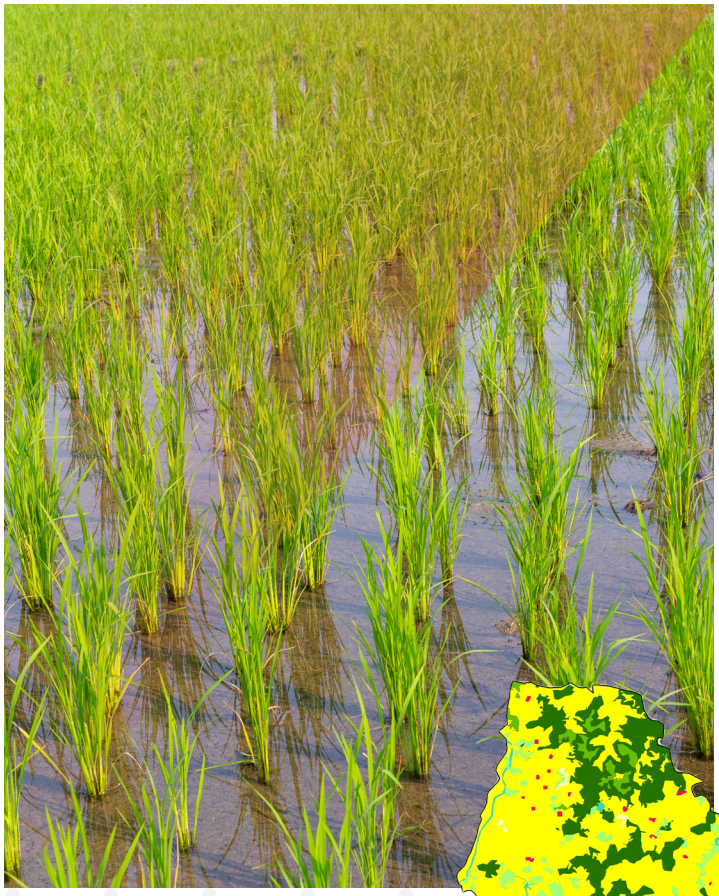
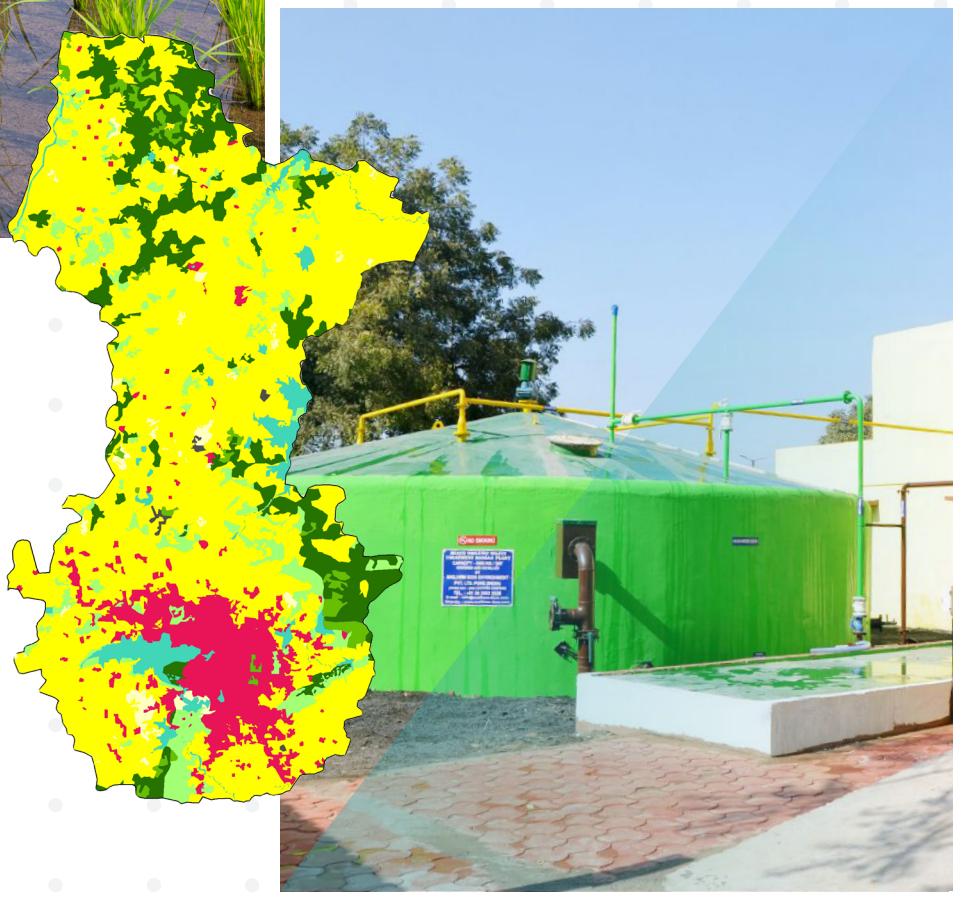
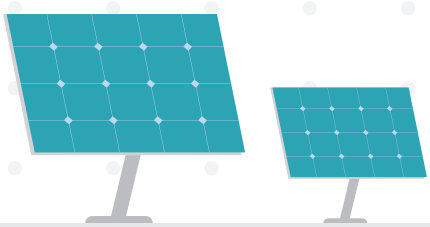
January, 2022



Climate Change and Environment Action Plan of

Bhopal District





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VASUDHA FOUNDATION
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SKMCCC, EPCO, Department of Environment
Government of Madhya Pradesh

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The Climate Change and Environment Action Plans (CCEAP) have been developed for multiple districts of India by Vasudha Foundation with support from Shakti Sustainable Energy Foundation. For Bhopal, the plan was developed in collaboration with the State Knowledge Management Centre on Climate Change (SKMCCC), Environmental Planning & Coordination Organisation (EPCO), Department of Housing and Environment, Government of Madhya Pradesh.

The CCEAP aims to complement the State Action Plan on Climate Change (SAPCC) version 2.0 as prescribed by the Ministry of Environment, Forest and Climate Change (MoEF&CC) and align it to India's latest climate change commitments to the United Nations Framework Convention on Climate Change (UNFCCC). The rationale behind this action plan is to follow a bottom-up approach to climate-proof development priorities for the district.

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January, 2022
Bhopal, Madhya Pradesh

Cover page images

Top left image:
Rice cultivation in Bhopal (sourced from freepik website)

Bottom right:
Waste to energy plant, Bhopal (sourced from Swachh Bhopal webpage).

Land use map of Bhopal district
created using data from Landsat 8, secondary data from NRSC/ISRO Bhuvan portal, Google Earth and ORNL-DAAC.

Dense forest | Mixed forest | Shrubland | Cropland | Fallow Land | Built-up Land
Barren Land | Grassland | Wasteland | Waterbodies

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FOREWORD

Aniruddhe Mukerjee (I.A.S.)
Principal Secretary

D.O. Letter No.

Foreword

The recently concluded 26th convention of the UNFCCC at Glasgow has brought forth the need for tangible actions on emissions. India has made ambitious commitments at CoP26. As the second largest Indian state, with a population of more than 8 million, Madhya Pradesh's efforts in combating climate change would be of significant importance in the national context. The state currently has the largest area under forest cover, and is home to one of the largest solar power projects in India, with a 750 MW solar power plant at Rewa. The state has also been taking initiatives to tackle climate change as highlighted in its State Action Plan for Climate Change (SAPCC).

While national and state level initiatives lead the movement to address climate change, it is important to equip the districts and guide communities for the same at the local level. In this light, I would like to congratulate the State Knowledge Management Centre on Climate Change, Environmental Planning & Coordination Organisation and Vasudha Foundation, New Delhi for formulating this in-depth Action Plan for Bhopal district. I appreciate that a detailed study was undertaken in consultation with various stakeholders to develop the Climate Change Action Plan of Bhopal district. I am thankful to Shakti Sustainable Energy Foundation for supporting its preparation.

The action plan is a comprehensive assessment of the sectoral greenhouse gas emissions, current and future climate change scenarios, and climate change drivers in the district. Based on the assessment, the plan identifies various local level interventions, which are in line with the SAPCC, other state and national-level programmes, to tackle climate change at the district level in a sustainable manner.

I would encourage the district administration to adopt this Action Plan and take initiatives for its implementation on the ground.

(Aniruddhe Mukerjee)

PREFACE

Shriman Shukla, IAS
Executive Director
EPCO

Preface

District Climate Action Plan (DCAP) for Bhopal district has been developed by State Knowledge Management Centre on Climate Change, EPCO in collaboration with Vasudha Foundation, New Delhi with the support of Shakti Sustainable Energy Foundation to assess the transition in terms of both climate & policy, to address the key issues related to climate change in the district.

The Bhopal DCAP includes district-level baseline studies on climate variability and projections, an emissions profile, a budgetary analysis to estimate climate finance, and analysis of state and national level policies and programmes active in the district. It also incorporates a comprehensive set of recommendations, in alignment with Sustainable Development Goals (SDGs), for various climate-related sectors and environmental issues of Bhopal district, as well as case studies and estimates of mitigation potential.

I applaud the extensive efforts made towards developing this comprehensive DCAP for Bhopal district. I am proud to state that the Government of Madhya Pradesh is committed to long-term development. As a result, adopting a district plan that incorporates climate action is a key first step towards attaining state and national climate targets. I am certain that this action plan will serve as a roadmap for district-level planning efforts to integrate climate action and development.

I would like to thank my colleagues at State Knowledge Management Centre on Climate Change, Bhopal District Administration, Vasudha Foundation & Shakti Sustainable Energy Foundation, and appreciate the efforts of all for undertaking this study for Bhopal district.

(Shriman Shukla)

ACKNOWLEDGEMENTS

We would like to thank Shriman Shukla, IAS (ED, EPCO), Tanvi Sundriyal, IAS (previous ED, EPCO), Jitendra Singh Raje, IAS (previous ED, EPCO), Lokendra Thakkar (General Manager & Coordinator, EPCO), Prateek Barapatre and other team members from Environmental Planning and Coordination Organisation (EPCO), Government of Madhya Pradesh as their inputs and support have been vital in the development of the Climate Change and Environment Action Plan for Bhopal district.

We express our appreciation to V. Subramanian, IAS (Retd.) (former Secretary, MNRE, GoI), for sharing pearls of wisdom during the course of this research.

We are grateful to Dr. Ashwini Kulkarni from IITM, Pune and Dr. Koteshwar Rao Kundeti for developing the district climate profile and modelling climate change projections for the district.

We would also like to extend our thanks to participants from various academic institutions, CSOs and line departments who contributed to the development and refinement of CCEAP through their inputs during stakeholder consultations.

We are also grateful to Swati Prasad for proofreading and giving the finishing touches to the manuscript, the team at Aspire Design, New Delhi for designing the final report.

We are thankful to our colleagues from the GIS team and Energy team at Vasudha Foundation for providing their expertise to assist the research and development of the final action plan.

Last but not the least, we extend our gratitude to Shakti Sustainable Energy Foundation (SSEF), New Delhi, for supporting the endeavour and also to Shubhashis Dey and Aishwarya KS from SSEF.

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ACRONYMS

AFOLU	Agriculture, forestry and other land use
AMRUT	Atal Mission for Rejuvenation and Urban Transformations
APMC	Agricultural Produce Market Committee
ARR	Aggregate revenue requirement
ASP	Activated sludge process
AT&C	Aggregate technical and commercial
BAU	Business as usual
BCC	Behaviour change communication
BCLL	Bhopal City Link Limited
BEE	Bureau of Energy Efficiency
BMC	Bhopal Municipal Corporation
BMW	Bio-medical waste
BOD	Biological oxygen demand
BRT	Bus rapid transit
BSCDCL	Bhopal Smart City Development Corporation Ltd.
C&D	Construction & demolition
CAGR	Cumulative annual growth rate
CapEx	Capital expenditure
CAAQMS	Continuous ambient air quality monitoring system
CBWTF	Common bio-medical waste treatment facility
CETP	Common effluent treatment plant
CFA	Central financial assistance
CGWB	Central Ground Water Board
CHP	Combined heat and power
CPCB	Central Pollution Control Board
CPEIR	Climate Public Expenditure and Institutional Review
CPP	Captive power plant
DDUGJY	Deen Dayal Upadhyaya Gram Jyoti Yojana
DG	Diesel generator
DISCOM	Distribution company
DRE	Decentralised renewable energy
EC	Electricity consumption
ECBC	Energy conservation building code
EEPS	Energy efficient pumping system
EESL	Energy Efficiency Services Limited
EF	Emission factor
EPCO	Environmental Planning and Coordination Organization
EV	Electric vehicle
FAME	Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles
FMCG	Fast moving consumer good
FSI	Forest Survey of India
FY	Financial year
GDP	Gross domestic product
GHG	Greenhouse gas
GHGPI	GHG Platform India
GIM	Green India Mission
GoI	Government of India
GoMP	Government of Madhya Pradesh
GW	Gigawatt
HW	Hazardous waste
ICAP	India Cooling Action Plan
ICE	Internal combustion engine
IEC	Information education and communication
IISS	Indian Institute of Soil Science
IMD	India Meteorological Department
IoT	Internet of things
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial processes and product use
IPT	Intermediate public transport
ISRO	Indian Space Research Organisation
ISWM	Integrated solid waste management
JFMC	Joint Forest Management Committee
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
KUSUM	Kisan Urja Suraksha evam Utthan Mahabhiyan
kW	Kilowatt
kWh	Kilowatt hour
LED	Light emitting diode
LMV	Light motor vehicle
M&E	Monitoring and evaluation
MCF	Methane correction factor
MGNREGS	Mahatma Gandhi National Rural Employment Guarantee Scheme

MI	Micro irrigation
MLD	Million litres per day
MMM	Multi-model mean
MPEDC	Madhya Pradesh Energy Development Corporation
MPERC	Madhya Pradesh Electricity Regulatory Commission
MPIDC	Madhya Pradesh Industrial Development Corporation
MPMKVVCL	Madhya Pradesh Madhya Kshetra Vidyut Vitaran Company Limited
MPPCB	Madhya Pradesh Pollution Control Board
MPPMCL	Madhya Pradesh Power Management Corporation Limited
MPSRTC	Madhya Pradesh State Road Transport Corporation MPUDCL Madhya Pradesh Urban Development Corporation Ltd.
MRF	Material recycling facility
MSME	Micro, small, and medium enterprises
$MtCO_2e$	Million tonnes of carbon dioxide equivalent
MU	Million units
MW	Megawatt
NASA	National Aeronautics and Space Administration
NCAP	National Clean Air Programme
NDCs	Nationally determined contributions
NEMMP	National Electric Mobility Mission Plan
NEX-GDDP	NASA Earth Exchange Global Daily Downscaled Projections
NPK	Nitrogen, phosphorus and potassium
NRSC	National Remote Sensing Centre
NTPC	National Thermal Power Corporation
ORNL-DAAC	Oak Ridge National Laboratory Distributed Active Archive Centre
PAT	Perform, achieve and trade
PCCP	Personal care and cosmetic products
PEG	Public electricity generation
PLF	Plant load factor
PM	Particulate matter
PMKSY	Pradhan Mantri Krishi Sinchai Yojana
PRIs	Panchayati raj institutions
PT	Public transport
PUC	Pollution under control
RCP	Representative concentration pathway
RE	Renewable energy
REC	Renewable energy certificate
RESCO	Renewable Energy Service Company
RO	Reverse osmosis
RPO	Renewable purchase obligation
RTS	Rooftop solar
RWA	Resident welfare association
RWHS	Rainwater harvesting system
SBR	Sequencing batch reactors
SDG	Sustainable development goals
SEZ	Special economic zone
SKMCCC	State Knowledge Management Centre on Climate Change
SLNP	Streetlight National Programme
SMB	Solar municipal bonds
SMNP	Smart Meter National Programme
STP	Sewage treatment plant
SUP	Single use plastic
SW	Solid waste
SWM	Solid waste management
T&D	Transmission and distribution
TOE	Tonnes of oil equivalent
ToU	Time of use
TPD	Tonnes per day
TPP	Thermal power plant
TSDF	Treatment, storage & disposal facility
UDAY	Ujwal DISCOM Assurance Yojana
UJALA	Unnat Jyoti by Affordable LEDs for all
ULB	Urban local body
W	Watt
W2E	Waste to energy
WEEE	Waste electrical and electronic equipment
WSP	Waste stabilisation pond
WW	Wastewater
ZEV	Zero emission vehicle

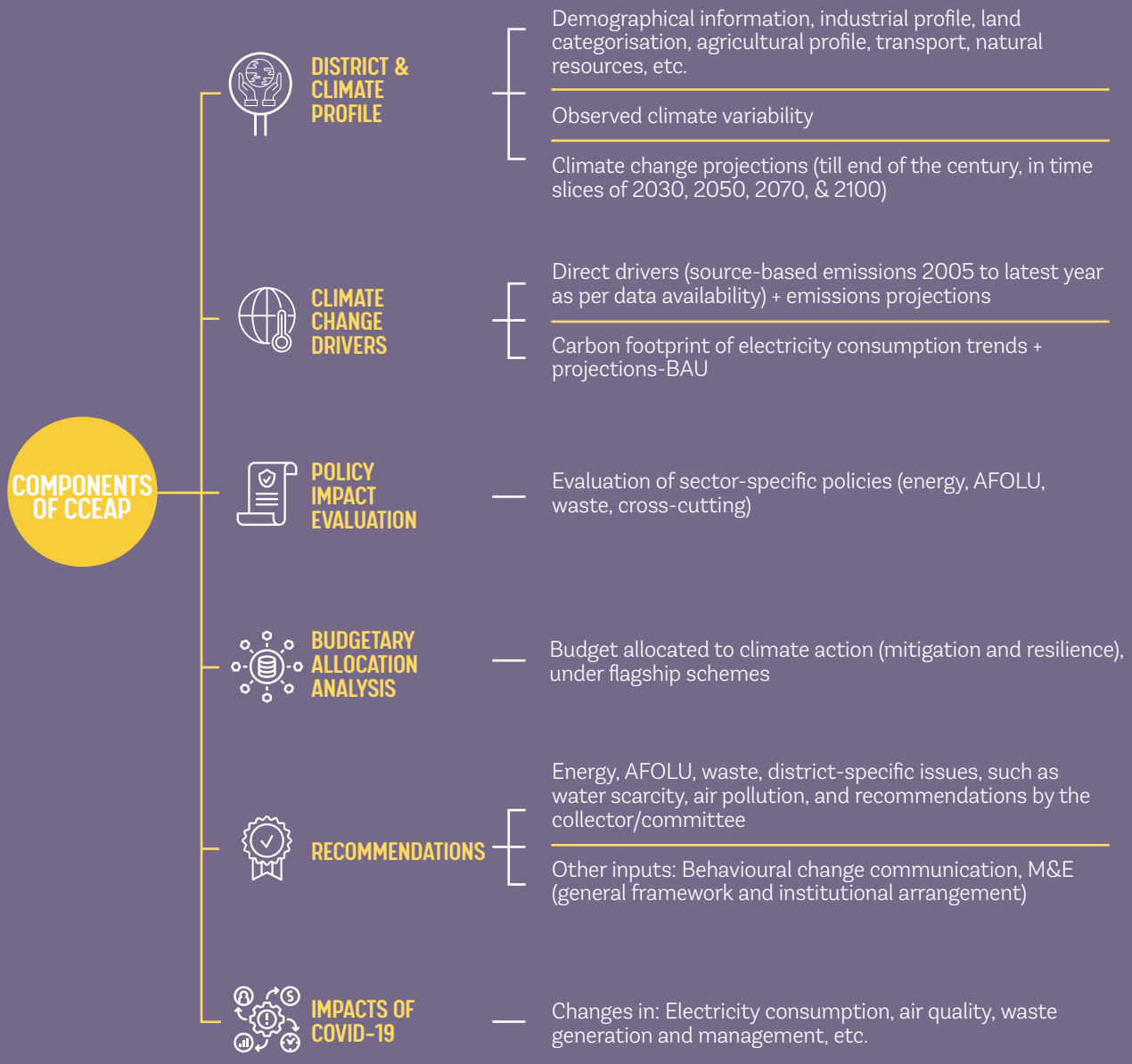
EXECUTIVE SUMMARY

This Climate Change and Environment Action Plan studies the past, present and the future of the district of Bhopal from both the climate and policy perspective to know where the district stands in terms of meeting India's climate commitments. Based on the findings, it evolves concrete recommendations and the way forward for the district collector and other in-line departments.

The ongoing COVID-19 pandemic, which began with a strict national lockdown, made it abundantly evident that anthropogenic activities have a far-reaching impact on the environment. On the flip side though, climate action has received a setback. A number of mitigation and adaptation-centric sectors have experienced unforeseen shifts. For instance, an overburdened health infrastructure has not been able to accommodate climate-related health issues. Considerable job losses have further diminished the adaptive capacities of the poor and vulnerable. Moreover, there has been a substantial spike in waste sector emissions with the rise in disposals of single use plastic and covid-related waste incineration.

This action plan, therefore, takes a holistic view of the current policies and recommends steps that need to be taken in the short-, medium- and long-term to bring about the necessary changes that are in compliance with India's overall climate goals and commitments.

The key components of this action plan are summarised in the chart below:



CLIMATE PROFILE AND PROJECTIONS

In this section, historical data and projected changes in rainfall and temperature for Bhopal district were analysed using IMD and NASA's NEX-GDDP datasets, by following the multi-modal mean (MMM) approach.

- **Warm days have gone up by 10 percent:** The maximum temperature has been observed to show a significant increasing trend in April and May. This trend has accelerated over the last two decades. The mean percentage of warm days is more pronounced in the recent years, having increased by 10 percent. Warm days may go up by 35 percent of the present climate – Bhopal district is projected to experience a warming of 2°C to 3°C under RCP4.5 and a warming of 2°C to 5°C under RCP8.5.[1] The percentage of warm days is also projected to increase by more than 35 percent in the future.
- **Cold days are decreasing:** The minimum temperature also projects an increasing trend and the cold days (in percentage) may decrease in all the epochs under changing climate conditions.
- **Rainy days are projected to increase:** The monsoon rainfall does not show any significant trend. July and August months are the principle rainy months for the district. The variability in rainy days is higher and shows a slight decreasing trend in monsoon months for the period 1951-2018. The seasonal rainfall of the district is projected to increase by five to 21 percent under RCP4.5 and by 17 to 39 percent under RCP8.5 emission scenarios. The number of rainy days is also projected to increase during the monsoon season, particularly during July and August.

SECTORAL GREENHOUSE GAS EMISSIONS PROFILE: CLIMATE CHANGE DRIVERS

- **Greenhouse gases have increased three-folds since 2005:** Between 2005 and 2019, the total greenhouse gas (GHG) emissions of Bhopal district increased by 291.80 percent (from 0.57 million tonnes CO_2e in 2005 to 2.21 million tonnes CO_2e in 2019) with a CAGR of 10.25 percent. These estimates represent GHG emissions from 12 categories covering three major sectors – energy, agriculture, forestry and other land use (AFOLU), and waste.
- **Energy sector is the highest contributor of emissions:** Energy sector (direct fuel combustion in transport, agriculture, residential categories etc.) is the highest contributor of GHG emissions. Although energy emissions of Bhopal district increased at a CAGR of 5.31 percent, its share has decreased from 84 percent in 2005 to 52 percent in 2019 due to increase in AFOLU emissions. There are no emissions from the industrial product use and processes (IPPU) sector because the district does not have any large-scale industries that fall under the IPPU industries, as per the IPCC guidelines.
- **From a net sink in 2011, AFOLU sector is now witnessing high GHG emissions:** The agriculture, forestry and other land use (AFOLU) sector has witnessed very high growth in GHG emission due to constant reduction of forest cover. Its CAGR between 2012 and 2015 (between positive values) was 9.66 percent. It may be noted that AFOLU sector was a net sink until 2011.
- **Waste sector's contribution to GHG emissions is decreasing:** Emissions from the waste sector have grown at a slow rate (CAGR of 2.89 percent) and its contribution has dropped from 16 percent (in 2005) to 7 percent (in 2019).
- **Business-as-usual scenario will be disastrous:** In business-as-usual scenario (i.e. no actions/policies are put in place to mitigate emissions), the total emissions of Bhopal by 2030 are likely to increase over three-folds – or by 342 percent –with respect to 2015 levels.

ASSESSMENT OF POLICIES THROUGH THE LENS OF CLIMATE CHANGE

Several national/state level policies and programmes of energy, AFOLU and waste sector being undertaken in Bhopal were evaluated for their climate mitigation potential.

1 Representative concentration pathways (RCPs) are concentration pathways used by the IPCC. They are prescribed pathways for greenhouse gas and aerosol concentrations, together with land use change, that are consistent with a set of broad climate outcomes used by the climate modelling community. The pathways are characterised by the radiative forcing produced by the end of the 21st century. Radiative forcing is the extra heat the lower atmosphere will retain as a result of additional greenhouse gases, measured in Watts per square metre (W/m^2). There are four RCPs, RCP2.5 (low pathway where radiative forcing peaks at approximately 3 W m^{-2} before 2100), RCP4.5 and RCP6.0 (two intermediate stabilisation pathways in which radiative forcing is stabilised at approximately 4.5 W m^{-2} and 6.0 W m^{-2} after 2100) and RCP8.5 (high pathway for which radiative forcing reaches greater than 8.5 W m^{-2} by 2100).

- **Power and energy:** For this sector 12 policies/programmes were evaluated (UDAY and PAT schemes are the biggest contributors to GHG mitigation)
  - Policies related to clean energy generation mitigated 2,11,113 tCO_2e emissions.
  - Policies pertaining to energy-efficient buildings and processes helped avoid 7,45,727 tCO_2e emissions.
  - Transportation interventions have led to an emission avoidance of 1,17,345 tCO_2e.
- **AFOLU and cross-cutting:** Nine policies were assessed.
  - Forestry policies alone led to a mitigation of 1,79,78,321 tCO_2e (as per scenario 1)[2], and 11,156 tonnes of CO_2e (as per scenario 2)[3].
  - Policies pertaining to livestock, proved to be beneficial for climate action by avoiding 4,326 tonnes of CO_2e.
  - Under the agricultural sub-sector, emissions from the National Food Security Mission (NFSM) were estimated to be 20,432 tonnes of CO_2e.
  - The cross-cutting sector: The National Mission on Micro Irrigation resulted in avoiding 911 tonnes of CO_2e emissions (from reducing use of urea alone). The Pradhan Mantri Ujjwala Yojana has helped mitigate 8,47,722 tonnes of CO_2e (as per scenario 1), and 87,891 tonnes of CO_2e (as per scenario 2).
- **Waste:** Sixteen policies were assessed.
  - Policies pertaining to sanitation added 88,846 tCO_2e emissions.
  - Composting as a part of solid waste management practices has mitigated 60,923 tCO_2e.
  - Domestic wastewater treatment interventions have led to 44,228 tCO_2e emissions.

BUDGETARY ANALYSIS TO ESTIMATE EXPENDITURE ON CLIMATE ACTION

This section analyses the regional expenditure to estimate spending on climate action. A total of 39 flagship schemes were reviewed to identify those with climate resilience and mitigation relevance. Of these, based on the availability of information across districts as well as the relevance to climate actions, five schemes were selected for further analysis.

Table 1: Summary of flagship schemes budgetary analysis for Bhopal district

Scheme selected	Climate relevant activities	Year	Total allocation to district under scheme (₹ lakh)	Allocation to climate action (₹ lakh)	% of total scheme budget for climate action at district level
MGNREGS	Eleven out of 17 activities were identified as climate relevant: drought proofing, fisheries, flood control and protection, land development, micro-irrigation, renovation of traditional water bodies, rural connectivity, drinking water, sanitation, water conservation and water harvesting	2018-19	4,084	322	8
		2019-20	1,194	233	*20
PMKSY	Micro-irrigation activities	2016-17	1,766	1,218	*69
GIM	Enhancing forest cover, ecosystem restoration, agro-forestry, social forestry, wetland restoration, promoting alternative fuels	2018-19	13.21	13.21	*100
		2019-20	10.30	10.30	
AMRUT	Water supply, sewage and septage management, urban transport, drainage, green spaces	2015-16	25,502	13,906	*54.5
		2016-17	31,438	17,139	
		2017-20	37,658	20,529	
DDUGJY + Saubhagya	New and upgradation of substations, LT lines, feeder segregation, consumer metering, DTR metering, etc	Upto April 2020	4,481	2,240.5	*50

*Percentage has been attributed by using Climate Public Expenditure and Institutional Review (CPEIR) methodology of UNDP.

2 Scenario 1- Carbon Stock density of MP (89.79 tonnes/ha) is used (as given in the FSI Reports for MP).

3 Scenario 2 - Carbon stock density 10 tonnes/ha is used (Bhopal specific carbon stock density was suggested by MP Forest Officials)

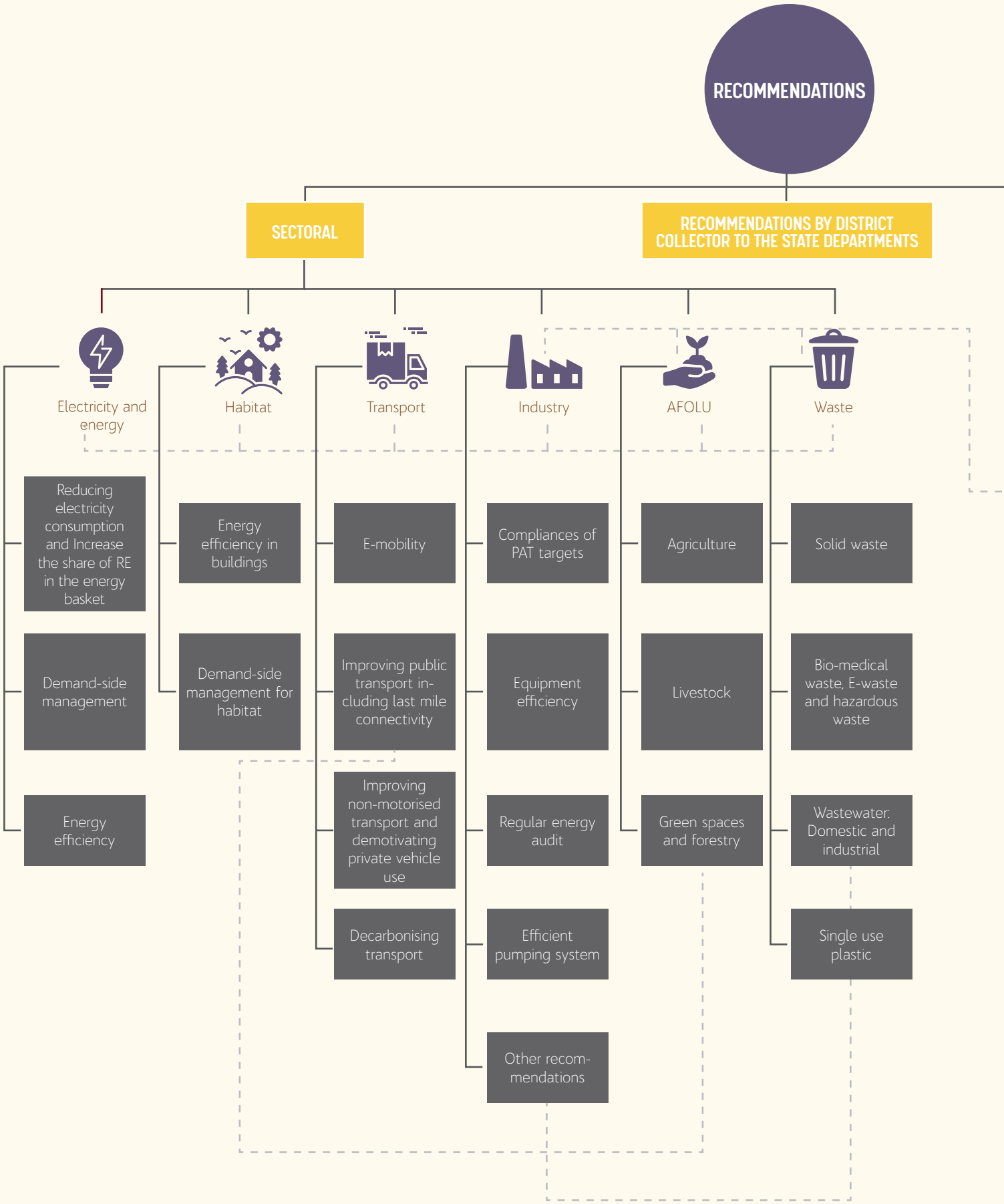
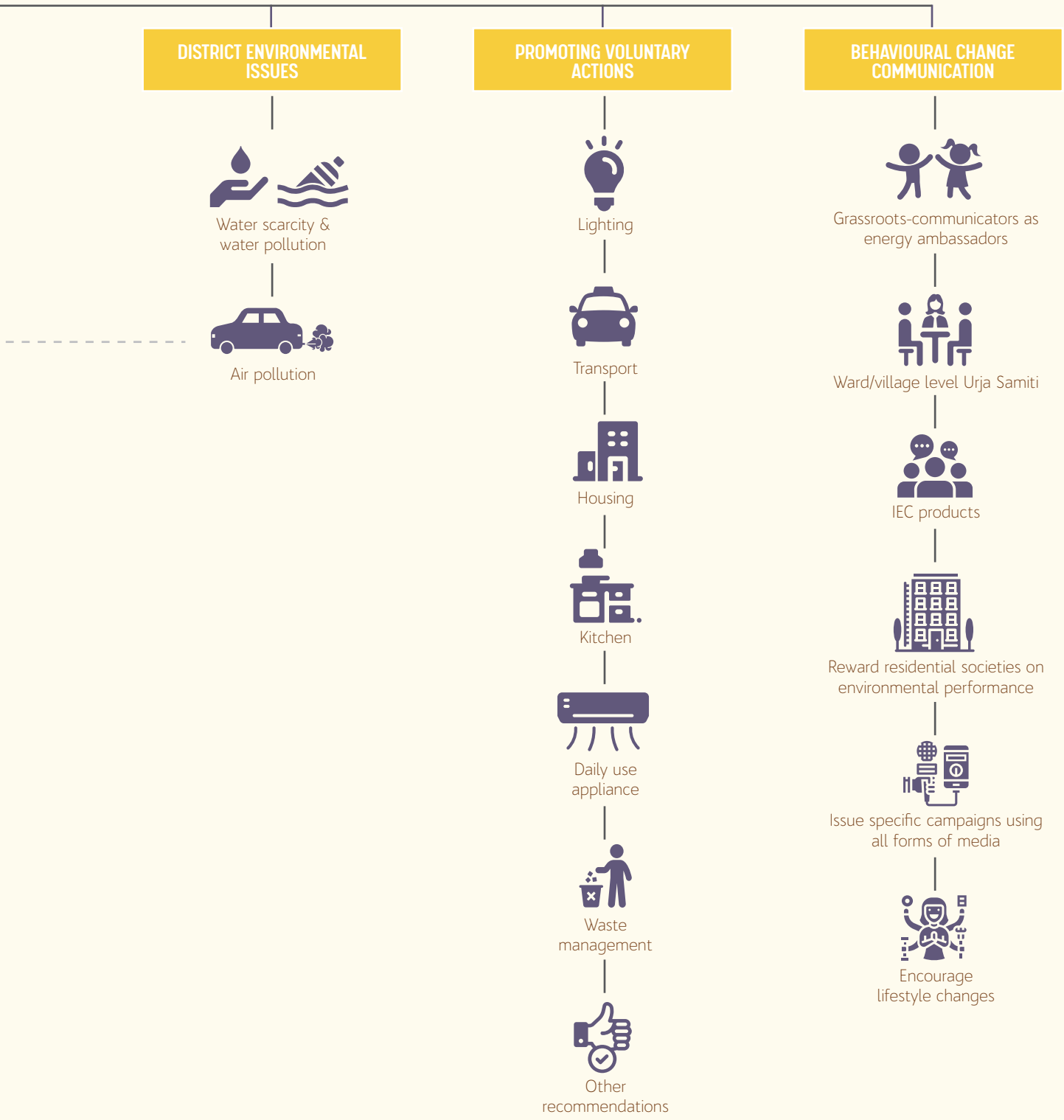


Figure 1 Recommendations for CCEAP Bhopal


DISTRICT ENVIRONMENTAL ISSUES
PROMOTING VOLUNTARY ACTIONS
BEHAVIOURAL CHANGE COMMUNICATION
Water scarcity & water pollution
Air pollution
Lighting
Transport
Housing
Kitchen
Daily use appliance
Waste management
Other recommendations
Grassroots-communicators as energy ambassadors
Ward/village level Urja Samiti
IEC products
Reward residential societies on environmental performance
Issue specific campaigns using all forms of media
Encourage lifestyle changes
: Interlinkages across sectors and sub-sectors (cross-cutting aspects)

RECOMMENDATIONS

The action plan provides comprehensive, sector-wise recommendations from a climate perspective. The aim is to align the district with India's climate commitments through this Climate Change and Environment Action Plan (CCEAP).

The recommendations factor-in state/district vision documents and development plans. They also list the current policies, programmes and schemes and identify concerned departments that can help streamline the actions. This section also provides information on SDGs and other co-benefits that will be addressed through these recommendations.

Overall, the mitigation actions suggested in the recommendations can help mitigate 6.86 Mt CO_2e per annum. The sectoral breakdown of the same is as following:

GHG mitigation potential of CCEAP recommendations (tCO_2e)

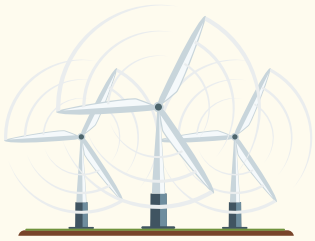
Energy
58,62,077

AFOLU
9,34,018

Waste
60,694

Some in-brief, sector-wise recommendations are provided in figure 1.

Power and energy



Though the energy sector is crucial to achieving India's growth ambitions, it is also responsible for around 70 percent of the country's annual GHG emissions. This calls for a paradigm shift in the energy sector.

Therefore, the action plan recommends (a) increasing the share of RE generation in the district by advancing on-grid and off-grid solar rooftop, ground-mounted installations and other RE installations, (b) encouraging faster penetration of energy-efficient and star-labelled fixtures and upgrading existing power-grid infrastructure to advanced metering infrastructure (in public, institutional and commercial setups), (c) promoting energy efficiency in the residential sector by encouraging the incorporation of ECBC in the building bye-laws, implementation of India Cooling Action Plan, 2018, etc., and (d) promoting energy conservation in the industrial sector by introducing measures such as a "cap and trade" system for MSMEs at the district level.

Transport

Being one of the fastest growing sectors in India, transport contributes 12 percent of India's total GHG emissions. The action plan recommends (a) promoting e-mobility through awareness, increase of e-vehicles modal share, transition of public transport (PT) and intermediate public transport (IPT) to electric-powered or hybrid vehicles, developing widespread charging infrastructure, incentivising e-vehicle owners, etc., (b) ensuring last-mile connectivity and promoting increased use of PT and IPT, (c) augmenting non-motorised transport through dedicated cycle lanes, and (d) improving traffic flow.

AFOLU

For agriculture, forestry and other land use (AFOLU) sector, it is important to promote climate-conscious practices that do not have an adverse impact on the ecosystem, biodiversity and natural resource dependent communities. Our recommendations include: (a) promoting the use of organic fertilisers, solar pumps and practices such as micro-irrigation and alternative ways to manage crop-residue under agriculture, (b) having a good mix of high-yield cross-breed cattle and indigenous cattle, and encouraging the use of good quality fodder to bring down enteric fermentation emissions, and (c) maintaining the forest area and the tree cover of the Bhopal district through strict M&E, afforestation in fallow and wasteland, use of alternative funding like CSR, adoption of Miyawaki urban forestry and study on suitability of plantation sites/species, etc. The action plan also recommends involvement of regional agriculture universities to initiate research on high yielding, drought- and temperature-resilient genotypes for various crops, among other measures.

Waste

With the waste sector being one of the biggest contributor of methane emissions globally, major recommendations revolve around reducing landfill disposal of waste and managing wastewater to reduce GHG emissions from them through measures such as: (a) reducing waste at source, (b) proper segregation, collection and channelisation of different categories of waste (including bio-medical waste and e-waste) for recycling and treatment, (c) 100 percent conversion of organic waste to compost and gas management of composting units, (d) recycling, recovery and reuse of 100 percent inert waste (plastic, construction waste, etc), and (e) setting up of centralised aerobic wastewater treatment plants with closed sewer networks and sludge removal facility.

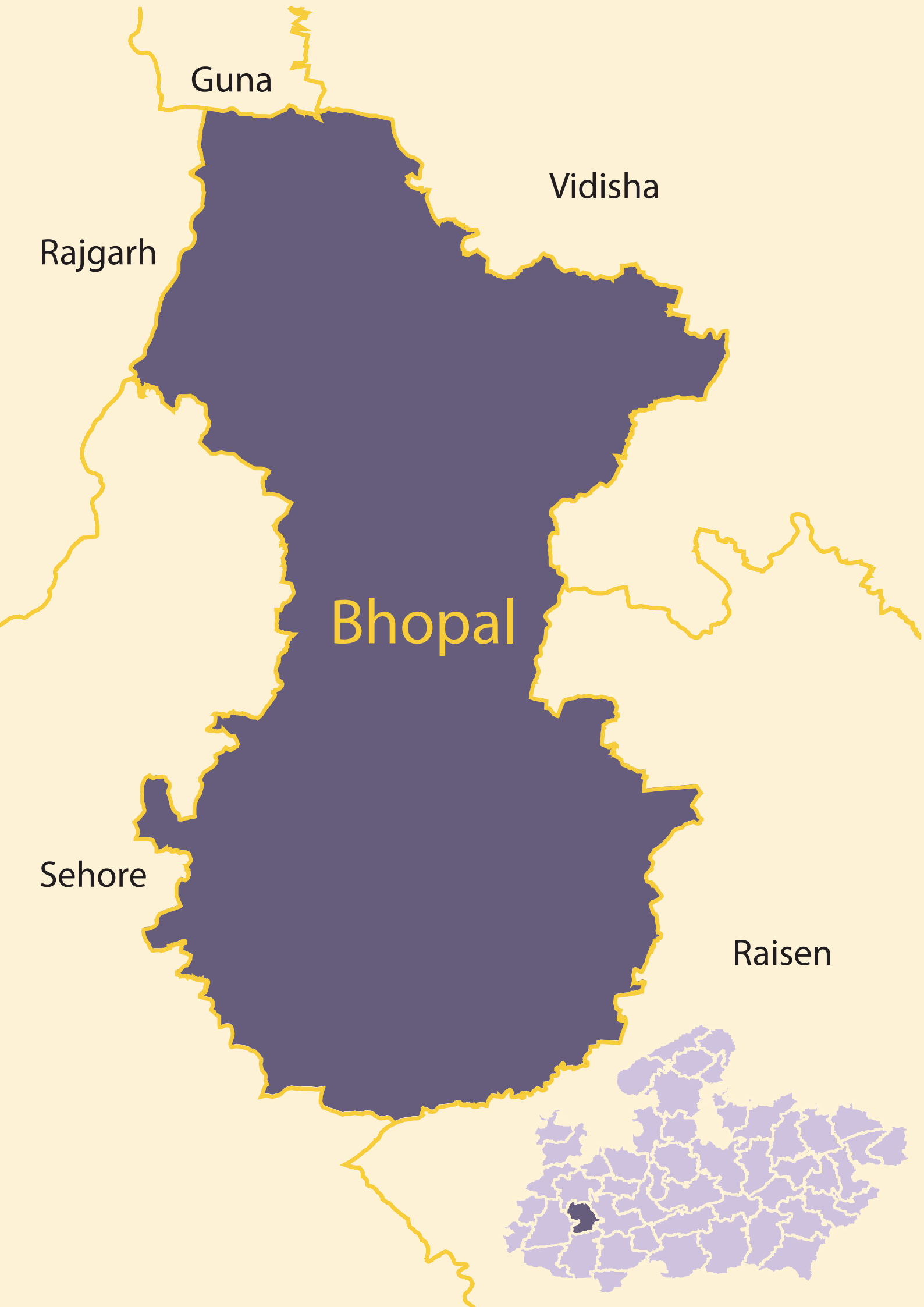
Given the unique environmental issues of the district, the action plan also recommends developing extensive infrastructure to monitor air pollution and suggestions on interventions for preventive measures and improvement and sustainable management of the Bhoj wetlands in Bhopal.

COVID-19 IMPACT

This section presents an assessment of how the COVID-19 pandemic has impacted various sectors and the developmental measures. During the national lockdown in 2020, the total energy demand in India went down considerably. However, in Madya Pradesh, power demand went up by 6.4 percent due to increase in consumption by the agricultural sector.

The pandemic has only underscored the need to increase focus on renewable energy and strengthen its integration into the grid. Bhopal district needs to increase implementation of RE generation through solar rooftops, biogas, solar pumps for agriculture and water supply.

Overall, the pandemic resulted in significant reduction in air pollution due to reduced transport and industrial activities during the lockdown and unlock periods. However, the most impacted sector was waste management with single-use plastic waste and bio-medical waste from both households and healthcare sector increasing manifold, leading to increased incineration, landfilling and single-use product consumption.


