



ADVANCING CITY CLIMATE ACTION IN MADHYA PRADESH

Towards a low-carbon, climate-resilient **BHOPAL**



Bhopal City Climate Action Plan

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Department of Environment, Government of Madhya Pradesh, 2023

DISCLAIMER

This document is prepared by WRI India in partnership with Environmental Planning & Coordination Organisation (EPCO), Department of Environment, Government of Madhya Pradesh to support Bhopal city in developing its Climate Action Plan. The data and information used for preparing this report have been sourced from Bhopal city, State Government departments, published sources of Government of India, etc. While due care has been taken to ensure authenticity of the data and other information used, any error in their accuracy or interpretation is absolutely unintentional.

About WRI India

WRI India is a research organization that turns big ideas into action at the nexus of environment, economic opportunity, and human well-being.

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Source: Bhopal Smart City Development Corporation Ltd.

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Preface

No evidence is required to prove that climate is changing and that too because of increased human activities which have serious repercussions on economic development and natural resource management. Various recent extreme weather events in Madhya Pradesh, urban flooding, and untimely rains have shown that developing localised mitigation and resilience strategies is the need of the hour.

Paris Agreement 2015 and Glasgow Pact 2021 have shown the commitments from the international communities for reducing or mitigating GHG emissions, however to resolve this global issue, there lie the local solutions at sub-national level, district level and city level. Hon'ble Prime Minister of India has also launched the LiFE Movement which emphasizes on change in the lifestyle and behavioural patterns of living. He has stressed on reduce, reuse and recycle concepts as also on the circular economy to be an integral part of our lifestyle and for sustainable development. Concept of inclusivity is also very much integrated with this movement.

We in Madhya Pradesh are also committed to addressing the challenge of climate change in order to pursue the state's development goals in a sustainable manner.

Taking the cue from Ministry of Housing & Urban Affairs (MoHUA) as part of Climate Smart Cities Assessment Framework, the preparation of Climate Action Plans (CAPs) of all the 7 smart cities of MP by State Knowledge Management Centre on Climate Change (SKMCCC), EPCO and WRI India are steps towards making the local authorities equipped with strengths for tackling the challenge of climate change. The city level GHG inventorisation also helps in quantifying the actions to reduce the CO₂ emissions and offsetting the current emissions.

The City level Climate Action Plans (CAPs) for all the 7 smart cities have been drafted after wide consultations and participation with city experts so as to bring all the stakeholders on board and make their say.

I appreciate the efforts of EPCO and WRI India for taking the lead in preparing the City level Climate Action Plans.

These CAPs have flagged important issues which require attention and are expected to be implemented by the local authorities & SPVs.

A handwritten signature in blue ink, appearing to be 'Gulshan Bamra', is written over a light blue rectangular background.

(Gulshan Bamra)



Foreword

As extreme weather events unfold across the globe, the climate crisis has reached our doorstep. While India is on track to achieve the Nationally Determined Contributions, the State of Madhya Pradesh (MP) is determined to lead India's fight against this impending crisis by policy-governance reforms and inculcating a climate action culture in the society. With MP's complex urban challenges and increasing climate risks and disasters, sustained actions ensuring cities to prepare for and develop the ability to thrive in the varying climate is crucial. In MP, the rising urban population has created a reason to be concerned about climate change, and therefore the interventions at the city level are deemed important.

In this connection, the Climate Smart Cities Assessment Framework (CSC-AF) issued by Ministry of Housing & Urban Affairs (MoHUA) plays an important role in devising the appropriate actions to keep our cities safe from the adverse impacts of climate change. This brings an opportune time to integrate the concerns of climate change into our on-going program & policies and achieve the goal of low carbon development with inclusive growth.

It has been a very good opportunity for EPCO to join the LiFE movement launched by Hon'ble Prime Minister of India during Glasgow CoP. All the concepts of LiFE have been tried and addressed in the cities while developing the plans.

It is also important for us to develop well researched strategies specific to the cities to respond effectively to the possible impacts of climate change. To address these challenges, City level Climate Action Plans (CAPs) have been developed by State Knowledge Management Centre on Climate Change, EPCO in association with WRI India. The CAPs have highlighted key concerns and strategies for actions as per the indicators outlined in the CSCAF.

I would like to acknowledge the efforts of EPCO professionals and WRI India team for their commendable work. I would also like to extend my gratitude towards UADD, all the SPVs and other stakeholders for extending their support to formulate these plans and providing necessary data and information to make these plans more robust.



(Mujeebur Rehman Khan)



Acknowledgements

Environmental Planning and Coordination Organization (EPCO) is grateful to Mr Gulshan Bamra, Principal Secretary, Government of Madhya Pradesh, Environment Department; Mr Mujeebur Rehman Khan, Executive Director EPCO; and other team members from EPCO for their continuous support and guidance at various stages of developing the inclusive-climate action plan for Bhopal city.

We extend gratitude to Commissioner, Urban Administration and Development Department (UADD) for facilitating the plan development process and providing necessary guidance. We also are grateful to Commissioner, Bhopal Municipal Corporation and Chief Executive Officer of Bhopal Smart City Development Corporation Limited for constant support in providing valuable city level inputs and facilitating data collection across all departments and parastatal agencies. We would also like to thank all officers and city experts from concerning line departments and external agencies who contributed to the development and refinement of this plan through timely provision of data and valuable insights during stakeholder consultations.

EPCO would like to thank World Resources Institute (WRI) India, especially Mr Madhav Pai, CEO, Dr OP Agarwal, Senior Advisor and Former CEO, Ms Ulka Kelkar, Director, Climate Program for providing technical support to EPCO and Bhopal city, which played a key role for developing this plan.

We would also take this opportunity to appreciate the efforts made by the study team Mr Saransh Bajpai, Mr Prateek Barapatre, Ms Ramya MA, Ms Faiza Solanki and Ms Avni Agrawal for providing their expertise to assist in the research and development of the climate action plan.

Lastly, we would like to thank the internal reviewers from WRI India including Ms Marie Duraisami, Ms Sumedha Malaviya, Mr Dhilon Subramanian, Ms Azra Khan, Ms Chaitanya Kanuri and Ms Sahana Goswami for providing valuable feedback to strengthen the sectoral strategies in the plan

(Lokendra Thakkar)

Coordinator,
State Knowledge Management
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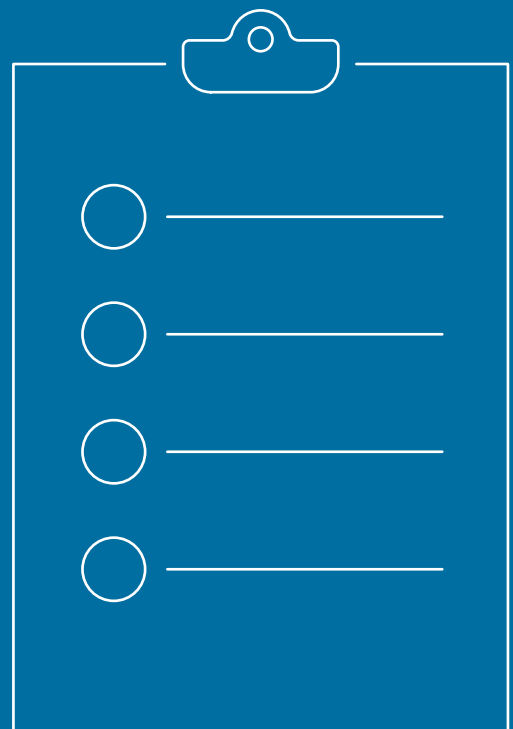
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Abbreviations