Guna
Vidisha
Rajgarh
Bhopal
Sehore
Raisen

DISTRICT PROFILE

Upper lake, Bhopal

1. DISTRICT PROFILE

The district of Bhopal was carved out of the former Sehore district in Madhya Pradesh in 1972. The city of Bhopal is both the state capital and the district headquarter. The district has a unique and varied physiography (consisting of Bhoj wetlands, Berasia shrub forests, Vindhya plateau, and the Narmada valley). This unique physiography plays a key role in Bhopal's micro-climatic variabilities. Bhopal's undulated topography (consisting of hills and lakes) has segmented the city into sub-cities. The district's altitude is comparatively higher than the North Indian planes.

1.1 Key statistics

Table 2: District profile of Bhopal

General characteristics of the district			
Location	Central part of India	**Area**	2,772 sq. km
Latitude	77.12° & 77.35° east		
Longitude	23.15° & 23.45° north	**Elevation**	427 msl
Agro-climatic zone			
Malwa plateau zone	Western plateau and hills region (46%); Soil: Red and black		
Vindhya plateau zone	Central plateau and hills region (42%); Soil: Medium and deep black		
Narmada valley	Central valley; Soil: Deep black with clay		
Administrative unit (District Administration, 2020)			
Tehsil	3	**ULBs**	3 (corporation – 1, municipality – 2)
		Gram panchayat	202
Constituency	7	**Villages**	6,144
Demography (Census of India, 2011)			
Population (total)	23,71,061	**Population density**	855 per sq km
Population (urban)	19,17,051	**Household**	4,87,750
Population (rural)	4,54,010	**% urbanisation**	81% (household and population share)
Population growth	28.62% (2011)	**Households headed by women**	40,687
Land use pattern (area in hectare) (DACNET, 2018)			
Area under non-agricultural uses	34,022	**Fallow lands other than current fallows**	3,681
Barren and unculturable land	3,949	**Current fallow**	809
Permanent pasture and other grazing land	32,460	**Net area sown**	1,53,182
Land under misc. tree crops and groves not included in net area sown	30	**Cropped area**	2,94,685
Culturable waste land	5,641	**Area sown more than once**	1,41,503
Agriculture profile (Department of Agriculture, 2012)			
Major crop season	Kharif (rainfed/irrigated) and rabi (rainfed/irrigated)		
Major field crops (Farmer Welfare & Agriculture Development Department, 2019)	Food grain: Rice, wheat, bajra, jowar, maize, pulses (tur, urad, mung), gram Oilseeds: Soybean, sesamum		
Soil type	Deep soil (60.31%), medium-deep soil (6.47%), shallow soil (33.22%)		
Industrial profile (MSME, 2016)			
Registered industrial units	10,989	**Registered medium and large units**	19
Total industrial unit	12,400 (approx.)	**No. of industrial areas**	4

As compared to Madhya Pradesh, Bhopal district's urban population is thrice that of MP in percentage terms, its average income is twice that of the state and its workforce participation is high. In terms of basic amenities, access to improved drinking water sources (93.5 percent), improved sanitation facilities (61.8 percent), clean fuel for cooking (74.9 percent) and electricity (98.3 percent) are also much higher than the state averages (84.7 percent, 33.7 percent, 29.6 percent and 89.9 percent, respectively) as per NFHS IV, 2015-16.

Table 3: Bhopal vs. Madhya Pradesh: A comparative profile

Particular	Bhopal district	Madhya Pradesh	% contribution
Total population (2011)	23,71,061	7,26,26,809	3.26%
Urban population (2011)	19,18,188	2,00,69,405	9.54%
Percentage of urban population	80.9%	27.6%	3 times higher than the state
Geographical area (sq. km)	2,772	3,08,252	0.9%
Forest cover (sq km) (Forest Survey of India, 2019)	328.67 (very dense: 0, medium dense: 120.92, open forest: 207.75)	77,482 (very dense: 6,676, medium dense: 34,341, open forest: 36,465)	0.42% (no dense forest in the district)
Per capita forest cover (ha/ person)	0.014	0.11	7 times less than that of the state
Total registered vehicles	16,53,052	6,88,64,960	2.4%
Total rice production (in '000 tonnes) 2018-19 (Farmer Welfare & Agriculture Development Department, 2019)	18	7,858	0.23%
Installed capacity of electricity generation (conventional, MW)	0	22,502.5	0%
Major types of industries (MSME, 2017)	Agri-export, rail coach workshop, heavy electrical, engineering, plastic processing, sandstone and lime industries	Mineral production, mineral-based industries, like, cement, thermal power, coal mines and auxiliaries, ceramic, hydrated lime, asbestos, clay, marble, granite products, etc.	--
Industrial land acquired and developed (hectare) under DTIC (MSME, 2017)	360.69 & 406.06	7,340.37 & 4,185	4.91% 9.7%
Human development index (HDI) (UNDP, 2008)	0.68	0.38	2 times higher than the state

1.2. Power and energy sector

Bhopal district receives it's electricity from the state's central zone DISCOM – Madhya Pradesh Madhyam Kshetra Vidyut Vitaran Company Limited (MPMKVVCL)—which in turn procures electricity from Madhya Pradesh Power Management Company Ltd (MPPMCL). Agriculture is the predominant electricity consuming sector in the district, followed by residential, industrial, and commercial sectors (Figure 2). The overall electricity consumption increased at a CAGR of 7.16 percent between 2012 and 2018, with the consumption mix remaining unchanged for that period (MPERC, 2021).

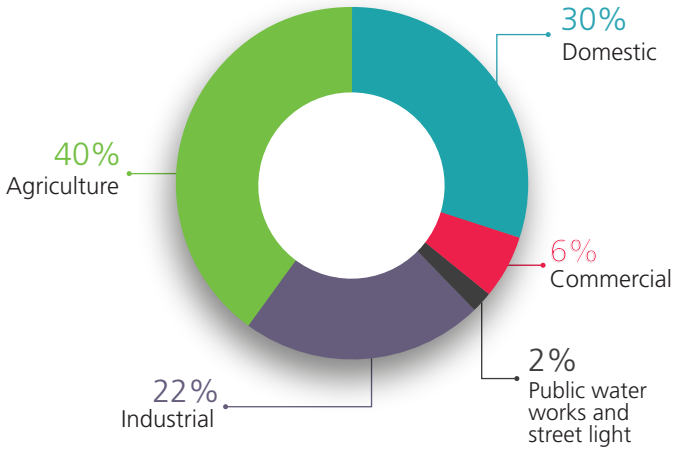
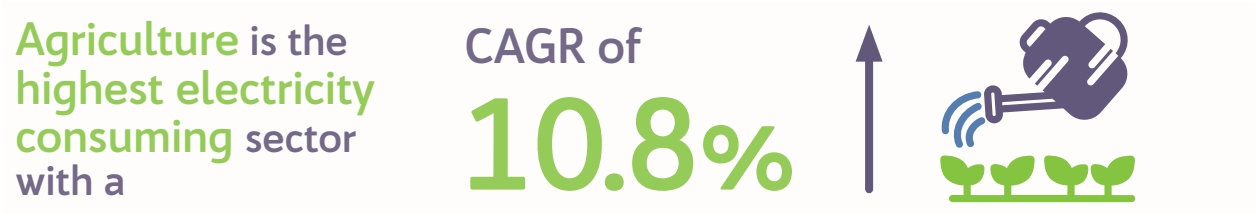


Figure 2: Consumer-wise electricity consumption in Bhopal (2019)



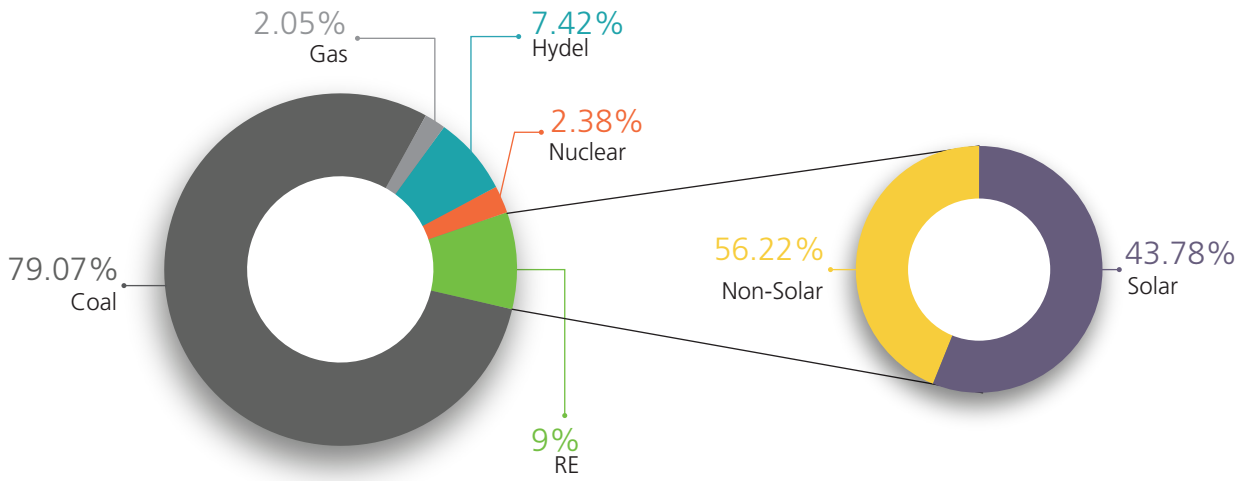


Figure 3: Electricity procurement- mix of MPPMCL (2019-20)

For FY 2019-20, MPPMCL purchased 90,858 MUs of electricity, of which about 79 percent came from coal, followed by renewable sources, hydel, nuclear, and gas-based generation, illustrated in Figure 3 (MPERC, 2020; Vasudha Power Info Hub, 2021). Out of the total renewable energy (RE) purchased, non-solar sources (wind, small hydro, biomass and waste to energy) contributed to around 56 percent (MPERC, 2020) (Vasudha Power Info Hub, 2021).

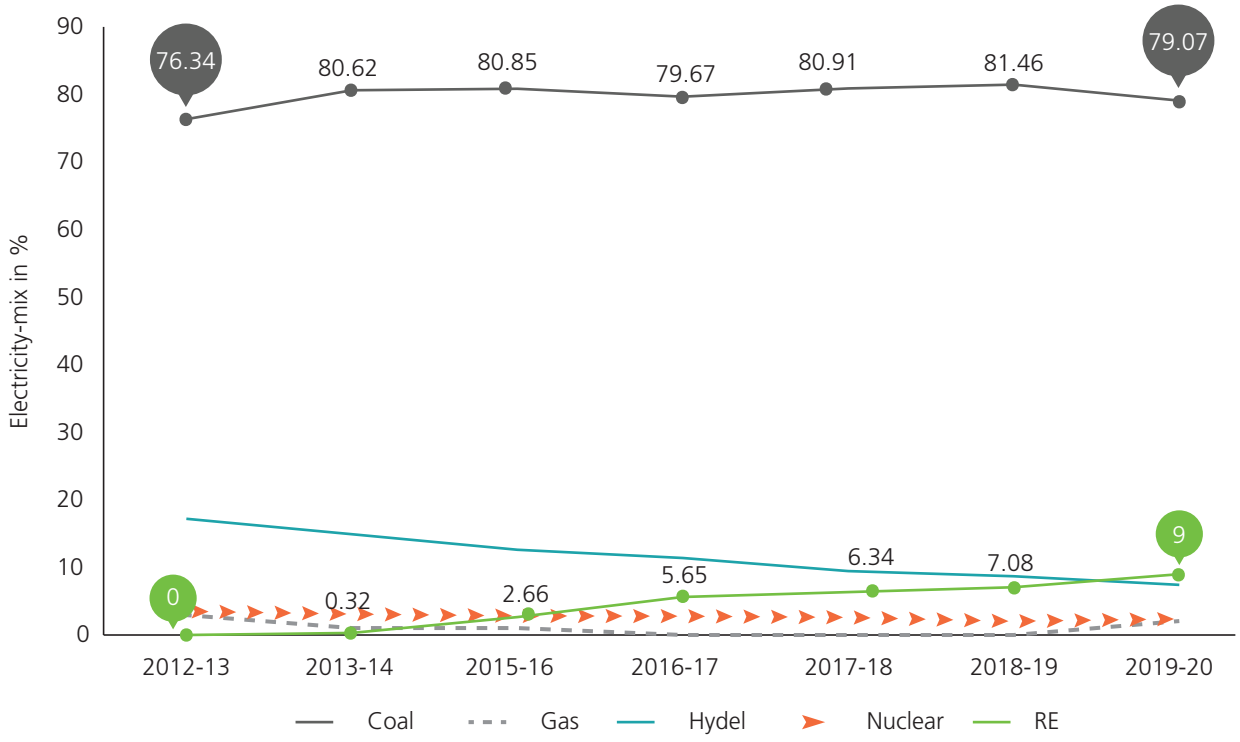
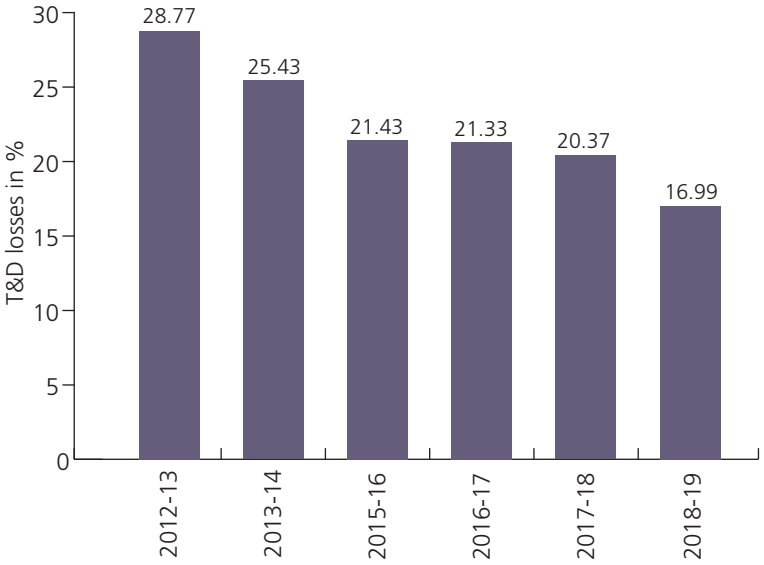


Figure 4: Trend of electricity-mix of MPPMCL over the years (%)

The transmission and distribution losses (Figure 5), for MPMKVVCL were 17 percent during FY 2018-19 (MPERC, 2019-20), almost at par with the national average of 21.42 percent (CEA , 2019). At present, the T&D losses of MPMKVVCL stand at 17 percent (MPERC, 2020).



T&D losses for MPMKVVCL is slightly lower than the national average and has scope to improve.

Figure 5: T&D losses (in %) for MPMKVVCL over the years

Information on category-wise electricity consumption (EC)[4] of the district and the projections of electricity consumption (based on short-term and long-term CAGR calculations) are presented in Figure 6.[5]

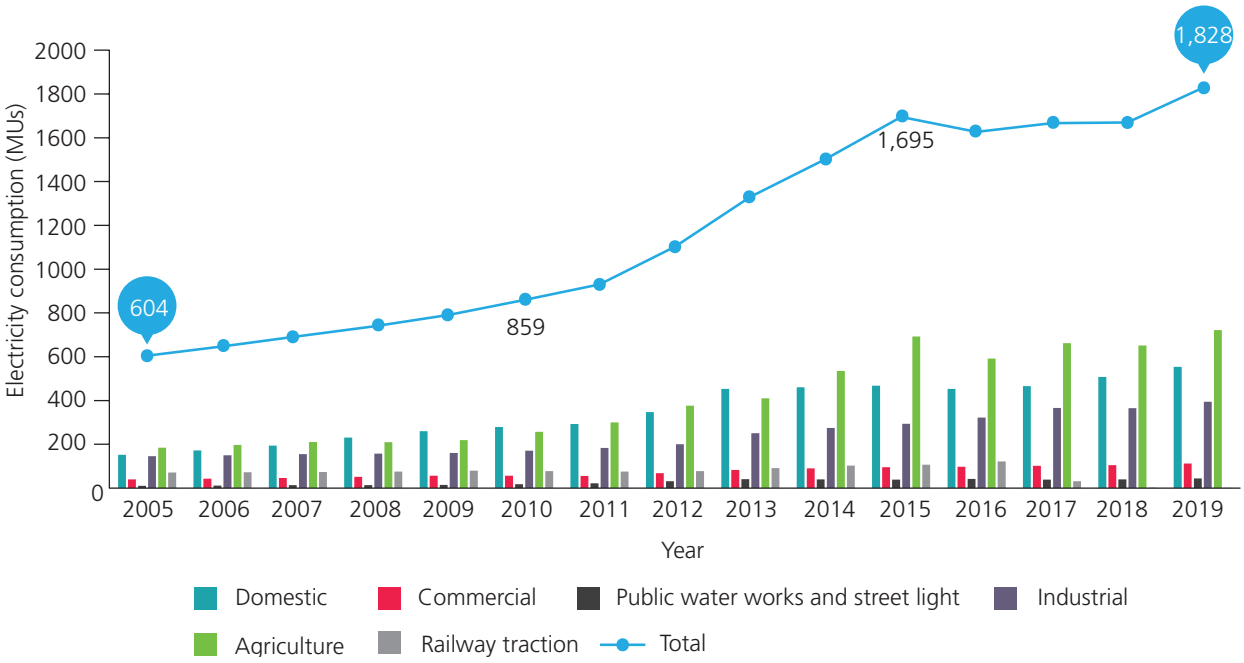


Figure 6: Category-wise electricity consumption in Bhopal district over the years (MUs)

4 MPMKVVCL provides combined data on total electricity supplied for all the 16 districts that it covers. The EC data for Bhopal district was computed by apportioning the total electricity supplied by the DISCOM to the population of Bhopal districts. From the total population of 16 districts that is catered to by MPMKVVCL, around 10.59% resides in Bhopal district.

5 Data on captive power plants (CPPs) was not available.

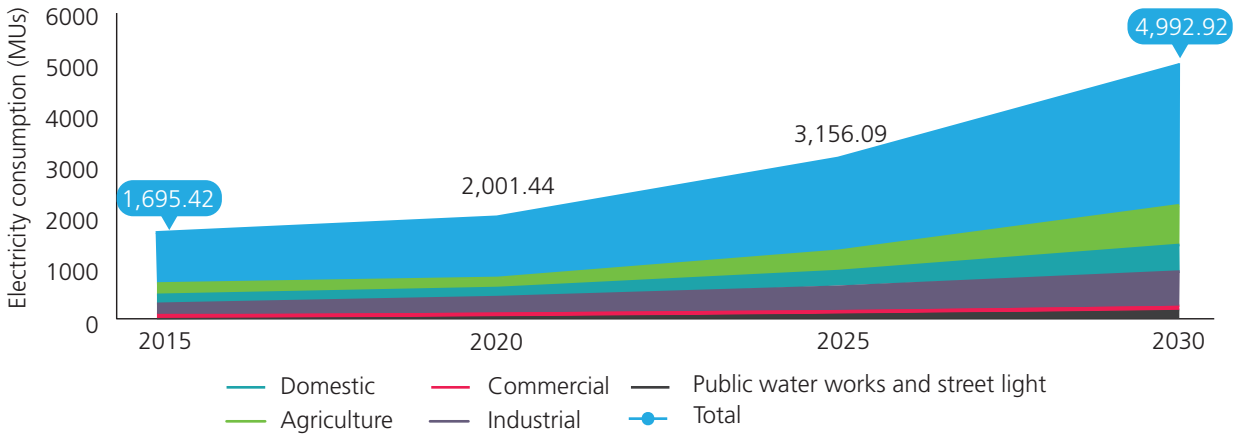


Figure 7: Projections of electricity consumption (w.r.t. CAGR between 2007-19)

In 2030 Bhopal's electricity consumption is projected to increase by

194% w.r.t. 2007-19 CAGR

66% w.r.t. 2015-19 CAGR

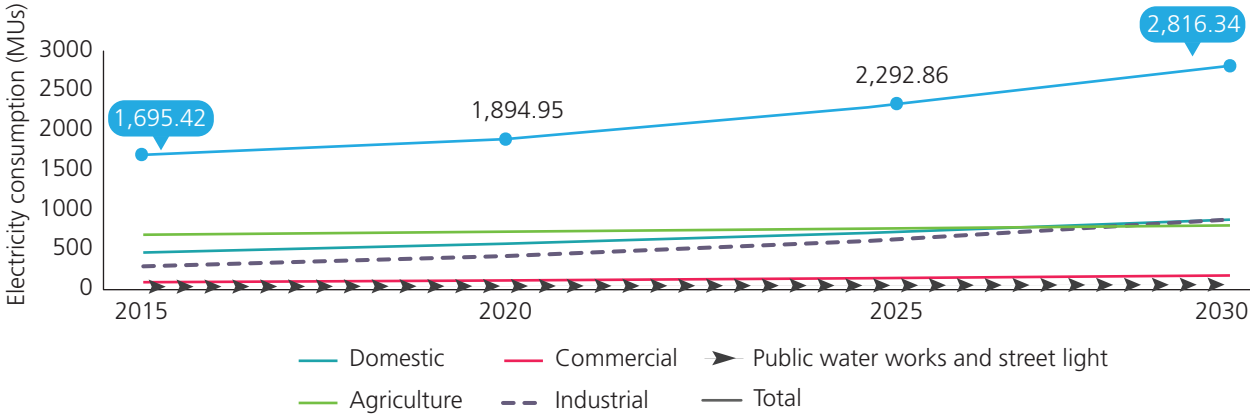


Figure 8: Projections of electricity consumption (w.r.t .CAGR between 2015-19)

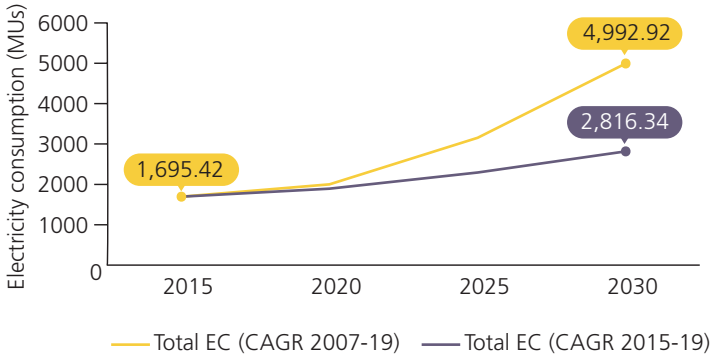
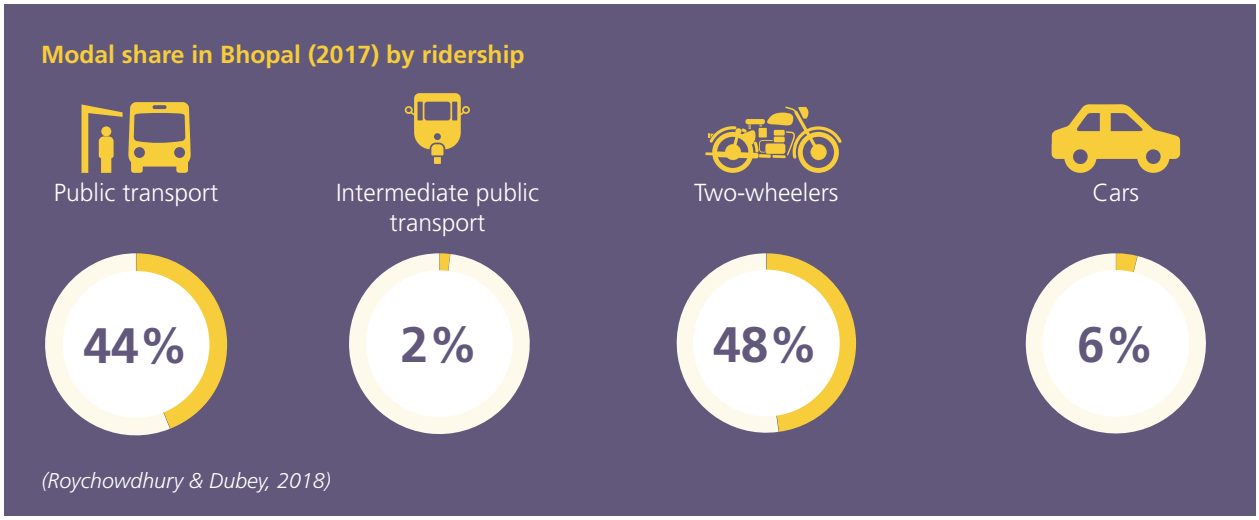


Figure 9: Comparison between two scenarios of electricity consumption

- Projections for future electricity consumption have been made using two CAGRs – one using a long-timeframe (2007-19), the other with a short timeframe (2015-19).
- Projections using the shorter timeframe are 77 percent lower than the former one.

1.3. Transport and related infrastructure

Road network in Bhopal consists of major district roads and national and state highways. The public transport system in Bhopal comprises of city bus services (GPS-enabled larger buses and smaller metro buses) run by Bhopal City Link Limited (BCLL), Star-bus and Red bus services initiated under the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) and mini buses run by private operators. Other major public transport options are radio taxis, auto-rickshaws and in some parts shared Tata Magic Vans which replaced diesel rickshaws. In 2013, Bhopal implemented a bus rapid transit system (BRTS) called MyBus. The vehicular modal share (%) for 2017 is given in the adjacent box. Bhopal, as a growing metropolis, presents many opportunities to upgrade and plan the road transport infrastructure, which can potentially minimise greenhouse gases (GHG) and pollutant emissions.



1.4. Habitat (urban and rural)

The district is spread over an area of 2,772 sq km. Bhopal city area is about 285.9 sq km, which falls under the Bhopal Municipal Corporation (BMC). The district has 80.9 percent of its population living in urban areas, three times higher than the state average (27.6 percent) (Census of India, 2011). The population density of the district is the highest in MP (around 855/sq km), which is 3.6 times the state average and twice the national average. Therefore, there is huge pressure on its resources and infrastructures. There are three urban local bodies in the district – Bhopal (municipal corporation), Berasia (municipality) and Kolar (municipality). Table 4 shows the category-wise change in developed area in Bhopal city.[6]

Table 4: Category-wise increase in area developed between 2005 and 2019 in Bhopal

Category	Developed area in 2005 (ha.)	Developed area in 2019 (ha.)	Increase in developed area from 2005 to 2019 (%)
Residential	4,980	9,719.94	95.18
Commercial	410	1,263.95	208.28
Public & semi-public (PSP) and public utility facility (PUF)	1,250	5,142.6	311.41
Industrial	900	1,277.51	41.95
Transportation	1,350	2,199.41	62.92
Recreational	1,600	2,769.04	73.07
Agriculture	Not provided	1,696.53	
Total	10,490	24,068.98	129.45

Source: Bhopal City Development Plan under JNNURM by Bhopal Municipal Corporation

6 Developed area means the area developed or maintained for a particular purpose such as a residential building, commercial building, park, garden, railway, road or other access route, or other infrastructure facilities.

1.5. Industrial profile

To promote industrial development and employment opportunities, the state is developing four investment corridors, of which two are in Bhopal, namely, Bhopal-Indore and Bhopal-Bina. Additionally, Bhopal is one of the seven Audyogik Kendra Vikas Nigam (AKVN) headquarters set up by the state government for the 51 districts of MP.

Bhopal district has four industrial areas: Govindpura, Kaliparad, Press Complex, and Bandikhedi. The total land developed in these four industrial areas is 406.06 hectares. There are seven large-scale industries/ public sector undertakings in Bhopal and 12 medium scale enterprises (see Annexure 1.1). Moreover, the district has 10,989 MSME units with a total investment of ₹ 1,825.2 million (MSME unit details provided in Annexure 1.2).

Bhopal does not have any large-scale industry having emissions from industrial processes and product use (IPPU) sector.

1.6. Natural resources

The three distinct agro-climatic zones in Bhopal district are Malwa plateau, Vindhya plateau and scrubland and Narmada valley. Overall cropping intensity of Bhopal is 193 percent with 1,53,182 hectares of net sown area (DACNET, 2018). Major produces are wheat, soybean, maize, sorghum, and chickpea. Of the total sown area, 88,700 hectares is irrigated and 64,600 hectares is rain-fed in the district.

Total livestock population of Bhopal is 3,60,794 (Livestock Census, 2012) (category wise livestock population details, provided in Table 5). Bovine density of the district is less (69.89 cattle count/sq km) compared to the state average (90.15 cattle count/sq km).

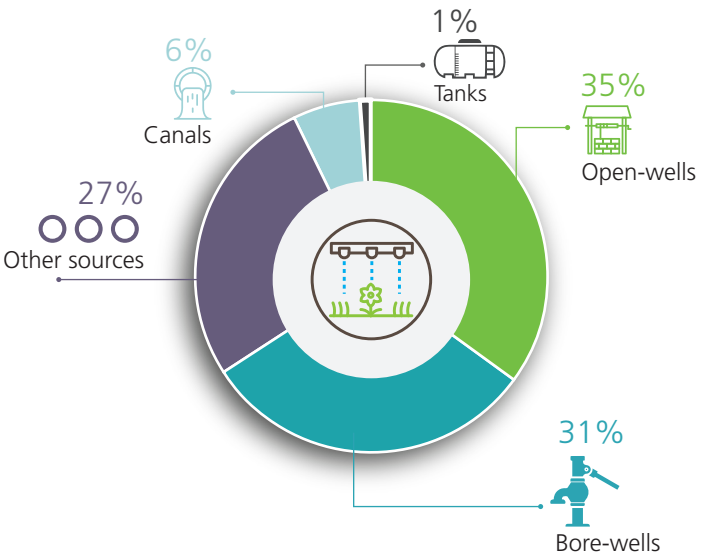


Figure 10: Share of type of irrigation in total irrigated area

Bhopal has only 11 percent of its geographical area under forest cover, which is much below the state average of 25 percent (Forest Survey of India, 2019). As per the latest assessment (Forest Survey of India, 2019), Bhopal has lost 25.33 sq km of forest area (7.2 percent of its forest cover between 2015 and 2017). The details of forest cover (by forest type) are given in Table 2.

Wetlands are a prominent feature of Bhopal district. Bhoj wetland situated in the heart of the district consists of an upper lake (31 sq km) and a lower lake (1.29 sq km). The upper lake serves as the principal source of drinking water (40 percent) for Bhopal city. Kolar dam and groundwater are the remaining sources of Bhopal's drinking water. Freshwater fisheries in Bhopal also depend on these water resources with 2,267 hectares of water spread area used for 'fresh water culture fisheries' and 2,341 kilo tonnes of total production.

Table 5: Livestock population of Bhopal (19th Livestock Census)[8]

Livestock	Number
Cattle	1,10,092
Buffaloes	83,655
Camels	837
Sheep	17,819
Goats	1,44,017
Horses and ponies	1,270
Donkeys	16,640
Others	10

Groundwater status in the district is an issue of concern. The stage of groundwater extraction is alarmingly high at 75 percent (CGWB, 2013). A CGWB study indicated steady decline in the groundwater level of Bhopal district by 0.08 m to 0.37 m from 2003 owing to agricultural, industrial and domestic uses. About 71 percent of the district area currently falls under 'semi-critical' category for groundwater availability.

7 Department of Animal Husbandry and Dairying, 19th Livestock census: http://dahd.nic.in/documents/statistics/livestock-census

As per the analysis based on IWRIS data,[8] the pre-monsoon groundwater level data of 28 stations located in Bhopal district indicates a significantly improved water level below the ground, particularly in the lower part of Huzoor tehsil. However, in contrast to this trend, some urban pockets like Berasia tehsil observed a marginal decline in ground water level (Figure 11). Post-monsoon trend also indicates a significantly improved groundwater level across the district (Figure 12).

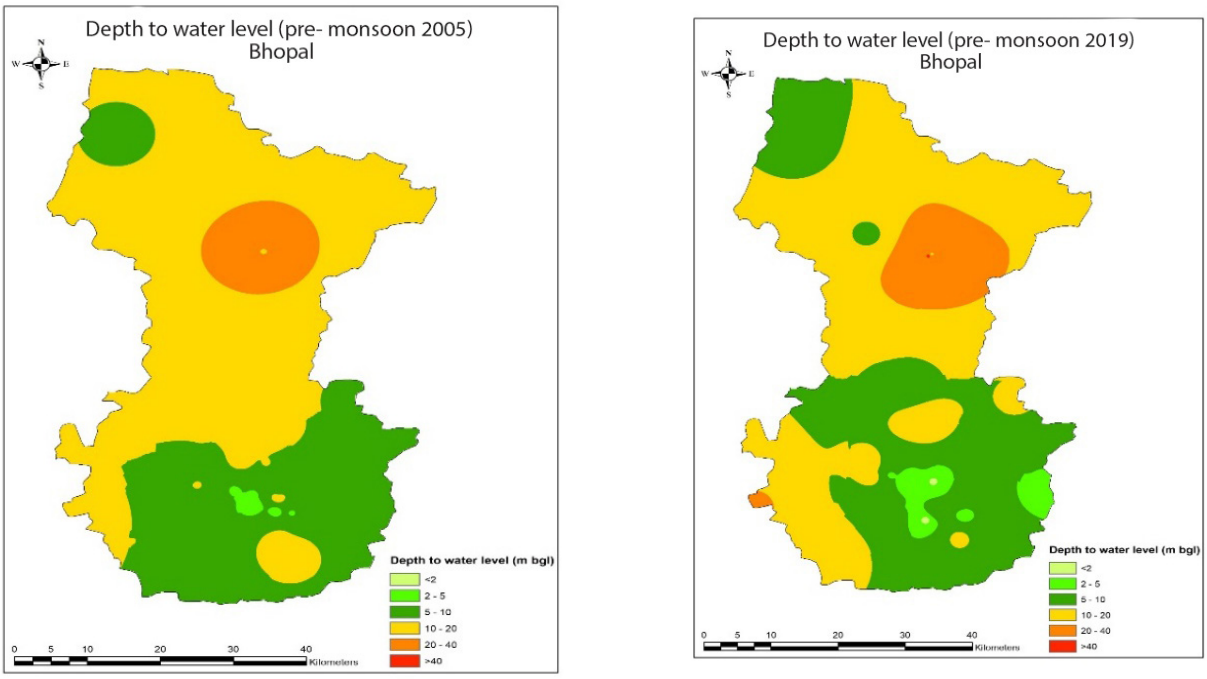


Figure 11: Pre-monsoon groundwater levels in Bhopal a) 2005 and b) 2019

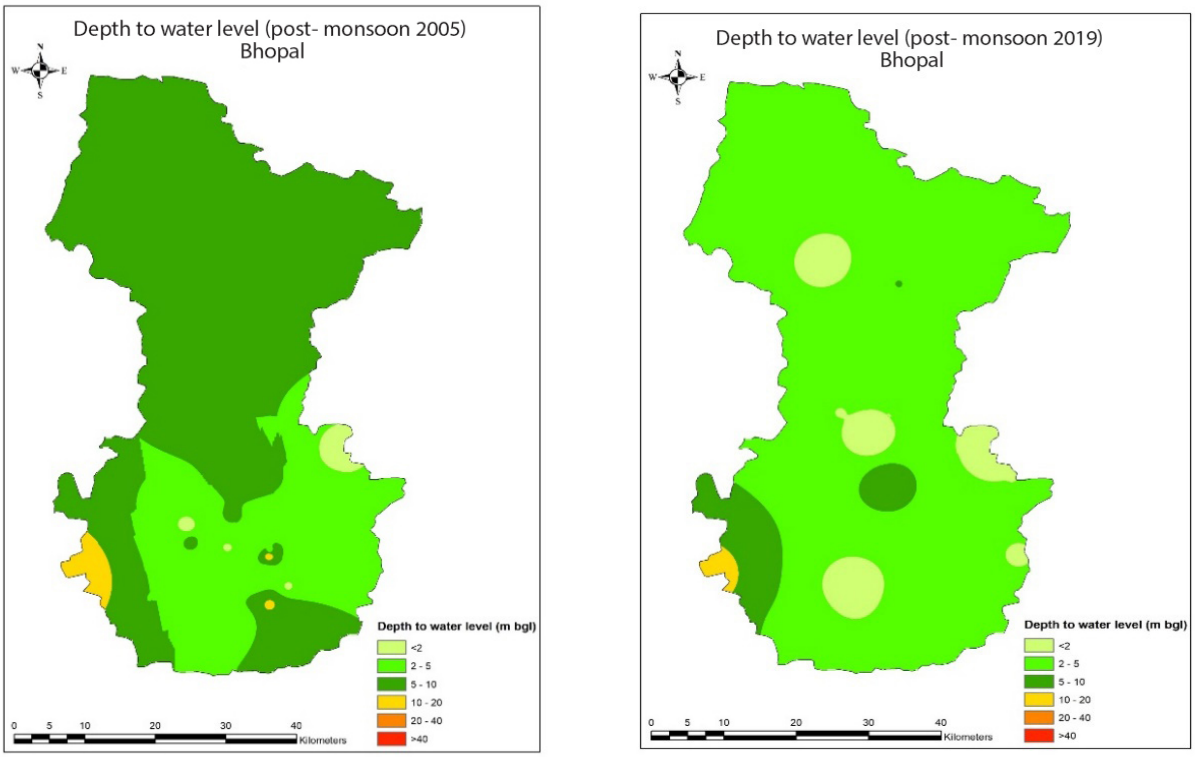


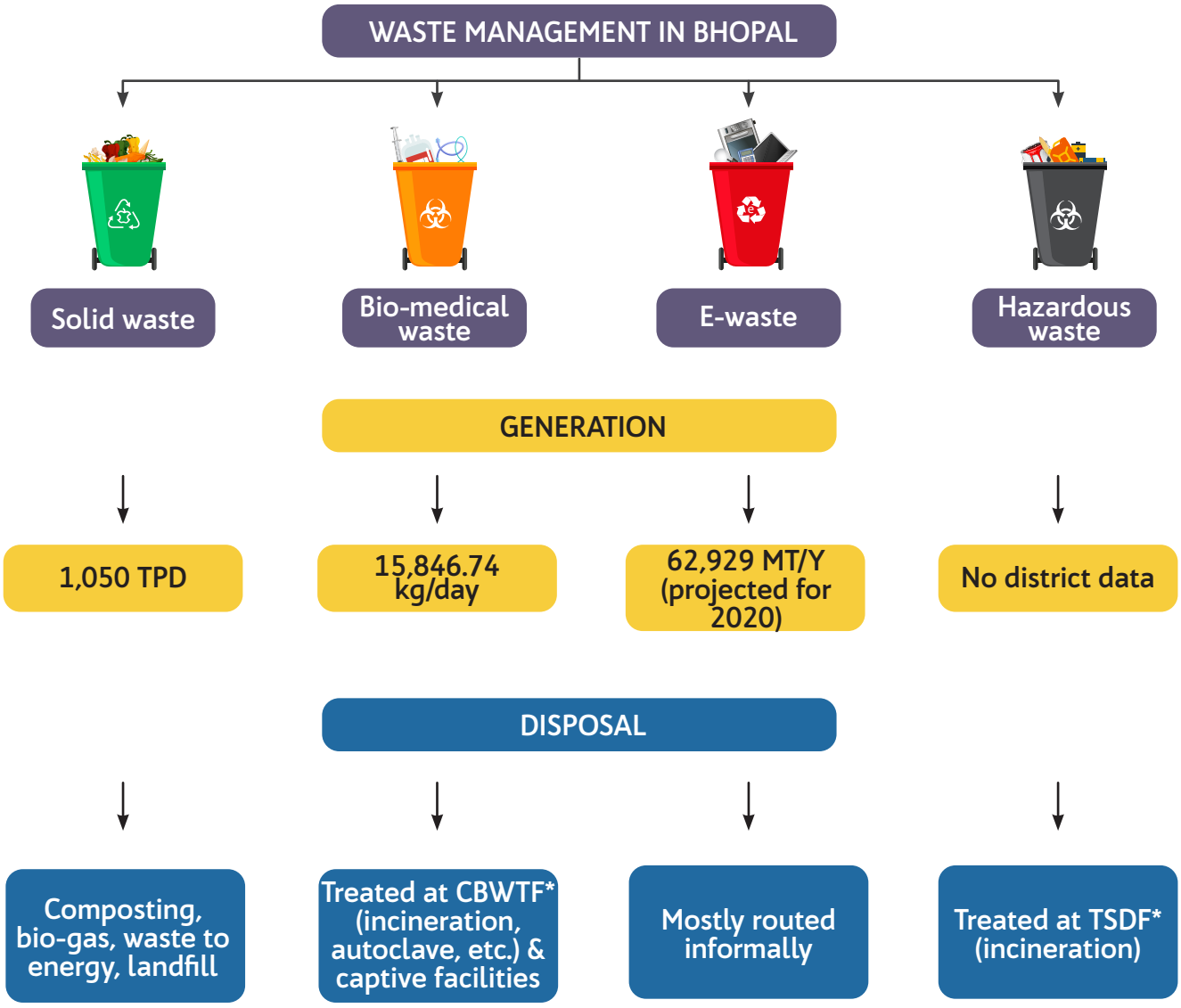
Figure 12: Post-monsoon groundwater levels in Bhopal a) 2005 and b)2019

8 India Water Resources Information System (IWRIS) by the Ministry of Jal Shakti provides single window solution for all water resources data and information in a standardized national GIS framework (Weblink: https://indiawris.gov.in/wris/#/about).

1.7 Waste sector

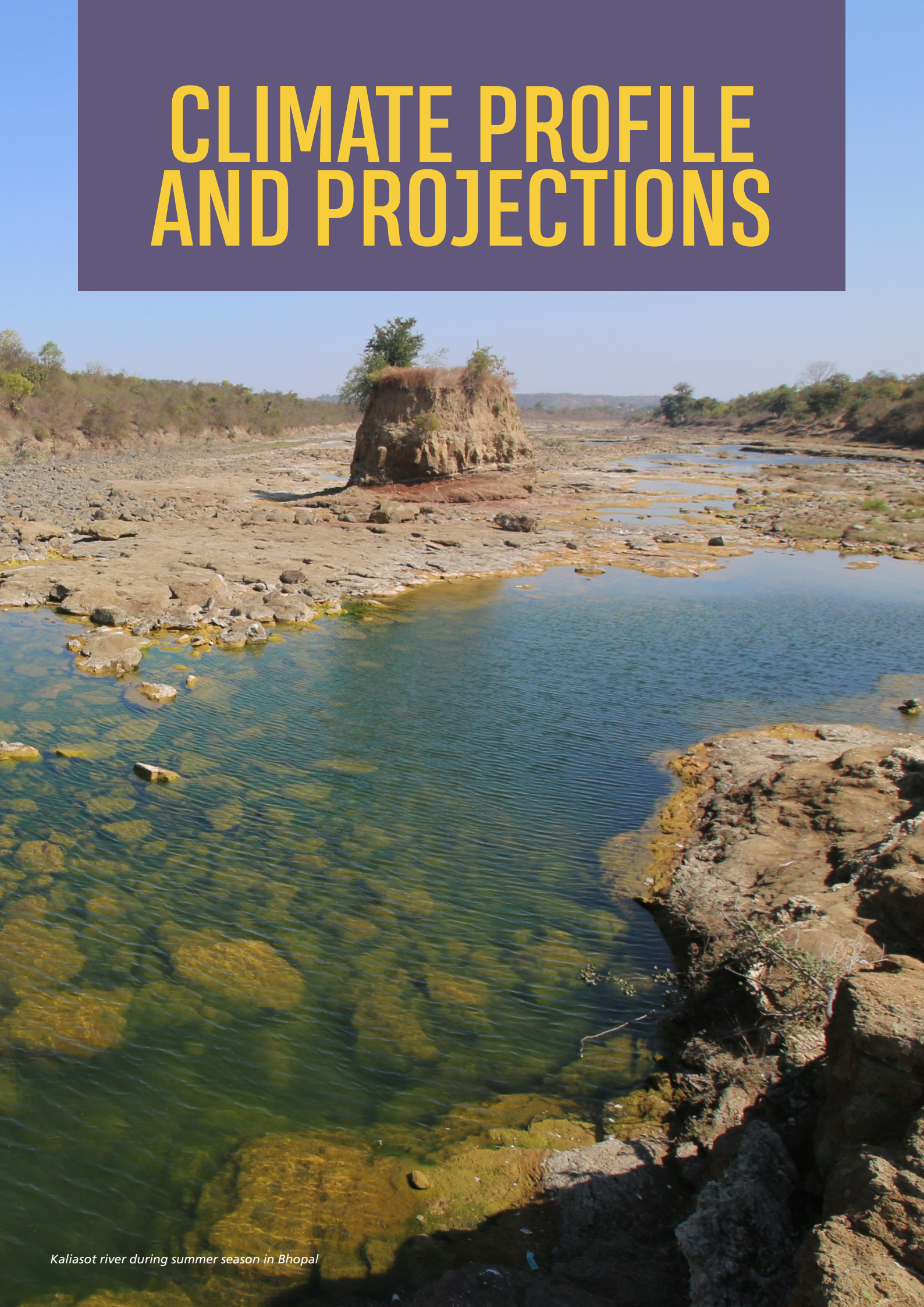
Bhopal is ranked as the Best 'Self-Sustainable State / National Capital or UT' and the seventh most clean city in India by Swachh Survekshan 2020 (cleanliness, hygiene and sanitation survey) (MoHUA, 2020). This is an improvement since the city was ranked 19 in 2019. Madhya Pradesh has adopted a cluster-based model of ULBs for Integrated Solid Waste Management (ISWM) on the concept of regional landfill. Bhopal ISWM cluster has eight ULBs belonging to the districts of Sehore, Bhopal and Raisen.