AAQ	Ambient Air Quality	ESCO	Energy Service Company
ABD	Area Based Development	ENS	Eco-Niwas Samhita
AMRUT	Atal Mission for Rejuvenation and Urban Transformation	FAME	Faster Adoption and Manufacturing of Electric Vehicles
AJAY	Atal Jothi Yojana		
BRTS	Bus Rapid Transit System	GHG	Greenhouse Gas
BMC	Bhopal Municipal Corporation	GI	Green Infrastructure
BOD	Biological Oxygen Demand	GoMP	Government of Madhya Pradesh
BSCDCL	Bhopal Smart City Development Corporation Limited	GRIHA	Green Rating for Integrated Habitat Assessment
BCLL	Bhopal City Link Limited		
BEMS	Building Energy Management Systems	HFAPoA	Housing for All Plan of Action
BESCOM	Bangalore Electricity Supply Company Limited		
BDA	Bhopal Development Authority	ICT	Information and Communications Technology
BHEL	Bharat Heavy Electricals Limited	IGBC	Indian Green Building Council
		IEISL	IL&FS Environmental Infrastructure and Services Limited
C&D	Construction and Demolition	IoT	Internet of Things
CAAQMS	Continuous Ambient Air Quality Monitoring System	IPT	Intermediate Public Transport
CAGR	Compound annual growth rate	ISRO	Indian Space Research Organization
CBD	Central Business District	IT	Information Technology
CAPEX	Capital Expenditure Model	ITS	Intelligent Transport System
CEEW	Council on Energy, Environment and Water		
CH₄	Methane	JV	Joint Venture
CNG	Compressed Natural Gas		
CO₂	Carbon Dioxide	kWh	Kilo Watt Hour
COD	Chemical Oxygen Demand	kW	Kilo Watt
CORDEX	Coordinated Regional Climate Downscaling Experiment	LCB	Low Carbon Buildings
CPWD	Central Public Works Department	LED	Light Emitting Diode
CPCB	Central Pollution Control Board	LEED	Leadership in Energy and Environmental Design
CSCAF	Climate Smart Cities Assessment Framework	LPCD	Liters Per Capita per Day
CSO	Civil Society Organization	LPG	Liquefied Petroleum Gas
CPHEEO	Central Public Health and Environmental Engineering Organization		
		MLD	Million Liters per Day
DEWATS	Decentralized Waste-Water Treatment System	MNRE	Ministry of New and Renewable Energy
DJB	Delhi Jal Board	MoHUA	Ministry of Housing & Urban Affairs
DISCOM	Electricity Distribution Companies	MSMEs	Micro, Small and Medium enterprises
		MPPHED	Madhya Pradesh Public Health Engineering Department
ECBC	Energy Conservation Building Code	MPPWD	Madhya Pradesh Public Works Department
EESL	Energy Efficiency Services Limited	MPUVN	Madhya Pradesh Urja Vikas Nigam
EPCO	Environmental Planning and Coordination Organization	MPMKVVCL	MP Madhya Kshetra Vidyut Vitaran Company Limited

MPWRD	Madhya Pradesh Water Resources Department	UNFCCC	United Nations Framework Convention on Climate Change
MPLADS	Member of Parliament Local Area Development Scheme	WPR	Workforce Participation Rate
MRF	Material Recovery Facility	WTP	Water Treatment Plant
MRV	Monitoring Reporting and Verification	ZCB	Zero Carbon Buildings
Mt	Metric Tonnes		
mt	Million Tonnes		
MWh	Mega Watt Hour		
NAAQS	National Ambient Air Quality Standards		
N₂O	Nitrous Oxide		
NDC	Nationally Determined Contribution		
NDMA	National Disaster Management Authority		
NMT	Non-Motorized Transport		
NMV	Non-Motorized Vehicle		
NRW	Non- Revenue Water		
NTPC	National Thermal Power Corporation		
NVVN	NTPC Vidyut Vyapar Nigam Ltd		
PMAY	Pradhan Mantri Awas Yojana		
PSP	Private Sector Participation		
PNG	Piped Natural Gas		
PPP	Public Private Partnership		
PT	Public Transport		
PUC	Pollution Under Control		
PWD	Public Works Department		
RCP	Representative Concentration Pathways		
RWH	Rainwater Harvesting		
RWA	Resident Welfare Association		
RFID	Radio Frequency Identification		
RTS	Roof Top Solar		
SAPCC	State Action Plan on Climate Change		
SCP	SMART City Plan		
SKMCCC	State Knowledge Management Centre on Climate Change		
SPA	School of Planning and Architecture		
STP	Sewage Treatment Plant		
SWH	Solar Water Heater		
T&D	Transmission and Distribution		
TOD	Transit Oriented Development		
TPD	Tonnes Per Day		
UADD	Directorate of Urban Administration & Development		
ULB	Urban Local Bodies		
UDD	Urban Development Department		
UNESCO	United Nations Educational, Scientific and Cultural Organization		

EXECUTIVE SUMMARY



Bhopal and its Vulnerability to Climate Change

Bhopal is the state capital and second largest city of Madhya Pradesh. Bhopal was also rated as the greenest city and the cleanest state capital city in India for three consecutive years – 2017, 2018 and 2019. Bhopal is situated in the Vindhya and Malwa plateau region and has a unique physiography with the Narmada valley in the central-east, Bhoj wetland towards the south-east, Berasia shrub forests in the west, upper and lower lake views, and various hill points. The city – also referred to as the ‘city of lakes’ – falls under the humid-tropical climatic zone, which contributes to its micro-climatic variabilities to a great extent. However, the city’s topography and lack of effective plan implementation have led to Bhopal expanding not as a single city, but as a series of discrete townships which are spreading fast beyond its planning area, and with limited connectivity. This demand for constant infrastructural upgradation to meet the basic needs of a growing population has led to a stress on the micro-climate of the region.

Given the challenges that Bhopal city faces and against the backdrop of the Smart Cities Mission, the Ministry of Housing and Urban Affairs has initiated the “Climate Smart Cities Assessment Framework (CSCAF)” for smart cities in 2019. The framework aims to provide a roadmap for cities to combat climate change, through mitigation and adaptation measures, while planning their city-level development actions and policies. It is made up of 28

indicators across five sectors namely, energy & green buildings, urban planning, green cover & biodiversity, mobility & air quality, water resource management and waste management. By taking appropriate measures, cities can make a significant contribution to mitigating climate change and becoming resilient to its impacts. Bhopal has been amongst the top three performing state capital cities under the CSCAF 2.0, scoring well particularly in the sanitation sector.

In this context, WRI India is supporting EPCO, Department of Environment, and Department of Urban Development and Housing, Government of Madhya Pradesh as a technical partner in planning adaptation and mitigation strategies and building a city climate action plan (CAP) for the seven smart cities in MP. These climate action plans are based on the GHG emissions profile and vulnerability assessment of cities. They identify existing gaps through a review of data submitted by cities under the CSCAF 2.0 to identify key entry points in terms of recommendations to achieve the sectoral priorities of cities through a low-carbon and climate-resilient pathway. The CAP identifies action points based on the current sectoral gaps to address future climate risks across five thematic areas. It also proposes an institutional framework which is necessary to implement the recommendations outlined in the CAP.