Adampur Chawni, the common landfill site for the Bhopal cluster, is 15 km away from Bhopal city (MPPCB, 2018). The district is not completely covered by underground sewerage. There are seven STPs (five aerobic and two anaerobic) for domestic wastewater treatment with a total capacity of 80.48 MLD (CPCB, 2015). Although there are several industrial clusters in the district, data on industrial wastewater generation or treatment is not in public domain apart from the common effluent treatment plant (CETP) information. Bhopal has one CETP with 0.6 MLD treatment capacity.



*CBWTF: Common bio-medical waste treatment facility; TSDF: Treatment, storage and disposal facility

CLIMATE PROFILE AND PROJECTIONS



Kaliasot river during summer season in Bhopal

2. CLIMATE PROFILE AND PROJECTIONS[9]

2.1 Observed climate variability over Bhopal district

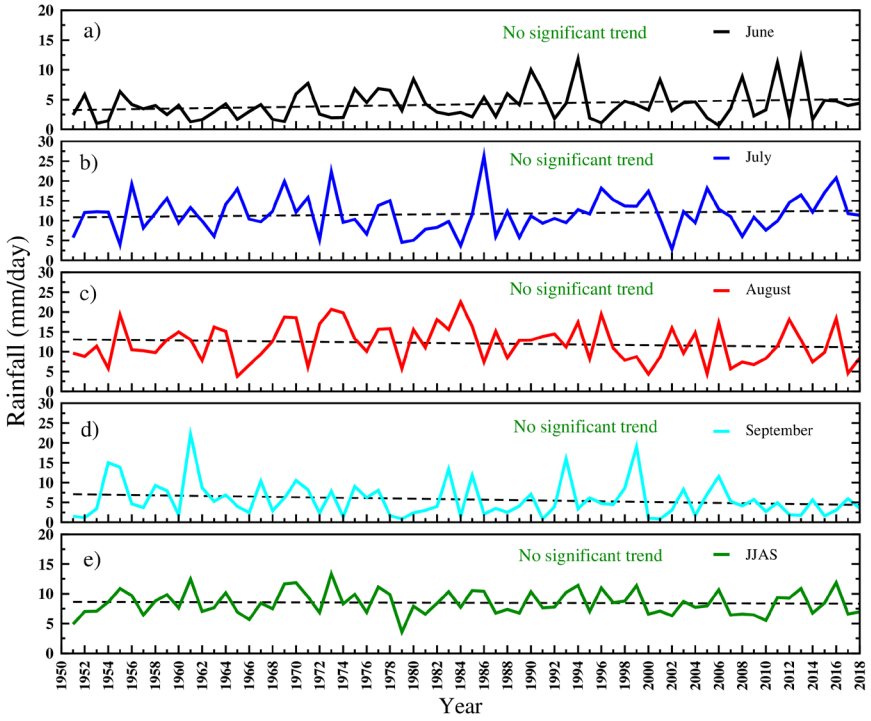
Climate variability refers to variations in the mean state (of temperature, monthly rainfall, etc.) and other statistics (such as standard deviations, statistics of extremes, etc.) of the climate on all temporal and spatial scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or due to variations in natural (e.g., solar and volcanic) external forcing (external variability).

This section focuses on the current mean climate variability in Bhopal district, analysing the observed data of the past 68 years. Precipitation and temperature are used as the key climate variables in this analysis.

2.1.1 Precipitation variability

Bhopal district has a sub-tropical hot summer, dry winter and well distributed rainfall during the southwest monsoon season (June-September). The mean monsoon rainfall over the district is around 1,015 mm of which the maximum rainfall is received during the months of July and August. The number of rainy days (days with rainfall of ≥ 2.5 mm) in the district vary from 9 to 17 in July and August and it receives more than 53 days of good rainfall during the summer monsoon season.

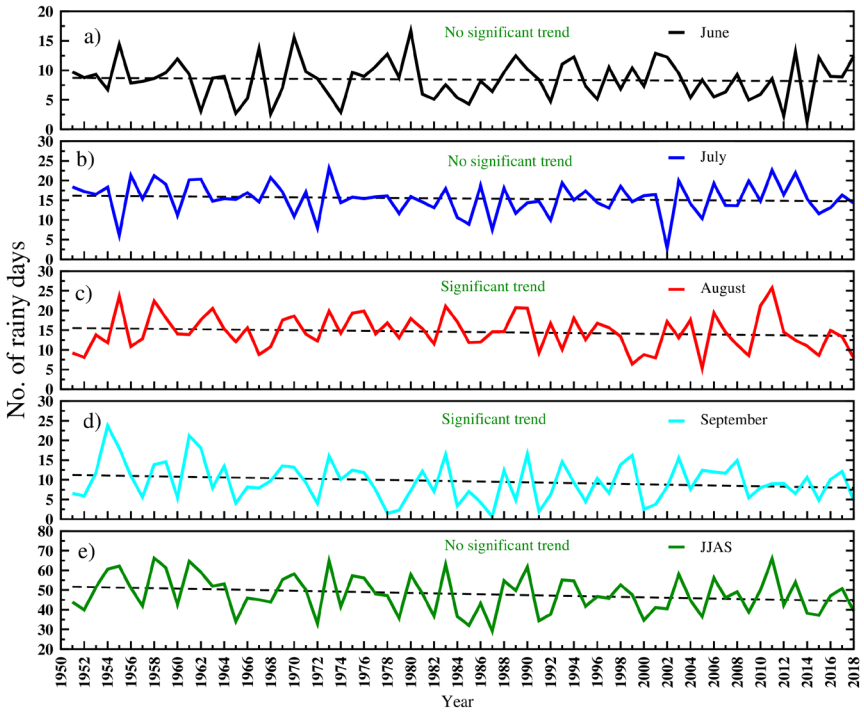
The year-to-year rainfall variability during monsoon months as well as seasonal mean for the period of 1951 to 2018 over the Bhopal district are depicted in Figure 13. No significant trend is observed in the monsoon rainfall in the individual months as well as during the seasons. However, the variability in rainy days is higher in July and August and also reflects a slight decreasing trend during the period of 1951 to 2018 (Figure 14).



Sub-tropical Bhopal receives 1,050 mm rainfall during the south-west monsoon season.

Figure 13: Inter-annual variability of rainfall (mm/day) over Bhopal for 1951-2018

9 Refer to Annexure 2.1 and 2.2 for background note of climate projections and methodology, respectively.



Rainy days show high variability in July and August with a slight decreasing trend during 1951-2018.

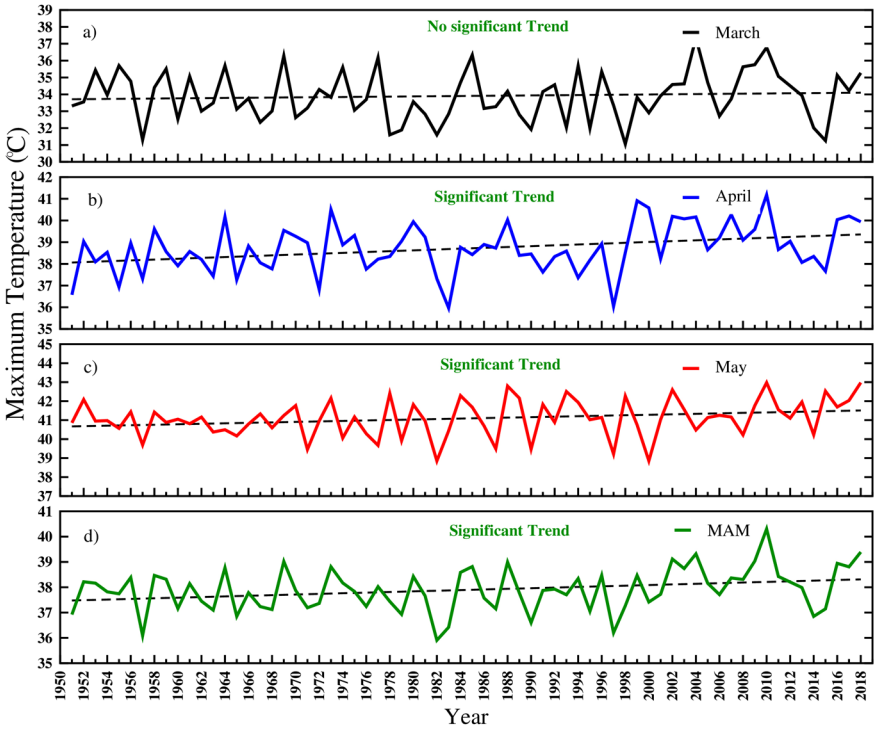
Figure 14: Inter-annual variability of rainy days (number of days) over Bhopal for 1951-2018

2.1.2 Temperature variability

The temperature in the district starts shooting up from the beginning of February and reaches its peak in May. The mean monthly maximum temperature ranges from 34°C to 41°C during summer, which also is the driest period of the year. The daily maximum temperature in May goes up to 42°C. The maximum temperatures show a significantly increasing trend during April and May with an accelerated rise from 1990s onwards (Figure 15). The mean percentage of warm days have also increased by about 10 percent during the period of 1986 to 2005 in the district (Figure 16).[10]

Migratory goose at a lake near Bhopal

10 Warm days - Correspond to cases when the maximum temperature exceeds the 90th percentile of the temperature distribution of the season.



Maximum temperature during summer months shows a significantly increasing trend.

Figure 15: Inter-annual variability of maximum temperature (°C) over Bhopal for 1951-2018

Mean percentage of warm days has increased by about 10%

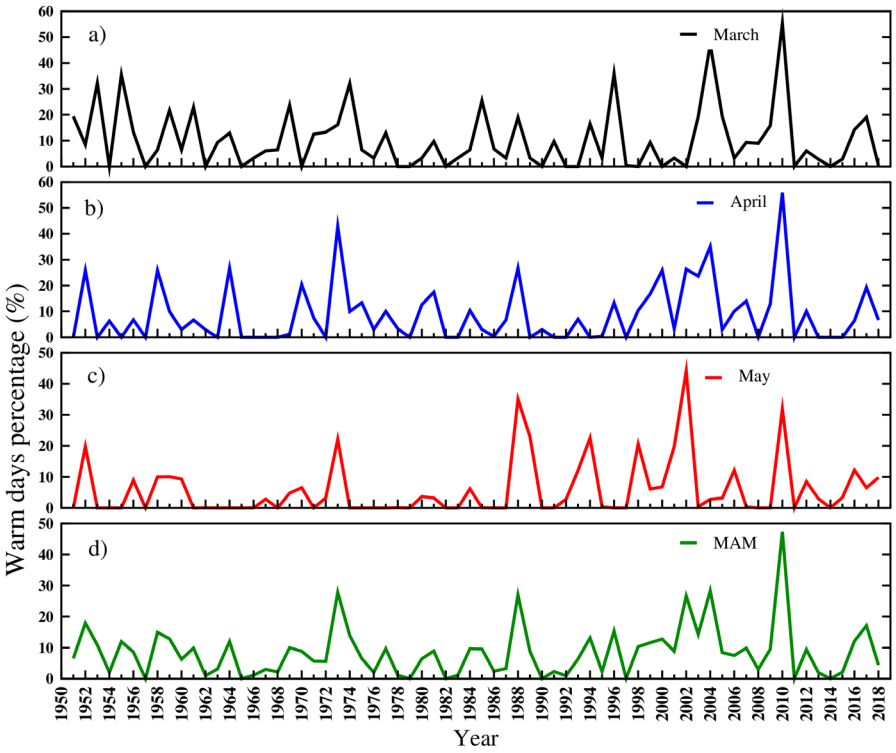
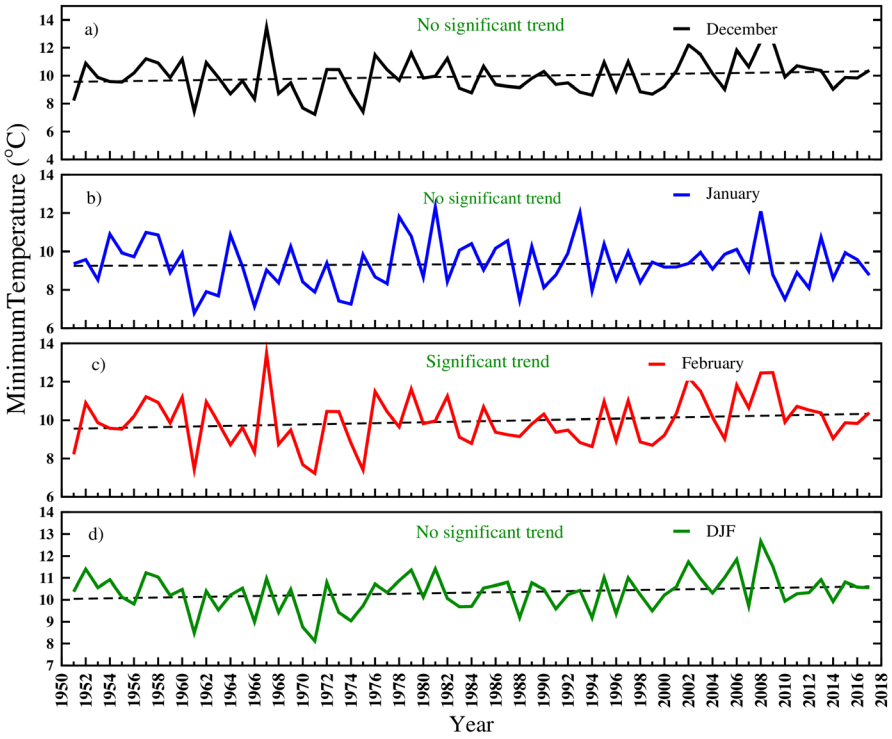


Figure 16: Inter-annual variability of warm days (%) over Bhopal for 1951-2018

The minimum temperatures during winter season (December, January and February) range from 9°C to 10°C, with January being the coldest month in the district. The year-on-year variability of minimum temperature shows an increasing trend during all months, particularly significant during January. The number of cold days also shows large variability during all the winter months (Figure 18).[11]

11 Cold days - Correspond to cases when the minimum temperature falls below the 10th percentile of the temperature distribution of the season.



Mean minimum temperature has an increasing trend, particularly significant during January

Figure 17: Inter-annual variability of minimum temperature (°C) over Bhopal for 1951-2018

Cold days show large variability during all the winter months

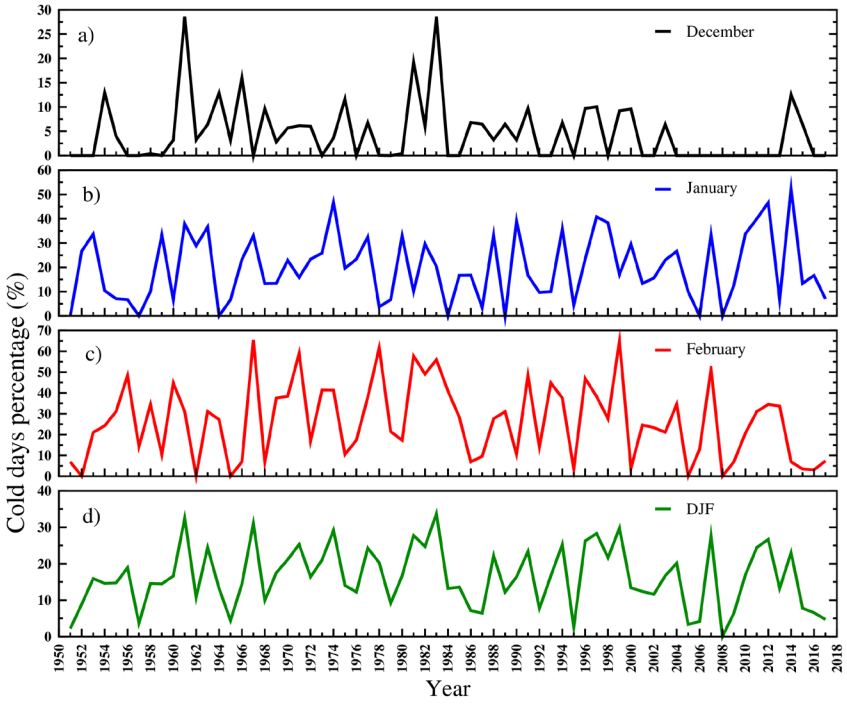


Figure 18: Inter-annual variability of cold days (%) over Bhopal for 1951-2018

2.2 Future climate projections for Bhopal district

The precipitation and temperature over Bhopal district for the period of 1986 to 2005 has been simulated using the multi model mean (MMM) ensemble. The district is projected to experience an increase in the mean rainfall in the monsoon months and the season as a whole in different epochs (2021-2040, 2041-2060, 2061-2080 and 2081-2100) under medium (RCP4.5) and high (RCP8.5) emission scenarios (Table 5). The projection shows an increase in seasonal mean precipitation under RCP4.5 by 5.6 to 21.6 percent compared to historical data between near-term (2030s) to end-century (2090s) and 17 to 39 percent under RCP8.5 for the same epochs. The number of rainy days is also projected to increase during the monsoon season, particularly July and August (Table 6).

Table 6: Observed (1986-2005), simulated (1986-2005) and projected (RCP4.5 and RCP8.5 emission scenarios) mean monthly and seasonal rainfall (mm) for Bhopal district

Rainfall (mm)	June	July	August	September	JJAS (Total of June, July, Aug and Sept)
Observed	139	370	339	163	1,018
Simulated	104	320	339	189	958
RCP4.5					
2030s (2021-2040)	116	312	349	230	1,012
2050s (2041-2060)	107	329	376	252	1,070
2070s (2061-2080)	119	330	408	272	1,135
2090s (2081-2100)	119	362	409	268	1,165
RCP8.5					
2030s	109	363	422	222	1,123
2050s	110	384	440	279	1,220
2070s	107	418	451	299	1,282
2090s	123	384	501	319	1,335

Table 7: Observed (1986-2005), simulated (1986-2005) and projected (RCP4.5 and RCP8.5 emission scenarios) mean monthly and seasonal rainy days (days with rainfall ≥ 2.5mm) for Bhopal district

Rainy days	June	July	August	September	JJAS (Total of June, July, Aug and Sept)
Observed	9	17	17	10	53
Simulated	7	17	17	10	51
RCP4.5					
2030s (2021-2040)	7	16	17	11	51
2050s (2041-2060)	6	17	17	12	53
2070s (2061-2080)	7	17	17	12	52
2090s (2081-2100)	7	18	18	12	54
RCP8.5					
2030s	6	17	18	11	52
2050s	7	16	18	12	53
2070s	6	17	17	12	52
2090s	6	16	17	12	52

The projected changes in maximum and minimum temperatures were analysed on a monthly scale during the summer/winter season. The projections in different time epochs show that the maximum temperatures may increase by 2°C to 3°C under RCP4.5 and 2°C to 5°C under RCP8.5 over the district. In particular, temperatures in May are higher compared to the temperatures in other summer months. The percentage of warm days is also projected to increase over the district, more so by the end of the century (Table 8). In the winter season, the minimum temperatures also show a projected increasing trend with the percentage of cold days decreasing in all the epochs under changing climatic conditions. The analysis shows there is a clear increase in temperature towards the end of the century.

Table 8: Observed (1986-2005), simulated (1986-2005) and projected (RCP4.5 and RCP8.5 emission scenarios) mean monthly and seasonal maximum temperature (°C) for Bhopal district.

Temp max (°C)	March	April	May	MAM (Average of March, April & May)
Observed	34	39	41	38
Simulated	33	38	41	37
RCP4.5				
2030s	35	39	42	39
2050s	35	40	42	39
2070s	36	41	43	40
2090s	36	41	43	40
RCP8.5				
2030s	35	39	42	39
2050s	36	40	43	40
2070s	37	42	44	41
2090s	38	43	45	42

Table 9: Observed (1986-2005), simulated (1986-2005) and projected (RCP4.5 and RCP8.5 emission scenarios) mean monthly and seasonal warm days (%) for Bhopal district

Warm days (%)	March	April	May	MAM (Average of March, April & May)
Observed	10	10	10	10
Simulated	9	10	9	9
RCP4.5				
2030s	30	32	39	34
2050s	39	45	56	47
2070s	47	57	64	57
2090s	53	59	69	61
RCP8.5				
2030s	32	36	46	38
2050s	51	59	69	61
2070s	73	78	87	80
2090s	86	89	95	90

Table 10: Observed (1986-2005), simulated (1986-2005) and projected (RCP4.5 and RCP8.5 emission scenarios) mean monthly and seasonal minimum temperature (°C) for Bhopal district

Temp min (°C)	Dec	Jan	Feb	DJF (Average of Dec, Jan and Feb)
Observed	10	9	10	10
Simulated	11	10	12	11
RCP4.5				
2030s	12	11	14	12
2050s	13	12	14	13
2070s	13	13	15	13
2090s	13	14	15	14
RCP8.5				
2030s	12	11	14	12
2050s	13	13	15	13
2070s	15	14	16	15
2090s	16	16	19	16

Table 11: Observed (1986-2005), simulated (1986-2005) and projected (RCP4.5 and RCP8.5 emission scenarios) mean monthly and seasonal cold days (%) for Bhopal district

Cold days (%)	Dec	Jan	Feb	DJF (Average of Dec, Jan and Feb)
Observed	4	20	26	16
Simulated	7	17	35	19
RCP4.5				
2030s	2	5	18	8
2050s	1	3	12	5
2070s	0	2	9	4
2090s	0	2	7	3
RCP8.5				
2030s	2	7	18	9
2050s	1	2	8	3
2070s	0	1	3	1
2090s	0	0	1	0

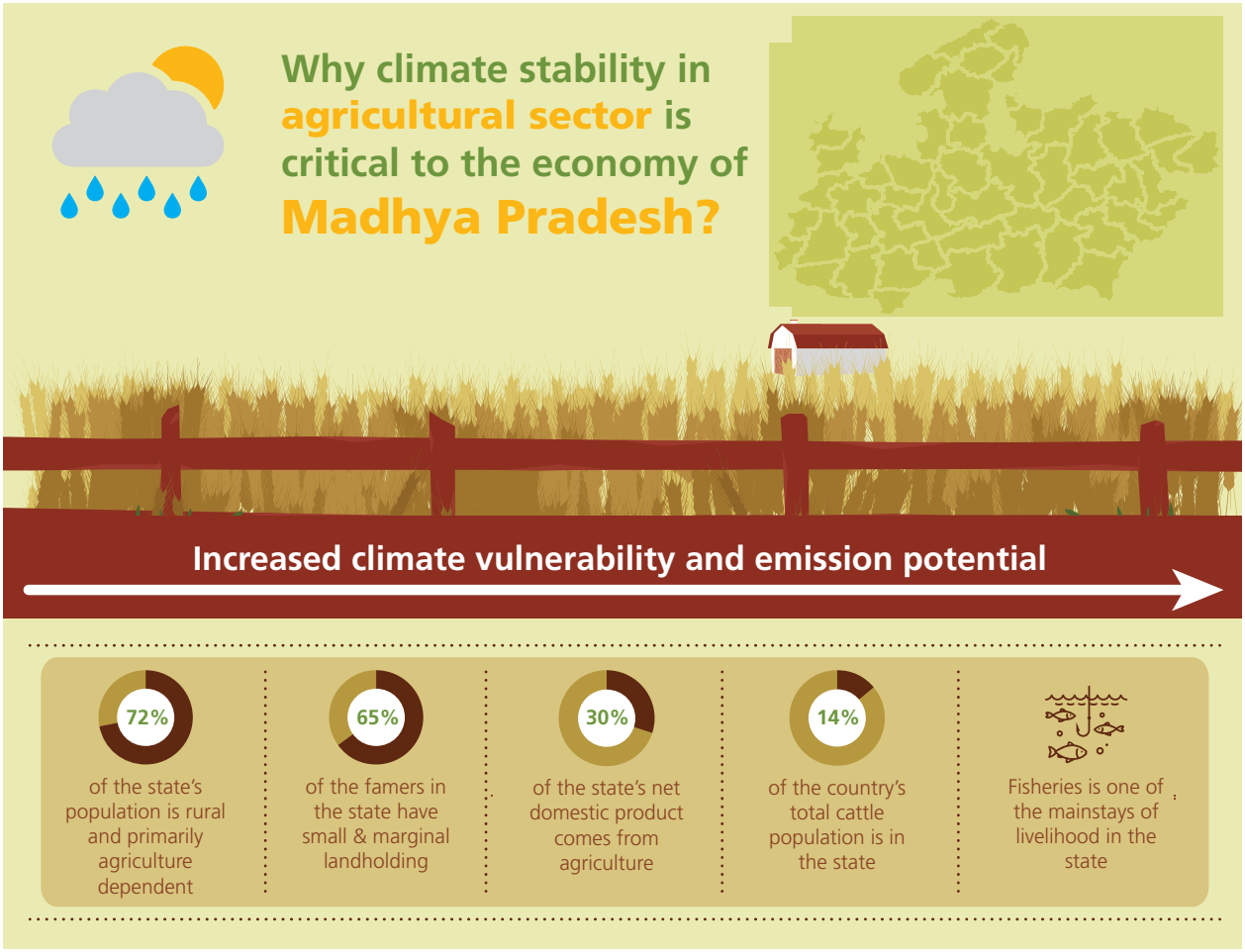
2.3 Sectoral impacts of climate change

2.3.1 Agriculture and allied sectors

Madhya Pradesh, a landlocked state with diverse topography and physiography, endowed with rain-fed rivers has its fair share of vulnerability to climate change. About 72 percent of the state's population is rural and depends primarily on agriculture and allied activities (horticulture, fishery, livestock, poultry and forestry) for their livelihoods. Agricultural sector in Madhya Pradesh consists largely of small and marginal landholdings (65 percent) making the sector highly vulnerable. However, considering the fact that the sector contributes to 30 percent of the state's net domestic product, the sectoral stability is critical to the state's economy. Animal husbandry is an important sector in context to both emission potential and vulnerability to climate change and the state has 14 percent of the country's total cattle population. Fisheries too, a livelihood completely dependent on the availability of water resources, is one of the mainstays of livelihood of the economically weaker sections in the state (EPCO, 2013).

Changing climatic conditions and variabilities (inter-annual variation and erratic distribution in rainfall, extreme events, like, heat and cold waves, etc) are expected to impact these natural resource-based livelihood sources significantly. Extreme weather events, like, frost, excess rain or high temperatures, have reportedly resulted in huge productivity loss in the state. Erratic rainfall patterns have often led to seasonal shift affecting cropping patterns. Heavy rain, intense storms and hailstorms cause physical damage to standing crops as well as horticulture during flowering and fruit bearing stage. Temperature rise at an initial stage of cropping leads to pest emergence. Changing climate has also been leading to a number of new diseases. Similarly, increased vector borne diseases, reduced productivity, impacts of heat and water stress, reduced availability of feed and fodder, etc are threats to livestock health. Increased temperatures impact availability of fish seeds and affect suitability of fish species to particular temperatures of water, leading to retardation of inland fish species, shifting of breeding period, ultimately affecting productivity (EPCO, 2013).

A composite vulnerability assessment of the districts of Madhya Pradesh in the State Action Plan for Climate Change, categorised Bhopal and Indore as low vulnerable districts with comparatively higher adaptive capacity given their better economic capacity, access to infrastructure, literacy rate, irrigation potential, forest area and less exposure to extreme



climatic events. However, owing to their higher emission potentials, it is critically important to address the climate concerns of Bhopal and Indore (EPCO, 2013).

A climate change impact (simulation) study on specific crops reveals an overall decline in wheat yield (by 15 to 45 percent) in all agro-climatic zones in the state with the southern part being more impacted due to higher temperature. The crop maturity duration will also be reduced by five to 11 days in all agro-climatic zones depending on production environments and locations. Accelerated maturing and reduced grain size at temperatures above 34°C along with a projected increase in temperature coupled with increased frequencies of extreme weather events could significantly constrain wheat production. Another study on effect of elevated temperature and CO_2 concentration on wheat productivity in MP, shows an average of eight percent decrease in wheat grain and biomass yield per 1°C increase in temperature. For rice too, the irrigated rice yield is projected to be reduced by six to 14 percent while the rainfed rice yield is projected to be reduced by 15 to 45 percent across the state by 2050 depending on different agro-climatic zones. High temperatures are also leading to, a) water shortage in rainfed rice during kharif owing to long dry spells, b) compromised pollination and grain filling in transplanted rice and c) increased water demand by crop canopy. Soybean yields are also projected to decline by four to 16 percent and maturity duration extended by three to four days almost identically for all agro-climatic zones with higher surface air temperatures. Heavy rainfall events will lead to waterlogging, leading to disease incidence and yield reduction (Ventakeswarlu & Rao, 2015; Mall, Sonkar, Sharma, & Singh, 2016; Mohanty, Sinha, Hati, Reddy, & Chaudhary, 2015).

2.3.2 Forest and water resources

Over the last two decades, the forest area remained stable in the state. Climate change simulation study for forested grids indicate a change in vegetation distribution, particularly in the dry forest areas of northern and western Madhya Pradesh which are likely to be replaced by wetter or moist forest types, more visible in the long-term, i.e., 2080s. Changes are majorly attributed to higher precipitation levels and increased CO_2 concentration. Evidently, the dry tropical thorn and scrub forests of MP are found to be highly disturbed, containing thorny and deciduous species. In fact, a comparative study done in 2013 found an increase in moisture in the 'very dry teak forests' of MP as compared to a 1968 delineation and there is a suggestion to rename these forests as 'dry teak forests'.

Net primary productivity (NPP) of current vegetation in MP in the same study shows a higher productivity in the southern and eastern part compared to the northern and western parts. In the projected climate scenarios of RCP4.5 and RCP8.5 by 2030s and 2080s, the NPP is likely to increase all over the state mainly by the CO_2 fertilisation effect and increased precipitation projections. However, the study states that in the long-term, NPP increase could likely be countered by increased losses from heterotrophic respiration, leading to tapering (or decline) in the net ecosystem productivity. For the same reason, the biomass carbon density and soil carbon density, in general, is also projected to increase all over the state in both scenarios by 2030s and 2080s. Soil carbon density is higher in the southern, western and eastern parts of the state currently. But post mid-century, the soil carbon tends to decline (Chaturvedi, 2015).

A study for impacts of climate change along the Narmada basin shows a considerable decrease of extreme flood events in the basin and no significant variability during the time zones of 2006-40, 2041-2070 to 2071-2099. This may be due to the moderation effects of the dams located upstream. However, with no hydraulic interventions at the virgin basin sites, extreme flood events are expected to increase substantially (Sudheer, 2016). For groundwater resources, a reduction in ground water recharge and substantial increase in evapotranspiration is projected in the state along its major river basins of Godavari, Narmada, Mahi, Tapi and Ganga (Gosain, et al., 2017).


पश्चिम मध्य रेल
भोपाल स्टेशन आपका स्वागत करता है
TOILET
शौचालय
SURJEET
i20

SECTORAL GREENHOUSE GAS EMISSIONS PROFILE

Traffic and auto-rickshaws outside Bhopal railway station

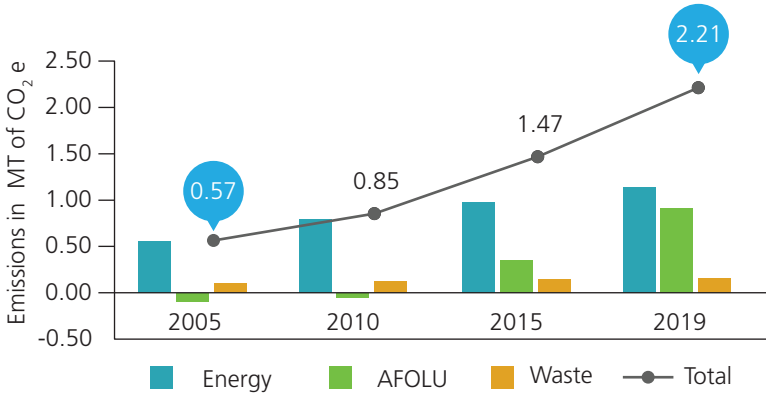
3. SECTORAL GREENHOUSE GAS EMISSIONS PROFILE

This section of the action plan estimates greenhouse gas (GHG) emissions for Bhopal district using the guidelines laid down by the Intergovernmental Panel on Climate Change (IPCC).[12] Estimates have been done for 12 categories covering three major sectors – energy; agriculture, forestry and other land use (AFOLU), and waste for the years 2005 to 2019.[13] Bhopal does not have any large-scale industries that fall under the listed industrial processes and product use (IPPU) industry categories of the IPCC guidelines. Therefore, there are no emissions from the IPPU sector. However, the energy used in industries and the corresponding emissions are reported in the energy sector.

The activity data was sourced from government-approved datasets for all the sectors and wherever possible country-specific emission factors were used in place of default emission factors.[14]

3.1. Direct emission estimates

3.1.1 Economy-wide emissions



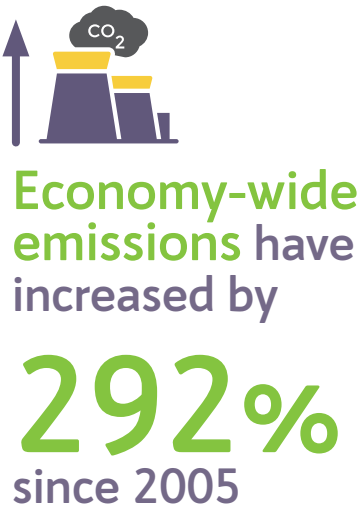


Figure 19: Economy-wide emissions of Bhopal district (Mt of CO_2 e.)

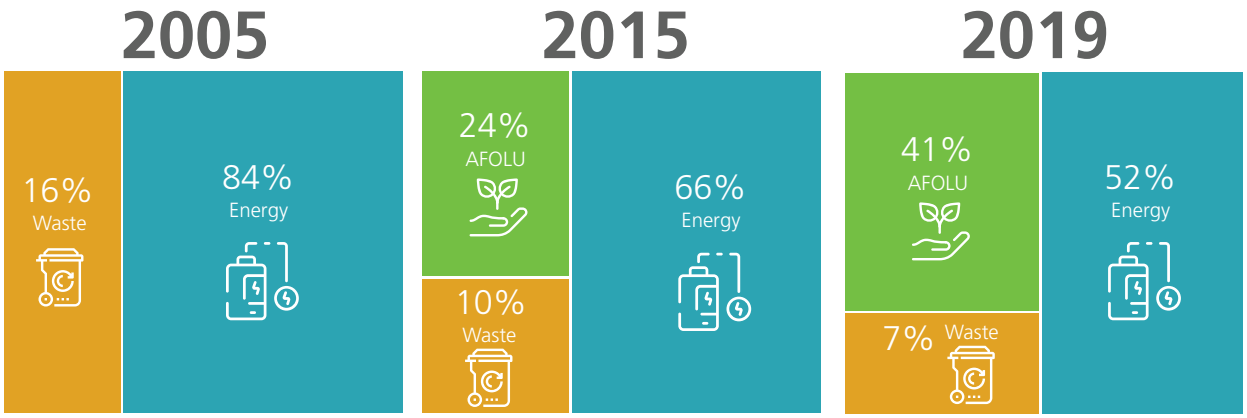


Figure 20: Contribution of different sectors in economy-wide emissions in 2005, 2015 and 2019

12 The guidelines for National Greenhouse Gas Inventories laid down by the Intergovernmental Panel on Climate Change (IPCC) were adopted to estimate emissions of Bhopal district. The 2006 IPCC guidelines were followed to the extent possible; and for a very few categories the 1996 IPCC guidelines were referred to.

13 Emissions for 2017, 2018 and/or 2019 are estimated by applying CAGR of the latest possible GHG estimates of each category.

14 Emissions from category-wise activity data sources are provided in Annexure 3.2.

- Between 2005 and 2019, the total emissions of the district increased by 291.80 percent (from 0.57 million tonnes CO_2e in 2005 to 2.21 million tonnes CO_2e in 2019) with a CAGR of 10.25 percent.
- Energy sector accounts for the highest emissions; although energy emissions increased with a CAGR of 5.31 percent, but its share has decreased from 84 percent in 2005 to 52 percent in 2019 due to increase in AFOLU emissions.
- The highest growth is seen in the AFOLU sector – at 9.66 percent CAGR between 2012 and 2015. Until 2011, AFOLU was a net sink.
- Waste sector emissions have grown at a slow rate (CAGR of 2.89 percent) and its contribution dropped from 16 percent (in 2005) to seven percent in 2019.
- IPPU sector is not applicable in Bhopal district.
- Sectoral details and analysis are given in the following sections.

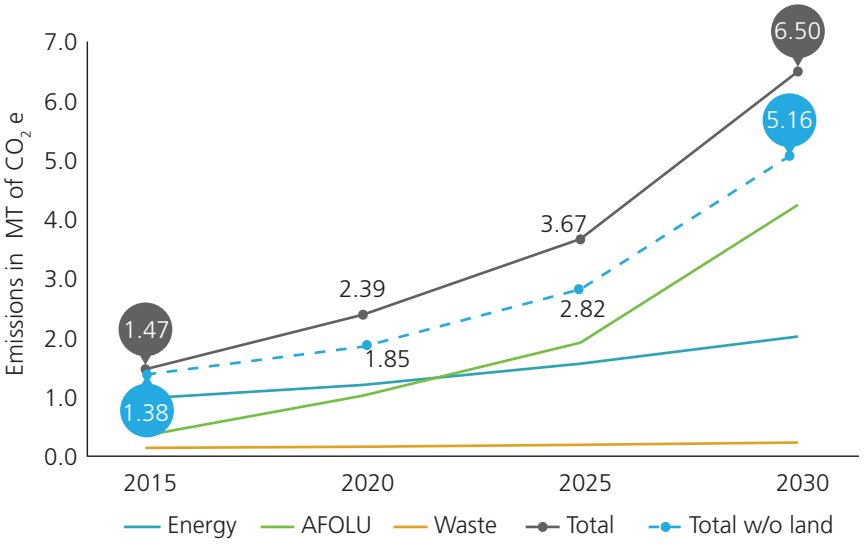


Figure 21: Projections of economy-wide emissions (BAU)

- In business-as-usual scenario (i.e., no actions/policies are put in place to mitigate the emissions), the total emissions of Bhopal are likely to grow by 342 percent (or 3.8 times) by 2030, with respect to 2015 levels.
- Excluding the emissions from 'removals by forest' (also popularly known as excluding land emissions), the overall growth in emissions between 2015 and 2030 will be 2.7 times (or 274 percent).
- If the emissions from the category of 'removals by forest' (which accounts for emissions due to change/loss in forest areas) are not curtailed, then the AFOLU sector will over-take the energy sector emissions by the year 2023. This is a highly concerning scenario.

In BAU scenario total emissions will rise by

342%,

whereas, total emissions without land will rise by

274%

3.1.2 Per capita emissions

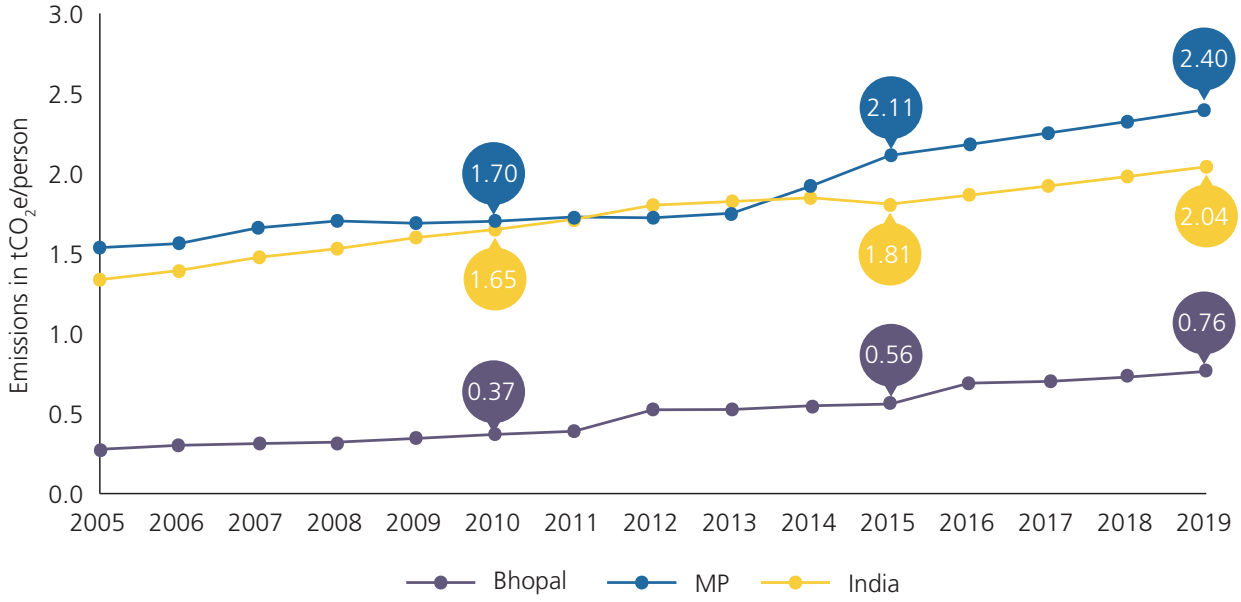


Figure 22: Per capita emissions (tonnes CO_2e/person) – comparison

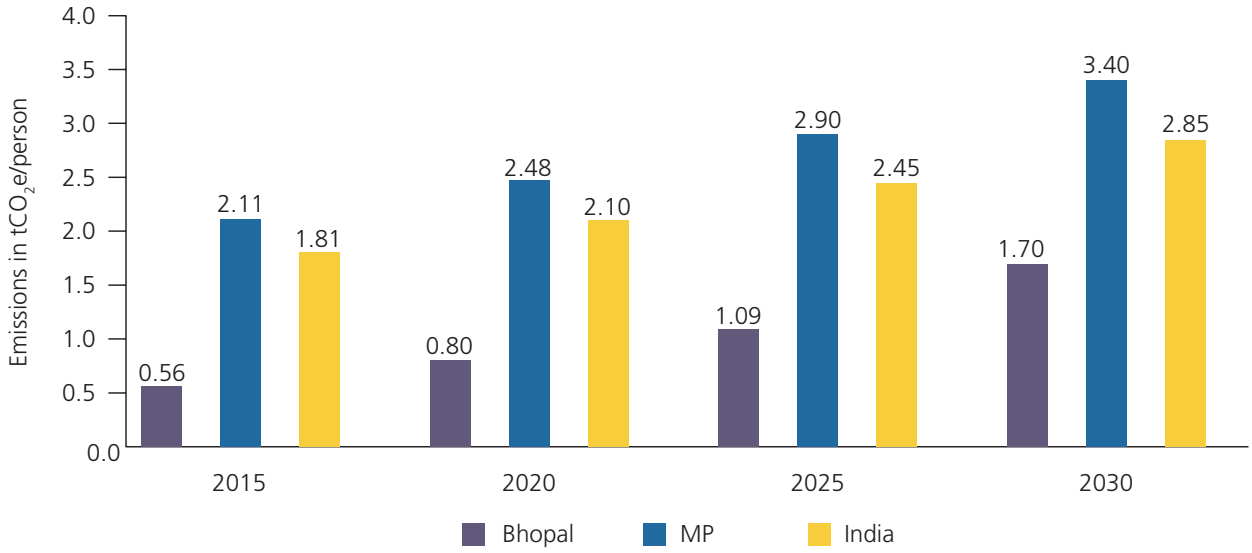


Figure 23: Projected per capita emissions tonnes CO_2 e/ person) comparison

- Per capita emissions of Bhopal district were computed using the district's total emissions estimated in this analysis (therefore, it does not include emissions from CPP, use of CNG and PNG etc.).
- As per this analysis, the per capita emissions of the district are very modest in comparison to Madhya Pradesh and the national average.
- Bhopal district does not have thermal power plants and industries that contribute to IPPU emissions. This is a major reason for overall low emissions, in comparison to the state.
- However, it may be noted that Bhopal's per capita electricity consumption is 588 kwh/person. And this consumption leads to higher emissions in some other region.

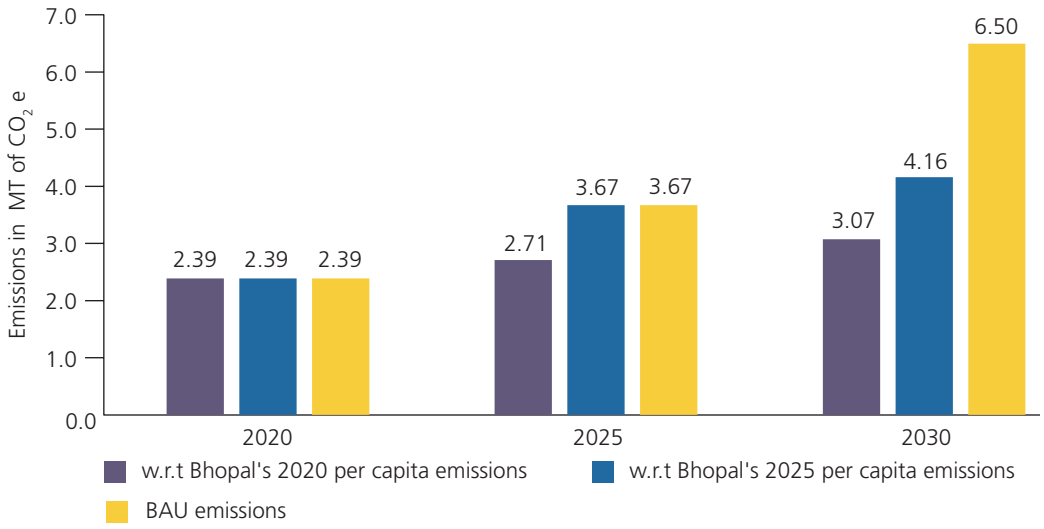


Figure 24: Projected total emissions with different per capita emissions scenarios

In 2030, total emissions (w.r.t. BAU) will be:

112% more if 2020 per capita emission levels are maintained.