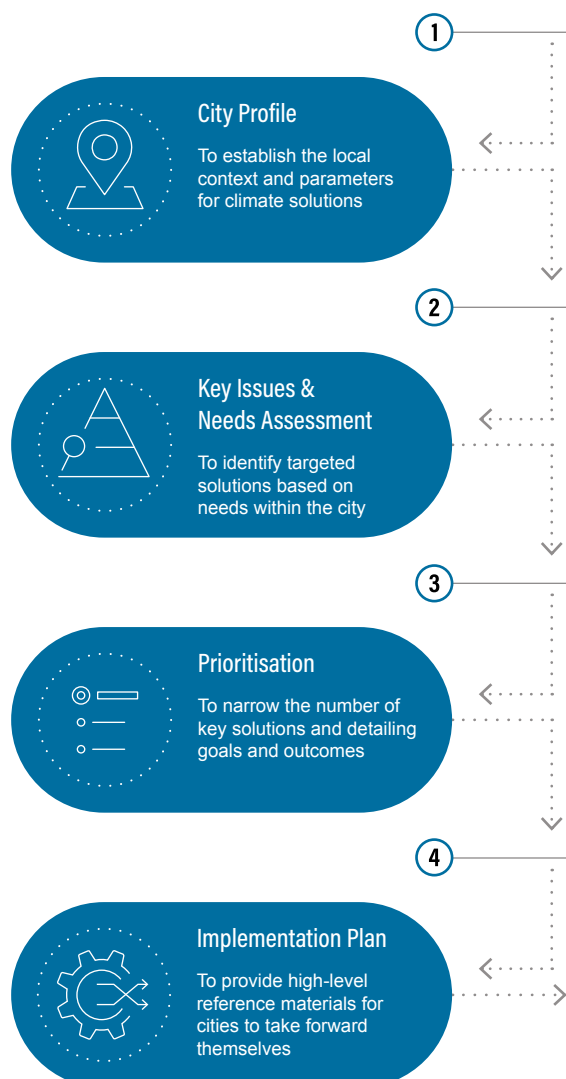
Climate Action Planning Process

WRI India adopted a 4-pronged approach in the entire process of preparing the Climate Action Plan (CAP) as illustrated in ES Figure 1:

- A planning-cum-launch workshop was organized in Bhopal on 20 February 2020 with participation from state and city officials, academicians, and civil society organizations to apprise participants of the relevance of developing these city-level plans and identify prominent development challenges and key climate risks for urban areas in Madhya Pradesh (MP).
- This was followed by an extensive desk review of the smart city proposal to identify the vision and key sectoral priorities envisaged by Bhopal city. A detailed climate profile of Bhopal city has been developed which includes temperature and rainfall projections, besides baseline and projected GHG inventory. The climate vulnerability assessment carried out by EPCO
- has been referred, to identify future climate risks. This review and analysis helped in drawing up a list of sectoral goals and actions which are outlined in the climate action plan.
- As the next step, a stakeholder consultation workshop was organized in Bhopal with participation from city officials, sectoral experts, and civil society representatives, to present the preliminary findings and seek inputs on the goals and actions proposed. This was used to develop the final CAP, which provides prioritized sectoral actions along with an implementation plan and CAP governance mechanism.

ES Figure 1: CAP development process (Source: WRI India)

INTENDED OUTCOME OF THE STEP



ENGAGEMENT OVERVIEW

1 City climate context workshop

Stakeholder consultations to identify:

- Priorities and brainstorm main challenge areas for emissions reduction across sectors
- Climate risks for resilience priorities
- On-going initiatives

2 Desk review and CSCAF performance analysis

Review of secondary literature to:

- Understand current performance levels
- Understand status of on-going initiatives
- Develop bucket list of solutions
- Draft report on city climate action for stakeholder consultation

3 Stakeholder engagement

Stakeholder consultations to:

- Assess societal, equity and spatial inclusion in the proposed solutions
- Align with current and future priorities
- Identify synergies with state and national level solutions

4 Dissemination workshop

Finalized city climate action plan:

- Climate vision and strategy for cities
- Inclusive solutions
- Prioritized actions across the sectors
- Implementation plan

Baseline Assessment

As highlighted in step 2 of the CAP planning process, a climate profile and baseline assessment for the city were developed using analysis from the CSCAF 2.0 along with an emissions inventory and vulnerability assessment of key urban climate risks.

| Climate Smart Cities Assessment Framework

Bhopal has performed above average in the first two rounds under CSCAF. The city has been performing extremely well in the waste management sector. It is reflected in its Swachh Survekshan rankings, being one of the cleanest capitals in the country. However, the city

must focus on improving its score and performance for indicators under the other sectors. Some of the current initiatives and possible areas of improvement have been highlighted in the table below.

| Greenhouse Gas Inventory

In 2019, Bhopal's GHG emissions were 2.5 mtCO₂e which was 1.1 tCO₂e per person. The emissions inventory was compiled according to the Global Protocol for Communities (GPC) BASIC standards using C40's City Inventory Reporting and Information System (CIRIS) tool. The inventory includes scope 1 emissions (GHG emissions from sources located within the chosen

ES Table 1: CSCAF 2.0 Scores for Bhopal (Source: CSCAF 2.0 submission by city)

Overall Score as per CSCAF 2.0	Energy and Green Buildings	Urban Planning, Green Cover and Biodiversity	Mobility and Air Quality	Water Management	Waste Management
★★★★	★★	★★★★	★★★★	★★	★★★★★
CSCAF 2.0 Score	205.5	244	201	145	567
Current measures being undertaken in the city	<ul style="list-style-type: none"> 37.35% of street lighting is LED and energy efficient City is promoting green buildings. Six Energy Conservation Building Code (ECBC) /Eco Niwas Samhita (ENS) compliant buildings have obtained construction approval through 2019-20. 5MW solar rooftop energy projects have been set up in the city as part of the city's solar energy project with lake front solar¹. 	<ul style="list-style-type: none"> >18% of the municipal area is under green cover Miyawaki plantation in place at various locations like Bhopal Water and Land Management Institute². Ankur program – where citizens are awarded for tree plantation – has been launched in the state and Pradhan Mantri Awas Yojana (PMAY) has been linked to it. Bhopal has initiated a city level biodiversity management committee, calculated its city biodiversity index, developed a people's biodiversity register and identified measures within the green and blue master plan to increase biodiversity. 	<ul style="list-style-type: none"> 18% of buses run on CNG³. Metro under construction⁴. Clean Air Action Plan of the city is in place and under implementation. Monitoring daily air quality index levels and making it public. 215 low floor buses are in use, 275 more planned as of 2022³. Plans of electrifying public bike sharing system- 94 stations installed with 480 cycles in operation and currently 30000+ users registered⁵. Placemaking projects in certain areas such as New Market, Subhash school area, Alkpuri park, etc⁵. 	<ul style="list-style-type: none"> Conducted water resource assessment for future demand & supply for 5 years. Bhopal has carried out rapid flood/water stagnation risk assessment City has completed a project on 100% consumer metering through Supervisory control and data acquisition (SCADA)⁵. 	<ul style="list-style-type: none"> Bhopal city has authorized and integrated waste pickers⁶. 100% of segregated domestic waste is collected at doorstep⁶. 96% of the wet waste is recycled in the city using four composting pits⁶. Six MRFs (material recovery facilities) for dry waste processing⁶. 100% C&D waste is being processed in a 100 TPD plant and used in low lying areas and paving blocks⁶.
Areas of improvement	<ul style="list-style-type: none"> Reducing transmission and distribution losses from 28% in 2019⁷. Increasing power generation from RE sources (0.05% currently). Promoting and adopting green buildings. 	<ul style="list-style-type: none"> City should monitor the impact of the biodiversity strategies. There is a need to monitor, update & mainstream the disaster management plan within departmental plans. 	<ul style="list-style-type: none"> Increasing the number of buses, only 0.09 buses are available per 1000 population. Increasing the NMT coverage of road length (15.56% currently). Increasing uptake of clean fuel vehicles (less than 15% of shared mobility vehicles run on clean fuels) 	<ul style="list-style-type: none"> Reducing NRW (currently between 20-30%). Increasing the access to drinking water to more than 90% citizens (currently 82%⁸) Increasing the percentage of wastewater recycled (<5% currently) 	<ul style="list-style-type: none"> Capturing of methane gas from scientific landfill and sewage treatment plants. Need for more waste transport infrastructure, 41 new vehicles for collecting garden waste and construction and demolition waste are needed⁶.

Overall Score as per CSCAF 2.0	Energy and Green Buildings	Urban Planning, Green Cover and Biodiversity	Mobility and Air Quality	Water Management	Waste Management
	<ul style="list-style-type: none"> Increasing energy efficient streetlighting. 		<ul style="list-style-type: none"> City should strengthen the institutional capacity to implement the clean air action plan and conduct an impact assessment of actions. 	<ul style="list-style-type: none"> Bhopal needs to prepare a water resources management plan with short-, medium- and long-term actions. City should prepare and implement a flood management plan. Should conduct an energy audit of the water supply system and wastewater pumping stations and treatment plants 	<ul style="list-style-type: none"> Need to increase capacity for bio-methanation to treat remaining 4% of organic waste⁶.