56% if 2025 per capita emission levels are maintained.

- The business-as-usual (BAU) projections of per capita emissions indicate that total emissions will increase by 172 percent (between 2020 and 2030, as shown in economy-wide section as well).
- However, if per capita emissions of 2020 are maintained, overall growth in emissions would only be around 29 percent.

3.1.3 Sectoral analysis

Energy sector

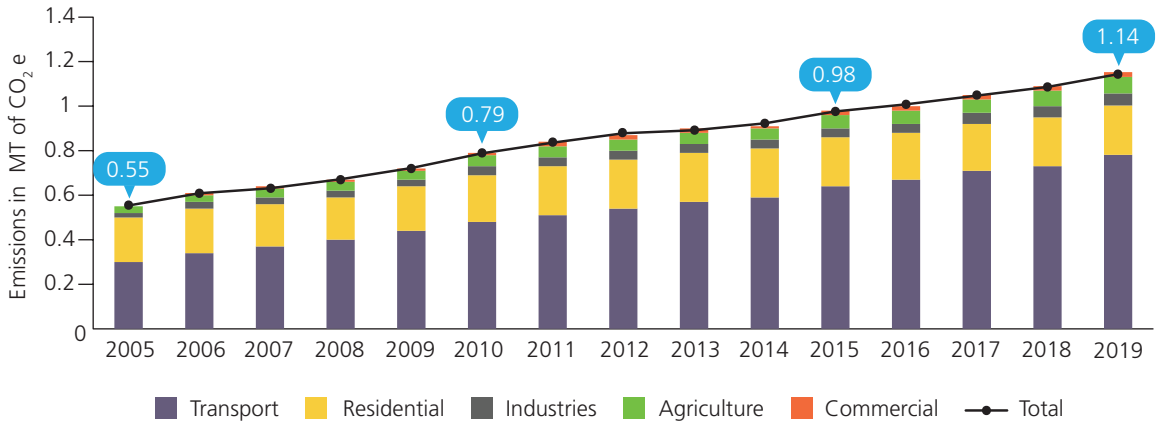


Figure 25: Energy sector emissions of Bhopal district (in Mt of CO_2e.)

Energy sector emissions have increased by **106%** since 2005

- This section estimates the emissions due to fossil-fuel consumption by various categories.
- Between 2005 and 2019, the emissions from energy sector have doubled (from 0.55 Mt of CO_2e in 2005 to 1.14 Mt of CO_2e in 2020) with a CAGR of 5.31 percent.
- In the absence of electricity generation in Bhopal, transport category is the highest contributor to the energy emissions.
- This is followed by residential, agriculture and industries sectors.

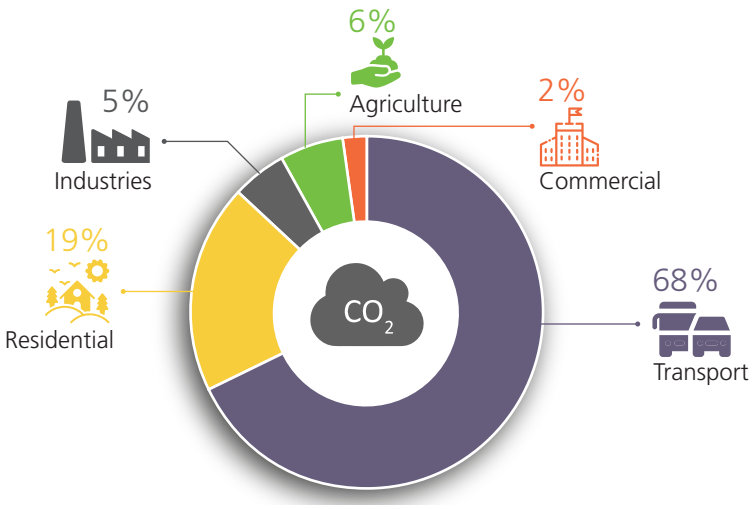


Figure 26: Percentage share in total energy emissions (2019)

Table 12: Growth in energy sector emissions (2005-18) and % share in 2019

Category	Sub-category	CAGR (2005-18)	% share in energy emissions (2019)	
Transport (CAGR: 7.87%)	Road (90.64% transport em.)	6.75%	55.81%	Total share of transport is 68%
	Aviation (6.98%)	13.42%	4.30%	
	Railway (2.37%)	7.18%	1.46%	
Industries		9.60%	5%	
Agriculture		8.84%	6%	
Residential and commercial		1.84%	21%	

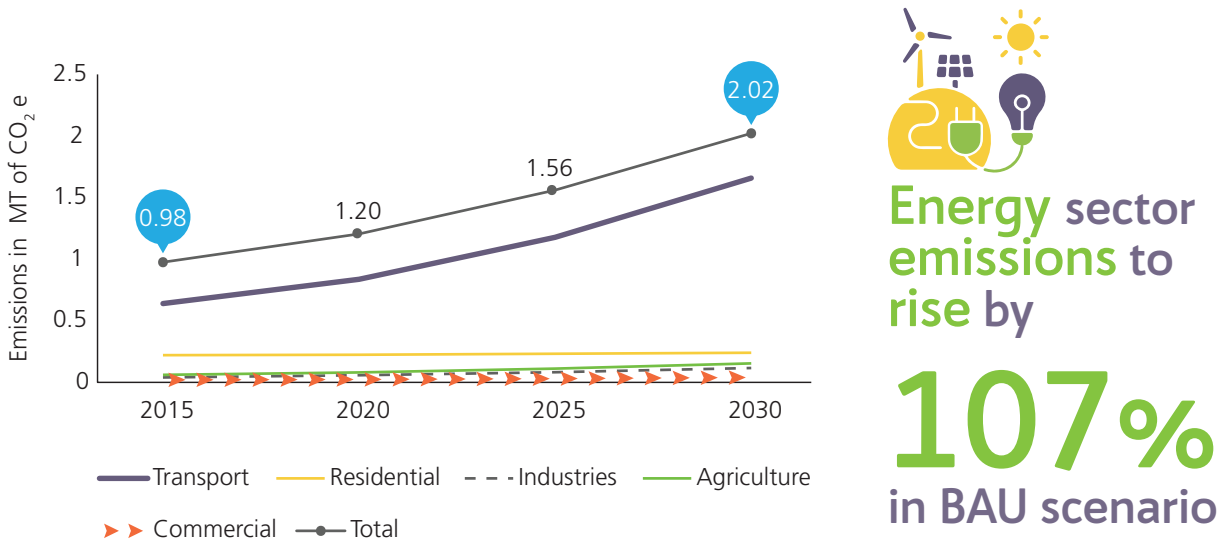
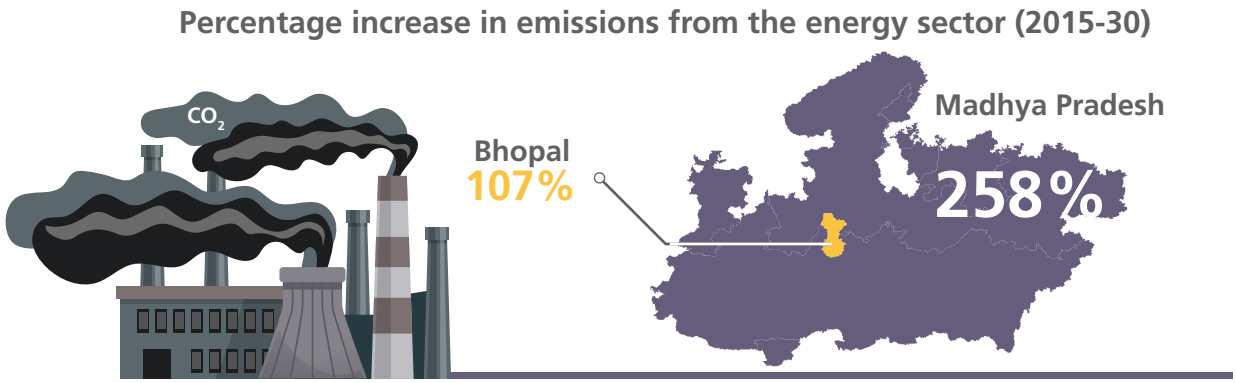


Figure 27: Projected emissions of energy sector (BAU)



- In business-as-usual scenario, the overall emissions of energy sector in Bhopal will increase by 107 percent by 2030 (w.r.t. 2015).
- However, a similar projection for Madhya Pradesh suggests that the state energy emissions will grow by 258 percent for the same time-frame (GHG Platform India, 2019).
- Despite very low contribution to overall energy emissions, the emissions from industrial energy category have seen the highest growth rate (within the energy sector) between 2005 and 2019 (CAGR of 9.60 percent) and is likely to grow at the same rate.

Agriculture, forestry and other land use (AFOLU)

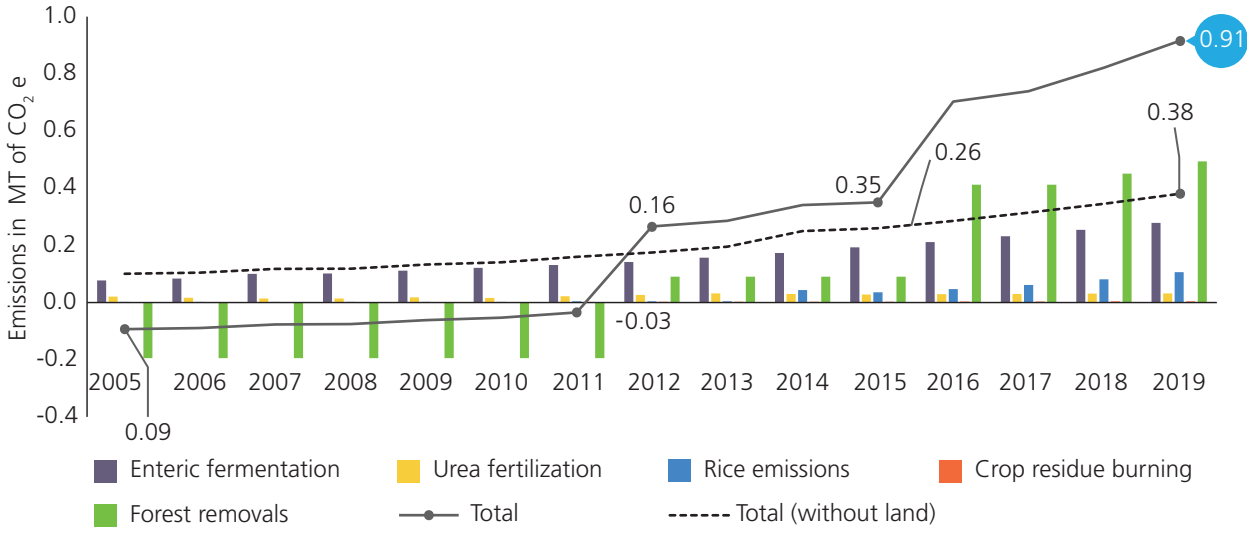


Figure 28: AFOLU sector emissions of Bhopal district (Mt of CO_2e.)

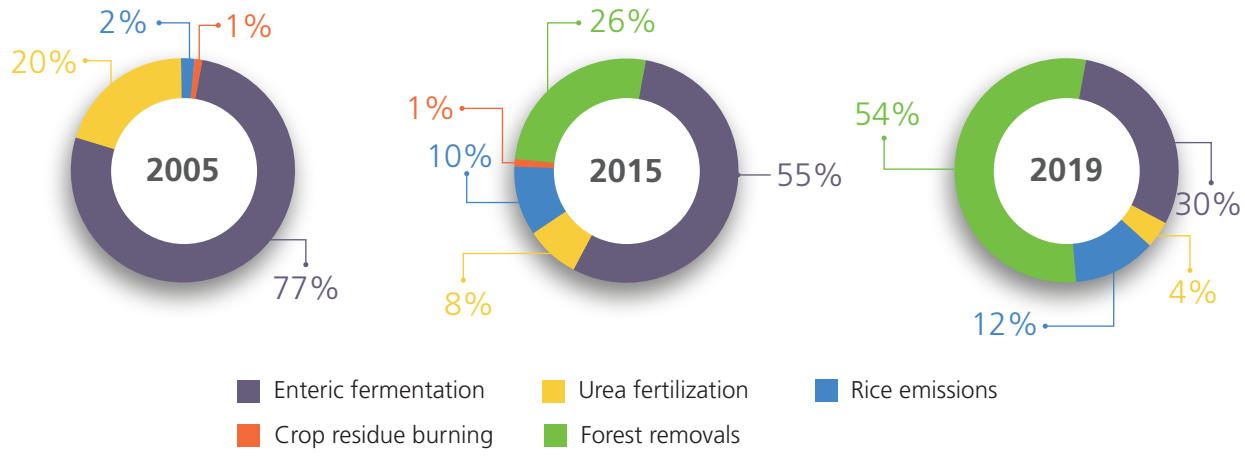


Figure 29: Contribution of categories in total AFOLU emissions in 2005, 2015, and 2019

Table 13: Growth in AFOLU emissions (2005-15) and % share

Category	CAGR (2005-15)	% share in AFOLU emissions (2005)	% share in AFOLU emissions (2019)
Enteric fermentation	9.62%	77%	30.46%
Forest removals	9.45%	Was a sink	53.98%
Urea fertilisation	3.30%	20%	3.52%
Rice cultivation	31.10%	2%	11.61%
Crop residue burning	11.35%	1%	1%
Total emissions	19.12% (2005-15) 9.67% (2012-15)	NA	NA

- AFOLU was a net sink in Bhopal till 2011. However, the constant reduction of forest cover resulted in making 'forest removals' category a source of emissions. This led to high emissions from AFOLU sector in the subsequent years.
- Area under rice cultivation also increased in the recent years, leading to higher emissions from this category as well.

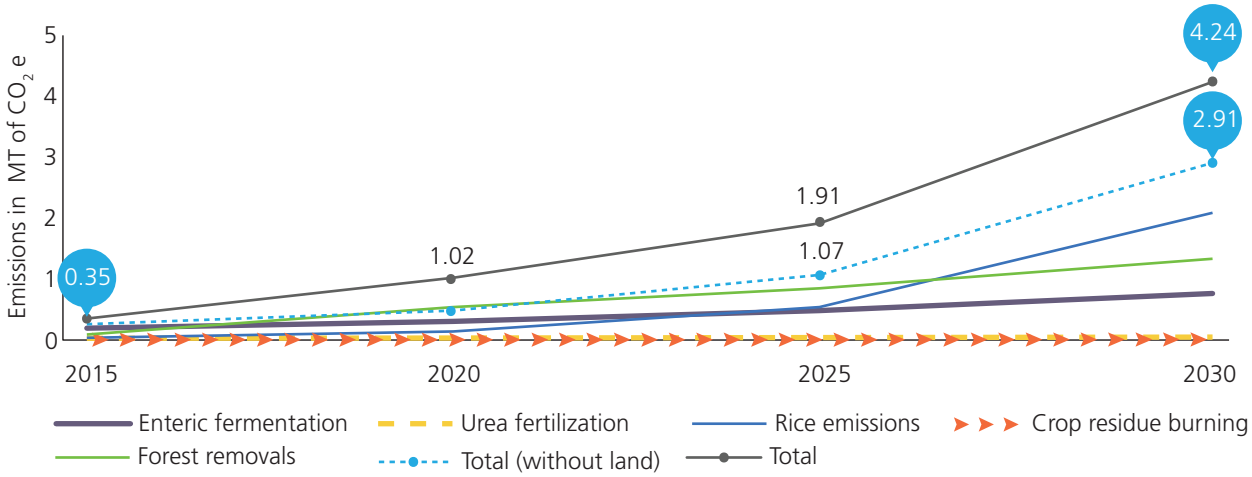


Figure 30: Projections of AFOLU emissions (BAU)

- If the reduction in forest cover and increase in area under rice cultivation continues at the same rate, AFOLU sector emissions will increase 11-folds (between 2015 and 2030).
- If the current trend of growth in 'area under rice cultivation' continues, then by 2025, emissions from rice cultivation are likely to overtake enteric fermentation and forest removal emissions in AFOLU sector.

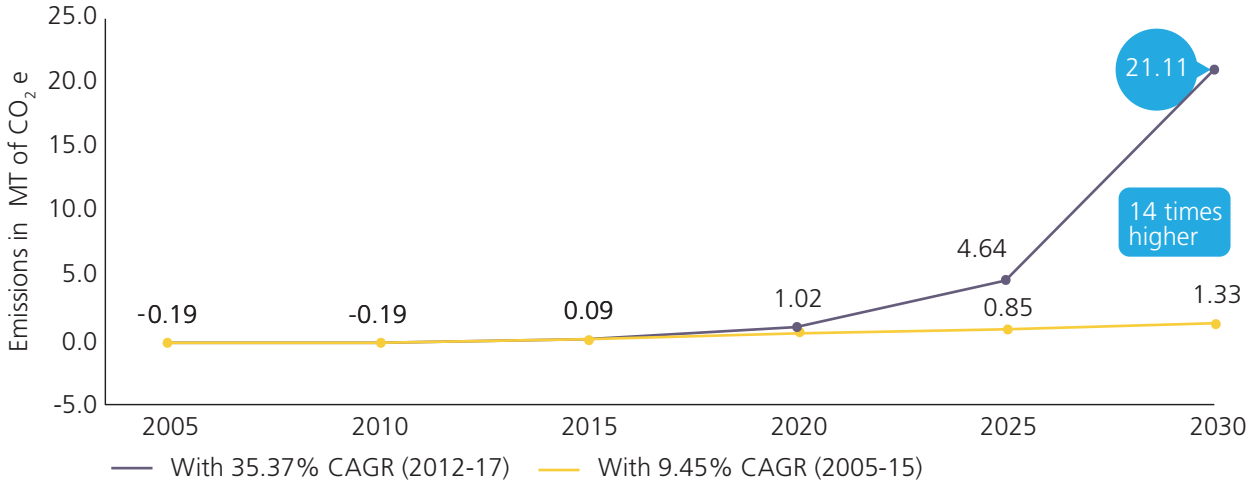


Figure 31: Projected emissions from change in forest cover.

- Forest removal calculations are done till 2017 (relying on data from FSI, 2019 report).
- Growth in emissions from 'forest removals' is calculated for two different timeframes: (a) for 2005 -15 (as done for other categories); (b) from 2012-17 (emissions became positive 2012 onwards).
- Growth of emissions between 2012 and 2017 is alarming. If this rate is used for future projections, emissions from 'forest removals' will be 14 times higher than the numbers projected using 2005-15 growth rate.

Projections for livestock sector

Bovine population density	
Region/district	**Cattle count/sq.km**
India	91.23
MP	90.15
Bhopal	69.89

- Density of bovine animals in Bhopal is lower than the state average, as per 19th Livestock Census (2012).
- A scenario has been assumed that Bhopal will not exceed the state average of bovine density till 2030.
- Based on this scenario, enteric fermentation calculations are done and compared with BAU projections.
- Under this scenario, emissions will be 81 percent lower than the BAU projections for enteric fermentation

Table 14: Projected emissions for livestock sector (2005 to 2030)

Year	2005	2010	2015	2020	2025	2030
Projected population (BAU)	94,966	1,61,546	2,67,403	4,57,495	7,82,720	13,39,141
BAU projected emissions (Mt of CO_2e.)	0.08	0.12	0.19	0.31	0.48	0.76
Projected population (keeping Bhopal's 2030 livestock population density equivalent to the current bovine population density of MP)	94,966	1,61,546	2,01,528	2,16,509	2,32,604	2,49,896
Projected emissions (livestock population and emissions decrease w.r.t. MP's livestock population density) (Mt of CO_2e.)	0.08	0.12	0.15	0.14	0.14	0.14

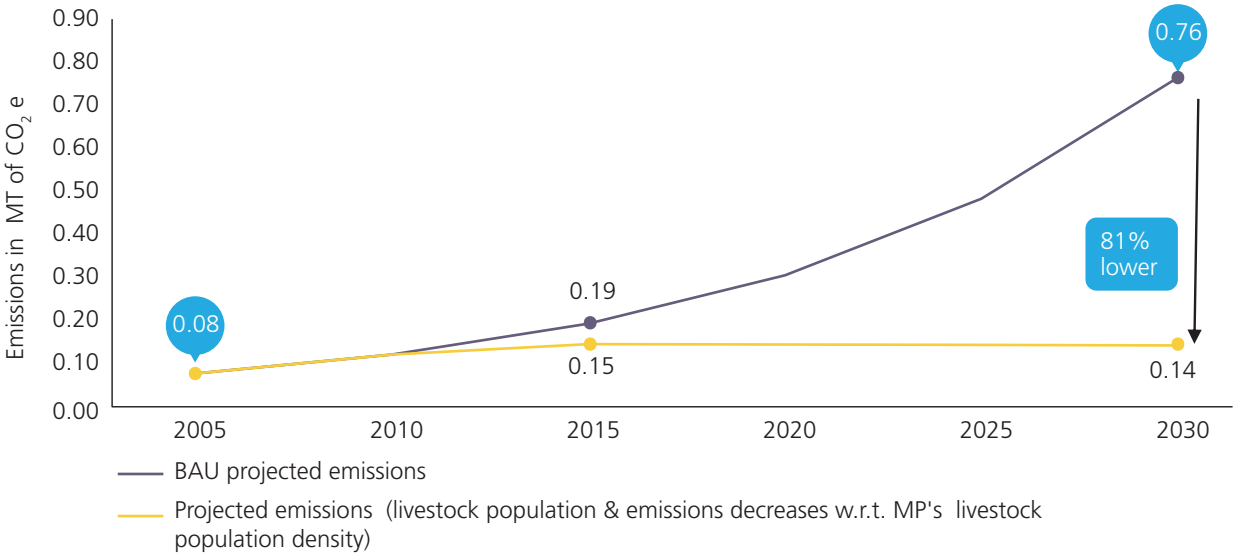


Figure 32: Projected emissions from enteric fermentation – a comparison

Waste sector

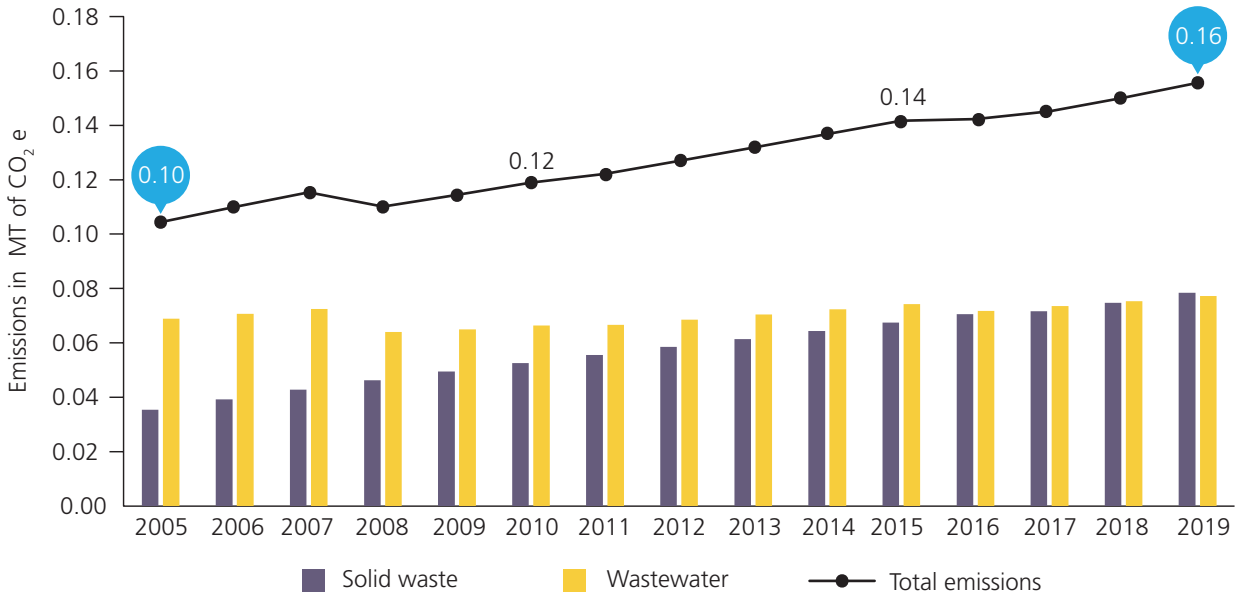


Figure 33: Waste sector emissions (Mt of CO_2e.)

Waste sector emissions have increased by 49% since 2005

- Overall, the waste sector has witnessed the slowest growth rate in emissions between 2005 and 2019 in Bhopal.
- The emissions have increased only by 49 percent (between 2005 and 2019) due to significant improvement in both sewerage treatment facility and sanitation coverage with respect to 2005 levels.
- If solid waste handling and management practices are not improved, in the coming years, emissions from solid waste will be as high as the emission levels from wastewater. This is alarming because solid waste emissions across the nation are always far lesser than wastewater emissions.

Growth in emissions (2005-19) and % share		
Category	**CAGR**	**% share in waste emissions**
Solid waste	3.33%	42%
Domestic wastewater	0.81%	58%

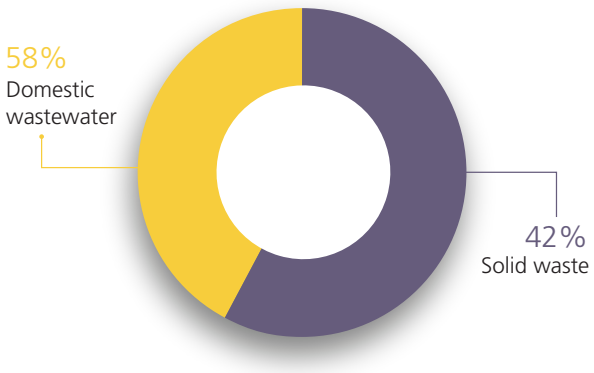


Figure 34: Share in waste sector emissions (2019)

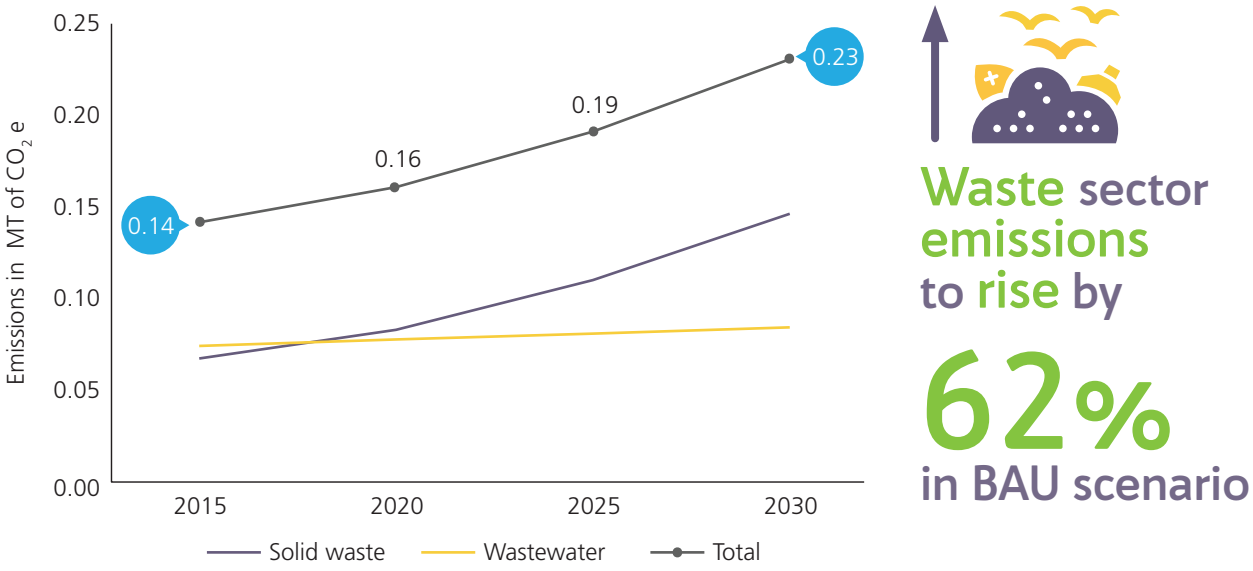


Figure 35: Projections for waste sector emissions (BAU)

3.2. Carbon footprint of electricity consumption[15]

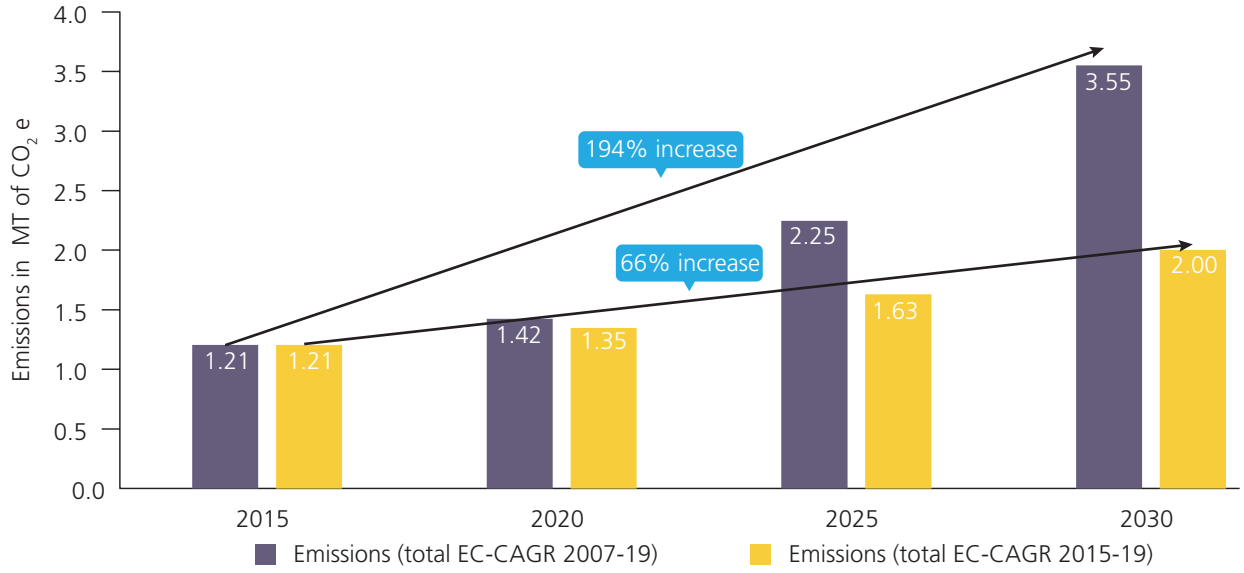


Figure 36: Carbon footprint of electricity consumption (EC) in Bhopal district (Mt of CO_2e.)

Table 15: Per capita electricity consumption in India and its cities

City/region	kWh/person
Bhopal	588
Indore	724
MP	1,084
India	1,181
New Delhi	1,548
Mumbai	1,121
Ahmedabad	1,564
Chennai	1,366
Bengaluru	1,074

- Besides emissions from energy sector (1.14 Mt of CO_2e. in 2019), electricity consumption of Bhopal leads to another 1.18 Mt of CO_2e emissions (at the site of electricity production, which is outside the district).
- These emissions are likely to grow by 66 percent (by applying CAGR of a shorter timeframe)

15 Grid emissions factor for electricity generated through coal = 0.86 kg CO_2/kWh; and through gas = 0.42 kg CO_2/kWh

3.3 Vehicular growth trends[16]

Table 16: Trend of vehicular growth in Bhopal (2005-2015)

Vehicular categories	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	CAGR	CAGR %
Privately owned four-wheelers	39,037	44,690	51,902	59,220	68,577	80,810	93,811	1,07,353	1,20,655	1,35,894	1,78,140	0.16	16.39
Tractors	10,108	9,753	9,902	10,376	10,911	11,763	12,579	13,298	14,046	14,753	11,428	0.01	1.24
Two-wheelers	3,77,374	4,17,179	4,54,110	4,89,077	5,29,900	5,87,250	6,43,891	6,78,873	7,13,577	8,16,196	7,95,685	0.08	7.74
Buses	2,894	3,037	3,144	3,249	3,359	3,567	3,794	4,055	4,330	4,673	5,086	0.06	5.80
LMV goods	5,919	6,809	7,692	8,489	9,343	10,447	11,532	12,966	14,620	16,924	21,908	0.14	13.98
LMV passenger	705	684	551	482	464	459	444	439	439	439	1,341	0.07	6.64
Three-wheelers	4,048	4,621	5,088	5,441	5,843	6,451	7,166	7,852	8,537	9,272	8,986	0.08	8.30
Multi-axled trucks, lorries	4,922	5,261	5,754	6,284	6,817	7,703	9,010	9,670	10,367	11,119	13,895	0.11	10.94
Trucks and lorries	4,723	4,813	4,919	5,054	5,283	5,432	5,429	5,122	4,992	5,106	6,879	0.04	3.83
Taxis	8,799	9,901	11,497	13,209	15,266	17,411	19,510	21,921	24,234	26,573	14,387	0.05	5.04
Total	4,58,529	5,06,748	5,54,559	6,00,881	6,55,763	7,31,293	8,07,166	8,61,549	9,15,797	10,40,949	10,57,735	0.8	79.9

Privately-owned four wheelers show the highest growth of all the vehicle categories:

16.39%
CAGR.

Table 17: Projections for vehicular growth (category-wise)

Vehicle category / year	2005	2010	2015	2020	2025	2030
Privately-owned four-wheelers	39,037	80,810	1,78,140	3,80,541	8,12,910	1,73,6534
Tractors	10,108	11,763	11,428	12,151	12,920	13,738
Two-wheelers	3,77,374	5,87,250	7,95,685	11,55,382	16,77,684	24,36,098
Buses	2,894	3,567	5,086	6,742	8,937	11,848
LMV goods	5,919	10,447	21,908	42,150	81,095	1,56,023
LMV passengers	705	459	1,341	1,850	2,551	3,518
Three-wheelers	4,048	6,451	8,986	13,388	19,948	29,721
Multi-axle trucks and lorries	4,922	7,703	13,895	23,346	39,225	65,906
Trucks and lorries	4,723	5,432	6,879	8,302	10,020	12,093
Taxis	8,799	17,411	14,387	18,396	23,523	30,079
Total	4,58,529	7,31,293	10,57,735	16,62,248	26,88,813	44,95,558

16 Per capita electricity consumption for states is sourced from the following government website: https://pib.gov.in/PressReleseDetailm.aspx?PRID=1592833. For cities it is calculated on the basis of total electricity consumption.

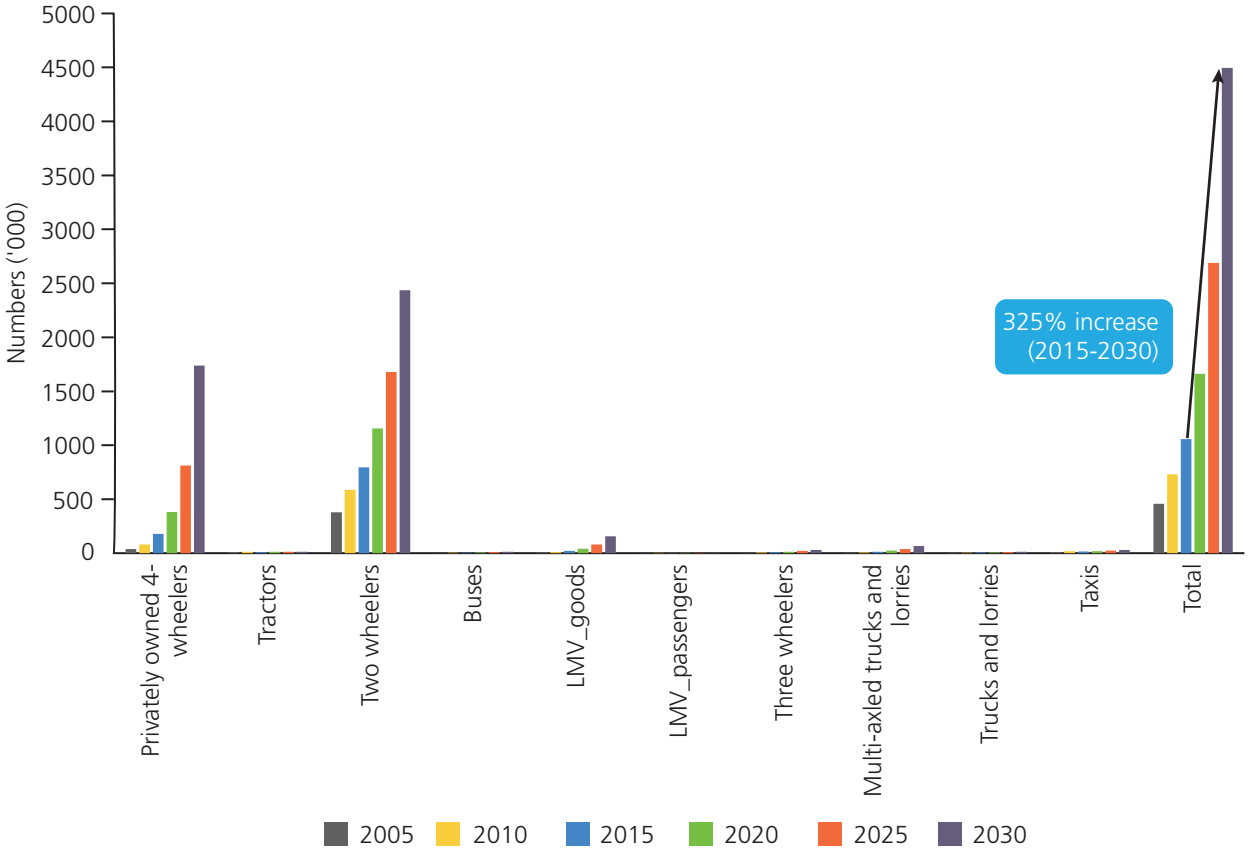


Figure 37: Projections for growth in vehicles (category wise)

Auto-rickshaws parked on the side of the road in Bhopal


SR-1
BAIRAGHARH
TO
BAIRAGHARH
CHICHLI
TATA
MP 04
PA2029

ASSESSMENT OF POLICIES THROUGH THE LENS OF CLIMATE CHANGE

A BRT Bus stop in Bhopal

4. ASSESSMENT OF POLICIES THROUGH THE LENS OF CLIMATE CHANGE

This section evaluates the impact of various national and state-level policies/programmes of three sectors – energy, AFOLU and waste – in Bhopal from the perspective of climate change mitigation. A total of 36 policies have been evaluated for these three sectors.

The methodology to calculate emissions has been derived from the 2006 IPCC guidelines, peer-reviewed papers on policy impact evaluation, briefing papers and Phase III work of GHGPI. Relevant methodological assumptions were made after consulting the sectoral experts.

4.1. Sector-wise policy impact analysis

4.1.1 Power and energy sector[17]

In this section, we look at policies on clean energy, power, energy efficiency, residential and industrial energy, and transport. A total of 12 policies/ programmes have been evaluated for analysing the climate impact by computing the GHG emissions added or avoided by these policies.

List of policies evaluated

Clean Energy

1) Solar Rooftop Policy, 2012, 2) Madhya Pradesh Policy for Decentralised Renewable Energy Systems, 2016, 3) Policy for the implementation of solar-based projects in Madhya Pradesh, 2012, 4) Madhya Pradesh Policy for Net-Metered Renewable Energy Applications, 2016, 5) Waste to Energy, 2016.

Energy Efficiency in buildings, public infrastructure and industrial processes

1) UJALA Scheme, 2018, 2) Streetlight National Programme (SLNP), 2015, 3) Integrated Power Development Scheme (IPDS), 4) Restructured Accelerated Power Development and Reforms Programme (R-APDRP), 5) UDAY Scheme, 2015, 6) PAT (Perform, Achieve and Trade) Scheme

Transport

1) BRTS Bhopal, 2013

Emissions evaluation

Amongst the policies evaluated,

- Clean energy generation resulted in avoiding 2,11,113 tonnes of CO_2e emissions (policies on solar energy: 1,54,800 tCO_2e; Waste to Energy: 56,313 tCO_2e)
- Enhancing energy efficiency in buildings and processes has led to avoiding 7,45,727 tonnes of CO_2e emissions [UJALA Scheme: 1,99,869 tCO_2e; SLNP:3,054 tCO_2e; IPDS, R-APDRP, UDAY: 5,38,000 tCO_2e; PAT Scheme (only for industries, DISCOM not included to avoid double counting): 4,804 tCO_2e],
- While interventions in transportation resulted in avoiding 1,17,345 tonnes of CO_2e. emissions.

17 The detailed impact analysis of policies and programmes (giving information on input indicators, calculation methodology etc.) for energy is given in Annexure 4.1

Information gaps

1) Policies pertaining to Renewable energy: a) Year-on-year data is not available for Bhopal, since inception of the policies; b) Electricity generation from the solar and W2E plants is not available.
2) Energy efficiency: a) Year-on-year data on number of UJALA LEDs distributed and the number of LED streetlamps installed in the district, is not available c) The DISCOM serves districts other than Bhopal as well, and the information available is applicable for the overall distribution. Electricity share for Bhopal is required for accurately calculating emissions avoided from reduction in T&D losses.
3) Transport: Annual utilisation factor of vehicles for each particular region is needed, for now, national values have been used.

4.1.2. Agriculture, forestry and other land use (AFOLU) and cross-cutting[18]

The policies, programmes and schemes pertaining to agriculture, animal husbandry/livestock rearing and forestry have been grouped together as AFOLU sector initiatives, to understand their impact on climate mitigation.

List of policies evaluated

For Bhopal district a total of seven policies/programmes under AFOLU sector and two additional policies of cross-cutting sector (agriculture and energy) have been considered for this evaluation.

Agriculture

(1) Soil Health Card Scheme; and (2) National Food Security Mission

Livestock

(1) Breed Improvement Programmes; and (2) Vats Paalan Protsahan Yojana

Forestry

(1) Gair Van Bhoomi par Vriksharopan Neeti, (2) Diversion of forests for non-forest purpose under the Forest Conservation Act, 1980, and (3) Wildlife Protection Act, 1972

Cross-cutting (agriculture and energy)

(1) National Mission on Micro Irrigation, and (2) Pradhan Mantri Ujjwala Yojna

18 The detailed impact analysis of policies and programmes (giving information on input indicators, calculation methodology etc.) for AFOLU is given in Annexure 4.2 and for cross-cutting (agriculture and energy) in 4.3.

Emissions evaluation

- An attempt has been made to quantify GHG emissions avoided/added by each initiative. However, for a few policies/programmes it could not be computed due to lack of required data/information. This exercise helped quantify the total emissions avoided due to forestry policies – at 1,79,78,321 tonnes of CO_2e (as per scenario 1)[20]; and 11,156 tonnes of CO_2e (as per scenario 2).[21]
- The Breed Improvement Programmes proved to be beneficial for climate action as well by avoiding 4326 tonnes of CO_2e/.
- Under the agricultural sub-sector, emissions from the National Food Security Mission (NFSM) were estimated to be 20,432 tonnes of CO_2e.
- Under the cross-cutting sector, the National Mission on Micro Irrigation resulted in avoiding 911 tonnes of CO_2e emissions annually (from reducing use of urea alone). Whereas, the Pradhan Mantri Ujjwala Yojana has helped to mitigate annually 8,47,722 tonnes of CO_2e as per scenario 1 and 87,891 tonnes of CO_2e as per scenario 2.

Information gaps

In order to accurately quantify the impact of these policies on the GHG emissions the following information is needed-

1) Annual district-level data on diversion of forest area for non-forest purposes.
2) Number of calves born through 'Vats Paalan Protsahan Yojana'.
3) Area covered under Soil Health Card Scheme.
4) Reduction in use of chemical fertilisers as a result of recommendations given in the soil health cards.
5) Production of pulses (in percentage terms) that can be attributed to the National Food Security Mission.

4.1.3. Waste management[21]

Waste sector policies implemented in the district are categorised into sanitation, waste management (solid, BMW and HW) and waste water management (domestic and industrial).

List of policies evaluated

A total of 16 national and state level policies/programmes were evaluated for their contribution as emission mitigation strategies.

Sanitation

1) Total Sanitation Campaign, 2) Nirmal Bharat Abhiyan or Clean India Campaign, 3) Swachh Bharat Mission Urban, 4) Integrated Low Cost Sanitation Scheme (ILCS), 5) Swachh Bharat Mission Rural, 6) Pradhan Mantri Awas Yojana, 7) Integrated Urban Sanitation Programme (IUSP)

Waste management

1) Solid Waste Management Rules, 2016 and Amendment, 2018: Integrated Solid Waste Management Projects (ISWM), Bhopal Smart City Development Corporation, 2) Bio-medical Waste Management Rules, 2016 and Amendment, 2018, 3) Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016

Domestic and industrial wastewater

1) National River Conservation Plan, 2) Jawaharlal Nehru National Urban Renewal Mission on Urban Infrastructure and Governance, 3) MP Urban (ADB) Project, 4) Atal Mission for Rejuvenation and Urban Transformation (AMRUT), 5) Common Effluent Treatment Plant (CETP) for Medium & Small-Scale industries, 6) Online Monitoring of Industrial Emission & Effluent (OCEMS)

19 Scenario 1- Carbon stock density of MP (89.79 tonnes/ha) is used (as given in the FSI Reports for MP)

20 Scenario 2 - Carbon stock density 10 tonnes/ha is used (Bhopal-specific carbon stock density was suggested by MP Forest Officials)

21 Detailed impact analysis of policies and programmes (giving information on input indicators, calculation methodology etc.) for waste is given in Annexure 4.4

Emissions evaluation

Along with the methane emission concerns from the sanitary measures and sewerage treatment plants, the current evaluation also considers the waste incineration emission potential for bio-medical waste and hazardous waste. The policy activities have led to the following annual average impacts:

- Emissions of 20,036 tCO_2 from individual household latrines (IHHL: two pit latrine) and 68,810 tCO_2 from community latrines (septic tank) constructed under sanitation programmes/policies.
- Emissions mitigation of 60,923 tCO_2 for biological treatment (composting) of MSW and 18.15 tCO_2 for incineration of bio-medical waste.
- Emissions of 44,228 tCO_2 for STPs constructed under sewerage connection programmes.
- It must be noted that the implementation of these activities has actually avoided an annual average emission (with respect to baseline17) of 18,702.5 tCO_2, 70,497.8 tCO_2 and 3,173.6 tCO_2 by sanitation, solid waste and liquid waste management/developmental policy initiatives respectively in the district.

Information gaps

1) Sanitation: For old and completed policies, there is a gap in availability of data in the public domain. In most cases, the district level data was not available.
2) Waste: District level hazardous waste incineration data was not available.
3) Domestic wastewater: No policy-wise data was available.
4) Industrial wastewater: Industry category-wise wastewater treatment and discharge data was not in public domain.

Gaps in Policy and implementation

Power and energy Sector

- **Renewable energy**
  - Madhya Pradesh ranks seventh in total solar installed capacity among all the states in India. The current total solar installed capacity of Madhya Pradesh stands at 2.46 GW, 96.88 percent of which is ground-mounted and 3.12 percent is solar rooftop (MNRE). It is noteworthy that GoMP provides a 30 percent subsidy to domestic consumers to install solar panels on rooftops or in any space available on the ground,. Government buildings get a 45 percent subsidy and certain government undertakings get a subsidy of 50 percent. Colleges and educational institutions can also install solar power units, wherever free space is available on the ground. Despite these efforts, the state is deficient by around 3.24 GW of the state target of 5.7 GW installed solar capacity by 2022. Therefore, the state needs to step up implementation of solar projects in order to cover this shortfall. Madhya Pradesh already hosts Asia's largest single-site solar plant of 750 MW capacity in Rewa. The completion of the proposed solar power plants in Neemuch, Shajapur, Agar, Omkareshwar, and Chhattarpur would not only help the state in achieving its target, but also help the state emerge as a leader in solar installations. Being an administrative head and a highly urbanised district, Bhopal also has a huge potential for solar rooftop installations.

The current total solar installed capacity of Madhya Pradesh stands at 2.46 GW,

96.88%

of which is ground-mounted

and 3.12 % is solar rooftop

- Under CM Solar Pump Yojna (GoMP), and in tandem with the PM KUSUM Yojna (GoI), 19 decentralised solar plants have been installed in the district for captive electricity consumption by the farmers, under Scheme-A of PM KUSUM Yojna. However, Scheme-B of PM KUSUM Yojna is still in the application phase and stand-alone solar pumps are yet to be installed in the state. Enhanced endeavours in implementing CM Solar Pump Yojna and PM-KUSUM Yojana would help the state strengthen its RE infrastructure.

- **Energy efficiency**
  - ECBC Compliance: The draft Energy Conservation Building Code (ECBC) was published in 2017. However, the code is yet to be notified and implemented in the building bylaws for MP.
- **Transport sector policies**
  - The modal share of public transport in Bhopal by ridership is 44 percent. However, all buses in the district run on diesel, thereby indicating that policy restrictions on the procurement of e-buses have not been addressed.
  - Policy level intervention is needed to improve BRTS and other public transport modes in terms of robustness, reliability, frequency and better reach in the district.
  - There is also a need for initiatives that will effectively help enabling the transitions towards cleaner or low carbon transportation as envisioned in the policy.

AFOLU and cross-cutting

- A reduction in Bhopal's forest cover has been a major concern. Between 2011 and 2015, Bhopal lost almost 11 sq km of forest cover; and another 25 sq km between 2015 and 2017.
  - District level initiatives are needed to curb the loss of forest cover. These interventions would not only help reduce emissions from the AFOLU sector, but also help India achieve the target of creating additional carbon sink of 2.5 to 3 billion tonnes CO_2e by 2030.
- The nexus between power and agriculture has a lacuna in policy level interventions. Agriculture activities, like non-judicious irrigation practices, lead to high electricity consumption patterns. Policies pertaining to electricity pricing, subsidies, and collection of tariffs need to be revised.
- Between 2011 and 2015, area under rice cultivation increased eight-folds in the district. There is need for policy interventions that promote low emission cultivation practices while ensuring unhindered rice production.

Between 2011 and 2017, Bhopal lost 36 sq. km of forest cover

Waste management

- Although waste generation and treatment reporting is mandated at the state level, the policy doesn't mandate districts to maintain and report data on the waste treatment methods adopted for any categories of waste, except for bio-medical waste.
- There are no policies that mandates the maintenance of data on domestic and industrial wastewater (industry category-wise) generation, treatment and discharge pathways.
- Waste policies do not suggest gas management/capture facilities for composting and incineration units that dispose waste.
- Reducing emissions in the area of waste transportation is not addressed in waste policies.
- Although it's mentioned in the Solid Waste Management Rules, 2016, producer take-back mechanism for disposables in municipal solid waste is never implemented as the policy does not suggest any monitoring or reporting framework for the same.

Inventories of different waste streams are critical to waste sector emission estimates

BUDGETARY ANALYSIS TO ESTIMATE EXPENDITURE ON CLIMATE ACTION

Laborers working in paddy farms

5. BUDGETARY ANALYSIS TO ESTIMATE EXPENDITURE ON CLIMATE ACTION

5.1 Introduction to budgetary analysis

"The Climate Public Expenditure and Institutional Review (CPEIR)" methodology of UNDP is used to analyse regional expenditure on climate action. The CPEIR is a systematic qualitative and quantitative analysis of public expenditures and how they relate to climate change. Since 2011, CPEIRs have been conducted in many countries in the Asia-Pacific, including Bangladesh, Indonesia, Nepal, Thailand and Vietnam among others at both national and sub-national levels.

Analysis of select flagship schemes at the district level has been presented in this section. A total of 39 schemes were reviewed to identify those with climate resilience and mitigation relevance. Of these, based on availability of information across districts as well as their relevance to climate actions, five schemes for Bhopal were selected for further analysis.

Annexure 5.1 and 5.2 detail the rationale, methodology and assumptions considered to conduct district-level analysis.

5.2 Analysis and findings of flagship schemes

5.2.1 Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS)[22]

2018-19

- Annual budgetary expenditure: ₹ 4,084 lakh
- Allocation to climate action: 8 percent
- Major climate action works: Water conservation, water harvesting and rural connectivity

2019-20

- Annual budgetary expenditure: ₹ 1,194 lakh
- Allocation to climate action: 20 percent
- Major climate action works: Water conservation and water harvesting

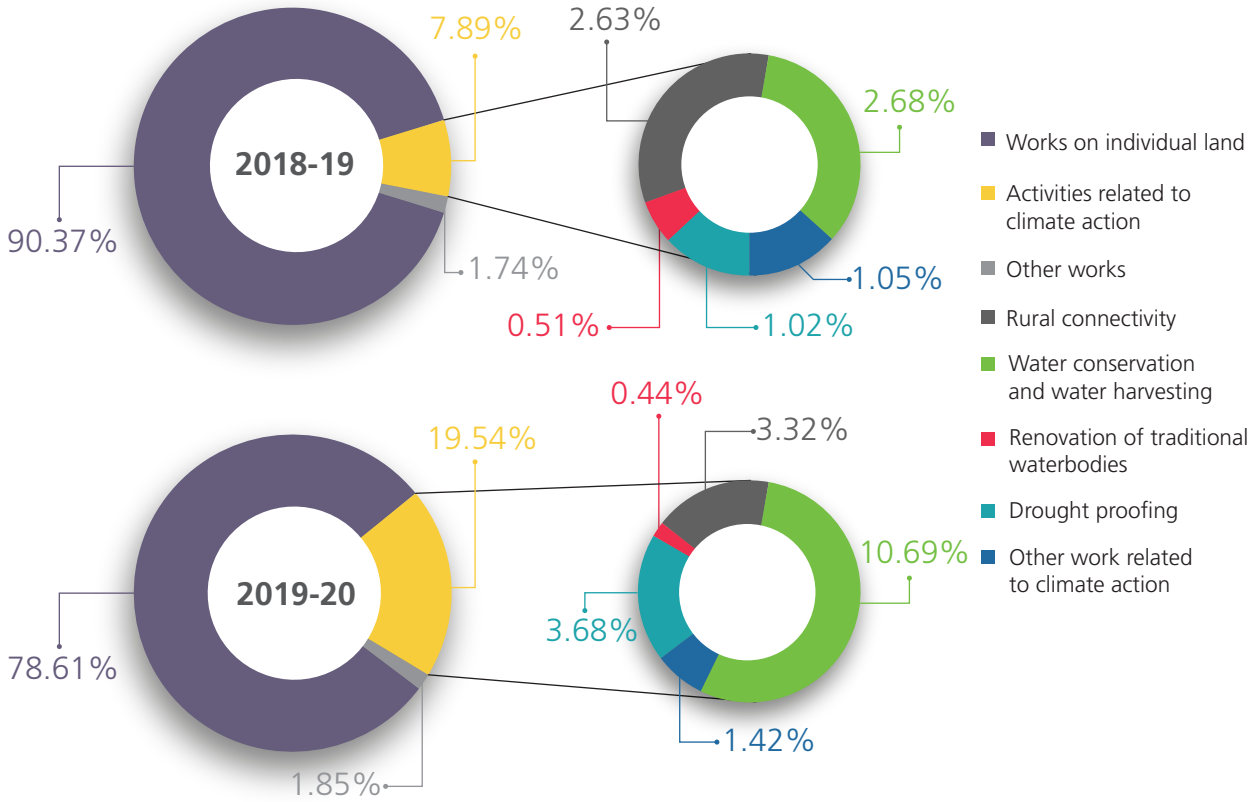


Figure 38: Expenditure on climate action under MGNREGS in Bhopal district (2018-19)[23]

22 Ministry of Rural Development (MoRD) lists 17 major activities under MGNREGS. Out of these, 11 can be assumed to be acting on climate change, categorised as mitigation-specific, resilience-specific or both, refer annexure 5.3 for details.

23 Other works under MGNREGS include works pertaining to anganwadi, Bharat Nirman Rajiv Gandhi Sewa Kendra, food grains, play grounds etc. Other works related to climate action include works pertaining to coastal areas, fisheries, flood control and protection, micro-irrigation works, rural drinking water, rural sanitation, land development etc.

Expenditure (₹ lakh)

	Drought proofing	Renovation of traditional water bodies	Rural connectivity	Water conservation and water harvesting	Other works related to climate action
2018-19	41.83	20.66	107.30	109.54	43.07
2019-20	43.88	5.20	39.58	127.57	16.96

Figure 39: Comparing expenditures (₹ lakh) on climate action under MGNREGS in Bhopal between 2018-19 and 2019-20

5.2.2 Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)

The micro-irrigation techniques employed in the district under this scheme are: 1) drip irrigation, and 2) sprinkler irrigation. Further, water conservation activities deployed under the scheme include: a) Construction of individual water storage/harvesting, b) Water harvesting/retaining and c) Ground water development and recharge. However, for FY 2019-20, no physical activity was carried out under PMKSY in the district.

Budget allocations	2016-17	2019-20
Budgetary spending on micro-irrigation activities (₹ lakh)	1,766	0
Budget attributed to climate action	1,218.54	0
State budget for PMKSY micro-irrigation (₹ lakh)	54,324	0
% attributed to climate action (micro-irrigation budget under PMKSY) given to district w.r.t state budget	3.25	0

5.2.3 Green India Mission (GIM)

For Bhopal district, the Department of Forests provides a five-year plan for expenditures in the six sub-missions under GIM. Figure 40 details the fund allocation.[24] Major activities under the mission have been to enhance the quality of the forest cover and to improve ecosystem services, i.e., sub-Mission 1 under the GIM.

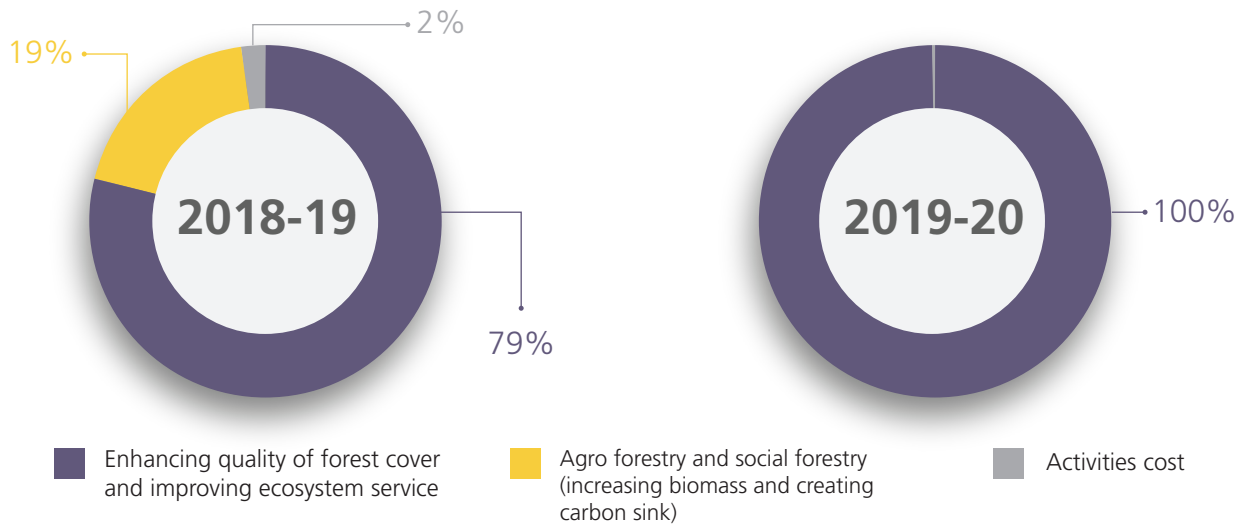


Figure 40: Mission-wise fund allocation under GIM in Bhopal district in 2018-19 and 2019-20

Fund allocation (₹ lakh)

	Enhancing quality of forest cover and improving ecosystem service	Ecosystem restoration and increase in forest cover	Enhancing tree cover in urban and peri-urban areas (including institutional lands	Agro forestry and social forestry (increasing biomass and creating carbon sink)	Restoration of wetlands	Promoting alternative fuel energy	Activities Cost
2018-19	10.40	0	0	2.42	0	0	0.30
2019-20	10.26	0	0	0	0	0	0.04

Figure 41:Comparing mission-wise fund allocation (₹ lakh) under GIM in Bhopal between 2018-19 and 2019-20

24 1) Enhancing the quality of forest cover and improving ecosystem service
2) Ecosystem restoration and increase in forest cover
3) Enhancing tree cover in urban and peri-urban areas (including institutional lands)
4) Agro forestry and social forestry (increasing biomass and creating carbon sink)
5) Restoration of wetlands
6) Promoting alternative fuel energy

5.2.4 Atal Mission for Rejuvenation and Urban Transformation (AMRUT)

Total budget under scheme (₹ lakh)	2015-16	2016-17	2017-20
	25,502	17,523	32,929

Based on the methodology and assumptions mentioned in Annexure 5.2, amounts of ₹ 139 crore, ₹ 171 crore and ₹ 205 crore can be attributed to climate action in FY 2015-16, FY 2016-17 and FY 2017-20, respectively (see Figure 42). Further, figure 43 gives a distribution of the total budgetary allocation of ₹ 946 crore to the district between 2015-16 and 2017-20.

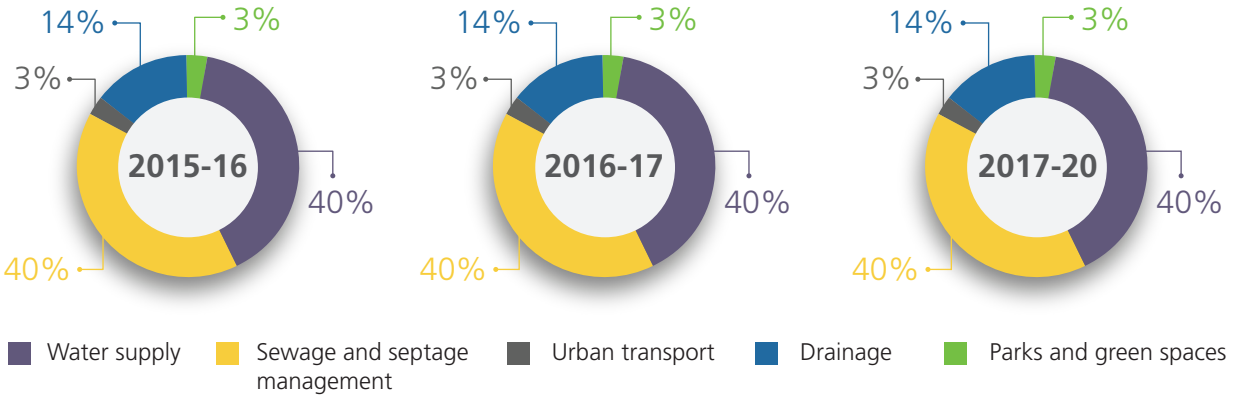


Figure 42: Distribution of budgetary allocation for activities under AMRUT scheme in Bhopal 2015-16, 2016-17 and 2017-20

Budgetary allocation (₹ crore)

	Water supply	Sewage and septage management	Urban transport	Drainage	Green space and parks
2015-16	56.30	55.39	3.77	19.58	4.03
2016-17	69.58	68.47	4.66	23.69	5.00
2017-20	83.35	82.02	5.58	28.37	5.98

Figure 43: Comparing sector-wise budgetary allocation (in ₹ crore) for activities under AMRUT in Bhopal for 2015-16, 2016-17 and 2017-20

5.2.5 Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY) and Saubhagya Scheme

Until April 30, 2020, an amount of ₹ 4,481 lakh had been released to carry out the above activities under DDUGJY and Saubhagya Scheme. Based on the CPIER methodology adopted, an amount of ₹ 2,240.5 lakh has been attributed towards climate action for the district Bhopal.

RECOMMENDATIONS

Electric bicycle sharing spot in Bhopal

6. RECOMMENDATIONS

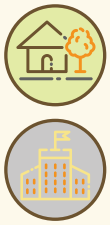
This section provides a comprehensive basket of sector-wise recommendations from a climate perspective, with an aim to complement India's 2030 NDC commitments through a district-level alignment in the form of this District Climate Change and Environment Plan. The salient features of these recommendations are as follows:

- Recommendations are grouped under four broad categories – energy, agriculture, forestry and other land use (AFOLU), waste, and district-specific environmental issues.
- Actions under each category on which recommendations can be made by the district collector/committee to the relevant state departments as well as inputs on innovative financing have been identified.
- These are based on district specific ground realities and situations.
- The state and district vision documents were factored in while developing the recommendations.
- Information provided on timeframe and framework for implementation would enable the district authorities and concerned departments to prioritise actions.
- List of existing policies, programmes and schemes that can help streamline the actions is provided along with the concerned primary and supporting departments in separate table following each sectoral recommendation matrix.
- Additionally, this section provides information on SDGs and other co-benefits that can be addressed through the mentioned recommendations in this action plan.
- Further, the cross-sectoral benefits of each recommendation have been identified and indicated using the icons as listed in the following table:

	Energy and electricity		Green space, forestry and allied activities and bio-diversity
	Habitat (residential)		Water resources and water conservation
	Commercial and public infrastructure		Solid waste
	Transport		Wastewater
	Industry		Air pollution
	Agriculture and allied activities		Awareness, communication and capacity building

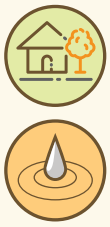
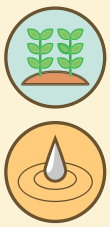
6.1. Sector-specific recommendations

6.1.1. Electricity and energy: Recommendations, cross-cutting sectors, qualifying priority and district scenario

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Increasing RE share in the electricity generation basket				
Increase the share of renewable energy (RE) generation by advancing rooftop and ground mounted installations, and other RE installations.		Short to medium-term (govt buildings) Medium-term (commercial buildings) Medium to long-term (residential and others)	Policy framework and RE targets exist (See section 6.1.1.1) Need to create awareness	India has a target of 40 GW for solar rooftop (2022). As of February 28, 2021, only 4.32GW has been achieved. Madhya Pradesh has only 76.91 MW solar rooftop capacity. Case example calculation: a) If equipped with solar rooftops, just the government schools in the district can generate 95.81 MUs electricity, thereby avoiding 0.08 $MtCO_2e$ annually. b) If the commercial/institutional buildings are also factored in, solar rooftop potential for such buildings would be 1,209 MW, which would help mitigate 1.2$MtCO_2e$ annually. c) Further, if 50% households in the district are equipped with solar rooftops, total installed capacity will be 1,772 MW, which can help avoid 1.86 Mt CO_2e annually. Adoption of solar energy can be accelerated by making it mandatory for hospitality industry/new construction (having a built-up area greater than 20,000 sq ft) / private healthcare infrastructure (above a certain bed-capacity) to have solar rooftops. Ground mounted solar: The current installed capacity of ground mounted solar in Madhya Pradesh stands at 2.38GW (as of February 2021). Bhopal district has a huge potential for solar power generation (rooftop and ground mounted). In Bhopal city, solar rooftop installation can be promoted. For the remaining district, ground- mounted solar installations can be a more viable option.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Aggressively promote battery storage for RE		Short to medium-term	Additional financial support can be created	Case example: Maharashtra Energy Development Agency has installed 650 Ah batteries for a few solar projects and has proposed hybrid inverters for RE projects across Maharashtra. Hybrid inverters take power from battery/RE installation up to a particular load, and on increased demand, they switch to the grid supply. Similar initiatives can be taken up in the district.
Encourage captive use of renewable energy, particularly in rural areas for small industries and local entrepreneurs.		Short to medium-term	Policy framework exists Need to create awareness	By 2030, electricity demand is expected to be approximately 5,000 MUs, annually. If this demand is entirely met from coal, around 4.3 $MtCO_2e$ would be caused, annually. Decentralised renewable energy (DRE) setups can power small/cottage industries, which in turn can play an important role in providing livelihoods in rural areas as well as support reverse-migration (that was recently witnessed during the COVID-19 pandemic). Such setups would also create new jobs, and empower rural entrepreneurs. The cold storage network across the district can be powered through DRE. Such set-ups can be especially useful for reliable storage of vaccines, farm produce, and rural non-farm productive use appliances.
Energy demand side management (DSM) and energy efficiency				
Encourage faster penetration of Street Lighting National Programme (SLNP). This would ensure that all street and public lighting fixtures are replaced with energy-efficient LED bulbs, prioritising premises and recreational areas of all government / public institutions.		Short-term	Policy framework and schemes exist	Smart streetlighting can reduce electricity use by up to 80%. Around 320 million streetlighting poles are in use globally, but fewer than 3% of these are Smart enabled. SLNP had a national target of replacing 1.34 crore conventional street lamps with LED lamps by March 2020. But till date only 1.18 crore LED lamps have been installed.[25] In Bhopal district, under the SLNP, if 36,222 existing conventional lamps are replaced by LED lamps, about 19,077 tCO_2e can be avoided, annually.

25 International Energy Agency. 2021. Empowering Cities for a Net Zero Future: Unlocking resilient, smart, sustainable urban energy systems. Available athttps://iea.blob.core.windows.net/assets/4d5c939d-9c37-490b-bb53-2c0d23f2cf3d/G20EmpoweringCitiesforaNetZeroFuture.pdf

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Expedite installation of smart meters in collaboration with MPPMCL (Madhya Pradesh Power Management Company Limited) in an effort to develop advanced metering infrastructure (AMI). Installing smart meters, along with its associated IT infrastructure would allow the DISCOM to obtain real time energy consumption data of each consumer for subsequent analysis and will pave the way for initiating various smart measures like (a) Time of day (TOD)/Time of use (TOU) billing, (b) Prediction and management of peak demand, (c) Providing real time energy consumption data to consumer, (d) Prepaid billing facility, (e) Remote connection and disconnection of load, (f) Development and adoption of a differential pricing model to demotivate energy consumption during peak hour, etc.		Short to medium-term	Policy framework and targets exist (section 6.1.1.1) Create awareness for consumer segment	Implemented by EESL (BEE), Smart Meter National Programme aims to replace 25 crore conventional metres across the country with smart meters. MPMKVVCL is planning to install around 3.7 lakh smart meters across Bhopal, covering around 80% of the city. If implemented, this would be a major step towards smartening of the grid, and reducing carbon footprint of the district.
Replace/upgrade existing inefficient pumping infrastructure with energy efficient pumps/solar pumps for supply of piped drinking water in both rural and urban pockets of Bhopal district.		Short to medium-term	Relevant schemes and programmes can help achieve this (section 6.1.1.1) Inter-departmental collaboration required	MPUVNL has been designated as the nodal agency for the Municipal Energy Efficiency Programme(MEEP) in Madhya Pradesh. This programme aims to save 120 MW through energy-efficiency project in 134 ULBs, which will result in avoidance of fresh generation capacity.
In agriculture, promote energy-efficient water pumps (provided by EESL), and solar pumps (through PM-KUSUM and SKY)		Short to medium-term	Policy framework exists (section 6.1.1.1)	According to BEE, 30-40% energy savings is possible in agriculture by adoption of energy-efficient star-labelled pump sets. If 50% of tube-wells in the district are converted to solar, 0.133 $MtCO_2e$ emissions can be saved annually.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Increase community awareness on and access to energy-efficient appliances and fixtures. Provide additional incentives (over and above existing schemes) on energy-efficient appliances. (Other recommendations pertaining to energy efficiency are listed under sections: Habitat, Industry and other recommendations that can be made by the Collector's office to the state departments)		Medium term	Additional financial support could be created Create awareness through dedicated IEC and long running campaigns	BSES Yamuna Power Ltd (BYPL) launched an AC replacement scheme in Delhi NCR with the objective of promoting energy efficiency among households. Under the programme, upfront rebate per air conditioner (BEE 5-star rated/ inverter) was offered by BYPL to the consumer in exchange of their old non-star rated air conditioner. MPMKVVCL can implement a similar scheme in its area of supply, with a pilot in Bhopal district.

6.1.1.1 Electricity and energy: Policy framework and concerned departments/agencies

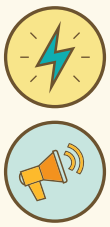
Sub-sectors	Policies and programmes[26] that can push forward the recommendation	Primary departments/ agencies	Supporting departments/agencies
Increase RE share in the electricity generation basket	1) MP Solar Policy, 2012 2) MP Policy for Decentralised Renewable Energy Systems, 2016 3) Waste to Energy Policy, 2016 4) National Solar Mission 5) SMART Project 6) PM KUSUM	1) MPUVNL, GoMP 2) Energy Department, GoMP	1) ALL ULBs 2) Madhya Pradesh Electricity Regulatory Commission (MPERC) 3) Rural Development Department, GoMP (reporting and monitoring) 4) Urban Development and Housing Department, GoMP 5) State Knowledge Management Centre on Climate Change (SKMCC) - EPCO 6) Department of Cottage and Rural Industries, GoMP 7) MPPMCL-MPMKVVCL, GoMP 8) Department of Agriculture, GoMP 9) Proposed District level Committee on Climate Change and Environment
Energy demand-side management (DSM) and energy efficiency	1) Smart Meter National Programme (SMNP) 2) National Smart Grid Mission 3) Streetlight National Programme (SLNP), 2015 4) UJALA Scheme, 2015 5) Standards and Labelling Programme 6) Sustainable Habitat Mission 7) Smart Cities Mission 8) National Mission for Enhanced Energy Efficiency 9) Municipal Energy Efficiency Programme (MEEP) 10) PM KUSUM 11) MP Solar Policy, 2012 12) MP Policy for Decentralised Renewable Energy Systems, 2016	1) BEE (EESL) 2) MPUVNL, GoMP 3) All ULBs 4) Panchayati Raj Institutions (PRIs) 5) Energy Department, GoMP	1) State Knowledge Management Centre on Climate Change (SKMCC)- EPCO 2) Department of Agriculture, GoMP 3) Urban Development and Housing Department, GoMP 4) Bhopal Smart City Development Corporation Limited (BSDCL) 5) Proposed District level Committee on Climate Change and Environment

26 This column enlists information on policies, programmes, rules, schemes and other regulatory provisions pertaining to the sector

6.1.2. Habitat (urban and rural development): Recommendations, cross-cutting sectors, qualifying priority and district scenario

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for Implementation	
Energy efficiency in buildings				
Energy Conservation Building Code (ECBC) to be incorporated in the building by-laws for all ULBs, as a pathway to buildings having net zero energy consumption.		Medium to long-term	Policy framework exists (section 6.1.2.1) Inter-departmental collaboration required Capital incentives/ relevant exemptions over and above the existing provisions from the district administration required	Residential and commercial sectors in Bhopal make up for around 17% of the total electricity consumed in the district. MPUVNL is working to incorporate ECBC into building compliance systems in MP. For example: By 2025, if 23% of the existing residential area becomes ECBC compliant, 2.07 $MtCO_2e$ can be avoided.
District administration, in collaboration with the ULBs, can implement the India Cooling Action Plan (ICAP) and achieve its objectives. District administration can also explore the possibilities of piloting solar-passive architecture/ other renewable energy technologies in a few of its iconic buildings. Implementing this at the district level could help avoid significant GHG emissions.		Medium-term	Policy framework exists (section 6.1.2.1) Needs inter-departmental collaboration Capital incentives/ relevant exemptions from the district administration required.	In September 2018, India became the first country in the world to have a Cooling Action Plan, which seeks to: i) Reduce cooling demand across sectors by 20% to 25% by 2037-38 ii) Reduce refrigerant demand by 25% to 30% by 2037-38 iii) Reduce cooling energy requirements by 25% to 40% by 2037-38 iv) Recognise "cooling and related areas" as a thrust area of research under national S&T Programme v) Training and certification of 1,00,000 servicing sector technicians by 2022-23, synergizing with Skill India Mission. The plan aims to provide the following benefits (i) Thermal comfort for all – provision for cooling EWS and LIG housing, (ii) Sustainable cooling – low GHG emissions related to cooling, (iii) Doubling farmers' income – better cold chain infrastructure (iv) Skilled workforce for better livelihoods and environmental protection, (v) Make in India – domestic manufacturing of air-conditioning and related cooling equipment, and other benefits. The district cooling system in the Gujarat International Finance Tec-City (GiFT City) in Gandhinagar provides reliable cooling to residential, commercial and industrial buildings. The system, regulated by advanced metering and supervisory control and data acquisition (SCADA) systems, is expected to consume only 60% to 85% of the energy used in conventional air conditioning.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for Implementation	
Replace diesel powered backup in a phased manner with solar-powered or other RE-powered backup. This can essentially be promoted in government / commercial / institutional buildings with built-up area >20,000 sq ft.		Short to medium term (government buildings) Medium to long-term (privately owned, commercial, institutional, and others)	Policy intervention is required Proper policy backup can mitigate GHG emissions and align India with Paris targets Needs inter-departmental collaboration	A DG set of 200kW, (used in industries/ huge commercial buildings) operating at full-load consumes approximately 45 litres of diesel/hour. This results in around 117 $KgCO_2e$/hour. Replacing DG sets with solar-powered backup could help avoid these emissions.
Upgrade public transport infrastructure to include RE and ECBC compliance. Roadside hoardings near such infrastructure can also be powered through RE.		Short to medium-term	Can be pushed forward by aligning with existing policy framework for solar rooftop (section 6.1.2.1) ECBC compliance of public transport infrastructure to be mandated by building bye-laws	Bhopal district can adopt and implement initiatives, similar to the one in Lucknow, where the municipal corporation has said it would set up 200 solar-powered bus stops.
Promoting formulation of energy communities in existing RWAs/other residential committees where residents have ownership over their energy supply. Energy communities can host wind and solar generation installations, or a self-sufficient system functioning as a microgrid/ undergrid-minigrid. These committees can make agreements between the community, the private developer and the utility company. Digitalisation can create innovative billing mechanisms and generate data that will provide important investment information to the energy market. Deploying public funding schemes like feed-in tariffs, leverage national and international funds, and providing digital upskilling opportunities to citizens can help promoting the initiative.		Medium-term	Can be pushed forward by aligning with existing policy framework	

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for Implementation	
Encourage fast penetration of UJALA scheme in every household of Bhopal district.		Short to medium-term	Schemes and programmes are available (section 6.1.2.1)	The UJALA scheme provides an LED bulb at a nominal price for replacement of incandescent lamps /conventional bulbs. By 2030, the UJALA scheme can potentially avoid emissions of 0.20 $MtCO_2e$ annually.
Energy-efficient vertical urban development should be promoted (instead of horizontal development) to conserve green cover.		Short-term and continuous	Needs collaborations and awareness	
Energy-efficient vertical urban development should be promoted to conserve green cover.		Medium to long-term	Policy intervention required	Vertical urban growth not only facilitates settlement of more people per sq m, but also contributes towards the environment. It averts the loss of agricultural land and makes the transport system much more efficient. India has high-rise buildings in Mumbai, Delhi NCR and Bengaluru. Other cities like Kolkata, Chennai, Hyderabad and Ahmedabad are also catching up.
Demand-side management for habitat				
Promote and subsidise good practices for all ULBs, such as installing rainwater harvesting setups in buildings that can considerably reduce energy dependence on submersible motors for groundwater pumping.		Short-term	Schemes and programmes exist (section 6.1.2.1) Need to raise awareness	The government of Madhya Pradesh is planning to make rainwater harvesting (RWH) a part of permission-related clauses for multi-storey buildings, thereby making it mandatory. The government aims to follow the Indore model in RWH setups. Indore Municipal Corporation (IMC) has mandated RWH in all new buildings in Indore, with an area of 250 sq m or more. Moreover, a rebate of 6% on property tax is provided as an incentive to install RWH system. Bhopal district can follow a similar model.
Implement individual water metering in residential sector to reduce water wastage, and introduce other energy efficient measures for drinking water and wastewater plants thereby bringing down the energy consumption.		Medium-term	Policy intervention is required Need to create awareness	In many cities, drinking water and wastewater plants are municipally owned and are among the largest municipal energy consumers, often accounting for 30% to 40% of total municipal energy consumption. By incorporating energy efficiency measures into their water and wastewater plants, municipalities can save 15% to 30% of their municipal budgets. Sixteen apartments in Mantri Residency, Bengaluru, installed with water meters, are consuming 25% to 30% less water every year.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for Implementation	
Encourage residential societies to adopt solar-thermal water heaters.		Short-term and continuous	Schemes and programmes exist (section 6.1.2.1) Inter-departmental collaboration required Scheme to be implemented as a part of green buildings	Multi-storey (up to 12 storeys) residential buildings can meet around 70% of the annual electricity requirement for water heating (BEE) through community solar water heating systems on the roof (assuming utilisation of 60% of roof area)
Promote installation of automatic/smart water pumps to control overflowing of tanks.		Short term	Need to create awareness	
Water cess/pricing by Municipal Corporation to be revised and gradually increased.		Medium term	Policy framework to be revised	
Digital tools, such as GIS, remote sensing can be used to identify opportunities to reduce energy demand and implement energy efficiency interventions where it holds most value, and identify where and how to set up mixed-use zones to flatten demand curves. Energy demands (for cooling) of the district can be mapped, combining weather data with demand data, to identify where efficiency interventions are needed.		Medium to long-term	Needs policy intervention and infrastructural development.	By identifying optimal locations for water features or vegetation, Bhopal can counteract on heat islands through tree plantations that provide shade and reduce the power demand for cooling in buildings.

6.1.2.1 Habitat: Policy framework and concerned departments/agencies

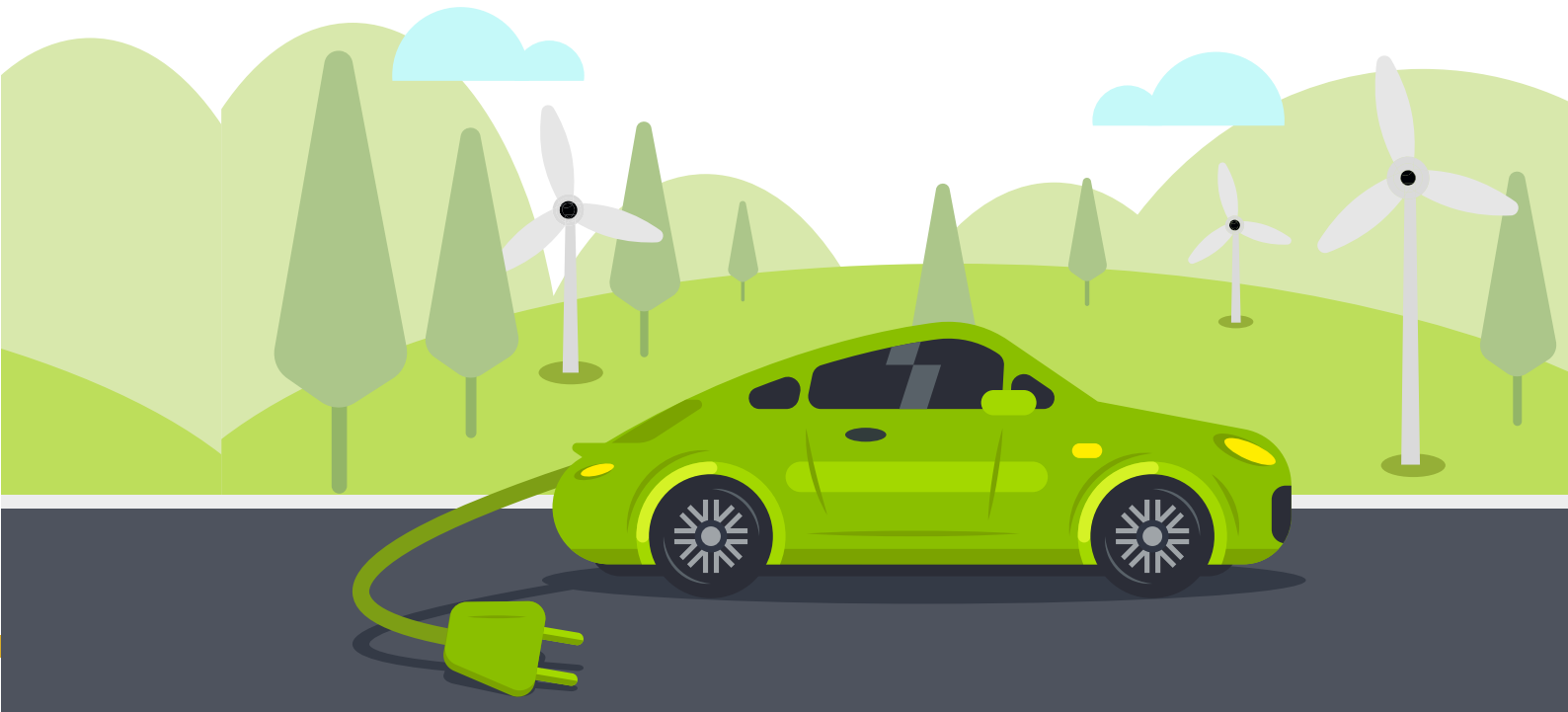
Sub-sectors	Policies and programmes that can push forward the recommendation	Primary departments/ agencies	Supporting departments/agencies
Energy efficiency in buildings	1) ECBC 2017 2) India Cooling Action Plan, 2018 3) UJALA Scheme, 2015 4) MP Solar Power Policy, 2012 5) MP Policy for Decentralised Renewable Energy Systems, 2016 6) Smart Cities Mission 7) Sustainable Habitat Mission	1) Urban Development and Housing Department, GoMP 2) All ULBs 3) Bhopal Smart City Development Corporation (BSDCL). 4) Panchayati Raj Institutions (PRIs)	1) MPUVNL, GoMP 2) State Knowledge Management Centre on Climate Change (SKMCC)- EPCO 3) BEE (EESL) 4) Rural Development Department, GoMP 5) MP Road Development Corporation Limited (MPDCL) 6) MP Transport Department 7) Proposed district-level committee on climate change and environment

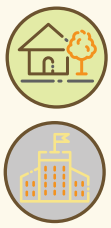
Sub-sectors	Policies and programmes that can push forward the recommendation	Primary departments/ agencies	Supporting departments/agencies
Demand-side management	1) MP Jal Viniyaman Adhiniyam, 2013 2) ECBC 3) Building bye-laws 4) Comprehensive General Development Control Regulations- Urban Development and Housing Development	1) Urban Development Housing Department, GoMP 2) All ULBs 3) Rural Development Department 4) Panchayati Raj Institutions (PRIs)	1) MP Jal Nigam. 2) Bhopal Smart City Development Corporation Limited (BSDCL) 3) MPPCB 4) Proposed district-level committee on climate change and environment 5) State Knowledge Management Centre on Climate Change (SKMCC) - EPCO

6.1.3 Transport: Recommendations, cross-cutting sectors, qualifying priority and district scenario

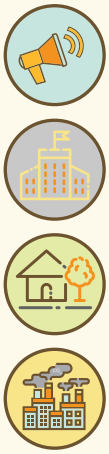
Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Promote e-mobility				
Generate awareness and information dissipation to encourage adoption of electric vehicles.		Short-term and continuous	Inter-departmental collaboration and dedicated long-running campaigns required	Madhya Pradesh EV Policy, 2019 plans to declare Bhopal as model electric mobility (EM) city. Planned awareness campaigns can encourage widespread acceptance of EVs in the district.
Increase the modal share of e-vehicles to achieve the target of National Electric Mobility Mission Plan (NEMMP) and FAME II.		Short-term and continuous	Policy framework exists (section 6.1.3.1) and budgetary provisions can be made available through various schemes	In January 2021, Bhopal Smart City Development Corporation Limited announced it will be installing 100 electric vehicle charging stations through an MoU with EESL. The MP Electric Vehicle Policy, 2019 aims to increase the modal share of electric vehicles in major cities of Madhya Pradesh through introduction of electric buses, two wheelers, three-wheelers and cars in the cities.
Make all public transport (PT) modes low carbon intensive, such as shifting current fossil fuel-based vehicles to electric powered or hybrid vehicles.		Medium to long-term	Policy framework (section 6.1.3.1) and budgetary provisions exist	In November 2019, NTPC announced plans to procure and operate 250 electric buses for three cities in MP – Jabalpur, Bhopal, and Indore. Around the same time, Bhopal Municipal Corporation also announced its plans to operate 100 electric buses on the city roads. The MP EV Policy, 2019 aims to achieve 25% new EV registration in public transport by 2026. It also targets 100% conversion of current public transport bus fleet into electric buses by 2028. Further, the policy also states that electric buses procured in the first five years will be charged 1% motor tax and will be exempted from vehicle registration fees.

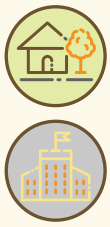
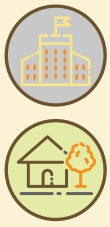
Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Similarly, initiate transition of intermediate public transport (IPT) vehicles to electric by incentivising IPT operators through: a) subsidies b) separate lanes c) dedicated parking spaces d) replacement of lead acid battery-powered electric IPT vehicles with more sustainable Li-ion battery e-vehicles in a phased manner.		Medium-term	Policy framework exists (section 6.1.3.1)	MP is providing subsidies for electric auto-rickshaws and other IPT vehicles as per FAME II. The MP EV Policy states that for the first five years of the policy, e-rickshaws and e-autos will be charged only 1% motor tax and vehicle registration fee will be exempt. Further, these vehicles will also not be charged parking fee at ULB-run parking facilities for the first five years. Converting Vikram auto (popular large auto in Bhopal) alone to electric auto will save 7 tonnes of CO_2e/auto/day, while a scenario in which passengers of Vikram auto shift to electric bus will save 20 tonnes of CO_2e/bus/day. In addition to the above, the district can provide dedicated parking spaces, plan for separate lanes for electric IPT vehicles.
District administration, ULBs (for office use and solid waste transport activities) and all district level government offices can adopt e-vehicle fleets. Additionally, all these offices need to install charging infrastructure at the earliest.		Short to medium-term	Policy framework exists (section 6.1.3.1)	The MP EV Policy 2019 has recommended all government office buildings to install charging infrastructure. Being the administrative capital, Bhopal can lead by example, taking advantage of this provision and build on the same to encourage government departments to transition their fleets to EV-based vehicles.