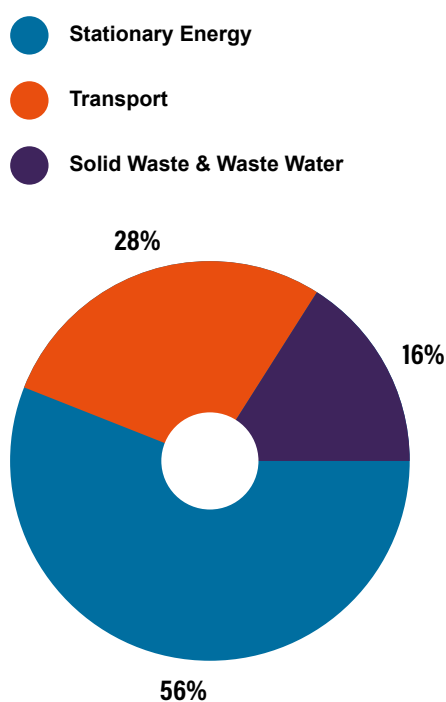
boundary), scope 2 emissions from grid supplied electricity and scope 3 emissions from waste sector alone (GHG emissions that occur outside the city boundary as a result of activities taking place within the city boundary). Stationary energy contributes 56% to the city's total emissions, followed by 28% from transportation. Waste and wastewater sector contributes 16% to the total emissions (ES Figure 2).

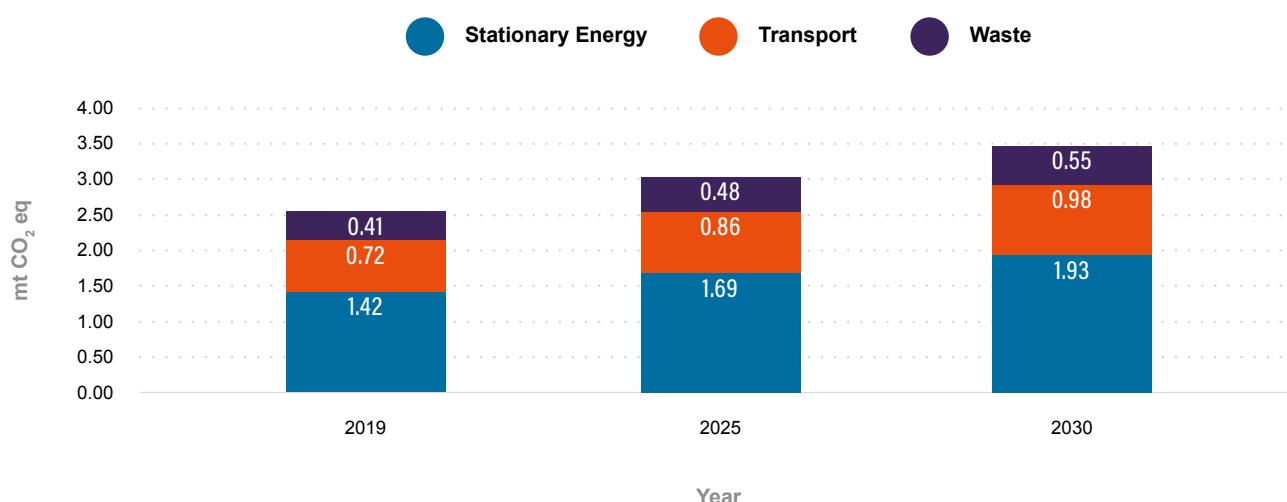
The business-as-usual projected emissions for Bhopal are presented in ES Figure 3. The emissions are projected to increase by 18.6 % by 2025 and 40% by the end of the decade till 2030 compared to the baseline emissions of 2019. This creates an urgent need for the city to implement measures presented in the report for achieving its vision of low carbon and climate resilient development.

Vulnerability analysis

According to this analysis, Bhopal has a low composite vulnerability, driven largely by the socioeconomic indicators. In terms of water resources, Bhopal falls under high vulnerability with a very high risk of decreasing availability of water, increasing crop water stresses and increase in frequency of extreme events like floods and droughts. Bhopal fares well in the forest sector owing to the large green cover. However, the projected changes in temperature and rainfall as well as variability in both are likely to result in increased climate risks.

ES Figure 2: Sectoral GHG Emissions Profile (Source: WRI analysis using primary data)



ES Figure 3: Projected emissions for Bhopal (Source: WRI India analysis using primary data)**ES Table 2:** Future Climate Risks for Bhopal (Source: CEEW)

Projected Climate Changes	Potential Impacts and Risks
Warmer conditions, including more intense and frequent high-temperature extremes and heat wave days.	<ul style="list-style-type: none"> Data indicates a clear trend towards higher temperatures and more frequent high temperature extremes, potentially leading to human heat stress and other negative health effects including potential increase in mortality. Negative impacts on labor productivity, particularly on outdoor workers and increase in cooling demand are also likely.
Higher annual rainfall totals and change in frequencies	<ul style="list-style-type: none"> Total rainfall can increase by an average of 8% in 2050 with the number of heavy rainfall days increasing by an average of four days. This can lead to a potential increase in flood risk.

Goals and Sectoral Strategies

The table below summarizes the goals and actions which the city may adopt to become low carbon and climate

resilient while also addressing concerns of equity and inclusivity in development.

ES Table 3: Summary of goals and actions for Bhopal (Source: WRI India)

Goals	Actions	Outcomes
Goal 1 Transform Bhopal into a solar city	<ul style="list-style-type: none"> Promoting energy efficiency improvements and renewable energy use in MSMEs Piloting solar bus stops Exploring common solar PV projects for low-income community housing Installing solar water heaters and solar photovoltaic panels on rooftops of educational institutions Incentivizing installation of rooftop solar panels and solar water heaters in all new residential constructions 	<ul style="list-style-type: none"> Sensitization of MSMEs and reduced emissions from industrial sector Long term reduced overall electricity consumption and costs Benefits for MSMEs due to reduced power bills Improved air quality Increased job opportunities Increased city wide off-grid supply source