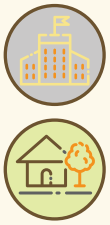


Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Develop robust and widespread charging infrastructure: a) Charging infrastructure to be at strategic locations – commercial hubs, public parking, airports and railway stations etc., preferably RE powered. b) Adoption of relevant policies. c) Prioritise land acquisition for setting up charging infrastructure. d) Dedicated parking spaces for EV rickshaws should be introduced with charging facilities. e) Restaurants and commercial spaces in highways can be incentivised to install charging infrastructure for e-vehicles to make long journeys with e-vehicles hassle-free. f) As a cost effective solution to reduce street clutter and to open access (particularly for those without garagaes), integrated EV charging points into lampposts can be evaluated on a trial basis to ascertain further implementation possibilities.		Medium-term	Policy framework exists (section 6.1.3.1) Inter-departmental collaboration required	Energy Efficiency Services Limited (EESL) and Bhopal Municipal Corporation (BMC) have partnered to establish infrastructure for electric vehicles (EVs) in Bhopal city. District authorities can promote EV charging infrastructure installation at key locations, such as local markets and recreational areas near lakes where they can collaborate with/incentivise business owners to set up charging points.
The district administration, in collaboration with the ULBs and state officials, may explore options to provide incentives to e-vehicle owners over and above existing programmes through: a) exemptions on road tax, b) exclusive parking for e-vehicles, c) additional subsidy schemes for women and students,		Short-term	Policy framework towards holistic integration of EVs needs to be enhanced	The MP EV Policy, 2019 has a target of increasing the modal share of EV and has suggested means to promote EVs. Bhopal can lead by example by easing transition to EV through additional incentives as suggested.
Promote fast registration of EVs at RTOs.		Short-term	Existing policy framework can be enhanced	MP EV Policy, 2019 has provisions to incentivise adoption of EVs including exemption of vehicle registration charges.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Encourage development of local network of rental e-vehicles across the district including cars and bikes as well as a battery rental network, for faster adoption of EVs. Further, this can be integrated with smart cards.		Medium-term	Needs policy backing	The successful rental model of Yulu bikes in Bengaluru can be emulated to develop hour-based electric bike rentals for key routes. These bikes can be a part of an integrated ticketing system that utilise smart cards for payments.
Encourage and promote adoption of EVs for all delivery operations within the district.		Short to medium-term	Policy framework is required	Currently, most delivery partners for food, courier, and other services rely on self-owned fossil fuel-based two or four-wheelers. In some cities, certain companies are working towards developing an EV fleet. The district can recommend a transition to EVs for such delivery persons.
Range anxiety is a key barrier to EV adoption. Mobile applications (local app, google map, etc) with real-time data availability of charging points and the cost of charging at various locations will be critical to ensure the popularity of EV by allowing the EV users to plan routes that have charging points.		Medium to long-term	Needs support for digitalisation	
Smart lampposts can radically improve electrical efficiency and enable a number of new services, like being equipped with PV modules to harvest and store solar energy during the day to power lighting at night. They could also be equipped with sensors and communication technologies that can adjust their output according to ambient light levels, monitor traffic, noise and air pollution, seismic activity and increase coverage of cellular and Wi-Fi networks.		Medium to long-term	Needs technological, infrastructural and policy interventions	

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Public transport (PT) and intermediate public transport (IPT)				
Increase reliability, accessibility and enhance last mile connectivity of public transport (PT) and intermediate public transport (IPT) through: a) Integrated ticketing and smart cards that works across all transport modes (IPT, cycle hire, etc), b) Integrating smart mobility applications with real-time service updates across modes, including car hire, public transit and shared micromobility schemes, c) Increasing fleet strength, d) Increasing frequency, e) Adding more stops, f) Enhancing reach to low/ non-serviced areas, peri-urban and rural areas g) Developing dedicated parking spaces for IPT.		Medium to long-term	Existing policy framework can be enhanced Interdepartmental collaboration required	Bhopal has multiple public transport services including city bus service by Bhopal City Link Limited (BCLL), star bus and red bus along with the BRTS called MyBus. BRTS: Route length 22 km, 1 route, fleet strength 50 buses, ridership 40,453 (2019) City bus: 11 routes, fleet strength 150 buses, ridership 95,369 (2019) The option of smart card for MyBus payments is available. However, it hasn't been popularised. Some examples of effective smart cards include: Janmitra Card in Ahmedabad, and Smart Cards in Delhi. Peri-urban areas are currently connected only through MPRTC services. The share of IPT by ridership in Bhopal city is just 2% (excluding mini buses) with majority of the population opting for private vehicles for commuting. Currently, the IPT sector is not completely formalised and the connectivity is limited to certain routes in and around popular commercial and residential areas. The informal IPT modes operating in the peri-urban areas of the district include mini buses, shared autos, omni vans and jeeps. Residents in city outskirts/ peri-urban areas still rely on private vehicles or walking. Mini buses in Bhopal city have a modal share of 35%. Majority of these are privately owned and operated.
District administration can collaborate with ULBs to discourage the use of personal vehicles by developing fiscal measures such as variable parking charges for peak hours.		Short-term and continuous	Requires policy framework based on research and interdepartmental cooperation	Bhopal can adopt recommendations from Delhi Master Plan 2021, which provides a Parking District Management Plan. The action plan suggests that the transport department, municipal corporations, traffic police and other agencies need to collaborate to develop and maintain parking areas. The plan also suggests that variable and time-based parking prices should be introduced.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Implement policy measures to discourage use of private vehicles: a) parking policy for vehicle ownership, b) no car days on certain roads, c) parking allowed only in dedicated areas.		Short to medium-term	Requires proper policy backing based on research and inter-departmental cooperation.	Sikkim Parking Policy, 2010 mandates that only houses with parking slots can procure vehicles.
Improve enforcement of vehicular pollution control norms to minimise emissions from fossil fuel-based PT and IPT vehicles.		Short-term and continuous	Policy framework exists (section 6.1.3.1); needs stricter implementation	
Awareness campaigns to popularise PT and IPT modes.		Short-term and continuous	Dedicated awareness campaigns required	
Augment non-motorised transport (NMT)				
Improve infrastructure to enhance modal share of NMT transport options in urban areas, by introducing measures such as segregated cycle lanes.		Medium-term	Policy based on research and inter-departmental cooperation is required	Current modal split in Bhopal indicates that the share of NMT is approximately 48%. However, over the years, it has been decreasing. Efforts are needed to make NMT a preferred and viable option.
Regular O&M of NMT infrastructure by: a) developing and maintaining well-lit, clean and safe pathways for pedestrians and cyclists, b) consulting and engaging local experts and community for development and maintenance, c) removing encroachments.		Short-term and continuous	Policy framework exists Requires inter-departmental cooperation	
Promote cycle hire service in key locations across the district.		Short-term	Needs proper policy backing and strategic awareness drives Further, PPP models can be explored for successful implementation	Bhopal Smart Bike Sharing Service: Bhopal was the first city to introduce a bike sharing scheme in Madhya Pradesh in 2017. In the first phase, 50 locations were chosen to set up rental stations in the city. In the second phase, the network is being expanded. Users can register for using the bikes through the website or app. Strategic placement of cycle hire stations, ease of use and reasonable pricing schemes can help popularise the programme.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Improving traffic flow				
Promote staggered and flexible work timings to limit traffic movement at peak hours to and from key busy routes across the district.		Short-term	Needs policy based on research, along with multi-stakeholder and inter-departmental cooperation	Bhopal district could emulate the following best practices to minimise congestion during peak hours. Delhi government in 2019 decided to stagger working hours of its offices during the implementation of the 12-day odd-even scheme, a move aimed at reducing traffic congestion and pollution in the city. Similar shift in work timing is also being planned in Bengaluru.
a) Create additional dedicated parking zones for vehicles in order to deter encroachment of road space and pavements. b) Direct business/ corporate centres to have mandatory private parking with sufficient parking slots so as to avoid parking on roads, service lanes and other public spaces.		a) Medium-term b) Short-term and continuous	Policy framework exists Multi stakeholder and inter-departmental cooperation is required	Bhopal has multiple parking spaces available. However, since awareness is low and maintenance is poor, utilisation is low. The municipal corporation and district authorities need to work towards building awareness and encouraging use of parking facilities.
Develop dedicated areas for street vendors to free up the pavements, so that traffic congestion on the roadsides can be minimized.		Short to medium-term	While the policy framework exists, implementation is irregular and for short timeframes Multi-stakeholder and inter-departmental cooperation is required	A town vending committee can be set-up in the district to identify all street vendors and be of aid in formulating an effective plan of action for their rehabilitation.
Regular maintenance of roads to ensure smooth flow of traffic can help reduce GHG emissions, while extending the life of the road.		Short to medium-term and continuous	While the policy framework exists, implementation is lacking in some areas Multi-stakeholder and inter-departmental cooperation is required	

6.1.3.1 Transport: Policy framework and concerned departments/agencies

Sub-sectors	Policies and programmes that can push forward the recommendation	Primary departments/ agencies	Supporting departments/agencies
Promoting e-mobility	1) FAME II 2) Madhya Pradesh EV Policy, 2019 3) JNNURM 4) National Electric Mobility Mission Plan 5) Smart Cities Mission 6) AMRUT 7) Proposed e-vehicle Policy (as per 2021-22 Union budget) 8) National Urban Transport Policy, 2006	1) All ULBs 2) RTOs 3) EESL	1) Urban Development and Housing Department, GoMP 2) MPUVNL 3) Madhya Pradesh Transport Department, GoMP 4) Madhya Pradesh Road Development Corporation Limited (MPRDCL), GoMP 5) State Knowledge Management Centre on Climate Change (SKMCC)- EPCO 6) Rural Development Department, GoMP 7) Bhopal Smart City Development Corporation Limited 8) PRIs 9) Airport Authority of India 10) Central Railways - Bhopal Division 11) Proposed District level Committee on Climate Change and Environment
Public transport and intermediate public transport	1) BRTS 2) JNNURM 3) ECBC 4) Smart Cities Mission 5) AMRUT 6) National Urban Transport Policy, 2006	1) All ULBs 2) Bhopal Smart City Development Corporation Limited (BSCDCL) 3) MPSRTC	1) Urban Development and Housing Department, GoMP 2) Madhya Pradesh Transport Department, GoMP 3) RTOs 4) Madhya Pradesh Road Development Corporation Limited (MPRDCL), GoMP 5) State Knowledge Management Centre on Climate Change (SKMCC)- EPCO 6) Rural Development Department, GoMP 7) MPUVNL 8) Proposed District level Committee on Climate Change and Environment
Augment non-motorised transport	1) Smart Cities Mission 2) AMRUT 3) National Urban Transport Policy, 2006	1) All ULBs 2) Bhopal Smart City Development Corporation Limited (BSCDCL)	1) Urban Development and Housing Department, GoMP 2) Madhya Pradesh Road Development Corporation Limited (MPRDCL), GoMP 3) State Knowledge Management Centre on Climate Change (SKMCC)- EPCO 4) Rural Development Department, GoMP 5) PRIs 6) MPUVNL 7) Police Department, GoMP 8) Proposed District level Committee on Climate Change and Environment

Sub-sectors	Policies and programmes that can push forward the recommendation	Primary departments/ agencies	Supporting departments/agencies
Improving traffic flow	1) BRTS 2) JNNURM 3) ECBC 4) Smart Cities Mission 5) AMRUT 6) National Urban Transport Policy, 2006	1) All ULBs 2) Bhopal Smart City Development Corporation Limited (BSCDCL) 3) RTOs	1) Urban Development and Housing Department, GoMP 2) Madhya Pradesh Road Development Corporation Limited (MPRDCL), GoMP 3) Madhya Pradesh Housing and Infrastructure Development Board (MPHIDB) 4) State Knowledge Management Centre on Climate Change (SKMCC)- EPCO (for policy support and reporting) 5) Rural Development Department, GoMP 6) Police Department, GoMP 7) Department of Industries, GoMP 8) PRIs 9) MPIDC, GoMP 10) Proposed District level Committee on Climate Change and Environment

6.1.4 Industry: Recommendations, cross-cutting sectors, qualifying priority and district scenario

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
The district can develop an incentive system, similar to a "cap and trade" system, for enhancing energy efficiency of MSMEs, in coordination with the state energy department.		Medium-term	Requires policy framework based on research and inter-departmental cooperation	
Promote combined heat and power (CHP)/ co-generation for running captive power plants.		Medium-term	Policy framework exists Inter-departmental collaboration required Awareness is needed to popularise the initiative	CHP systems can achieve system efficiencies close to 80%, as compared to around 60% by conventional technologies

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Optimise equipment efficiency. Equipment that are not usually turned off during downtime, such as heating or cooling equipment, pumps, alarm systems, etc., need to be energy-efficient and strategies must be developed to switch them off whenever possible.		Medium-term	Policy framework exists (section 6.1.4.1)	MP Industrial Promotion Policy, 2014 undertakes the following measures: a) Creates a level-playing field for all investors that helps them conduct their businesses with ease b) Strengthens the single-window system to make it more effective under the provisions of the Madhya Pradesh Investment Facilitation Act, 2008 c) Provides competitive fiscal incentives and exemptions to attract investment d) Provides support to the investors in making government and private land available for industrial projects across different scales of investments e) Upgrades industrial infrastructure in existing industrial growth centres f) Promotes the creation of ancillaries to strengthen local vendors g) Enhances the employability of youth by focused skill development efforts h) Strengthens MSMEs through an attractive package of incentives and concessions i) Ensures harmony between private sector investors and local citizens through an enhanced dispute settlement mechanism j) Promotes thrust sectors through sector-specific promotion policies k) Establishes a 'land bank' keeping in mind future requirements of land for industries l) Develops world-class infrastructural facilities for industries with active participation of the private sector m) Provisions for the protection of the environment and encourages water conservation measures in the industry through go-green strategies n) Promotes industrial parks for cluster development of similar micro and small-scale industries in regions that are rich in the raw material being used by that particular industry
Invest in green projects such as plantation drives and afforestation activities within and around industrial areas.		Short-term	Policy framework exists. Improved monitoring and evaluation will give recommendation a further push	
Target better M&E of energy audits to improve accountability.		Short to medium-term	Policy framework exists Inter-departmental collaboration is required for successful implementation	
Encourage industries to use recycled water from their plants rather than freshwater.		Short-term	Policy framework exists. However, it needs to be upgraded in collaboration with the responsible agencies and departments.	

6.1.4.1 Industry: Policy framework and concerned departments/agencies

Sectors	Policies and programmes that can push forward the recommendation	Primary departments/ agencies	Supporting departments/agencies
Industry	1) MP Industrial Promotion Policy, 2014 2) MP Solar Policy, 2021 3) National Mission on Enhanced Energy Efficiency	1) Department of Industry Policy and Investment Promotion, GoMP	1) MP Audyogik Vikas Nigam (MPIDC) 2) Energy Department, GoMP 3) District Industries Centre 4) BEE 5) MPUVNL, GoMP 6) MPPMCL-MPMKVVCL 7) Proposed District level Committee on Climate Change and Environment

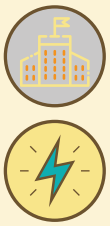
6.1.5 AFOLU: Recommendations, cross-cutting sectors, qualifying priority and district scenario

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
AFOLU: Agriculture				
Promotion of sustainable farming practices and programmes, like use of non-chemical fertilisers and zero budget natural farming in the district.		Short to medium-term	Policy framework exists (section 6.1.5.1) Budgetary provisions are available	In 2017-18, Bhopal used approximately 41,430 tonnes of urea in agriculture. Replacing just 10% of this with non-chemical fertilisers will help avoid 3,038.2 tonnes of CO_2e emissions/annum in Bhopal. This initiative would also contribute towards: a) cutting down of compostable solid waste from landfilling/dumping and converting it into organic waste which can be used to make organic fertilisers (thereby, reducing emission from waste sector); b) reduction of harmful agricultural run-off (thereby reducing water pollution and eutrophication).
Promote adoption of alternative ways to manage crop residue, other than burning. Promoting adoption of improved harvesting practices, such as land leveller, direct seeding, nutrition management, etc. through agricultural extension programme and financial assistance/ formation of cooperatives, etc. Stubble can be used as feedstock for different industries to make products including paper, cardboard, furniture, organic fertiliser and animal feed, which will also act as an alternative source of income for farmers.		Short to medium-term	Policy framework required Collaboration required Farmers to have easy access to markets/ industries that would take crop residue/ stubble Helps meet the following targets: -- SDG#8 (Decent Work and Economic Growth): 8.2 -- SDG#12 (Responsible Consumption and Production): 12.5, 12. a	Improved harvesting practices, such as the use of happy seeder, which has the capacity to eliminate 78% of GHG emissions (from crop residue burning). It also has the potential to add to farmers' profits by at least 10%. Feasibility studies for a cost-benefit analysis of such improved harvesting machines and practices need to be undertaken. Direct sowing of rice reduces soil disturbance, enabling it to retain more nutrients, moisture and organic content. It also, removes the need for stubble-burning, thereby reducing air pollution. Other feasibility studies or projects can be initiated, such as the development of biofuel pellets from crop residue.
Farmers should be encouraged to follow the recommendation given in soil health cards.		Short to medium-term	Can be implemented by raising awareness	According to Soil Health Card Portal, 23,15,844 samples have been collected and tested in cycle-II in Madhya Pradesh. In Bhopal, of all the samples tested, 60%, 6% and 7% of the samples had very low nitrogen, phosphorus and potassium, respectively. However, micronutrient status was found to be sufficient.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Promotion of micro-irrigation (MI) to improve water use efficiency. It saves water, energy and fertiliser consumption.		Short to medium-term	Policy framework is available (section 6.1.5.1) Enable swift procedures and subsidy disbursement for adoption of micro-irrigation District may consider providing additional subsidies	Currently, Madhya Pradesh holds 4.99% of the total area under micro-irrigation in India. [27] Under the prevailing subsidy regime of Madhya Pradesh, the extent of subsidy varies between 70% and 80% of the cost of the drip system. While the central government provides 50% of the equipment cost as subsidy to small and marginal farmers (belonging to both general category as well as SC/ST category), the extent of subsidy is 40% in the case of other farmers. Additionally, the state government provides between 20% and 30% of the cost as subsidy. The total subsidy varies between 70% and 80% for different category of farmers.[28] MI helps in attaining greater water-use efficiency, thereby reducing the pressure on groundwater sources and reducing GHG emissions. Drip systems have 95% water use efficiency. According to PMKSY Achievement Report, 2,615.74 ha of land was covered under MI in Bhopal during 2019-20, which should have led to avoidance of approximately 2,211.32 tonnes of CO2 emissions. (w.r.t to conventional irrigation through groundwater).
Encourage adoption of latest technologies, such as: a) Solar pumps (under PM KUSUM Yojana), b) Star-rated Energy Efficient Pump System (EEPS), c) Smart Control Panels and Internet of Things (IoT) based systems for optimum resource utilisation (water, energy).		Short to medium-term	Policy framework is available (section 6.1.5.1) Support in capital investment over and above the existing policy can be considered	According to MNRE, Madhya Pradesh has achieved 92.4% of the target of installing solar pumps under PM-Garib Kalyan Rojgar Abhiyan (as of January 21, 2021, MP has installed 3,224 solar pumps, against the target of 3,490 pumps, in 24 districts of the state). Replacement of 1 lakh diesel pumps with solar pumps, over a period of five years, would result in diesel use mitigation of 900 million litres over the life cycle of solar pumps, which translates into diesel subsidy saving of ₹ 840 crore and CO_2 emission abatement of 2.53 million tonnes. Under PM KUSUM Yojana and CM Solar Pumps Yojana, government provides 83% to 65% subsidy for various pumps and about 50% subsidy for cowsheds (gaushalas). Such initiatives by the state will increase farmers' income, provide reliable source for irrigation and reduce dependence on diesel in the farm sector.

27 Suresh A. and Samuel M. P., 2020, Micro-irrigation development in India: Challenges and strategies

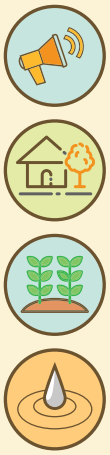
28 Towards Accelerating Adoption of Drip Irrigation in Madhya Pradesh, International Water Management Institute Centre for Environment and Development Studies, Jaipur

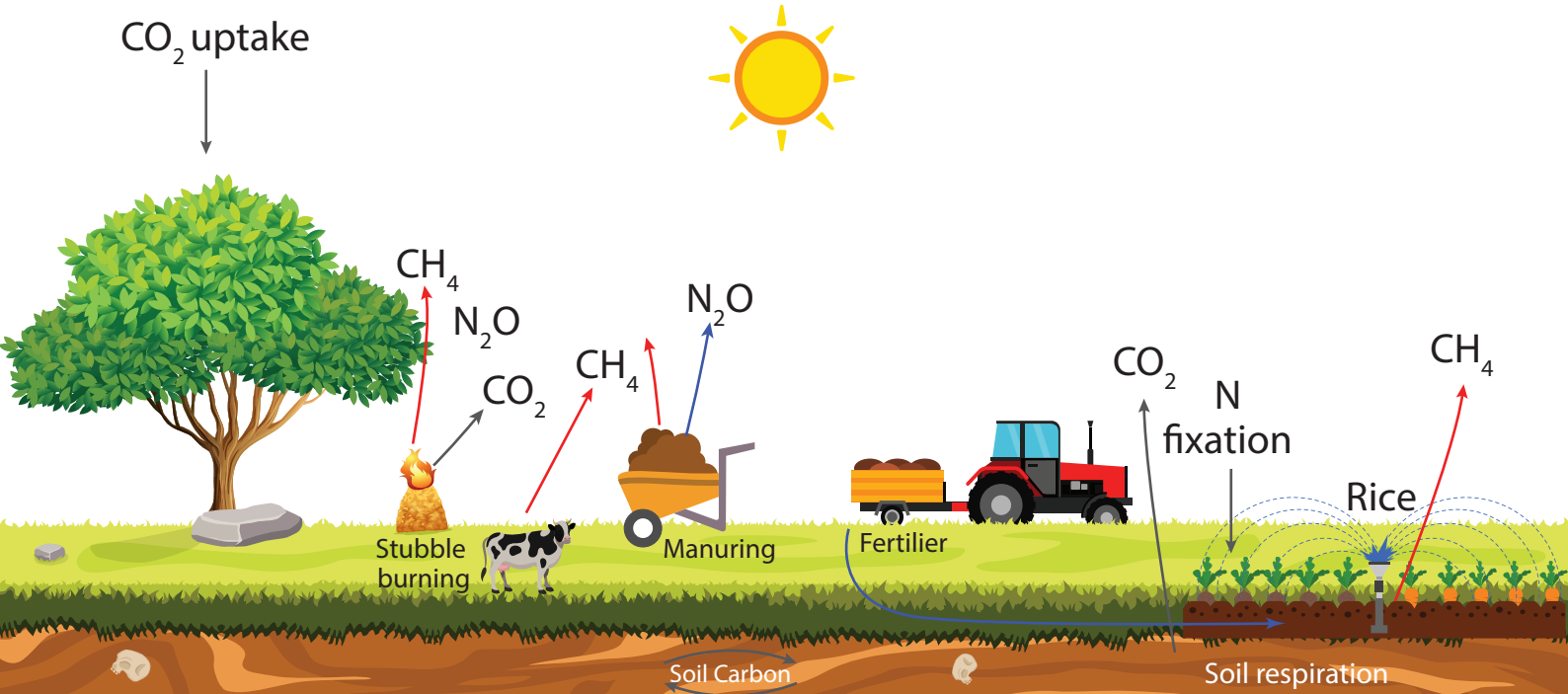
Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Enhance the efficiency/ network of cold storage systems and wherever possible, power them with renewable energy.		Medium to long-term	Policy framework exists and can be enhanced (section 6.1.5.1.) Capital investment required Align with solar rooftop policies and ECBC	
AFOLU: Livestock				
Promote grasslands and cultivation of cattle feedstock for good quality forage and to manage fodder scarcity.		Short to medium-term	Policy framework exists (section 6.1.5.1) Research inputs required Collaboration between different communities (farming and pastoral) is needed	Intensive cultivation of *Sesbania grandiflora* which produces about 7.8 kg/tree/year or 93.6 MT/year/ha when fed to lactating crossbred cows leads to an increase in milk yield by 11.97%.[29] Straws from millets, corn and maize have better feeding quality than straws from rice, barley and wheat. This change in quality of forage species leads to better productivity and an estimated reduction of 30% in emissions. ICAR-NIANP has recently developed a feed supplement - Harit Dhara and Tamarin Plus, for cattle, buffalo and sheep. It is found effective in cutting down methane emissions by 20%. Use of this feed supplement can be encouraged by Bhopal at the district level.[30]
Promote cattle breeds with higher productivity. Moreover, productivity of indigenous cattle should also be improved (for instance, through the provision of Nand Ghars) However, it's essential to maintain the balance between resilience and productivity. Currently, in most areas flock sizes are negatively impacting the climate and ecology.		Medium to long-term	Policy framework exists (section 6.1.5.1) Research collaboration required (to ensure biodiversity of the region is not impacted) Raise awareness Provide monetary support to the pastoral community	These initiatives will help meet growing demand of milk, while keeping the livestock headcount low. In Bhopal, if there is a 10% decrease in the number of indigenous cattle over a period of five years, the loss in milk production will be 12 lakh litres and 78,449.54 tonnes of CO_2e emission will be avoided. To compensate for this loss in milk production, a total of 7,91,912 new crossbreed cattle are required, resulting in 71,524.78 tonnes CO_2e emissions. The net emissions avoided per year will be 1,380 tonnes CO_2e.
Promote the use of waste from livestock and poultry as an important source of organic manure for crops. Poultry manure, which is rich in nitrogen, can be used for various crops like sugarcane, potato etc. for enhancing crop production.		Short to medium-term	Collaboration between different communities (farming and pastoral) is needed Policy framework is available (section 6.1.5.1)	Poultry manure fertiliser is rich in nitrogen and contains all 13 essentials nutrients required for crop production. In comparison to cow manure, it is two to three times richer in inorganic fertiliser content.

29 Earagariyanna M.Y. et. al., 2017, Fodder Resource Management in India-Critical Analysis

30 http://nianp.res.in/harit-dhara-tamarin-plus

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
AFOLU: Forestry and green spaces				
Ensure minimum diversion of forest land for any activity or project and promote compensatory afforestation (of the same species) from the funds given by the user agency. Funds for continuous tree improvement and tree breeding programmes can be ensured through the Compensatory Afforestation Fund Management and Planning Authority (CAMPA).		Short to medium-term	Policy framework and budget provisions exist (section 6.1.5.1) Policy implementation required Stringent monitoring and evaluation needed	As per India State of Forest Report, 2019, during the period January 2015 to February 2019, a total of 12,785 hectares of forest land was diverted for non-forestry purposes under the Forest Conservation Act, 1980. According to Environmental Clearance Report, 2019, 298.06 ha of total forest area in Bhopal had been diverted since 1980. In 2019, Madhya Pradesh received Rs 5,196.69 crore from the CAMPA, which aims to promote afforestation and regeneration activities as a way of compensating for forest land diverted to non-forest uses.
Measures to increase trees outside forest (TOF) area and green spaces in Bhopal: a) Setting up of urban parks, b) Adopting Miyawaki Urban Forestry method, c) Transplanting trees with the help of tree transplanter machines, d) Setting up of floating gardens, butterfly gardens etc, e) Initiate afforestation activities on wastelands and fallow lands, f) Plantation along village roads can be taken up under MGNREGS, g) Development of green belt along the major terrain roads, and surrounding the industrial areas, h) Tree census should be conducted periodically.		Medium to long-term	Policy framework is available (section 6.1.5.1) Capital investment, research collaboration, and inter-departmental cooperation required	According to 2019 FSI assessment report, the extent of TOF for Madhya Pradesh is 21,069 sq km. Dominant tree species in TOF are Babul *(Acacia arabica),* Neem (*Azadirachta indica),* Ber *(Zizyphus jujuba),* sacred tree (*Butea frondose)* and many more. Currently, the forest area in Bhopal district is only 11.86%. If 25% of geographical area of Bhopal (equivalent to state average forest cover) is converted to forest and tree cover, 8.79 million tonnes of CO_2 emissions can be avoided over a period of 10 years. Miyawaki Urban Forestry method has reported 15% faster growth rate per year compared to other reforestation methods. AIIMS Bhopal has developed the state's first Miyawaki forest on 24,000 sq ft of land. Green belts help in mitigating air pollution, increasing urban green cover, thereby leading to carbon sequestration.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Enhance forest cover by promoting agro-forestry and social forestry to increase forest biomass and soil moisture. Here are some more measures that are needed in forestry: a) Control illegal timber trade, b) Carry out mapping of agroforestry area to monitor the coverage, c) Create provisions of financial instruments/ relaxation in other taxes (over and above the existing schemes) to encourage the farming community to adopt agroforestry.		Medium to long-term	Policy framework and budget is available, implementation is required Stringent monitoring and evaluation are necessary	According to 2019 FSI Assessment Report, the tree cover of Madhya Pradesh is 8,339 sq km. Currently, the forest cover of Bhopal district is 11.87% of the total geographical area. In an assumed scenario of increased forest cover by 25%, over a period of 10 years, 8.79 $MtCO_2e$ emissions would be sequestered.
Ensure ULBs regularly monitor survival of trees, post plantation: a) Thorough study to be done on suitability of the site and survival ratio of species (majorly native species) before initiating any plantation drive, b) Prepare an audit every year on the number of saplings surviving after plantation drives, c) Ensure geo-tagging of trees (along with site and species) for proper monitoring.		Short to medium-term	Monitoring and evaluation required Collaboration among different stakeholders required	To develop a "City Forest" in Bhopal, a target of 21 lakh saplings, set in 2020, was given to BMC, Bhopal Smart City Development Corporation Limited, Forest Department, BDA, Horticulture Department, School Education Department, Higher Education Department, RDC, Tribal Welfare Department, Bhopal's citizens, CPA, NHI, and other agencies, by the Divisional Commissioner.



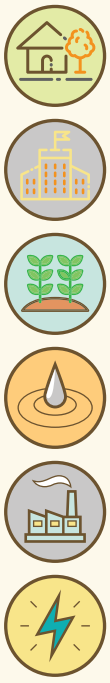
Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Promote regeneration of degraded and open forest areas by developing awareness among locals on the importance of green spaces.		Long-term	Strengthen the existing policy framework Collaboration among different stakeholders	According to 2019 Forest Survey of India report, there is a decrease in forest cover by 25.33 sq km in Bhopal from 2017 assessment.
Various aspects of Joint Forest Management (JFM) need to be promoted: a) Capacity building and skill development of joint forest management committees in tribal and non-tribal areas through workshops and training. b) Initiate participatory forest management programmes at micro scale.		Short to medium-term	Exclusive communication strategy and IEC material to be developed and used Provisions of monetary support	According to 2015 ENVIS Database, total area under JFM in Madhya Pradesh is 66,87,390 ha. There are about 15,228 joint forest management committees.
Prevent invasion of non-indigenous species by adopting the following measures: a) Develop a database and update information on invasive species and their management, b) Raise awareness at regional levels, c) Strengthen and maintain institutions to coordinate invasive species programmes.		Medium to long-term	Research studies of flora specific to the region Exclusive communication strategy and IEC material to be developed and used Requires funding, monitoring and evaluation, stakeholder collaboration	*Lantana camara, Cassia tora, Ageratina adenophora, Ageratum conyzoides* and *Senna occidentalis* are some major invasive species of Madhya Pradesh. Preventing seed production helps in managing spread of invasive species. Removing flower heads prior to seed set will reduce the number of seeds available for spread by birds or other animals.[31]
Develop participatory forest fire management strategies such as: a) Collecting baseline forest fire data with respect to perceptions, beliefs, expectations and behaviour of local people in regard to forest fires, b) Training local communities to tackle forest fires, c) Organising awareness programmes in local schools, d) Capacity building to develop an early warning system.		Medium to long-term	Provisions of monetary support Exclusive communication strategy and information, education and communication (IEC) material to be developed and used Monitoring and evaluation required Collaboration among different stakeholders	According to Technical Information Series Volume-I, FSI Report 2019, 0.14%, 19.36% and 64.84% of the total forest cover area of Madhya Pradesh is under extreme fire prone, moderately fire prone and least fire prone area, respectively.

31 Solanki H.A., 2018, Checklist of invasive plants of Gujarat and some most insidious plants of Gujarat, their hazards, its management and public perspective

6.1.5.1 AFOLU: Policy framework and concerned departments/agencies

Sectors	Policies and programmes that can push forward the recommendation	Primary departments/ agencies	Supporting departments/agencies
Agriculture	1) Rashtriya Krishi Vikas Yojana: Remunerative Approaches for Agriculture and Allied Sector Rejuvenation (RAFTAAR) 2) National Mission for Sustainable Agriculture 3) Pradhan Mantri Krishi Sinchayee Yojana 4) PM KUSUM Yojana 5) Soil Health Card 6) National Mission on Food Security 7) National Mission on Micro-irrigation 8) CM Solar Pump Scheme 9) National Policy for Crop Residue Management 10) Price Support Scheme 11) CM Farmer Promotion Scheme 12) MP Kisan Anudan Yojana 13) Pradhan Mantri Garib Kalyan Abhiyan 14) National Food Security Mission 15) Krishi Vikas Yojana	1) Farmers' Welfare and Agricultural Development Department, Government of Madhya Pradesh	1) Panchayat and Rural Development Department, GoMP 2) Water Resources Department, GoMP 3) Energy Department, GoMP 4) Department of Animal Husbandry, GoMP 5) State Knowledge Management Centre on Climate Change (SKMCCC), EPCO – (for reporting) 6) Forest Department, GoMP 7) Madhya Pradesh State Agro Industries Development Corporation 8) Madhya Pradesh Small Farmers Agri- Business Consortium, Bhopal (MAPFAC) 9) Madhya Pradesh State Agriculture Marketing Board 10) APMCs 11) MPIDC 12) Proposed District level Committee on Climate Change and Environment
Livestock	1) National Livestock Mission 2) Rashtriya Gokul Mission 3) Kisan Credit Cards to Livestock farmers 4) National Programme for Dairy Development 5) Livestock Health and Disease Control 6) National Programme for Dairy Development 7) Intensive Cattle Development Programme 8) Nandi Shala Yojana 9) Upgraded Animal Breeding Scheme 10) Supply of (10 + 1) goat unit on bank loans and grants 11) Acharya Vidyasagar Cow Promotion Scheme 12) VAT observance promotion scheme	1) Department of Animal Husbandry, Government of Madhya Pradesh	1) Forest Department, GoMP 2) Farmers' Welfare and Agricultural Development Department, GoMP 3) State Knowledge Management Centre on Climate Change (SKMCCC), EPCO 4) Proposed District level Committee on Climate Change and Environment
Forestry and green spaces	1) National Afforestation Programme (NAP) 2) Project Tiger 3) Compensatory Afforestation Fund Management and Planning Authority (CAMPA) 4) Green India Mission (GIM) 5) Integrated Development of Wildlife Habitat (IDWH) 6) Intensification of Forest Management Scheme (IFMS) 7) Pradhan Mantri Ujjwala Yojana	1) Forest Department, Government of Madhya Pradesh	1) Farmers' Welfare and Agricultural Development Department, GoMP 2) State Knowledge Management Centre on Climate Change (SKMCCC), EPCO 3) All ULBs (BMC + other Municipalities) 4) Mineral Resources Department, GoMP 5) Urban Development and Housing Department, GoMP 6) Rural Development Department, GoMP 7) Proposed District level Committee on Climate Change and Environment 8) All PRIs

6.1.6 Waste management: Recommendations, cross-cutting sectors, qualifying priority and district scenario

Recommendations	Cross-cutting with	Qualifying priority		District scenario/ case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Solid waste				
Waste prevention: Reducing landfilling				
Minimising landfill waste disposal by: a) promoting reduction of waste at source through product reuse, extending lifetime (maximum use of resources) and right to repair, b) ensuring efficient and 100% segregated waste collection from across the district (both urban and rural); distributing colour-coded bins, monitoring waste collected from household and penalising households not practicing segregation, c) ensuring and maximising recycling, recovery, optimum resource utilisation throughout product lifecycle and treatment, d) promoting resource efficiency and circular economy practices across sectors.		a) Medium to long-term b) Short to medium-term c) Medium-term d) Long-term	a) Needs policy intervention, awareness generation and incentivisation b) Policy framework exists (section 6.1.6.1) c) Needs policy intervention and execution (Resource Efficiency Policy has been drafted by NITI Aayog, but has not been implemented yet)	Landfills are considered to be one of the largest anthropogenic source of methane emissions contributing to 11% of all global CH_4 emissions. Hence, reducing landfill load and emission is critical in achieving India's NDCs. Here are some initiatives adopted by Bhopal that will reduce landfill emissions in the city and can be adopted across the district as well: Bhopal is ranked as the Best 'Self-Sustainable State / National Capital or UT' (based on GFC/ODF/Cost Vs Revenue) and the seventh most clean city in India by Swachh Survekshan 2020 (cleanliness, hygiene and sanitation survey). Madhya Pradesh has 94% waste collection efficiency and 76% waste treatment rate. Bhopal has almost 100% collection efficiency with 30% processed in composting/vermin-compost plants, 1.5% routing to the bio-gas plant and the rest treated in the waste to energy plant operational from 2019. MP has adopted a 'cluster-based model of ULBs for effective integrated solid waste management (ISWM) based on the concepts of regional landfill and implementation through public private partnership (PPP) mode. Bhopal is one of the 26 clusters in the state having eight ULBs, viz., Ashta, Berasia, Bhopal, Ichhawar, Kothri, Mandideep, Obedullaganj, Sehore, belonging to the districts of Sehore, Bhopal and Raisen. MP has a target of 80% resource recovery out of the total solid waste generated. Bhopal cluster generates 1,060 TPD MSW and has one Waste to Energy plant. In Bhopal, the old Bhanpura landfill site (16 km from the city) is closed for recovery and a new site for ISWM of Bhopal cluster is opened at Adampur Chawni (at a distance of 15 km from the city). Bhopal Smart City has introduced 130 smart underground dustbins at 70 locations, each displaying LED indicator live waste capacity (each of $3m^3$ capacity), having separate blue-green sections for dry and wet waste, monitored through Integrated Control and Command Centre (ICCC). ICCC directs the waste collection vehicles for immediate transport of waste.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/ case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Minimising single use plastic (SUP): Detailed information and recommendations on SUP are given in section 6.1.6.2		Short to medium-term	Already a national priority Policy framework exists (section 6.1.6.2), but can be accelerated with district level interventions / implementation.	Disposable SW take-back has not been implemented in Madhya Pradesh. About 32% of the total waste generated in Bhopal is inert and plastic waste. Paper waste is 9% and much of it can be treated/recycled.
Implementing producers (manufacturer/brand owners, etc) take-back mechanism (SWM Rules, 2016) either through financial assistance by the producers or a defined collection system facilitated by the producers for disposables, such as tin, glass, plastics packaging, sanitary napkins and diapers, for efficient management of these waste materials, thereby reducing landfill inert waste load.		Short to medium-term	Mandated by the SWM Rules (2016) Needs regional policy formulation and interventions	
Ensure 100% recycling of recyclables at landfill through material recycling facilities (MRFs), refuse derived fuel (RDF), waste to energy, etc. Encourage use of LDPE and HDPE plastic waste in road construction.[32]		Short to medium-term	Capacity enhancement of existing facilities required	
Management of construction and demolition (C&D) waste: a) Ensure segregation, collection, transport and proper management, b) Facilitate processing and recycling, c) Incentivise initiatives for C&D waste reuse in non-structural concrete, paving blocks, lower layers of road pavements, colony and rural roads, d) Mandatory procurement of C&D materials (10% to 20%) in municipal and government contracts (subject to quality control).		Short to medium-term	Mandated by the rules, CPCB guidelines exist (section 6.1.6.1) Needs state-level policy formulation, implementation and enforcement Capital investment in infrastructure required	
Increasing consumer awareness and access to recycling facilities and repair options within the district.		Short to medium-term	Dedicated awareness campaign required	

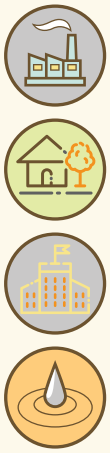
32 https://pib.gov.in/PressReleasePage.aspx?PRID=1736774. Guidelines given by Indian Roads Congress in this regard can be followed

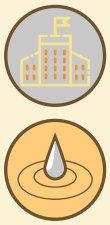
Recommendations	Cross-cutting with	Qualifying priority		District scenario/ case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Education and awareness drives for 100% at source segregation of biodegradable waste, non-biodegradable waste, domestic hazardous waste and household biomedical waste.		Short-term	Dedicated awareness campaign required	About 10% to15% of global GHG emissions can be reduced through improved waste management that follows a lifecycle assessment approach[33]. Prevention and recovery of waste (as secondary material or energy) can significantly save GHG emissions across sectors such as energy, forestry, agriculture, mining, transport and manufacturing sectors.
Introduce fiscal instruments to encourage waste reduction, such as, mandatory carry bag charges, pay-per-bin schemes (charging residents for each community refuse bin).		Short-term	Needs district level scheme/notification and community participation	
Conduct behavioural change communication workshops targeting corporates, educational institutes, PSUs, government offices to influence behaviour at both individual and organisational level to better manage resource and reduce waste generated. For example, conducting weekly workshops at all public schools for waste reduction and recovery. These workshops can also address issues, such as energy efficiency and water conservation.		Short-term and continuous	Needs sustained campaign for the target groups	
Consumer awareness for demand-side management of product choices with: a) sustainable packaging, b) displayed higher product lifespan, c) displayed recycling/resource recovery efforts and information.		Short-term and continuous	Dedicated awareness campaign required	
Conduct waste audits at household level, corporate offices, institutes, etc. to identify scope of waste minimisation and promote the same as an evidence-based practice.		Short to medium-term	Needs research collaboration	
Ensure segregation, collection and treatment of sanitary waste (sanitary napkins and diapers) to reduce landfill load.		Short to medium-term	Mandated by the SWM Rules, 2016; capital investment in infrastructure development (for treatment) is required, which can be obtained from the producers	Sanitary waste treatment is currently not practiced in the district.

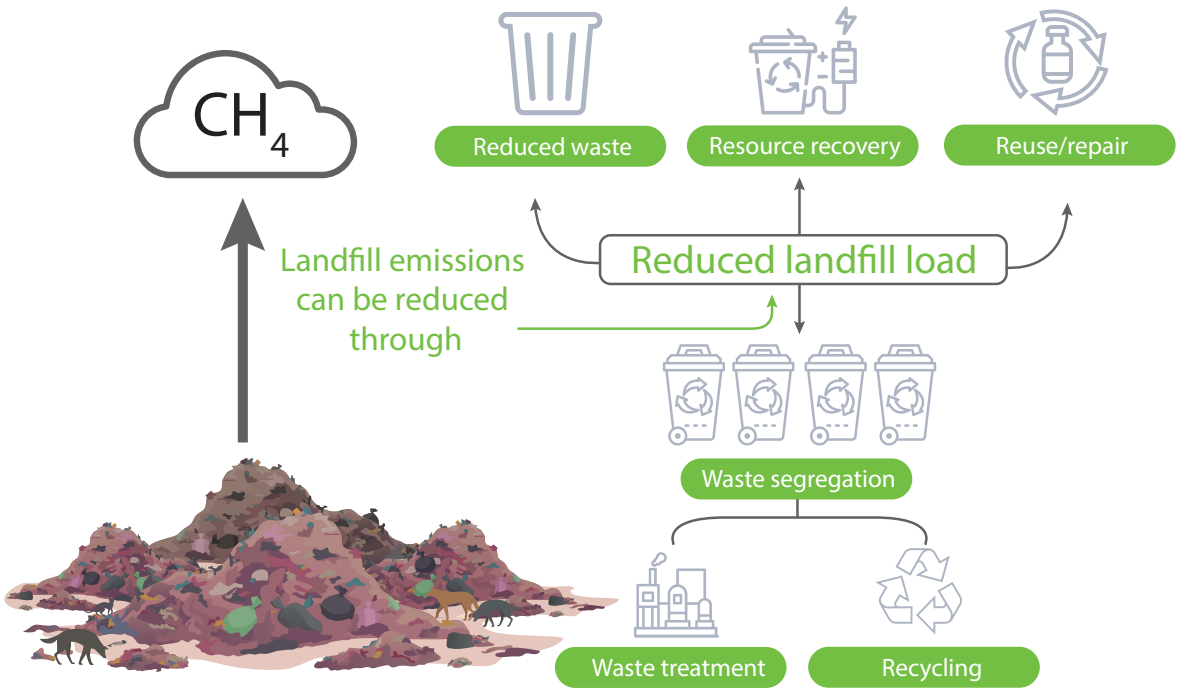
33 Global Waste Management Outlook - UNEP/ISWA, 2015

Recommendations	Cross-cutting with	Qualifying priority		District scenario/ case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Transitioning the district to a green market approach by: a) promoting local circular business models, b) mainstreaming of alternative sustainable business models for consumers to have a basket of choice.		Medium-term and continuous	Needs alternative business models, collaborations and awareness	
Reduce emissions from waste transportation: a) Encourage shifting to electric or zero-emission vehicles for all kinds of waste transport, including municipal solid waste in all ULBs, bio-medical waste in all common bio-medical waste treatment facilities (CBWTFs) and hazardous waste in all treatment, storage and disposal facilities (TSDFs), b) Installation of waste bins with sensors to monitor volume and optimise the routes of collection vehicles to reduce consumption of fuels for waste transport and related emissions.		Medium to long-term	Needs capital investments	Current common landfill (cluster) waste disposal of eight ULBs requires very long distance (>100 kms) waste transportation. BMC is currently operating more than 420 vehicles for collection and transport of solid waste. Waste transport from within the city to Adampur Chawni landfill (15 km from the city) site can potentially lead to an emission of 9,006 kg/day, translating to about 3,287 tCO_2e/year.[34] Solid waste transport emission profile of the district will be many times higher, considering the distance of ULBs from common landfill site. This emission can be avoided with a shift to ZEVs. Bhopal Smart City has set up nine waste transfer stations fully-automated with total waste segregation, compacting and waste-box pick-up by transfer vehicle hook facilities. This reduces the requirement for waste transport and improves efficiency of waste management. Though there are several specifications in place for CBWTF vehicles to ensure efficient management and monitoring of BMW, they do not factor-in the emission reduction part from transport.