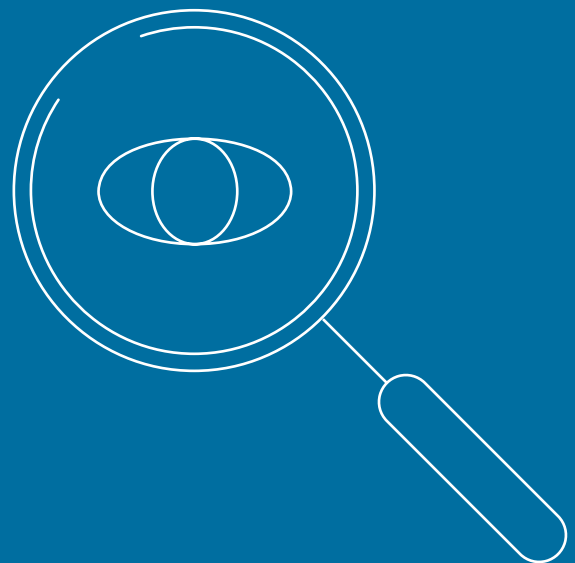
Goals	Actions	Outcomes
	<ul style="list-style-type: none"> Initiatives towards reduced transmission and distribution losses 	<ul style="list-style-type: none"> 100% RE-powered educational campuses Green hospitals and hotels PPP engagement for efficient infrastructural distribution Reduction in emissions from the consumption of grid supplied electricity Improved access to energy Reduced power cuts Improved health benefits Better market for RE technologies Increased institutional capacity within in-line department
Goal 2 Sustainable & circular waste management economy in Bhopal	<ul style="list-style-type: none"> Innovative models for managing electronic waste in Bhopal Piloting fuel generation from plastic waste Connecting all the vegetable and fruit markets in the city with the proposed 200 TPD bio-CNG plant Upgrading waste collection and transportation infrastructure to electric vehicles Public-private partnership models for managing construction and demolition waste 	<ul style="list-style-type: none"> Formalization of informal waste sector Driveway for skill-development capacities among the marginalized Creates jobs for self-help groups Mechanized e-waste recycling and refurbishment Reduced waste transportation costs Reduced emissions caused by landfill gas Reduced daily waste collection trips Decreased open ground dumping and better landfill management after implementation of the plan
Goal 3 Greening the transport sector in Bhopal	<ul style="list-style-type: none"> Improving last mile connectivity of planned metro in Bhopal Piloting electric buses as part of Mybus (Bhopal BRTS) NMT focused street design guidelines for Bhopal Promoting electric two wheelers in Bhopal Fuel efficiency training and management for public and private bus operators Increasing the spatial network of Pollution Under Control (PUC) certificate and Ambient Air Quality (AAQ) Monitoring System stations in the city 	<ul style="list-style-type: none"> Increased NMT infrastructure Decreased air pollution due to transport Increased availability and accessibility of public transport Reduced emissions from transport Improved access and last mile connectivity
Goal 4 Green & inclusive spaces in Bhopal	<ul style="list-style-type: none"> Engaging citizens in urban green cover conservation Promoting green terraces and kitchen gardens in residential buildings and schools Bioremediation for conserving the Bhoj wetland (upper and lower lakes) Institutionalizing a tree cell to prevent illegal logging and implementing policies for scientific transplantation and heritage tree protection Data, information, and awareness for biodiversity conservation 	<ul style="list-style-type: none"> Improved flood resilience Improved carbon sequestration Better physical health benefits Decreased air pollution

Goals	Actions	Outcomes
Goal 5 Water-resilient Bhopal	<ul style="list-style-type: none"> Developing and implementing a demand management plan for Bhopal city Developing and implementing an integrated flood and storm water management plan Implementing solar-powered sewage treatment plants 	<ul style="list-style-type: none"> Increased access to potable water Increased flood resistance Better sewage management Reduced water costs and improved equitable access Reduced emissions from water treatment Better demand management Increased ground water table
Goal 6 Sustainable & climate-resilient infrastructure in Bhopal	<ul style="list-style-type: none"> Implementing measures to promote green buildings in Bhopal Promoting low-carbon, ECBC compliant development in the construction of government housing phase II & III under ABD, heritage development of Sadar Manzil and place making projects Promotion of green and cool roofs in residential projects/ colonies/apartments to reduce cooling demand 	<ul style="list-style-type: none"> Climate-resilient urban housing Improved access to housing for all Better energy demand management Energy savings Improved access to energy and water CSCAF's indicator 5 & 6 under energy & green buildings, indicator 3 under water resource management addressed

The city's authorities can select actions and sectoral strategies provided in this plan to develop a detailed implementation plan for pilot projects that can be rolled out in the short, medium, and long term. The GHG emission profile of the city included in the plan may be used as a guiding analysis to prioritize implementation of actions in different sectors. The plan also provides guidance on mainstreaming actions with existing policies, schemes, and programs to establish convergence of implementation.

Lastly, this plan must be treated as a dynamic document and must be updated regularly with the latest emissions profile of the city. Instituting a climate change cell at the city-level with representation of ULB departments concerned, smart city officials, citizen forums, academic institutions and civil society becomes necessary to lead and coordinate this process. Organizing periodic stakeholder consultations would help in strengthening the plan as per the evolving requirements of the city.

INTRODUCTION



Cities are significant contributors to climate change and are also vulnerable to its consequences. By taking appropriate measures, cities can make a significant contribution to mitigating climate change and becoming resilient to its impacts. State Action Plans for Climate Change (SAPCC) have served as the primary policy document guiding climate actions at the sub-national level. Thus, any city-level climate action must be in synergy with the SAPCC. The actions that cities take would not just help India meet its international NDC commitments but also help it achieve the Sustainable Development Goals (SDGs).

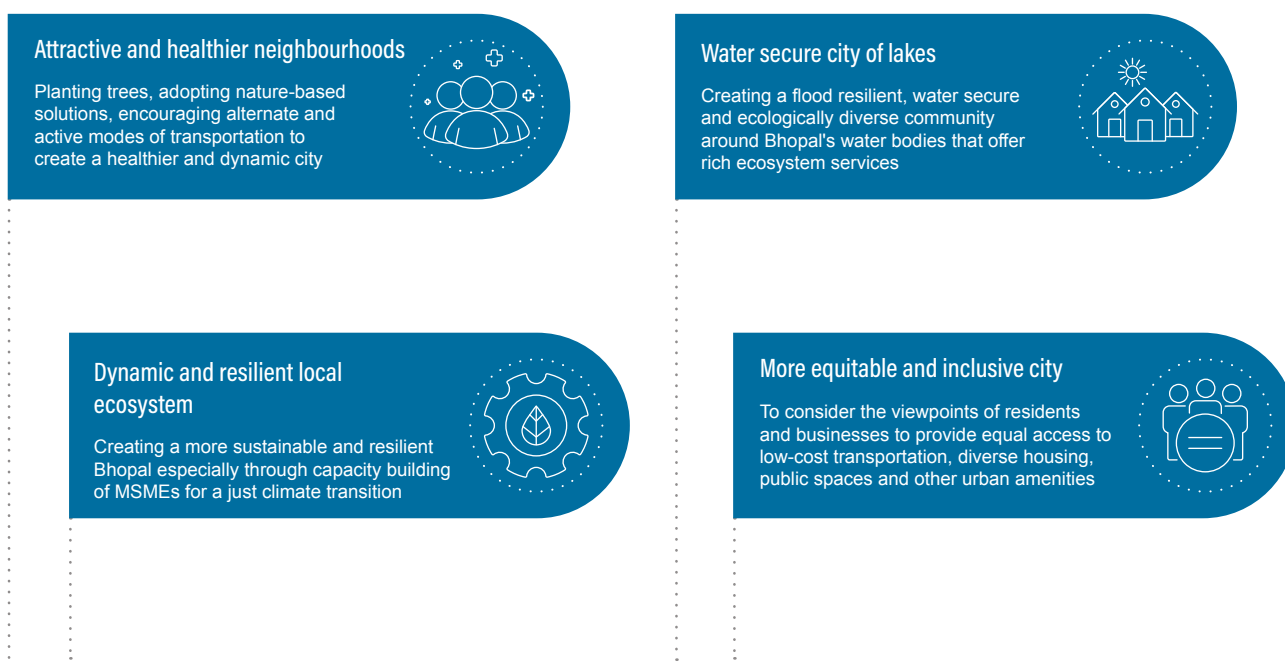
In this context, World Resources Institute India has partnered with State Knowledge Management Centre on Climate Change, EPCO, Department of Environment, Government of Madhya Pradesh, for supporting Department of Urban Development and Housing, Government of MP and seven Smart Cities in MP, to build their capacities in terms of planning adaptation and mitigation strategies, and to develop a city climate action plan in line with the Climate Smart Cities Assessment Framework (CSCAF 2.0) launched by the Ministry of Housing & Urban Affairs, Government of India.

Vision of Bhopal Climate Action Plan

Bhopal Climate Action Plan envisions a city of the future of international standard – a vibrant, equitable city, strengthened through its diversity; a city that provides real quality of life; a city that provides sustainability for all its citizens and enables a low-carbon, climate-resilient and adaptive society. The role of the Bhopal City Climate Action Plan is about more than just reducing negative

effects on the environment; it is about making holistic improvements to Bhopal's community and way of life. Taking cues from the risks that climate change poses to future generations living in the city, the CAP recognizes that actions must be taken on priority towards six goals to provide community benefits across the following areas:

Figure 1: Vision for Bhopal (Source: WRI India)



Climate Action Planning Process

WRI India adopted a 4-pronged approach in the entire process of preparing the Climate Action Plan (CAP) as illustrated in Figure 2.