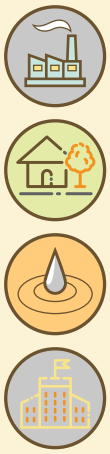
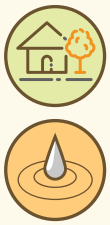
34 Estimated by applying the average distance travelled by different category of vehicles and using the IPCC & NATCOM2 values for emission factors and Net Calorific Value of diesel.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/ case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Waste treatment : Composting				
Encourage 100% conversion of organic waste to biological waste processing (composting, bio-gas, etc).		Short to medium-term	Policy framework exists (section 6.1.6.1) Needs awareness and infrastructure development	Although organic treatment of compostable waste initially leads to emissions, it reduces GHG emissions drastically over the long run, as compared to landfill emissions. It takes at least three decades for landfill emissions to balance with those from aerobic composting. A number of best practices and technologies are available for reducing GHG emissions from composting. Even in the absence of gas management system, composting is considered a more environmentally sustainable practice as compared to methane capturing from landfilling of organic waste. In Bhopal, 56% of solid waste is biodegradable. Reportedly (MPPCB), 304 TPD waste is being composted now. Composting emission potential: 9,320 tCO_2e/year. Currently, there are no gas management systems at composting units. Composting with gas management of 100% organic waste going to landfill can reduce emission by 13,293 tCO_2e/year in Bhopal.
Develop composting facilities at ULB level in addition to cluster level to avoid: a) loss of carbon content in long route organic waste transport, and b) reduce waste transport emissions.		Medium-term	Needs land and infrastructural investment at ULB level	
a) Equip new composting units and upgrade/convert existing composting units with gas management systems for gas capture after conducting feasibility studies, b) Biomethane produced from wastewater and solid waste processing can be used as a fuel for industrial production, to provide energy services in buildings or as a transport fuel. A benefit of biomethane is that existing gas infrastructure can be utilised for transport and distribution. As a local, sustainable source of power and heat, biomethane offers communities and municipalities a flexible option that can contribute to lowering emissions.		Long-term	Needs policy intervention, district-level capital investment and research collaboration	
Emission profiling and reduction				
Facilitating research and documentation on characteristics and percentage share of waste, moisture content, localised BODs for domestic wastewater and industrial wastewater, etc. is important for accurate city or district-level emission estimations from the waste sector.		Short-term	Needs research collaboration	

Recommendations	Cross-cutting with	Qualifying priority		District scenario/ case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Ensure better compliance to waste management rules in terms of maintaining segregated waste collection and treatment data (solid waste, bio-medical waste, e-waste and hazardous waste) in the public domain (annual reports/websites), particularly at the district level.		Short-term and continuous	Policy framework exists in most cases (section 6.1.6.1)	
Bio-medical waste and hazardous waste				
a) Promote installation of modern incinerators with energy-recovery facilities (like, use of recovered heat for preheating of waste to be burnt or use of incinerator steam to generate electricity) for new CBWTFs and TSDFs, and upgradation of the existing ones, b) Using smart controls, waste treatment plants equipped with energy recovery incineration facilities can be integrated as distributed energy sources into the electricity grid and as heat sources into the district energy network.		Long-term	Need policy formulation and investment in infrastructure	Though not a recommended treatment due to its emission potential, incineration prevents manual scavenging and further contamination from certain kinds of infectious waste (particularly, the anatomical, contaminated waste, discarded medicines and chemical waste). Incineration is the best available and recommended practice right now in India. Wherever applicable, there should be a policy provision for modern incinerators with energy-recovery facilities (such as, use of recovered heat for preheating of waste to be burnt or use of incinerator steam to generate electricity). Current annual BMW incineration emission in the district is 184 tCO_2e/ year. Energy recovery incineration is not practiced. District level HW generation/ incineration data not available
Strict monitoring of adherence to recommended incineration technologies, standard and practices through regular monitoring by District Bio-medical waste Management Monitoring Committee.		Short-term and continuous	Mandated by the rules (section 6.1.6.1) Needs monitoring by district level BMWM committee	
Ensure 100% segregation, collection, and treatment of bio-medical waste through coverage and registration of all healthcare facilities to CBWTFs.		Short-term and continuous	Mandated by the rules (section 6.1.6.1)	



Recommendations	Cross-cutting with	Qualifying priority		District scenario/ case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Waste electrical and electronic equipment (WEEE)				
As per the provisions of E-waste Management Rules, 2016, a state level e-waste inventory with district level category wise e-waste generation information needs to be developed. The inventory must include all sources of generation and consider all WEEE categories as per the rules.		Short to medium-term	Preparation of e-waste inventory is mandated by the rules (section 6.1.6.1) Need research collaborations	About 95% of the e-waste in India is processed informally (including rudimentary operations like open burning, acid wash, open smelting, etc.) City-based studies show that efficient management and recycling of electrical and electronic waste (WEEE) can significantly contribute to emission reduction targets. There is no authentic database available for MP for the amount of e-waste generated annually and their routes to recycling or disposal. MP has an e-waste inventory dating back to 2011 made for Bhopal, Indore, Gwalior and Jabalpur divisions, which projects 62,928.76 MT/year WEEE generation in 2020 in Bhopal. However, only 534.43 MT/year WEEE was collected during 2018-19 in the entire state which clearly indicates informal routing of most of the e-waste generated.
Ensure stringent policy implementation: Trace informal routing, ensure proper collection, restrict informal processing of e-waste (open burning, metal smelting, etc.), ensure proper disposal of electrical waste (lighting infrastructure including mercury containing lamps) and strict monitoring to stop landfilling of the same.		Short term and continuous	Mandated by the rules (section 6.1.6.1), Needs monitoring, manufacturer collaboration and consumer awareness	
Tapping into the informal e-waste collection network and formalisation of the same to channelise e-waste disposal to the formal sector.		Short to medium term	Can be achieved through the producers/ recyclers/Producer Responsibility Organisation (PROs)	
Improve consumer awareness on responsible e-waste disposal and make information readily available about e-waste collection points, recyclers, producers (manufacturer), producer responsibility organisations or local e-waste collection drives at the district level.		Short-term and continuous	Mandated by the rules for the producers (section 6.1.6.1) Dedicated awareness campaign required Can be achieved by collaborating with producers	
Formulation of district level e-waste management programme.		Short to medium-term	Needs inter-departmental collaboration	

Recommendations	Cross-cutting with	Qualifying priority		District scenario/ case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Wastewater: Domestic and industrial				
Achieve 100% domestic wastewater treatment through: a) In both urban and rural areas of the district, set up 100% closed and underground sewer collection network, b) Shift 100% domestic wastewater treatment to aerobic set ups by having only aerobic STPs for new constructions. Transition of old anaerobic STPs to aerobic set up, c) Operation and regular maintenance of sludge removal facilities of all STPs. The sludge can be used again for the bio-methanation of compost.		Medium to long-term	Policy intervention and capital investment required	Wastewater, if treated anaerobically, can be a huge source of methane and even nitrous oxide emissions. Being stagnant and subject to heating (anaerobic conditions), open sewers emit CH_4. Closed underground sewers, on the other hand, are considered to be an insignificant source of CH_4. Bhopal has seven STPs, of which five aerobic plants with 45.5 MLD capacity and two anaerobic plants with 35 MLD capacity are operational in the district.
Development of rural wastewater disposal and treatment plan for the district.		Medium to long-term	Requires capital investment and inter-departmental collaboration	No information is available on coverage and treatment of rural sewerage.
Create appropriate connecting infrastructure for the industries to utilise treated industrial and domestic wastewater. Provide subsidy/tax rebate provisions to industries, healthcare, hospitality sectors for smart recycled water investment.		Medium to long-term	Policy implementation required Needs capital investment in infrastructure and technology upgradation	Fully closed and underground sewers and centralized aerobic well-managed STPs can potentially reduce 47,401 tCO_2e emission from STPs, making them negligible or nearly non-existent in Bhopal. Case example: Ahmedabad Municipal Corporation has set up the first sewage sludge hygienisation plant in the country at Pirana (operational from 2019) which can convert 100 tonnes of dry sludge into fertiliser per day. A similar plant can be developed for Bhopal.
Implement and operationalise the guidelines and regulations of National Policy on Faecal Sludge and Septage Management, 2017 to reduce emissions from faecal sludge. Regular collection and appropriate disposal of sludge shall also be ensured.		Medium to long-term	Needs ULB level implementation and capital investment in infrastructure	
Develop a policy mandate for data transparency and availability of waste and wastewater generation, treatment and discharge information for industrial sector.		Medium to long-term	Needs policy intervention, and inter-departmental collaboration	Data transparency on wastewater by industries is key to reducing water pollution. This can be achieved through rating of industries based on their emissions and effluent discharge and treatment. For example, under its Star Rating Programme, the Odisha State Pollution Control Board gives star rating to industries and presents it through their website. This can help in environmental compliance and encourage public participation.
Encourage data transparency by the industries for wastewater generation, treatment and discharge information including those of CETPs.		Short to medium-term	Needs collaborative efforts	

6.1.6.1 Waste management: Policy framework and concerned departments/agencies

Sectors	Policies and programmes that can push forward the recommendation	Primary departments/ agencies	Supporting departments/agencies
Solid waste	1) Solid Waste Management Rules, 2016 and Amendment, 2018 2) Plastic Waste Management Rules, 2016 and Amendment Rules, 2021 3) Construction & Demolition Waste Management Rules, 2016 4) Integrated Solid Waste Management Project 5) Swachh Bharat Mission - Urban and Rural 6) Bhopal Master Plan, 2021 and Bhopal Development Plan 7) National Smart Cities Mission 8) National Resource Efficiency Policy (draft) 9) Guidelines on Environmental Management of C&D Waste Management in India, CPCB 10) GPCB Solid Waste Annual Report	1) Urban Development and Housing Department, GoMP 2) All ULBs 3) Panchayats and Rural Development Department, GoMP 4) All Gram Panchayats 5) Madhya Pradesh Pollution Control Board (MPPCB)	1) Bhopal District Administration and the proposed District Level Climate Change and Environment Committee 2) Madhya Pradesh Urban Development Company Limited (MPUDCL) 3) Bhopal Development Authority (BDA) 4) Department of Housing and Environment, GoMP 5) Community or Residential Associations 6) State Knowledge Management Centre on Climate Change, EPCO, GoMP
Bio-medical waste and hazardous waste	1) Bio-medical Waste Management Rules, 2016 2) Hazardous and Other Waste (Management and Transboundary Movement) Rules, 2016 3) Batteries (Management and Handling) Rules, 2001 4) MPPCB Annual Reports (for data availability) 5) Revised Guidelines for Common Bio-medical Waste Treatment and Disposal Facilities, 2016, CPCB	Research funding can be obtained from Department of Environment, GoMP; SKMCC-EPCO; MPPCB, etc.[35]	1) MPPCB 2) Bhopal District Administration 3) Proposed District Level Climate Change and Environment Committee 4) Healthcare facilities 5) CBWTF
Waste-electrical and electronic equipment (WEEE)	1) E-waste Management Rules, 2016 2) Implementation Guidelines for E-Waste (Management) Rules, 2016, CPCB	Only implementation monitoring and research needs resources which can be obtained from the Dept of Environment, GoMP; SKMCC; MPPCB, etc.[36]	1) MPPCB 2) Bhopal District Administration 3) Proposed District Level Climate Change & Environment Committee 4) Electronic and Electrical Producer Manufacturers/ Producers/Brand owners, Producer Responsibility Organisations
Wastewater : Domestic	1) Atal Mission for Rejuvenation and Urban Transformation (AMRUT) 2) Jawaharlal Nehru National Urban Renewal Mission on Urban Infrastructure and Governance (JNNURM) 3) National River Conservation Plan 4) Integrated Urban Sanitation Programme 5) Swachh Bharat Mission (Urban) – MP 6) Swachh Bharat Mission (Rural) – MP 7) Bhopal Smart City Mission 8) Bhopal Master Plan, 2021 and Bhopal Development Plan	1) Urban Development and Housing Department, GoMP 2) All ULBs 3) Panchayats and Rural Development Department, GoMP 4) MP Jal Nigam	1) Bhopal Development Authority 2) MPUDCL 3) Bhopal Smart City Development Corporation 4) All Gram Panchayats 5) Bhopal District Administration and the proposed District Level Climate Change and Environment Committee
Wastewater: Industrial	1) Common Effluent Treatment Plant System 2) Online Continuous Emission Monitoring System 3) MPPCB Annual Report	1) Madhya Pradesh Pollution Control Board (MPPCB) 2) Madhya Pradesh Industrial Development Corporation (MPIDC)	1) Bhopal District Administration and the proposed District Level Climate Change and Environment Committee

6.1.6.2 Single-use plastics (SUPs) – critical to replace

Definition

35. Bio-medical and hazardous waste management is profitable and not funded by the government, except for providing the land, which generally belongs to the Industrial Development Corporation

36. E-waste management (collection, transport, disposal, treatment – dismantling or recycling) is profitable and is the responsibility of the producers, recyclers, producer responsibility organisations (PROs).

- SUPs are often referred to as disposable plastics and are commonly used for plastic packaging. They include items intended to be used only once before they are thrown away or recycled, such as grocery bags, food packaging, bottles, straws, containers, cups and cutlery (UNEP).

Concerns

- Since SUPs are made for single use, they increase, waste load and are resource intensive.
- SUPs often get out of the collection and treatment network and a) are one of the biggest ocean polluters and are ingested by aquatic animals; b) stay in the environment forever, leading to microplastic pollution; and c) block waterways and intensify natural disasters.
- They have high carbon footprint and cost for collection, transport and treatment/recycling requirement.
- SUPs release harmful toxic chemical additives at their end-of-life disposal (unscientific) and further contaminate soil, water and the food chain.

Easily replaceable SUP, their alternatives and key user industries

SUPs	Type of plastic majorly used	Key user industries	Alternatives	Pros and cons of various alternatives
Polythene Bags	Low Density Polyethylene (LDPE)	Fast Moving Consumer Goods (FMCG)	Cotton bags, jute bags, bio-plastics	**Cloth (cotton)** • Pros: Natural fibre, durable, reusable, biodegradable, profitable and non-food crop • Cons: High consumption of chemical fertilisers and pesticides in cotton farming, high cost, water intensive crop, not moisture resistant, needs to be reused many times to offset high degradation/recycling carbon footprint **Jute** • Pros: Natural fibre, durable, reusable and biodegradable, high carbon assimilation rate • Cons: Expensive, water-intensive crop, highly dependent on rainfall, product not moisture-resistant **Bioplastics** • Pros: Bio-degradable, moisture resistant, inexpensive, light-weight • Cons: Contains significant number of plastic polymers leading to microplastic pollution; needs commercial composting facility to degrade; can mistakenly be mixed with plastic recyclables in municipal solid waste; needs quality check and control **Paper** • Pros: Bio-degradable, low manufacturing cost, can be made from recycled paper • Cons: Water intensive, high carbon footprint, not durable, not moisture resistant **Glass** • Pros: Inert, infinitely recyclable, no toxic chemical additives, low manufacturing carbon footprint • Cons: Fragile, higher cost, injury and health risk, weight **Metal** • Pros: Renewable resource, durable, can be recovered and infinitely recycled • Cons: Expensive, higher transportation carbon footprint, tin-coated steel can leach into food and contaminate, heat conductor
Plastic packaging a) Food packaging b) Insulated food packaging, fragile item protective packaging c) Multi-layered packaging (chips, biscuits, noodle, etc) d) Packaging for online delivery	a) LDPE b) Expanded Polystyrene (EPS) c) Paper + foil + LDPE/ PE + foil + paper/ Polyethylene Terephthalate (PET) + foil + LDPE, etc. d) LDPE	FMCG (food & beverages), hospitality and e-commerce	Bio-plastics, recycled paper	
Plastic bottles, tubes for household, personal care and cosmetics, sanitisers, toiletries, etc.	High density polyethylene (HDPE)	FMCG (personal care and cosmetics products /PCCP), food, household and toiletries, beauty, hospitality	Glass, metal (tin-plated steel, aluminium), bamboo, pottery and other ceramics	
Plastic sachet	LDPE	FMCG (food & beverages, PCCP), hospitality	Cellophane/ other bio-degradable alternatives	
Styrofoam products (plates, tray, cups)	Expanded polystyrene (EPS)		Bioplastic, recycled paper, leaf, bamboo	
Biscuit tray, plastic box, air seal for food etc.	Polypropylene (PP)	FMCG (food & beverages), hospitality	Bioplastic	
Plastic water and other drink bottles	Polyethylene terephthalate (PET)	Hospitality, FMCG (food & beverages)	Glass, metal, ceramics, bulk vending	
Plastic cutlery, plates, cups, and stirrers	Polystyrene (PS)	Hospitality	Bioplastic, recycled paper, steel	
Plastic 'use and throw' pens	Polypropylene (PP)	FMCG (stationary)	Paper, bamboo, refillable pens	
Straws, stirrers, balloon sticks	Polypropylene (PP)	FMCG (stationary)	Bamboo, recycled paper	
Milk packets	LDPE	FMCG (food & beverages), hospitality	Tetra pack, bottling and bulk vending	
Face shields	Polycarbonate and polyester (PET)	Healthcare	Compostable/ bio-degradable face shield	
Sticks of cotton buds		FMCG (PCCP)	Recycled paper, other eco-designed materials, bamboo	
Cigarette butts	Cellulose acetate	Tobacco industry	--	
Freezer bags	LDPE	Hospitality, healthcare, R&D	Glass container, sealable stainless steel	

Microplastics

- Definition: Microplastics are defined by UNEP as solid phase materials, particulates < 5mm, water insoluble, non-degradable and made of plastic. The European Commission defines them as man-made, conventional plastics including bio-degradable plastics, bio-based analogue plastics and bio-based alternative plastics with a particle size below 5 mm and include nanometer-sized plastics as well (nanoparticles).
- Major sources: a) vehicle tyres, b) fishing gear, rope, painting and maintenance of ships and boats, c) loss from plastic manufacturing industries, d) painting, construction and road marking, e) fibres from synthetic textile, f) microbeads in personal care and cosmetic products, g) breakdown of plastic products.
- Out of these sources, intentionally-added microbeads in cosmetics and personal care products are 'designed to drain' SUPs. Replacement of microbeads in PCCPs come under central regulation. However, at a district level, consumer awareness can make a change through shifting of demand to sustainable alternatives.

Regulatory provisions in India for single-use plastics

- Plastic Waste Management (Amendment) Rules, 2021 (announced on March 11, 2021): a) The manufacture, import, stocking, distribution, sale and use of the SUP commodities: Ear buds with plastic sticks, plastic sticks for balloons, plastic flags, candy sticks, ice-cream sticks, polystyrene (thermocol) for decoration shall be prohibited from January 1, 2022, b) The manufacture, import, stocking, distribution, sale and use of the SUPs (including polystyrene and expanded polystyrene) items – plates, cups, glasses, cutlery such as forks, spoons, knives, straw, trays, wrapping/packing films around sweet boxes; invitation cards; and cigarette packets, plastic/PVC banners less than 100 micron, stirrers shall be prohibited from July 1, 2022.
- Plastic Waste Management Rules, 2016 and Amendment Rules, 2018: a) Puts the onus on the producers, through extended producer responsibility (EPR), to collect plastic waste either individually or through the concerned local body; b) The primary responsibility is on producers, importers and brand owners (who introduce the products in the market) to collect used multi-layered plastic sachet, pouches and other packaging; c) Manufacturing and use of multi-layered plastic, which is non-recyclable or non-energy recoverable or with no alternate use, should be phased out in two years.
- Solid Waste Management Rules, 2016: a) Introduces EPR for manufacturers or brand owners of disposable products (including plastic packaging, sanitary napkins and diapers) to provide financial assistance to local authorities for waste management system and to set up a collection/take back system for packaging waste.
- Different policy frameworks for SUP ban or restrictions (of different kind) exist in at least 23 states and five union territories of India. Madhya Pradesh does not have any policy directive at the state-level as of now.

Recommendations[37]

- Implement the ban (as specified by the Plastic Waste Management Amendment Rules, 2021) on manufacture, import, stocking, distribution, sale and use of the single use plastic.
- Formulate policies with provisions to: a) mandate producer responsibility for awareness, labelling requirement on disposal, clean-up, collection and treatment of SUP products/packaging; b) mandate collection target (can be a differential target for different products) for SUP producers as part of EPR; c) penalise consumers for accepting banned SUP carrier bags or products; d) strict and random monitoring for implementation of bans in supermarkets, street vendors, shopping malls, large organised markets, etc; e) gradual phasing out of other selected categories of SUP products (by granting the producers some transition time). The phasing out can be achieved by sensitising key producers and sectors and encouraging them to take voluntary action.
- Promote eco-friendly alternatives to SUPs through: a) identifying alternative sustainable products; b) identifying micro-enterprises and cottage industries for the products; c) integrating them into the mainstream business models through connecting/cross-cutting policies; d) providing financial incentives for the alternative industries and for integrating sustainable products into mainstream business models, such as in the hospitality industry; e) strict quality control and certification requirement for plastic-free alternatives (for instance, resin or plastic powder should not be mixed in the product as an alternative).

37 Note: A sustainable solution to SUP products needs both state and district level collaborations at all levels including policy formulations and implementations
UNEP. 2018. Single use plastics: a roadmap for sustainability. Available at http://www.indiaenvironmentportal.org.in/files/file/singleUsePlastic_sustainability.pdf
Toxics Link. 2020. Single use plastic, the last straw: a watershed moment in the anthropogenic era.
MoEF&CC. 2016. Solid Waste Management Rules, 2016.
MoEF&CC. 2018. Plastic Waste Management (Amendment) Rules, 2018

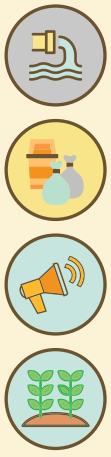
- Promote extended lifespan and reuse of products (including sustainable ones) through continued and lasting campaigns for 'No Single Use' to ensure public participation. Replacing the concept of 'single use' is critical as biodegradability or recyclability have 'time' and 'conditions' (such as energy and water footprint, transport requirement, etc) attached to them.
- Introduce economic incentives/support: a) Invest in R&D to develop alternatives to different SUP products, b) support technology incubation and stimulate creation of micro-enterprises to drive job creation, c) introduce livelihood support schemes and/or include special provisions in the existing schemes to accommodate the job loss from plastic industry, d) tax rebate to alternative models, public-private partnerships, etc; e) incentivise plastic industries for shifting to sustainable alternatives.

6.2. Innovative financing

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Promote green municipal bonds to mobilise untapped investments towards green projects, such as RE infrastructure, waste management etc.		Medium to long-term	Needs policy formulation Collaboration among various stakeholders Create specific financial instruments	Bhopal Municipal Corporation issued municipal bonds worth ₹ 175 crore (approximately) in 2018. The funds raised were to be used for various projects under AMRUT.
Voluntary carbon market mechanism can be developed for the district to motivate industries, ULBs and other sectors to lower their emission levels through monetary incentives.	All sectors	Medium-term	Needs feasibility studies, research and interdepartmental and multi-stakeholder collaboration Institutional structure needs to be established	Case example: In 2020, Smart City Indore collected carbon credit of around ₹ 50 lakh through its two bio-methanisation plants. The gas generated from these plants is used by the city buses – City Bus and iBus. Through these projects, Indore has avoided emissions of 1,70,000 tCO_2e since 2019 and generated carbon credits.

6.3. Recommendations based on district-specific environmental problems: Recommendations, cross-cutting sectors, qualifying priority and district scenario

Recommendations	Cross-cutting with	Qualifying priority		District scenario /case examples
		Timeframe to attain the recommendations	Framework for implementation	
Urban wetlands				
Periodic de-silting and dredging of the lakes, deepening and widening of spill channels and allocating dedicated funds for ensuring a sustained de-siltation. Use of excavated materials for agricultural and plantation lands.		Short-term and continuous	Sector-specific policy framework exists; need to ensure compliance	Bhoj Wetland (area: 3.201 ha) was declared a Ramsar site on August 19, 2002. The wetland consists of two contiguous human-made reservoirs – the Upper Lake created in the 11th century and the Lower Lake constructed nearly 200 years ago. The lakes are very rich in biodiversity, particularly for macrophytes, phytoplankton, zooplankton, both natural and cultured fish species, both resident and migratory birds, insects, and reptiles and amphibians. The Bhopal Development Plan 2005 prescribes the following regulatory measures for protection and management of lakes: a) Fringe areas of the lakes to be declared as sensitive zones. No construction and development activities in 50 m space from full tank level of the Upper Lake and 33 m space from the edge of the Lower Lake; b) Planting of indigenous trees and shrubs along the slopes of the lakes (to the extent of 50-100 m from max tank level) to arrest pollution and entrance of silt c) Water from the Upper Lake shall not be allowed to be used for water-based recreational activities that adversely affect water quality d) Discouraging practice of agriculture along the lake fringe to stop chemical pollution from agriculture.
(a) Promote use of RE-powered sources for recreational activities around all three lakes of Bhopal (including lighting; electricity to stalls etc). RE can be sourced from decentralised solar panels around the periphery of the lakes. (b) Phase out diesel-run boats (if any) and introduce RE based options. (c) RE-powered aerators can be installed to avoid eutrophication in different pockets of the wetlands.	   	(a) Short to medium-term (b) Medium-term (c) Short-term		

Recommendations	Cross-cutting with	Qualifying priority		District scenario /case examples
		Timeframe to attain the recommendations	Framework for implementation	
Promote/implement measures to protect the catchment area of the lakes, for example: a) Evaluate the carrying capacity of the Upper, Lower and Shahpura lakes and surrounding ecosystem and consider the same before permitting any new construction or activity around its periphery, b) Tap nonpoint source runoff (from the drains), c) Generate awareness through government extension services machinery to facilitate change in fertiliser consumption patterns (from chemical to organic) in the agricultural activities in lake catchment areas, d) De-motivate excessive ground water pumping in residential areas around the lakes. Incentivise rain-water harvesting systems for the nearby areas, e) Construct check dams, silt traps, toe walls. and cascading and garland drains to treat the catchment area.		Short-term and continuous	Needs planning and infrastructural investment Existing wetland specific studies need to be considered for further planning	Bhopal Development Plan 2031 (Draft) mentions the constant threat of the wetland from discharge of sewage water, growth of thick mats of aquatic weeds in the peripheral areas and increasing silt load from the surrounding hills and its catchment area. Solar power projects are being developed along the VIP road near Upper Lake which will enable solar energy operation of Karbala pump and solar energy lit street lights on VIP road.
Promote aqua-culture for biological control of weeds, and carry out regular de-weeding activities in the wetland.		Short-term and continuous		
(a) Ensure monitoring to prevent encroachment in the lake fringe area; (b) manage waste; and (c) reduce traffic pressure in the Link Road and Lake View Promenade, created as a buffer between the lake and the human settlements.		Short-term and continuous		
Restrict dumping of solid waste, inflow of untreated wastewater (both domestic and industrial) and agricultural run-off into the catchment area. Also ensure effective functioning of CETPs, STPs in and around the wetland.		Short to medium-term and continuous		

Recommendations	Cross-cutting with	Qualifying priority		District scenario /case examples
		Timeframe to attain the recommendations	Framework for implementation	
Promote the use of native species in any upcoming infrastructure development near wetland to protect native biodiversity.		Short-term and continuous	More research and collaboration needed	
Promote more focused research on the wetland biodiversity and its interactions with the habitat, hydrology, soils, and landform.		Medium to long-term		
Involve the stakeholders (fishermen community, local community, hawkers etc.) in spatial planning and wetland management activities whenever possible.		Medium to long-term		
Ensure that all the principles/ wetland practices according to the Ramsar Convention are followed.		Short-term and continuous		
Managing air pollution				
Facilitate source apportionment studies to identify the sources and take particular containment measures.		Short to medium-term	Needs research collaboration	MPPCB has developed an action plan to control air pollution in Bhopal, which mentions vehicular emission, road dust, construction activities, biomass and garbage burning, industrial emissions as the major source of air pollution in Bhopal. However, no source apportionment studies have been conducted.

Recommendations	Cross-cutting with	Qualifying priority		District scenario /case examples
		Timeframe to attain the recommendations	Framework for implementation	
Increase the number of continuous ambient air quality monitoring stations (CAAQMS) to statistically, spatially and temporally, represent the mix of sources and range of pollution in the city. Also increase the number of air quality display facilities in public places.		Short to medium-term	Policy framework and budgetary provisions exist	Bhopal has two CAQMS by MPPCB, two CAQMS by CPCB and two manual air quality monitoring stations and a few air quality display screens placed in the city. The district needs more CAQMS and regular operation and information display of the same. Bhopal is categorised as one of the 124 non-attainment cities in India and one of the six in Madhya Pradesh for particulate matter concentration (PM_{10}) exceeding the prescribed norms by CPCB under the National Clean Air Programme (NCAP) with multiple timelines to clean air.
Increase the modal share of public and non-motorised transportation. Further, promote e-vehicles (detailed recommendation provided in the Transport sector: section 6.1.3).	 	Medium to long-term	Policy framework available Needs awareness generation Capital investment required Needs inter-departmental coordination	
Better traffic management, re-direction of traffic movement, development of multi-layered parking and ban on-street parking within specific perimeters of the multi-layered parking to ensure parking inside the facility.		Short to medium-term	Feasibility studies required Needs implementation of existing rules/ policies Capital investment	
Increase/create green cover or green buffers along the major traffic corridors, roundabouts and industrial areas.	  	Medium to long-term	Needs inter-departmental coordination Needs efficient maintenance and monitoring of plantation sites	
Enforce environmental standards for stack emissions in industrial sector.		Short-term and continuous	Requires robust M&E	

Recommendations	Cross-cutting with	Qualifying priority		District scenario /case examples
		Timeframe to attain the recommendations	Framework for implementation	
Sprinkling of water (preferably, recycled grey water) for road dust suspension during peak pollution episodes.		Short-term and continuous	Needs inter-departmental co-operation	Bhopal reportedly has 27 emission generating industries in the Govindpura Industrial Area which have adequate Air Pollution Control Devices (APCD). The city has: a) Thirty eight vehicle emission monitoring centres for periodic check-up and certification of PUC, b) Two multi-level parking operational in most congested areas, c) A 12 km cycle track and 80 cycle-stands under public bike sharing.
Open waste burning (of solid waste, biomass, plastic, horticulture waste etc.) should be regulated by the municipal corporation/nagar panchayats.		Short to medium- term	Needs implementation of existing rules/ regulations	
Implementation of action plan for construction and demolition waste (as per CPCB guidelines)		Short to medium-term	Needs implementation of existing rules/ regulations	
Ensure installation and operation of air pollution control devices in industries and adherence to emission standards.		Medium to long-term	Requires implementation of existing rules/ regulations Robust M&E required	

6.3.1 Recommendations based on district-specific environmental problems: Policy framework and concerned departments/agencies

Sectors	Policies and programmes that can push forward the recommendation	Primary departments/ agencies	Supporting departments/agencies
Urban wetlands	1) Ramsar Convention, 1971 2) Water (Prevention and Control of Pollution) Act, 1974 3) Environment Protection Act, 1986 4) Wetlands (Conservation and Management) Rules, 2017 5) Madhya Pradesh Municipal Corporation Act, 1956 (as Amended in 1995) 6) National Water Mission 7) National Wetlands Conservation Programme (NWCP) 8) National Lake Conservation Plan (NLCP)	1) Department of Housing and Environment, GoMP 2) Madhya Pradesh Forest Department, GoMP 3) Madhya Pradesh Pollution Control Board (MPPCB) 4) Madhya Pradesh State Biodiversity Board	1) Urban Development and Housing Department, GoMP 2) Panchayat and Rural Development Department, GoMP 3) Department of Farmers Welfare and Agriculture Development, GoMP 4) Fisheries department, GoMP 5) Revenue department, GoMP 6) MP Tourism Department & MP Tourism Board, GoMP 7) Water Resources Department, GoMP 8) All ULB 9) All PRIs 10) Proposed District Level Climate Change and Environment Committee
Air Pollution	1) Air (Prevention and Control of Pollution) Act- 1981 2) Environment (Protection) Act, 1986 3) National Clean Air Programme 4) Solid Waste Management Rules, 2016 and Amendment 2018 5) Construction & Demolition Waste Management Rules, 2016	1) MPPCB 2) System of Air Quality and Weather Forecasting And Research (SAFAR), IMD 3) All ULBs	1) District Administration and the proposed District Level Climate Change and Environment Committee 2) Department of Housing and Environment, GoMP 3) SKMCC, GoMP 4) Transport Department, GoMP 5) Energy Department, GoMP 6) RTO 7) Proposed District Level Climate Change and Environment Committee

6.4. Actions district authorities can recommend to state departments

Recommendations that could be pursued by the district collector/ state-level committee	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time-frame for the action to be accomplished	Framework for implementation	
POWER SECTOR: Upgrade DISCOM infrastructure and their supply network to reduce AT&C losses, billing inefficiencies etc. Furthermore, introduction of smart billing system would help curtail power thefts, and increase billing efficiency, helping the DISCOM generate more revenue.		Short to medium-term	Policy framework and targets exist (section 6.4.1) With optimum push, this initiative can help India align with the Paris Agreement targets	The current AT&C losses of MPMKVVCL are 25.8% – this is way higher than the international standard range of 6% to 8%. MPMKVVCL needs to upgrade its infrastructure, introduce smart metering, smart billing, etc. to increase its efficiency. For example: EESL has signed an MoU with Uttar Haryana Bijli Vitran Nigam and Dakshin Haryana Bijli Vitran Nigam for 10 lakh Smart meters. The deployment of smart meters in the country has led to 20% increase in monthly revenue per customer for DISCOMs, a 5% reduction in AT&C losses (on an average), remote disconnection provision for defaulters and has completely eliminated manual meter reading requirements, leading to reduced expenditure (as per EESL). MPMKVVCL can implement such pilot projects in Bhopal district.
HABITAT: Provide subsidies/tax rebates to builders/building owners to encourage adoption of ECBC or IGBC (e.g., property tax/ water cess/IT rebate).		Medium to long-term	Policy framework exists (section 6.4.1), but targets need to be set Needs inter-departmental collaboration	ECBC buildings deliver 20% to 25% of energy savings, in different climates, when compared with the conventional buildings (BEE, 2017). By 2025, if 30% of the commercial area in the district becomes ECBC compliant, around 0.3 $MtCO_2e$ emissions can be avoided.
TRANSPORT: Energy efficiency of infrastructure in railways can be enhanced through the following measures: a) Installing solar panels along electrified tracks and on railway station rooftops, b) Installing optimal light control systems and appliances, smart sensors and building management systems at station buildings, c) Ensuring regeneration of energy (through rolling stock) parallel to the grid.		Medium-term	Needs inter-departmental collaboration	Rail Land Development Authority and National Building Construction Corporation have signed an MoU for redevelopment of 10 railway stations across India as 'smart railway stations'. Railway stations in Bhopal district can also be developed along similar lines.

Recommendations that could be pursued by the district collector/ state-level committee	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time-frame for the action to be accomplished	Framework for implementation	
TRANSPORT: Use fiscal instruments to discourage the use of personal vehicles like a) increasing charges on registration of internal combustion engines (ICE) vehicles, b) levying congestion charges and other green tax, c) phasing out of older, more polluting vehicles.		Short-term and continuous	Proper policy backing based on research and inter-departmental cooperation is required	In January 2021, the Ministry of Road Transport and Highways announced additional taxes on old vehicles that are unfit for roads as 'green taxes'.
TRANSPORT: Identify and shift key commercial / business centres from all the ULBs to outside city limits to reduce traffic load.		Long-term	Proper policy backing based on research and inter-departmental cooperation is needed	Development of areas outside BMC limits to accommodate the shifting of industries, business centres, IT parks etc. is required.
District authorities while gradually rolling out EV infrastructure, can advocate to state and national governments for standardised EV cables and infrastructures for easier integration and interoperability for implementation of smart charging on a large scale.		Medium to long-term	Needs policy intervention	
INDUSTRY: a) Ensure regular PAT compliance of DISCOMs and other designated consumers (DCs) in the district; b) Increase the number of designated consumers for the PAT scheme and ensure the compliance of targets.		a) Short-term and continuous b) Medium to long-term	Policy framework exists (section 6.4.1), but targets need to be revised gradually Ensure M&E Collaboration required	Until PAT Cycle VI (2020-21), only two DCs had volunteered under the scheme. Over the years, various DCs from the district have helped avoid around 11.94 $MtCO_2e$ by improving their systemic energy efficiency, under the PAT scheme.
INDUSTRY/ENERGY: Ensure compliance to renewable purchase obligations (RPOs) and (gradually) increase the RPO targets.		Medium to long-term	Policy framework exists (section 6.4.1)	For FY 2021-22, the RPO target for industries is 17%.

Recommendations that could be pursued by the district collector/ state-level committee	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time-frame for the action to be accomplished	Framework for implementation	
AGRICULTURE: Encourage millet cultivation (requires less water to grow, shows good productivity under extreme climate conditions and is rich in nutrition).		Medium to long-term	Needs creation of appropriate financial mechanisms to encourage farmers to grow millets Requires research collaboration This would also enable achievement of the following targets of SDG#2 (Zero Hunger): 2.1, 2.3, 2.4	In Bhopal, jowar production has continuously decreased from 1,000 tonnes in 2016-17 to 33 tonnes in 2018-19.
AGRICULTURE: To compensate for predicted decrease in crop productivity, initiate research on high yield, drought and temperature resilient genotypes for various food and cash crops in association with agricultural institutes/ universities.		Medium to long-term	Needs research collaboration and capital investment This would also enable achievement of the following targets of SDG#2 (Zero Hunger): Targets 2.1, 2.3, 2.4, 2.a.	Rainfed area (for agriculture) of Bhopal decreased significantly from 1.47 lakh ha (in 2010-11) to 1.25 lakh ha (2015-16). However, the irrigated area increased from 0.96 lakh ha (2010-11) to 1.04 lakh ha (2015-16). Area under wheat cultivation decreased from 81,000 ha to 51,175 ha (between 2017-18 and 2018-19), and production reduced from 2.356 lakh MT to 1.75 lakh MT (between 2016-17 and 2018-19), and the yield reduced by 17.5%. In order to meet the food demand in the future, crop failures need to be reduced through the adoption of climate-smart agriculture. Area under paddy cultivation increased from 8,950 ha (2017-18) to 12,920 ha (2018-19). Production increased significantly from 8,480 MT (2017-18) to 18,125 MT (2018-19), leading to higher GHG emissions. Therefore, temperature and drought resilient rice varieties having climate-friendly irrigation practices/water regimes should be preferred. Moreover, avoid rice cultivation in non-traditional rice areas.
AGRICULTURE: For overall reduction in electricity and water consumption in agriculture, subsidies need to be reduced in a phased manner.		Medium to long-term	Policy intervention needed Requires awareness generation and collaboration with the farming communities	The tariffs are as per different consumption slabs as well as the horsepower of pump being used. As per the Madhya Pradesh Electricity Regulatory Commission, Aggregate Revenue Requirement and Retail Supply Tariff Order for FY 2020-21, 645 paise/unit and 469 paisa/unit is the energy charge for domestic and agriculture and allied activities respectively, upon utilisation of 300 units. Electricity tariff policies, in conjunction with large subsidies for agricultural power, have caused rapid groundwater depletion in many regions as well as massive financial losses to power utilities and governments – both state and central. Flat tariffs lead to more equitable distribution of electricity between high-income and marginal consumers, but fail to encourage water conservation. Metered tariffs have the potential to promote water conservation, but are difficult to manage and are expensive for low-income farmers.[38]

38 Sindhu B.S. et. al., Power tariffs for groundwater irrigation in India: A comparative analysis of the environmental, equity, and economic trade-offs

Recommendations that could be pursued by the district collector/ state-level committee	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time-frame for the action to be accomplished	Framework for implementation	
FORESTRY/GREEN SPACES: Promote regeneration of degraded and open forest areas through corporate social responsibility (CSR) (or similar mandates) and encourage corporates to dedicate some percentage of their profit for greening of open spaces in the district.		Long-term	Needs strengthening of the existing policy framework Needs stakeholder collaboration	Green belts help in mitigating air pollution, increasing urban cover, thereby leading to carbon sequestration.
E-WASTE: Adopting 'green marketing' by: (a) Promoting green products; (b) Displaying product lifespan on the label of e-products to influence purchase decisions, thereby, using the labels as behavioural intervention.		Medium to long-term	Needs policy intervention, collaborations and awareness	

6.4.1 Actions district authorities can recommend to state departments: Policy framework and concerned departments/agencies

Sub-sectors	Policies and programmes that can push forward the recommendation	Primary departments / agencies	Supporting departments/ agencies
Power sector	1) National Smart Grid Mission 2) Smart Metering National Programme 3) Integrated Power Development Scheme (IPDS) 4) Restructured Accelerated Power Development and Reforms Programme (R-APDRP) 5) UDAY Scheme, 2015 6) National Mission on energy Efficiency, specifically PAT (Perform, Achieve and Trade) Scheme 7) MP Solar Power Policy, 2012 8) Policy for Decentralized Renewable projects, 2016 9) Standards and Labelling Programme	1) MPPMCL-MPMKVVCL, GoMP 2) MNRE, GoI 3) MPUVNL, GoMP 4) BEE (EESL)	1) State Knowledge Management Centre on Climate Change (SKMCCC)-EPCO 2) West Central Railways - Bhopal Division 3) Proposed District Level Climate Change and Environment Committee
Habitat	1) ECBC 2017	1) Urban Development and Housing Department, GoMP 2) All ULBs 3) Bhopal Smart City Development Corporation Limited (BSDCL)	1) Proposed District Level Climate Change and Environment Committee 2) MPUVNL

Sub-sectors	Policies and programmes that can push forward the recommendation	Primary departments / agencies	Supporting departments/ agencies
Transport	1) ECBC 2) JNNURM 3) Smart Cities Mission 4) AMRUT	1) Madhya Pradesh Transport Department 2) All RTOs 3) ALL ULBs	1) MPSRTC 2) MPUVNL 3) Bhopal Smart City Development Corporation Limited 4) West Central Railways - Bhopal Division
Industry	1) PAT Scheme 2) Industrial Promotion Policy, 2014	1) Department of Industry Policy and Investment Promotion, GoMP	1) Industries Commissionerate 2) District Industries Centre 3) Proposed District Level Climate Change and Environment Committee
AFOLU	1) National Mission on Food Security 2) Rashtriya Krishi Vikas Yojana: Remunerative Approaches for Agriculture and Allied Sector Rejuvenation (RAFTAAR) 3) National Mission for Sustainable Agriculture 4) Price Support Scheme 5) National Afforestation Programme (NAP) 6) Green India Mission 7) CSR Act, 2013	1) Farmers' Welfare and Agricultural Development Department, Government of Madhya Pradesh 2) Forest Department, Government of Madhya Pradesh	1) APMCs 2) MPIDC 3) Energy Department, GoMP 4) Madhya Pradesh State Agro Industries Development Corporation 5) Mineral Resources Department, GoMP 6) Madhya Pradesh State Agriculture Marketing Board 7) Proposed District level Committee on Climate Change and Environment
Waste	1) E-waste Management Rules, 2016	1) Science and Technology Department, GoMP	1) Proposed District Level Climate Change and Environment Committee

6.5. Sustainable Development Goals being addressed

SDGs	Targets	Sector (sub-sectors) addressing the recommendation
SDG 1: No Poverty 	Target 1.4: Ensure that all men and women, in particular the poor and the vulnerable, have access to basic services	Waste
SDG 2: Zero Hunger 	Target 2.1: End hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round	AFOLU (agriculture)
	Target 2.3: Double Agricultural Productivity	AFOLU (agriculture)
	Target 2.4: Implement resilient agricultural practices that increase productivity and production	AFOLU (agriculture)
	Target 2.a: Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research	AFOLU (agriculture)
	Target 2.a; Article 10.3.e: Development of sustainable irrigation programmes for both crops and livestock.	AFOLU (agriculture and livestock)

SDGs	Targets	Sector (sub-sectors) addressing the recommendation
SDG 3: Good Health and Well-being	Target 3.3: End the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases	Co-benefits from waste
	Target 3.4: Reduce by one-third premature mortality from non-communicable diseases through prevention	Co-benefits from waste
	Target 3.9: Substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination	Waste, air pollution
		Waste, energy (industry)
SDG 6: Clean Water & Sanitation	Target 6.3: Improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally	
	Target 6.4: Substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals	Energy (habitat – demand-side management, by-laws for new construction; industry); AFOLU (agriculture and green spaces)
	Target 6.5: Implement integrated water resources management at all levels	AFOLU (agriculture and green spaces/forestry)
	Target 6.8: Support and strengthen the participation of local communities	Waste
	Target 6.a: Expand international cooperation and capacity-building support to developing countries in water-and sanitation-related activities and programmes, including wastewater treatment, recycling and reuse technologies	Waste; AFOLU; Transport
SDG 7: Affordable & Clean Energy	Target 7.1: Ensure universal access to affordable, reliable and modern energy services	Energy (power and energy; habitat); AFOLU (agriculture)
	Target 7.2: Increase share of renewable energy in energy mix	Energy (power and energy; transport; habitat – energy efficiency in building and bye-laws for new construction; industry)
	Target 7.3: Double the global rate of improvement in energy efficiency	Energy (power and energy; habitat; industry)
	Target 7.a: Enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology	Energy (power and energy)
	Target 7.b: Expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries in accordance with their respective programmes of support	Energy (power and energy); AFOLU
SDG 8: Decent Work and Economic Growth	All targets	AFOLU (agriculture and livestock)
	Target 8.2: Achieve higher levels of economic production through diversification, upgradation and innovation	Energy; AFOLU (agriculture and livestock)
	Target 8.4: Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-year framework of programmes on sustainable consumption and production	Waste
	Target 8.9: Devise and implement policies to promote sustainable tourism	Wetland; AFOLU (agriculture and livestock)

SDGs	Targets	Sector (sub-sectors) addressing the recommendation
SDG 9: Industry, Innovation and Infrastructure 	Target 9.1: Develop quality, reliable, sustainable and resilient infrastructure	Energy (habitat – energy-efficiency in building and transport); waste
	Target 9.2: Promote inclusive and sustainable industrialization	Energy (industry)
	Target 9.3: Improving access and connectivity to industries/other enterprises	Energy (transport)
	Target 9.4: Upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes	AFOLU (agriculture); waste; energy (industry)
	Target 9.5: Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending	Energy (power and energy); waste
	Target 9.b: Research and innovation in developing countries, including by ensuring a conducive policy environment	Waste; energy (power and energy, industry); air pollution
SDG 11: Sustainable Cities and Communities 	Target 11.1: Ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums	Waste
	Target 11.2: Safe, affordable, accessible and sustainable transport systems for all	Energy (transport); air pollution
	Target 11.3: Enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management	Waste; energy (power and energy; habitat – energy efficient building); all district-specific sectors
	Target 11.4: Strengthen efforts to protect and safeguard the world's cultural and natural heritage	Wetland
	Target 11.6: Reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management	Waste, energy (power and energy, transport, industry) and air pollution
	Target 11.7: Provide universal access to safe, inclusive and accessible, green and public spaces	AFOLU (green spaces); habitat; air pollution
	Target 11.a: Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening regional development planning	Energy (transport and industry); AFOLU
	Target 11.b: Substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change	Energy; AFOLU; waste

SDGs	Targets	Sector (sub-sectors) addressing the recommendation
SDG 12: Responsible Consumption and Production	Target 12.1: Implement the 10-year framework of programmes on sustainable consumption and production, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries	Energy; waste
	Target 12.2: Achieve the sustainable management and efficient use of natural resources	Energy; AFOLU; waste; air pollution
	Target 12.3: Halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses	AFOLU; waste
	Target 12.4: Achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil	AFOLU; waste; air pollution
	Target 12.5: Substantially reduce waste generation through prevention, reduction, recycling and reuse	Waste; energy (habitat and industry)
	Target 12.6: Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle	Waste; energy (industry)
	Target 12.8: Ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature	Individual action and behavioural change communication
	Target 12.a: Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production	Waste; AFOLU (agriculture and livestock)
SDG 13: Climate Action	All targets	All sectors
SDG 14: Life under Water	Target 14.1: Prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution.	Waste (single use plastic)
SDG 15: Life on Land	Target 15.1: Ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements	AFOLU; waste; and wetland
	Target 15.2: Promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation	AFOLU (forestry/green spaces)
	Target 15.3: Combat desertification, restore degraded land and soil	AFOLU (forestry/green spaces)
	Target 15.5: Take urgent and significant action to reduce degradation of natural habitats, halt loss of biodiversity	Wetland, AFOLU
	Target 15.9: Integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies	AFOLU
	Target 15.a and 15.b: Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity, ecosystems and sustainable forest management	AFOLU; wetland
SDG 17: Partnerships for the Goals	Target 17.7: Promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries	Energy; AFOLU; waste
	Target 17.16: Enhance the global partnership for sustainable development, complemented by multi-stakeholder partnerships that mobilize and share knowledge, expertise, technology and financial resources, to support the achievement of the sustainable development goals in all countries, in particular developing countries	Energy; AFOLU; waste

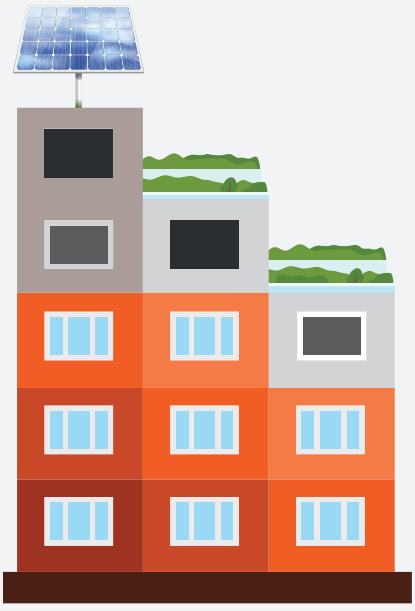
6.6. Promoting voluntary individual climate action

Waste management

1. Practice source segregation and handover segregated waste: biodegradable, non-biodegradable, domestic hazardous waste and household clinical waste.
2. Go for sustainable tourism/eco-tourism or tourism efforts for lowered waste footprint.
3. Electronic brand website gives information on e-waste collection points, ensure formal recycling of your electronic products by going through the collection points.
4. Responsibly dispose your e-waste: send them to a recycler, producer (manufacturer), producer responsibility organisation or dispose during local e-waste collection drives.
5. Say no to personal care products using microplastics/microbeads, read the labels before buying.
6. Say no to easily avoidable single use plastic products, like, plastic cutlery, straws, plastic carry bags, pouch products, food wraps, multi-layered packaging products.
7. Choose products with: a) less packaging waste, b) sustainable packaging, c) displayed higher product lifespan, d) displayed recycling/resource recovery efforts and information.

Housing

1. Insulate the building as much as possible, ensure proper sealing of doors and windows to avoid cooling/heating leakage.
2. Develop and maintain provision for rainwater harvesting.
3. Install solar rooftop panels, if feasible.
4. Adopt wastewater recycling and reuse.
5. Rooftop gardens can considerably reduce space cooling requirement.



Lighting

1. Switch off lights and fans when not required.
2. Replace incandescent bulbs with LEDs.
3. De-dust lighting fixtures to maintain illumination.
4. Smart LEDs are even more convenient – they can be controlled even when the person is not at home.

Kitchen

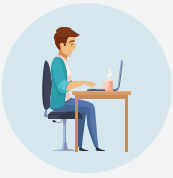
1. While cooking on gas stove, use moderate flame setting to conserve LPG.
2. Prefer the use of pressure cookers.
3. Keep the burner clean.
4. Use lids to cover the pan while cooking.
5. Use flat bottomed pan on electric stove.
6. Turn off electric stove several minutes before the specified cooking time.

Other climate-conscious precepts

Be mindful of water consumption. Use bucket instead of shower. Use bucket instead of hose for cleaning cars/ porch/back-yard. Opt for dual-flush toilets. Close the tap while brushing. Reuse RO reject water.

Carry your own bottled water, adopt minimalist lifestyle to reduce overconsumption of resource, purchase only when necessary.

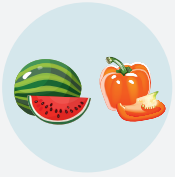
Go for climate conscious producers/ manufacturers. Develop a knowledge and preference for locally available and sustainably produced and designed products.



If possible, opt for work from home option for a few days in a week.

Encourage elected representatives and policy makers to opt for green choices/deals/decisions.

Choose standard shipping while ordering online.



Buy locally available produces, especially food, items vegetables and other perishable products.

Invest time and effort in greening local areas through collective community action.

Develop a habit of repair and reusing appliances and products at home instead of buying new ones. Follow reduce, reuse and recycle principles in the household to reduce footprint.

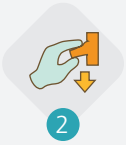
Include more meat-free meals and limit food wastage.

Buy local and organic food items not only for health but also to cut down emissions from transport and chemical fertilisers.

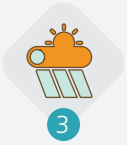
Opt for water saving fittings and fix any leakages in the house.

Daily use appliance

1. Purchase BEE star-rated energy efficient appliances



2. Shift consumption to off-peak hours (i.e. other than 10 am to 8 pm)



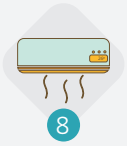
3. Replace electric water heater with a solar water heater, if feasible

4. Unplug idle devices/appliances.

5. A power strip can be used to reduce plug load. Devices such as desktops, TVs, microwaves, etc. use standby power even when off. Switching off the power strip has the same effect as unplugging all devices

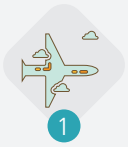
6. Proper maintenance of air conditioners helps to increase efficiency

7. Do not overload the refrigerator



8. Set the AC thermostat at 25°-26°C, for optimum cooling

Transport



1. Choose direct flights to reduce carbon footprint

2. Travel light to reduce carbon emissions

3. Strictly abide by pollution norms

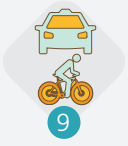
4. Put on your shoes for short trips

5. Ensure regular maintenance of vehicles

6. Choose inter-modal transport (private + public)

7. Reduce demand for vehicle travel by expanding personal mobility choices such as car-sharing and bike-sharing

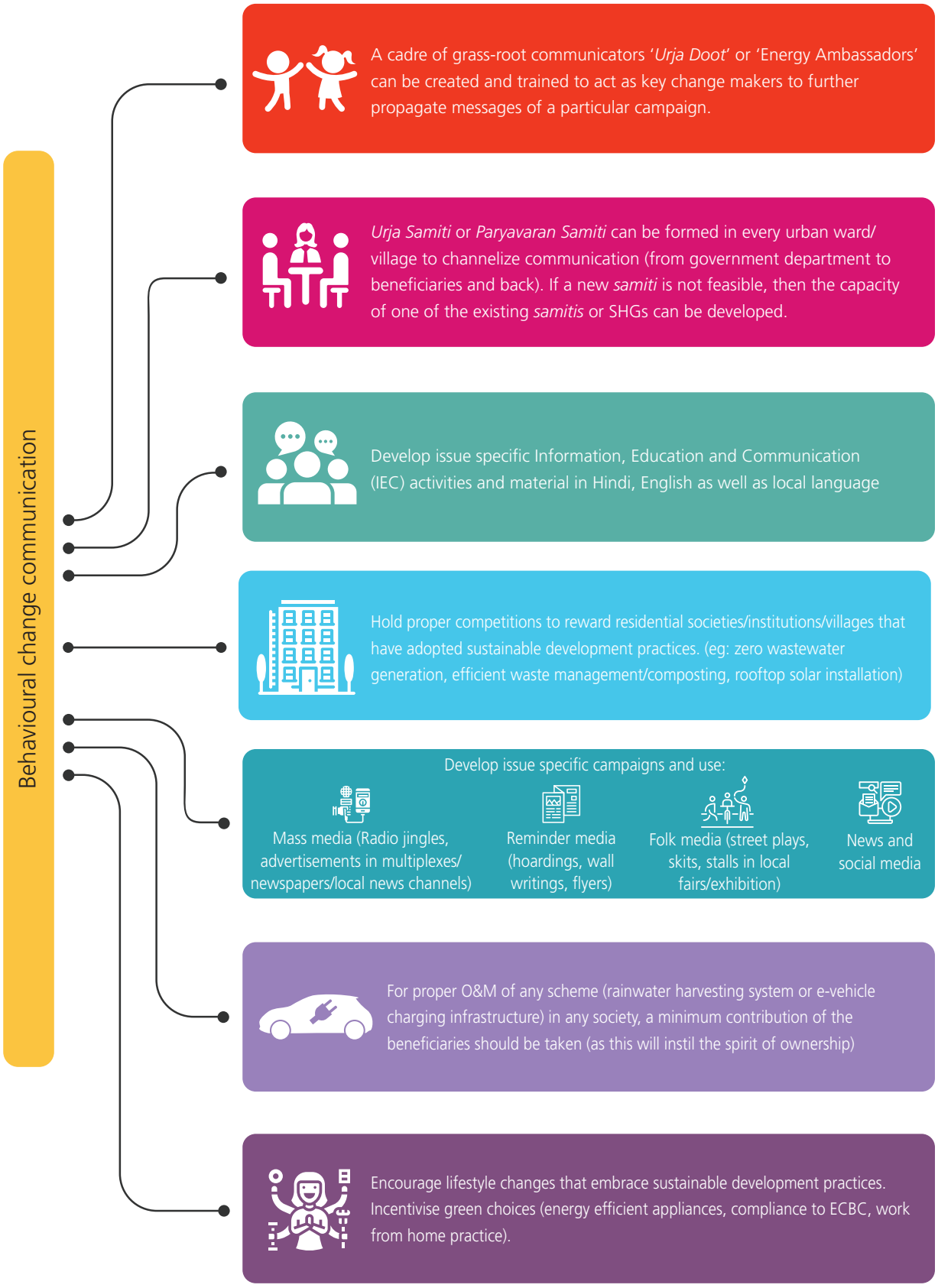
8. Shift to clean, non-petroleum fuels such as electricity (through RE) to power vehicles



9. Car pool to work, Use bicycles park and ride

10. Swicth off the ignition at traffic signals

6.7. Behavioural change communication (BCC) techniques




SMART
CITY
BHOPAL
हमारा
BHOPAL

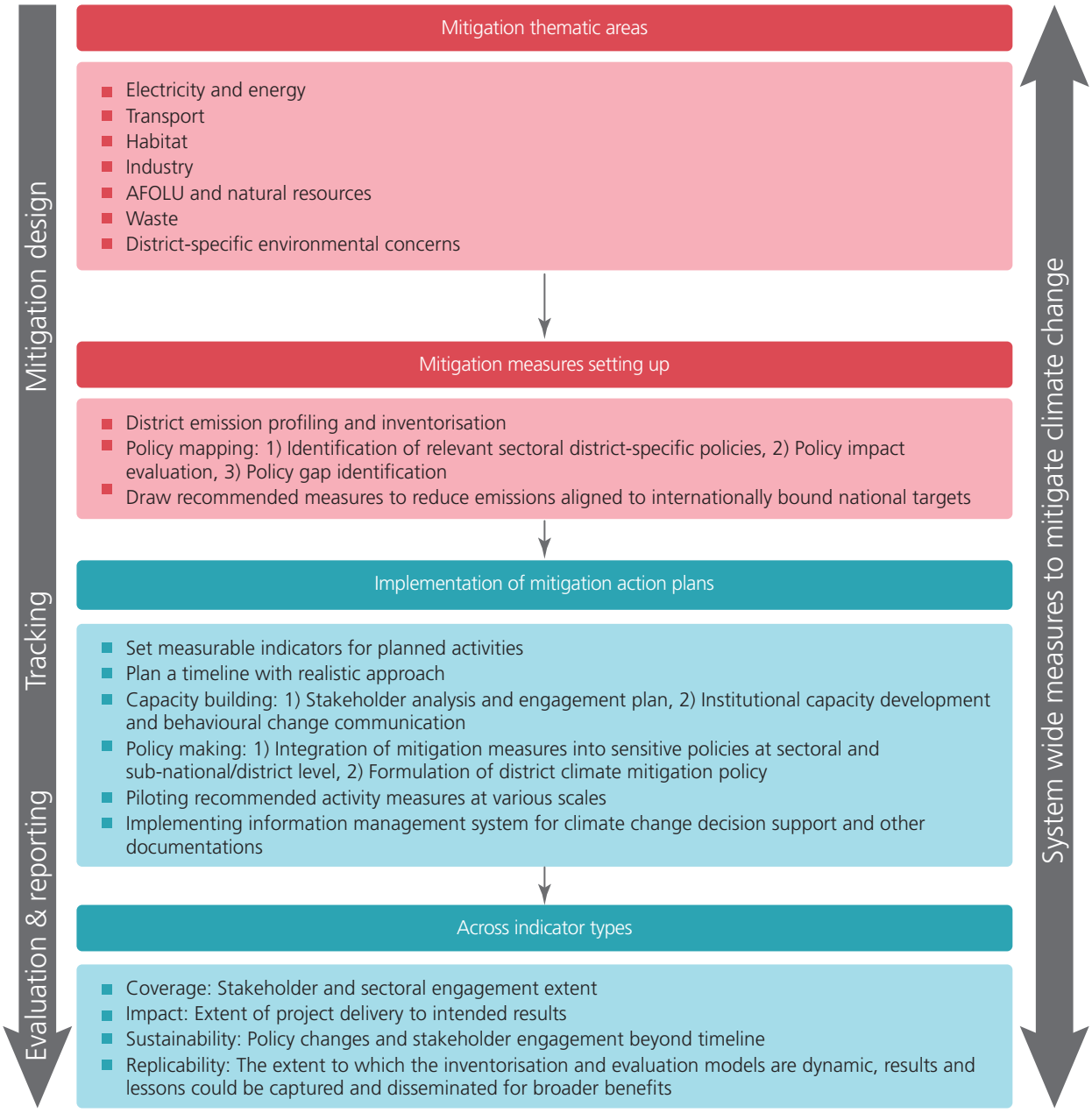
MONITORING AND EVALUATION PLAN

View of clean Bhopal

7. MONITORING AND EVALUATION PLAN

7.1. Framework for monitoring and evaluation

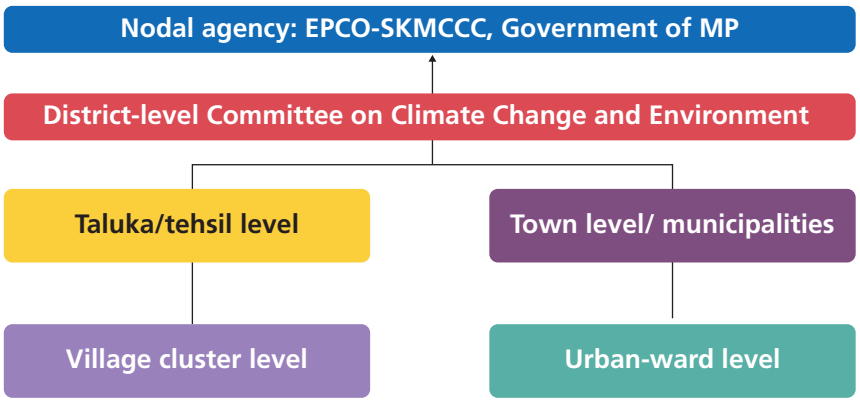
This section describes the planning for monitoring and evaluation (M&E) of the climate change mitigation measures that the district may adopt for the sectors identified in the report. M&E is crucial to realise the achievement and track the effectiveness of results envisaged in order to compliment the national endeavours to attain nationally determined contributions. The framework proposes to incorporate: a) district level mitigation profiling; b) planning for mitigation measures; c) tracking of implementation and integration to the national mitigation response and d) evaluation of relevance and effectivity.[39]



39 Activities that are already covered in the current CCEAP for Bhopal District are in red colour. Activities that are 1) to be based on the CCEAP findings and recommendations or 2) potentially mapped out through the CCEAP report, like the stakeholder mapping or behavioural change communication plan, etc. are given in the blue colour.

7.2. Proposed institutional set-up

As a central authority or body to steer the wheels of climate mitigation, it is recommended to formulate a district climate cell/committee or include the perspective of climate change in the existing District Environment Committee.[40] The committee shall assign tasks according to stakeholder analysis and engagement, as outlined in the model given below. This committee shall comprise of representatives from concerned administrative bodies, sectoral experts, civil society organisations and civic/other associations (as applicable) and shall similarly be formed at block, ULB, cluster and ward level. The committee shall oversee implementation of deliverables following the prescribed recommendations/ framework and the outputs. A proposed set-up of the committee at each of the levels is as follows:



District level committee

Chairman: District Collector

Members: Municipal Corporation Commissioner, District Development Officer, Superintendent of Police, Deputy Collector, district Level officers/representatives of Pollution Control Board, MSMEs, Agriculture & Animal Husbandry, department of Statistics and Planning, District Urban Development Agency, Industry Department, Urban Development Department, water supply, Rural Development Department, health care department, Regional Transport Office, etc

Taluka level

Chairman: Mamlatdar/Taluka Development Officer

Members: Taluka Level Members of: Rural Development Department, Department of Irrigation, Water Supply Department, Agriculture & Animal Husbandry and other departments mentioned in the district committee

Town level/municipalities

Chairman: Head of Municipality/Nagarpalika

Members: Town-level representatives of the departments mentioned above

Village cluster level

Chairman: Deputy Mamlatdar

Members: Sarpanch and other PRI members, Self-help group members, head of women committee, village water and sanitation committee, grassroot communicators

Urban-ward level

Chairman: Ward Representatives

Members: President of RWAs, grassroot communicators, civil societies, members of *samittee*

40 As per the Hon'ble NGT order in O.A. No. 710-713/2017 dated 15.07.2015

IMPACT OF COVID-19 VIS-À-VIS CLIMATE ACTION

COVID protocols being followed in Bhopal

8. IMPACT OF COVID-19 VIS-À-VIS CLIMATE ACTION

8.1. Introduction

The ongoing COVID-19 pandemic situation has gravely affected almost every corner and sector of the country. Bhopal district too did not go unaffected and reported 1,23,430 cases (September 30, 2021) making up for 15.6 percent of the state's total cases (Covid19India, 2021). This affected management of climate crisis, in the backdrop of an already vulnerable governance, poor emergency response and warning systems and an over-stretched public health infrastructure. The economic and social costs (both direct and indirect) of the pandemic may take priority over the global climate goals and national climate commitments in both the short and the long-run.

Positive impacts: Lockdowns have had several positive impacts on the environment. For the first time in nearly four decades, India has seen a reduction in CO_2 emissions by 30 million tonnes CO_2 (1.4 percent) in FY 2019-20 due to a slowdown and restrictions on economic and other activities (Lauri & Dahiya, 2020). In April 2020, aerosol levels were at a 20-year low in north India, one of the most polluted regions in the world (NASA, 2020). Improved water quality and biodiversity sightings were also reported from different parts of the country during mid-March to June 2020 (Goswami, 2020).

Here are some likely impacts of COVID-19 on climate mitigation measures in the district of Bhopal.

8.2. Energy consumption

8.2.1 Electricity demand

Coal-based power generation reduced by 26 percent in just two weeks after the lockdown, a significantly larger drop as compared to 6 percent globally (Pillay, 2020). In April, India's power consumption shrank by 22.75 percent, but increased by 14.16 percent in May with relaxations in lockdown restrictions (The Economic Times, 2020). Furthermore, at the national level, during the strict lockdown period, fuel consumption took a dip of around 70 percent and electricity demand fell by 20 to 25 percent as compared to pre-COVID levels.

The total energy demand reduced largely due to decreased demand from services and industry sectors (IEA, 2020). However, in Madhya Pradesh, power demand has gone up by 6.4 percent due to an increase in consumption of agricultural power (The Financial Express, 2020). In the long run, India's electricity demand is projected to be seven to 17 percent lower by 2025 due to the downward revision of its GDP growth, partly due to the COVID-19 economic shock (Spencer, 2020).[41]

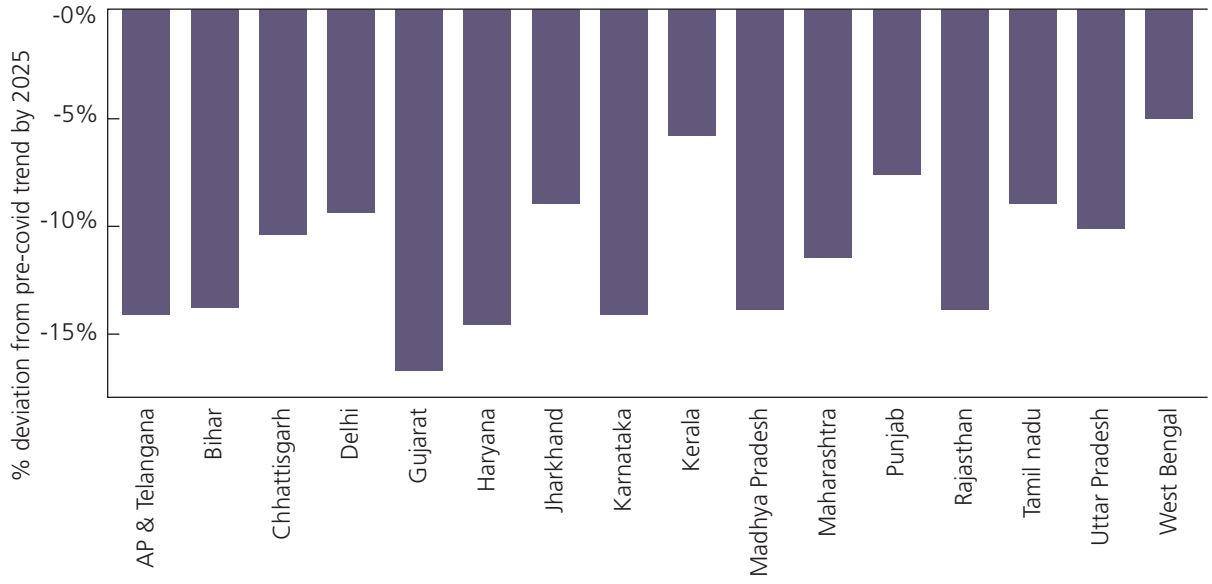


Figure 44: 2025 Deviation of electricity demand from pre-COVID trends projected from major Indian states

41 However, as per Central Electricity Authority's Power Supply Report, the national energy requirement in August, 2021 was 1,28,519 MU, recording a 14 percent rise in comparison to the same month in 2019.

Outlook for Bhopal

Due to lower demand, some states have reduced coal power generation. Contribution of coal in total power generation in India reduced from an average of 72.5 percent in March 2020 to 65.6 percent in April 2020. This can be attributed to the fact that renewable energy sources have a 'must run' status and the running cost of renewable power plants is lower as compared to thermal power plants (Surya, 2020). This only underscores the need to increase focus on renewable energy and strengthen its integration into the grid. Bhopal district can contribute to Madhya Pradesh's RE generation capacity by encouraging projects such as solar rooftops, biogas and solar pumps for agriculture.

8.2.2. Fuel consumption

India's fuel consumption fell 45.8 percent to 9.93 million tonnes in April, down from 18.32 million tonnes in the same month a year back (Business Standard, 2020). In July, diesel consumption declined by 12.7 percent compared to the previous month – from 6.3 million tonnes to 5.5 million tonnes. Overall consumption of petroleum products dropped by 3.7 percent to 15.7 million tonnes in July as compared to 16.3 million tonnes in June (The Hindustan Times, 2020). The only fuel that showed growth was LPG as the government *dole* of free cooking gas cylinders to poor households fired up consumption by 12.2 percent to 2.13 million tonnes in April. With gradual unlocking, moderately progressing economic recovery, restricted movement and industries mostly operating at 70 to 80 percent capacity, the demand for fuel has also reduced.

Outlook for Bhopal

In June 2020, Madhya Pradesh government revised the price of fuel by levying a Corona tax of ₹ 1. Overall, there is an uncertainty around fossil fuel prices. In such a scenario, the paradigm shift of the transport system towards e-mobility needs to be better planned, and implemented in phased manner.

8.3. Agriculture

COVID-19 caused disruption to agriculture and supply chains. Non-availability of migrant labour and farmers' inability to hire harvesters and other machines interrupted harvesting activities for wheat and pulses. There were disruptions in supply chains due to the lockdown. The demand of milk went down due to closure of hotels, sweet shops etc . Faced with the double-whammy of the lockdown and misinformation on social media, poultry farmers were hit badly.

In Madhya Pradesh, the government began importing maize. Coupled with the lockdown, this led to a price crash that further hurt the farmers, and they were forced to sell their produce at half the MSP ensured by the Central Government in 2019 (Pandey, 2020).

On the flip side, reverse migration proved to be fruitful for *kharif* (monsoon) crops. As on July 17, 2020, total kharif crops have been sown on 691.86 lakh ha area against 570.86 lakh ha area during the corresponding period of 2019 – an increase in area coverage by 21.20 percent in the country (WBCSD, 2020) (PIB, 2020).

Outlook for Bhopal

To prevent loss of yield, the district administration must ensure availability of irrigation facilities, composts, seeds, farming machines during sowing and harvesting periods. Small farmers must be prioritised while provisioning facilities.

8.4. Migration

India has seen a national migrant crisis resulting from halted economic activity, leading to widespread loss of jobs, particularly for wage labourers during the nationwide lockdown. The influx of migrant workers to the districts certainly adds stress to energy, food and water resources, and increases the waste footprint. By June 2020, Madhya Pradesh saw an influx of 7.3 lakh migrants returning from various parts of the country.

Outlook for Bhopal

With unlocking and renewed opportunities of employment, some migrants may return to their city of employment. The district administrator must understand the migration pattern in Bhopal and plan accordingly for resource allocation and management. Agriculture sector schemes, MGNREGS and state employment guarantee programmes can be used to fast-track incorporation of these migrants into the state rolls, while also increasing employment opportunities.

8.5. Waste management

The pandemic has had a tremendous impact on the waste sector that calls for rapid overhaul of the waste management systems. Grappled with an already burdened healthcare and municipal waste management system, Indian states and district-level administrations are going to face serious environmental governance challenges leading to a risk of higher emission from this sector. Here are some challenges confronting administrations:

- Use of disposable PPEs, masks, single-use plastic containers for sanitisers, online shopping packaging waste and double layered bags (two bags) for collection of COVID-19 waste in the hospitals, etc. are leading to huge amount of additional waste that's different in both composition and density of municipal solid waste and hospital waste.
- All COVID-19 medical waste from hospitals treating COVID-19 patients is categorised as yellow waste, which is to be incinerated as per the Bio-medical Waste Management Rules, 2016. Similarly, biomedical waste generated from quarantine camps/homes is to be treated as 'domestic hazardous waste' under the Solid Waste Management Rules, 2016. This increases emissions from waste incineration manifold (CPCB, 2020).
- The CPCB guideline mandates immediate disposal of COVID-19 bio-medical waste and permits operation of incineration facilities for extra hours at the CBWTF, if required, causing further increase in emissions.
- For rural areas not having CBWTF facilities, COVID-19 waste is to be disposed of in the existing captive facilities which would have more emission potential (equal to landfilling) than that of incineration. It is to be noted that most of rural India is not connected to CBWTFs and is already impacted by COVID-19.
- Use of hazardous waste treatment facilities (TSDF) for incinerating COVID-19 waste from solid waste stream leads to increased emissions from TSDFs.

8.6. Air pollution

Comparisons of 24-hour average of $PM_{2.5}$ over Bhopal district between Jan to Feb for the years 2019 and 2020 show that $PM_{2.5}$ concentration reduced significantly during the lockdown months (See Figure 45). Concentration of PM_{10} also reduced significantly during the lockdown months in Bhopal as compared to the previous year. The concentration remained below 0-100 microgram/m^3 (Figure 46).

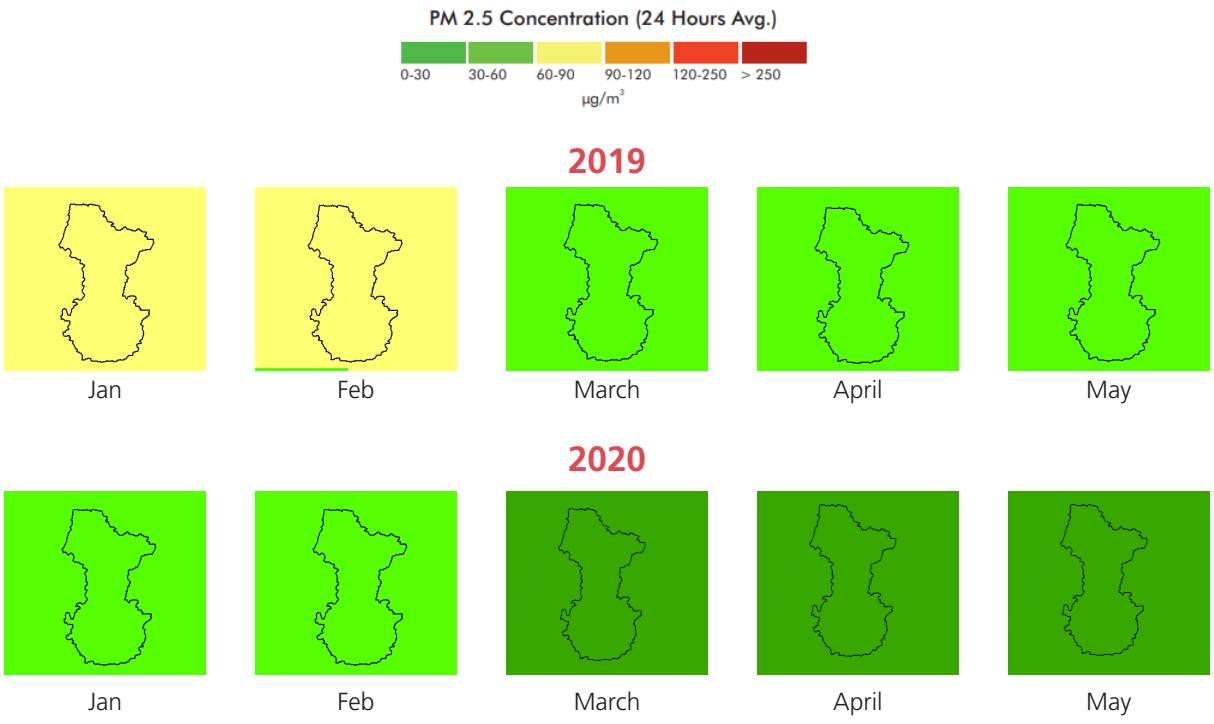


Figure 45: $PM_{2.5}$ concentration Jan-May 2019 vs 2020

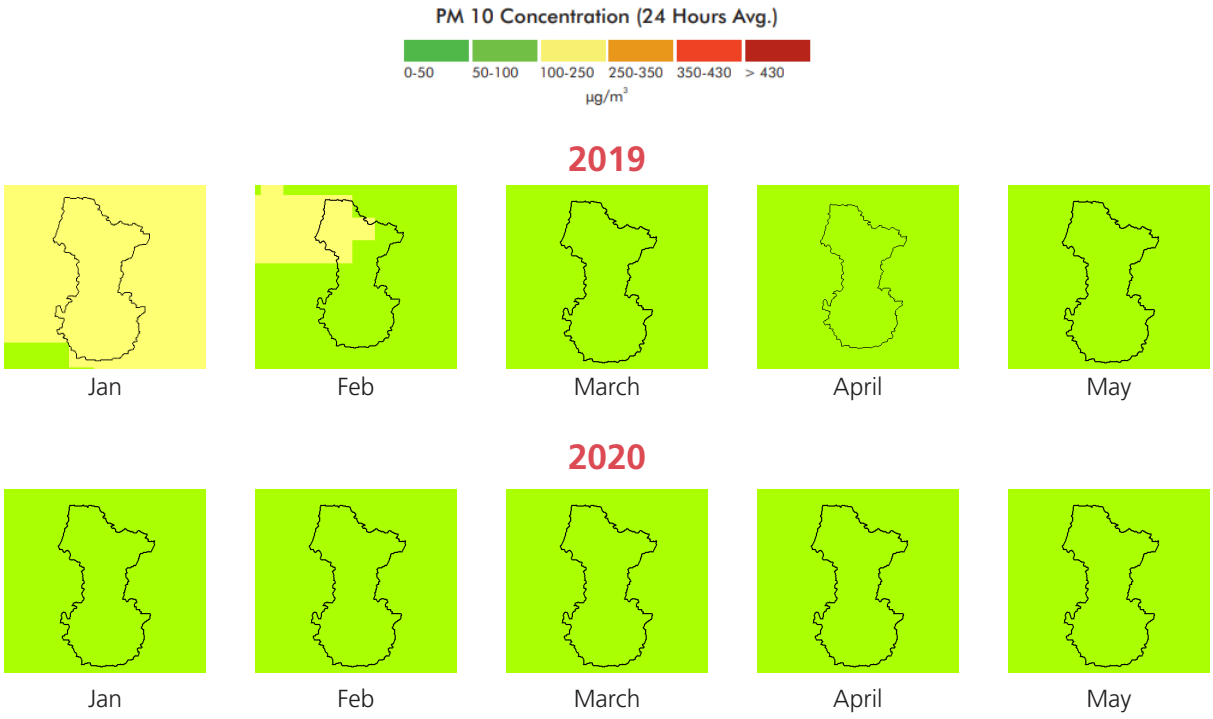


Figure 46: PM_{10} concentration Jan-May 2019 vs 2020

During the lockdown, most anthropogenic activities were at a standstill or were limited. Therefore, the nitrogen dioxide concentration over Bhopal reduced significantly as compared to NO_2 concentration for the same months in 2019 (Figure 47). A similar effect was observed on SO_2 concentration over Bhopal. The concentration of SO_2 was particularly impacted during April and May 2020 when it decreased from its usual 350 to 420 µmole/m^2 to 0 to 280 µmole/m^2 (Figure 48).

Outlook for Bhopal

The lockdown provided a temporary relief from air pollution in most Indian cities. However, once the unlock process started, air pollution levels increased gradually with the levels going back to pre-Covid days post-October.

The lockdown has given us hope that air pollution levels can be controlled. Source apportionment studies can help identify air pollution hotspots in the district. Authorities in Bhopal can focus on measures to minimise and/or optimise industrial processes to reduce atmospheric emissions. Further, authorities must also work towards reducing traffic during peak hours and encouraging use of public transport to minimise vehicular emissions.

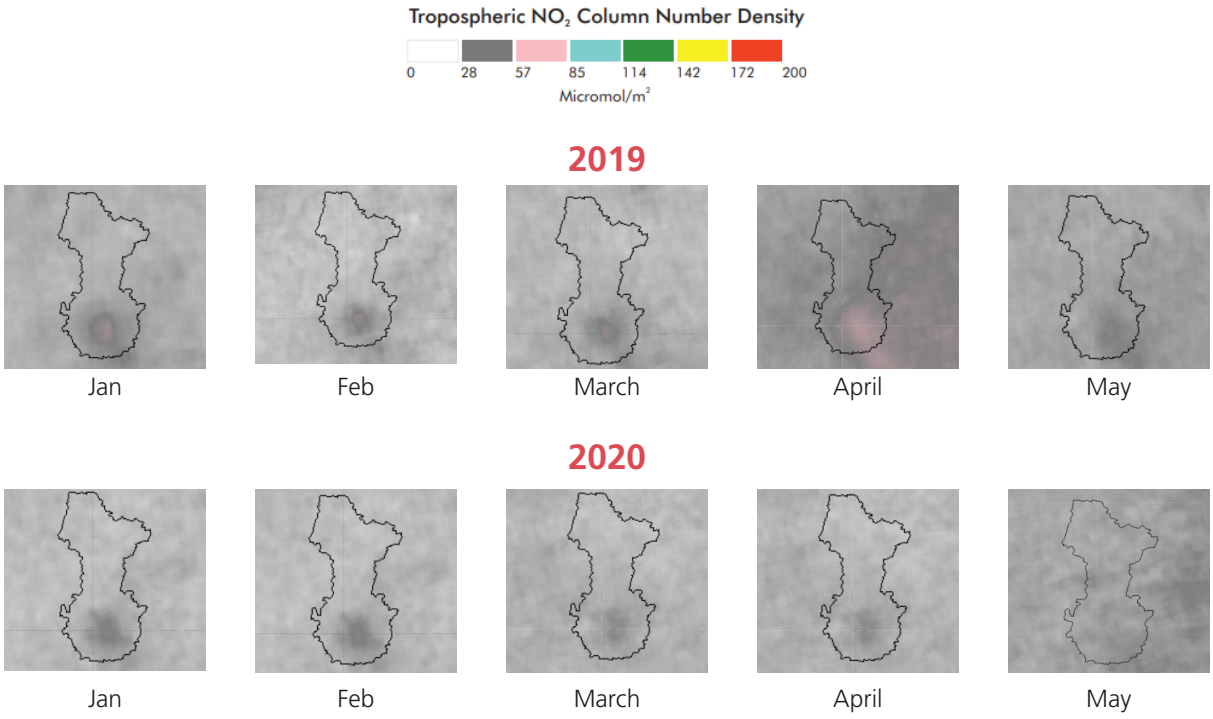


Figure 47: NO_2 concentration Jan-May 2019 vs 2020

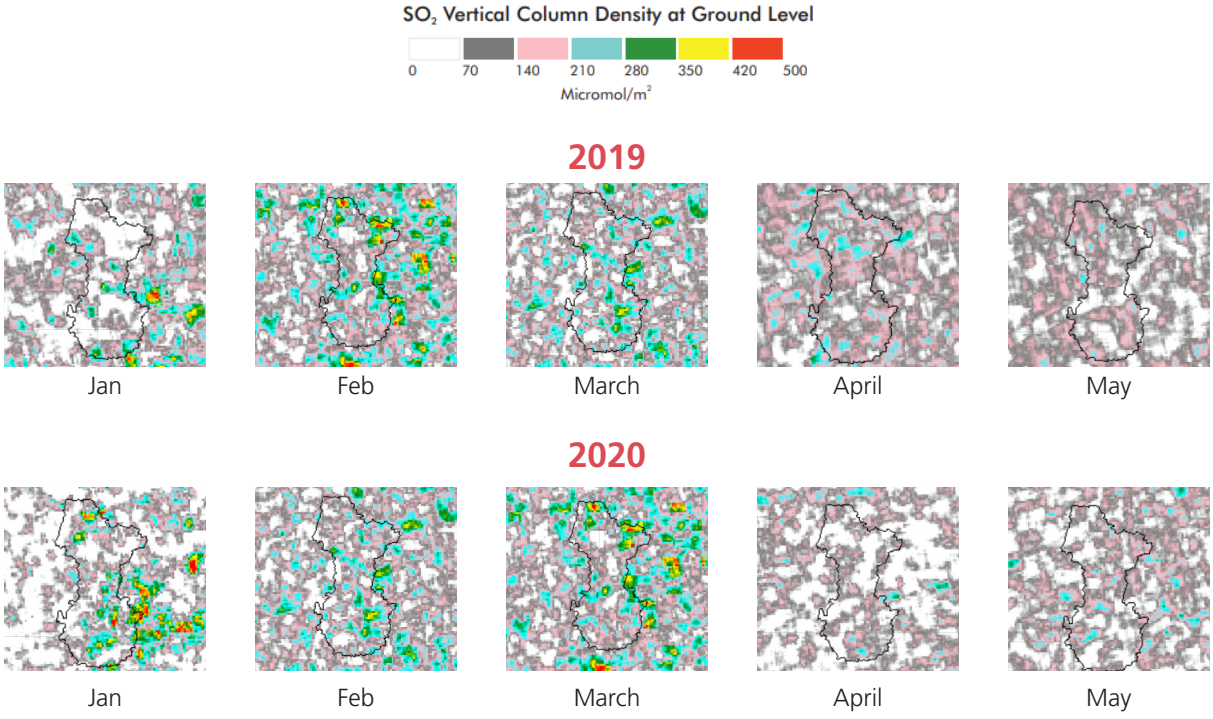


Figure 48: SO_2 concentration Jan-May 2019 vs 2020

THE WAY FORWARD

Aerial view of Rewa Solar power plant, Madhya Pradesh - one of the largest in the country

THE WAY FORWARD

India has set a target to meet its 50% of energy demand through RE by 2030, at COP26/Glasgow, 2021. It's important to break that overall plan into smaller action plans for each district and involve various stakeholders to work towards meeting the targets.

The district of Bhopal has taken several steps towards sustainability, and the need to mitigate climate change. Bhopal city has the longest bus rapid transit system (BRTS) corridor in the country. It is also the first district in Madhya Pradesh to install a 'waste to energy' plant. The city also has 100 percent waste collection efficiency. Bhopal was ranked as the best 'self-sustainable capital city' and the seventh most clean city in India by Swachh Survekshan 2020.

The state of Madhya Pradesh has achieved 92.4 percent of its target of installing solar pumps under PM-Garib Kalyan Rojgar Abhiyan. In terms of adopting electric vehicles, Madhya Pradesh has launched an Electric Vehicle Policy in 2019, which provides incentives to electric vehicle buyers and promotes installation of charging infrastructures in government office buildings.

The district can select recommendations from the comprehensive list provided in Chapter 6 and develop a detailed implementation plan for pilot projects that can be rolled out in the short-, medium- and the long-term.

With the availability of a district-level policy and scheme-wise budgetary allocation, a detailed budgetary analysis with respect to climate action can be carried out for Bhopal as an add-on to this action plan. However, this must be treated as a dynamic document and the action plan shall be updated regularly with the latest emissions profile and mitigation potential of the district. Organising periodic stakeholder consultations would help strengthen the action plan, as per the changing requirements of the district.

Van Vihar, Bhopal

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Shakti Sustainable Energy Foundation (SSEF) seeks to facilitate India's transition to a sustainable energy future by aiding the design and implementation of policies in the following sectors: clean power, energy efficiency, sustainable urban transport, climate policy and clean energy finance.

Vasudha Foundation is a not for profit organization set up in April 2010 with the belief in conservation of Vasudha, which in Sanskrit means the Earth, the giver of wealth and with the objective of promoting sustainable consumption of its bounties.

The core mission is to promote environment -friendly, socially just and sustainable models of energy by focusing on renewable energy and energy efficient technologies and lifestyle solutions. Climate change mitigation is one of the key verticals of the organization. The focus is to bring about reduction in greenhouse gas emissions in the environment and ensure energy efficiency, energy security, energy independence, and sustainable development as well as simultaneously, promoting the concept of “Low Carbon Solutions” and “Green Economies'.

SKMCCC, EPCO, Department of Environment
Government of Madhya Pradesh

The Environmental Planning & Coordination Organisation (EPCO), state's premier organisation in the field of environmental matters, was established by the Housing and Environment Department of the Government of Madhya Pradesh in 1981 and is presently under the Urban Development and Environment Department of the Government of Madhya Pradesh. It works closely with the State Government, despite having established its own identity as an autonomous organisation.

Vasudha Foundation

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