- To kick-start the process of developing the CAP, a planning-cum-launch workshop was organized in Bhopal on 20 February 2020 with participation from state and city officials, academicians, and civil society organizations. The idea of the workshop was to apprise the participants and cities about the importance and relevance of developing these city-level plans, to brainstorm and identify prominent development challenges and key climate risks for urban areas in MP, and to understand the ongoing initiatives in order to establish a local context for climate solutions.

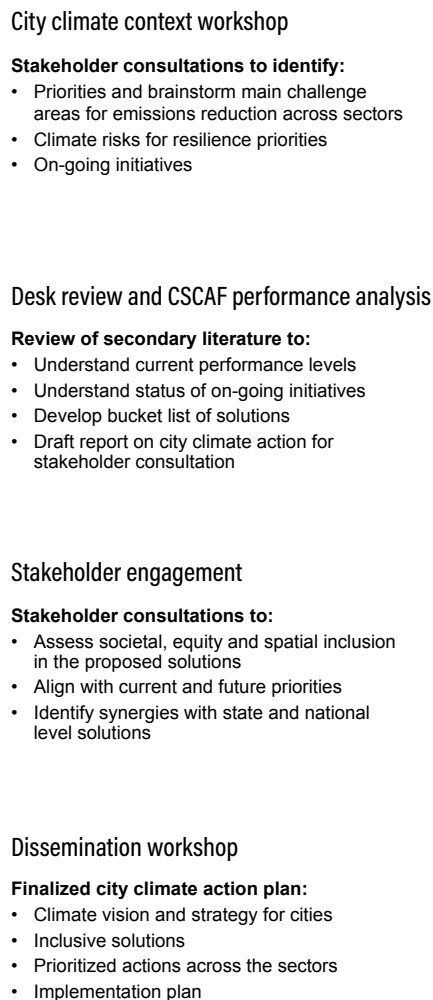
- This was followed by an extensive desk review of the smart city proposal and current project list to identify the vision and key sectoral priorities envisaged by Bhopal city. A thorough review of submissions made by Bhopal as a part of CSCAF 2.0, sectoral plans, government reports and other documents was done to identify key issues and gaps in achieving the sectoral priorities. A detailed climate profile of Bhopal city has been developed which includes temperature and rainfall projections, a baseline and projected GHG inventory. The climate vulnerability assessment carried out by EPCO has been used to identify future climate risks. This review and analysis helped in drawing up a list of sectoral goals and actions which are outlined in the climate action plan.

Figure 2: CAP development process (Source: WRI India)

INTENDED OUTCOME OF THE STEP



ENGAGEMENT OVERVIEW



- As the next step, in order to narrow the number of sectoral actions and detail the goals and outcomes, a stakeholder consultation workshop was organized in Bhopal in September 2021, with participation from city officials, sectoral experts and civil society representatives. The preliminary findings were presented during the workshop and inputs were sought on the goals and actions proposed for a low-carbon and climate-resilient development pathway for Bhopal. These consultations also provided inputs for bringing inclusion principles in the actions, aligning the actions with current and future priorities of Bhopal city as well as with state and national programs.
- The final CAP provides prioritized inclusive sectoral actions along with an implementation plan and CAP governance mechanism for effective coordination and monitoring.



Source: Bhopal Smart City Development Corporation Ltd.

CITY PROFILE



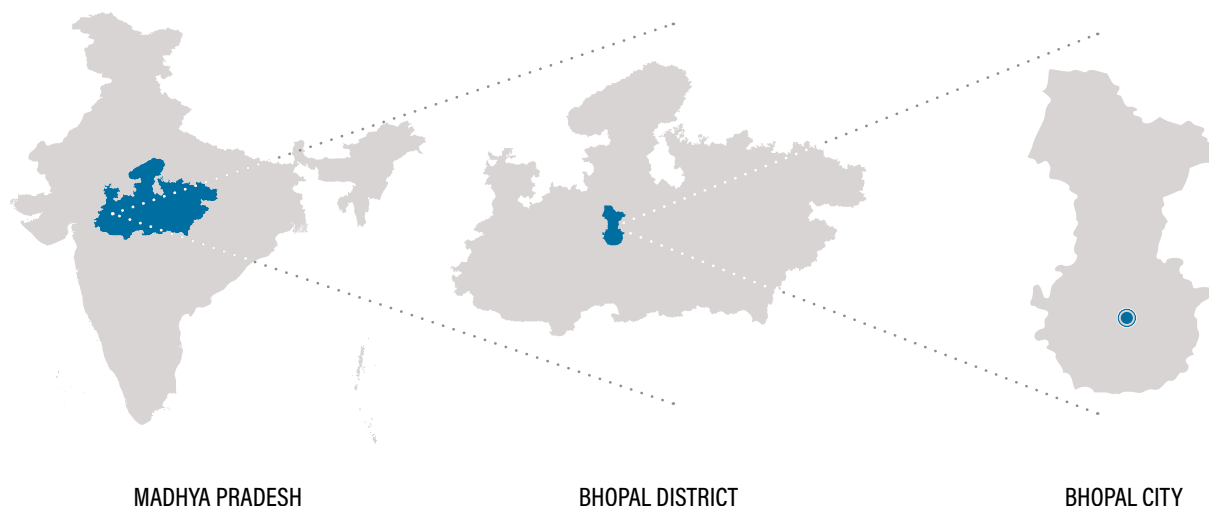
Bhopal in the state of Madhya Pradesh in central India is one of the first 20 cities to be selected under the Smart cities mission. Bhopal was also rated as the greenest city and the cleanest state capital city in India for three consecutive years – 2017, 2018 and 2019⁹. Being the state capital and the district headquarters, Bhopal is situated in the Vindhya and Malwa plateau region (23°16'N, 77°22'E)⁸ and has a unique physiography with the Narmada valley in the central-east, Bhoj wetland towards the south-east, Berasia shrub forests in the west, upper and lower lake views, and various hill points. The city – also referred to as the 'city of lakes' – falls under the humid-tropical climatic zone, which contributes to its micro-climatic variabilities to a great extent. Located at 192 km from Indore and surrounded by significant tourist and trade destinations, the city is well connected by road, rail, and air routes. In the past years, there has been a rapid rise in the urban sprawl due to the prevailing educational facilities, job opportunities and health-infrastructure developments. New developments are concentrated largely in the southeast quadrant of Bhopal, along the Hoshangabad Road, driven by investments in transportation corridors with large roadways and availability of cheaper land. However, the city's topography and the lack of an effective implementation plan has led to Bhopal expanding not as a single city, but as a series

of discrete townships that are spreading fast beyond its planning area, and with limited connectivity. This demand for constant infrastructural upgradation to meet the basic needs of a growing population has led to a stress on the micro-climate of the region⁸.

According to the 2011 Census, the population of Bhopal city (the area under Bhopal Municipal Corporation) was 1,798,218, with 936,168 males and 862,050 females. The highest average elevation is 542m and the lowest elevation is 479m above mean sea level. Presently Bhopal municipal corporation has a population of 23,71,000, across 85 wards¹⁰ occupying a total area of 417.8 km². Its population density is 50 persons per hectare (PPH), which is quite less compared to the other cities of Madhya Pradesh¹¹.

With a decadal growth rate of 27.53%¹⁰, mostly due to migrant labor in the industrial township of Bharat Heavy Electricals Limited (BHEL), on one hand, there is a huge pressure on the city to address challenges related to urban infrastructure along with tackling climatic impacts. On the other hand, this growing metropolis also brings many opportunities to upgrade and plan urban development in a climate-smart and resilient manner to minimize its greenhouse gas as well as air pollutant emissions.

Figure 3: Map of Bhopal (Source: WRI India)

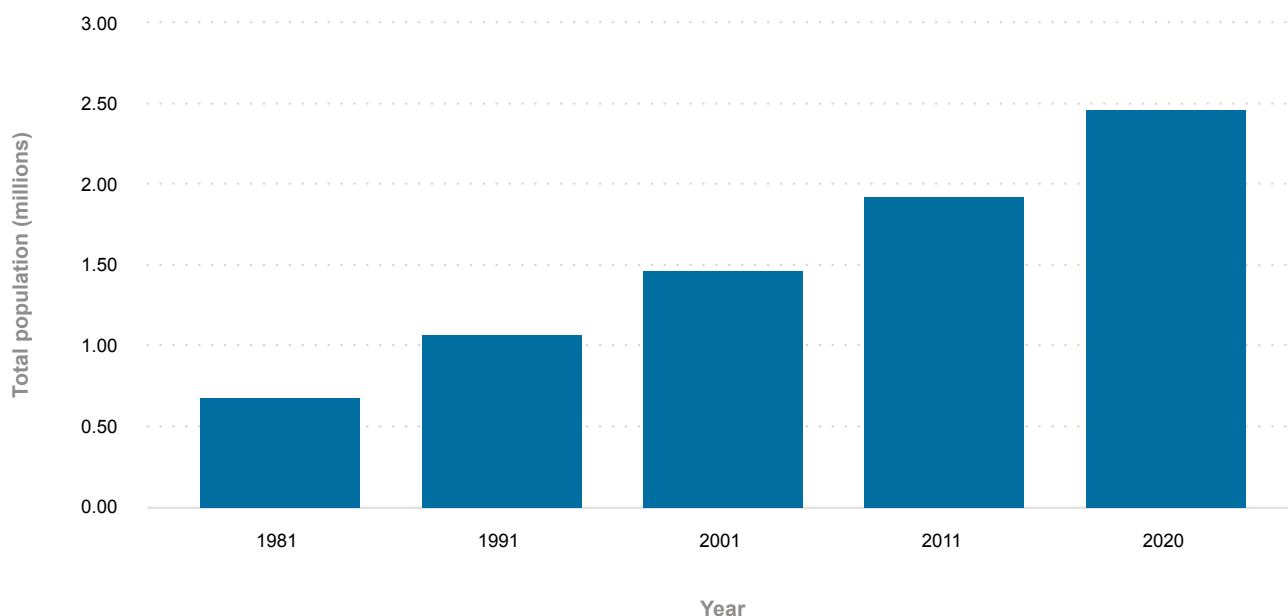


Demography

The city primarily has a young demography due to premier educational institutions. The population of Bhopal city increased from approximately 1.4 million to 1.9 million between 2001 and 2011. The decadal growth rate of 31% during that period is higher than the state figure of 20.3%. Population growth can be attributed to migration from

surrounding rural areas due to excellent overall quality of life and moderate cost of living. The highest growth in population happened in the last decade of the census, indicating the inward migration due to economic opportunities available in the city (Figure 4).

Figure 4: Population growth in Bhopal between 1981-2020 (Source: Census of India and CSCAF 2.0)



The population of Bhopal city was 23.7 lakh in 2020 spread across a municipal area of 417.8 km² making it a densely populated city with 5672 people residing per

sq.km¹². The demographic indicators, based on the last two census rounds, are presented in the table below:

Table 1: City statistics (Source: Census 2011)

Particulars	2001 ¹³			2011 ¹⁴		
	Total	Males	Females	Total	Males	Females
Population	14,58,416	7,68,391	6,90,025	17,98,218	9,36,168	8,62,080
Literates	9,94,330	5,63,187	4,31,143	13,20,675	7,20,207	6,00,468
SC Population	180,474	94,562	85,912	2,42,103	1,25,393	1,16,710
ST Population	43,782	23,125	20,657	46,076	23,863	22,213
Total Workers	4,32,372	3,60,984	71,388	6,31,112	4,90,496	1,40,616
Number of Households	2,83,176			3,82,690		
Slum Households	1,25,720			1,02,803		

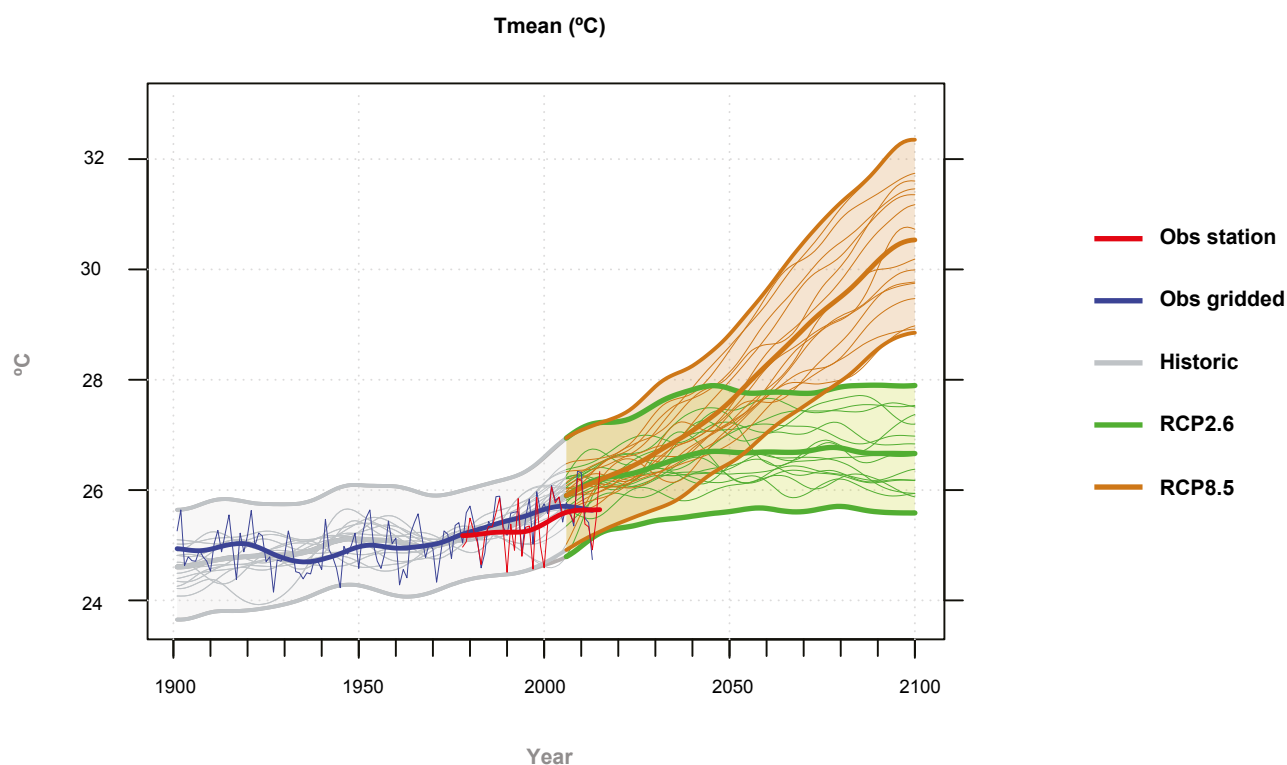
Climate Profile

Bhopal has a moderate climate with temperature ranging from 10°C to 40°C. It receives an annual rainfall of 1260 mm¹⁵. The climate risk profile of Bhopal city, as outlined in the analysis below, focusses on observed changes and future projections of temperature and rainfall. Projections are provided for two emissions scenarios of two different representative concentration pathways (RCPs), which

span the range considered in the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC):

- RCP8.5: A high-end 'business-as-usual' scenario.
- RCP2.6: A low-end, mitigation scenario (consistent with the objective of the 2015 Paris Agreement to limit the global temperature increase to 2°C or lower compared to pre-industrial conditions).

Figure 5: Increase in mean annual temperature for Bhopal (Source: CEEW)

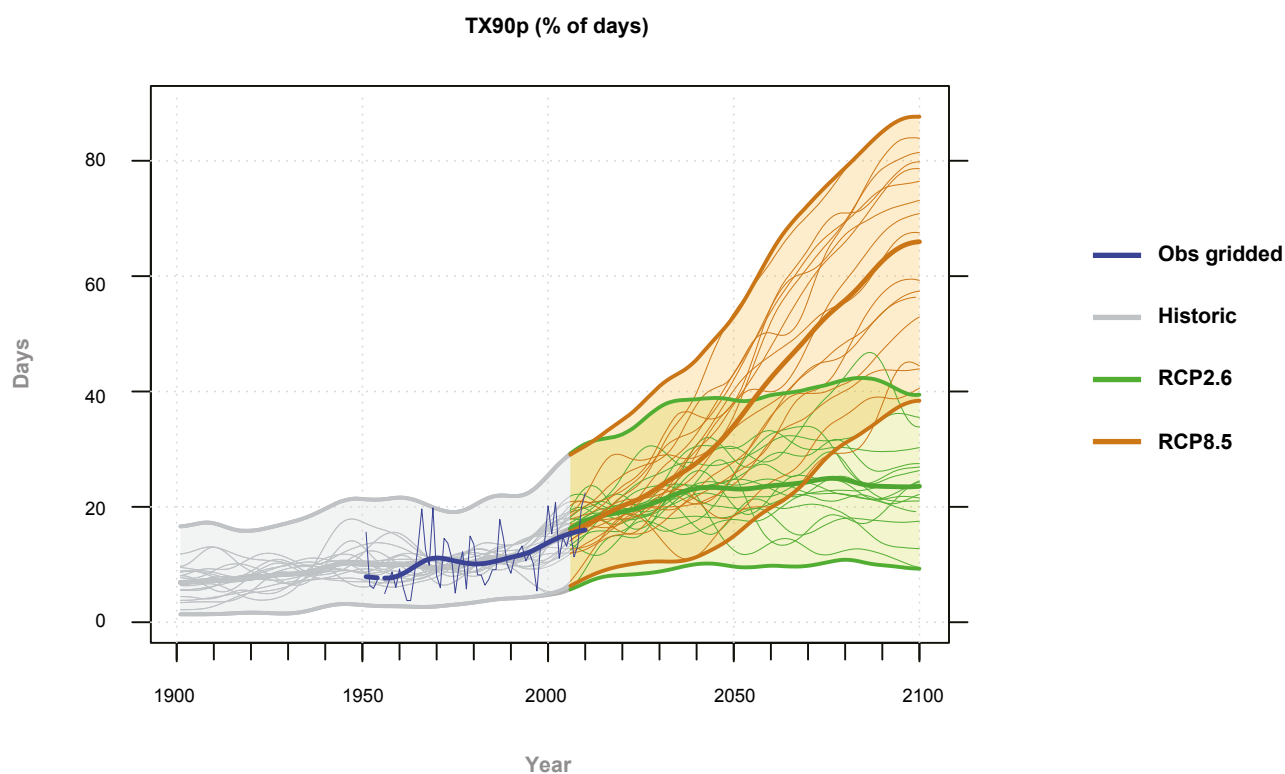


Temperature

The observations as well as simulations show an upward trend in mean annual temperature (Figure 5). Under a high emissions scenario (RCP 8.5), this trend is projected to

continue until the end of the century, with a rise of 4.3°C on an average from 1981-2010 to 2071-2100. If emissions decrease rapidly in a low emissions or RCP 2.6 scenario, this rise is limited to about 1.2°C on an average¹⁵.

Figure 6: Increase in temperature extremes for Bhopal (Source: CEEW)

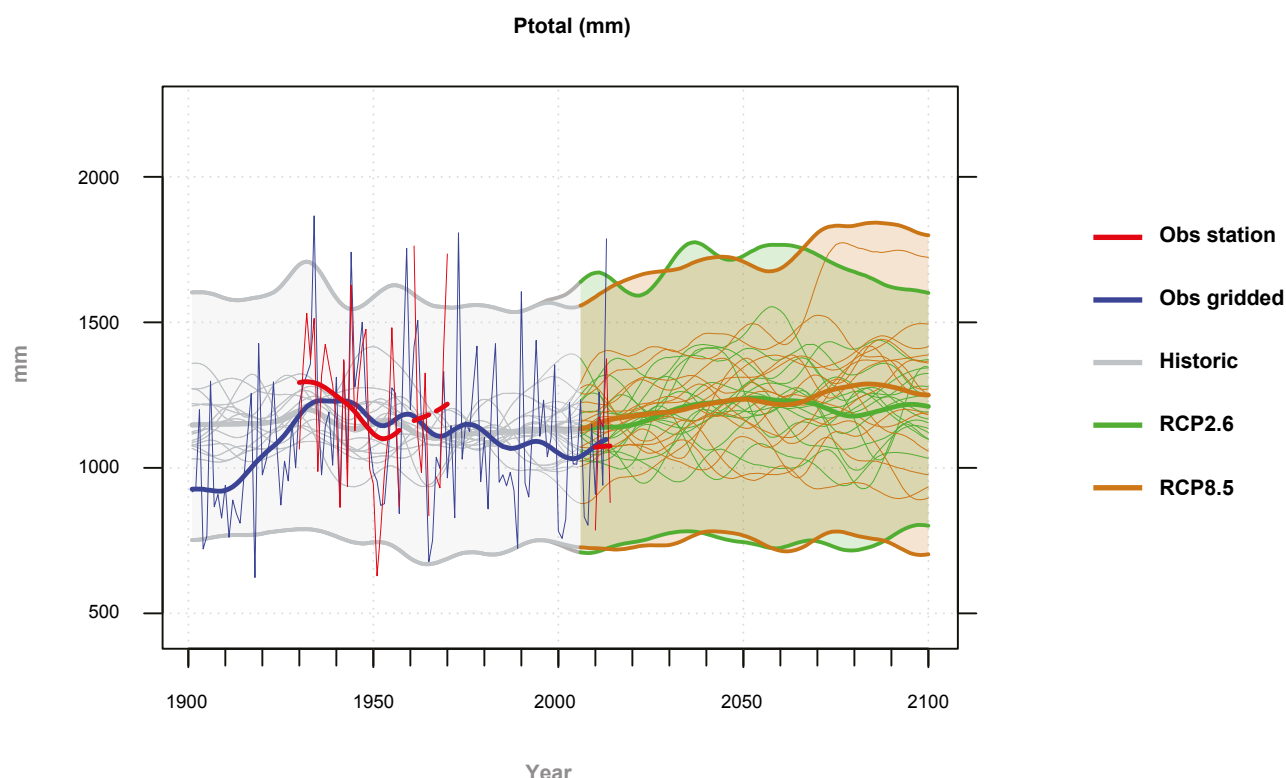


The observations and simulations on temperature extremes (figure 6) are consistent in indicating more high temperature extremes (warm days and warm nights, days of heat wave) and fewer cold temperature extremes (cold days and cold nights, days of cold wave). The number of warm days is projected to increase by about 50 days on an average from 1981-2010 to 2071-2100 under a high emissions scenario (and the number of heat wave days to increase by around 170 days on an average). If emissions decrease rapidly, the increase in warm days is limited to about 10 days on an average, and the increase in heat wave days is about 30 days on an average.

Rainfall

The rainfall observations (figure 7) are dominated by large decade-to-decade and year-to-year variability. The simulations show a general tendency towards increasing total annual rainfall, although the variability is large. Under a high emissions scenario, total annual rainfall is projected to increase by about 145mm on an average from 1981-2010 to 2071-2100. If emissions decrease rapidly, this rise is limited to about 70mm.

Figure 7: Increase in mean precipitation for Bhopal (Source: CEEW)



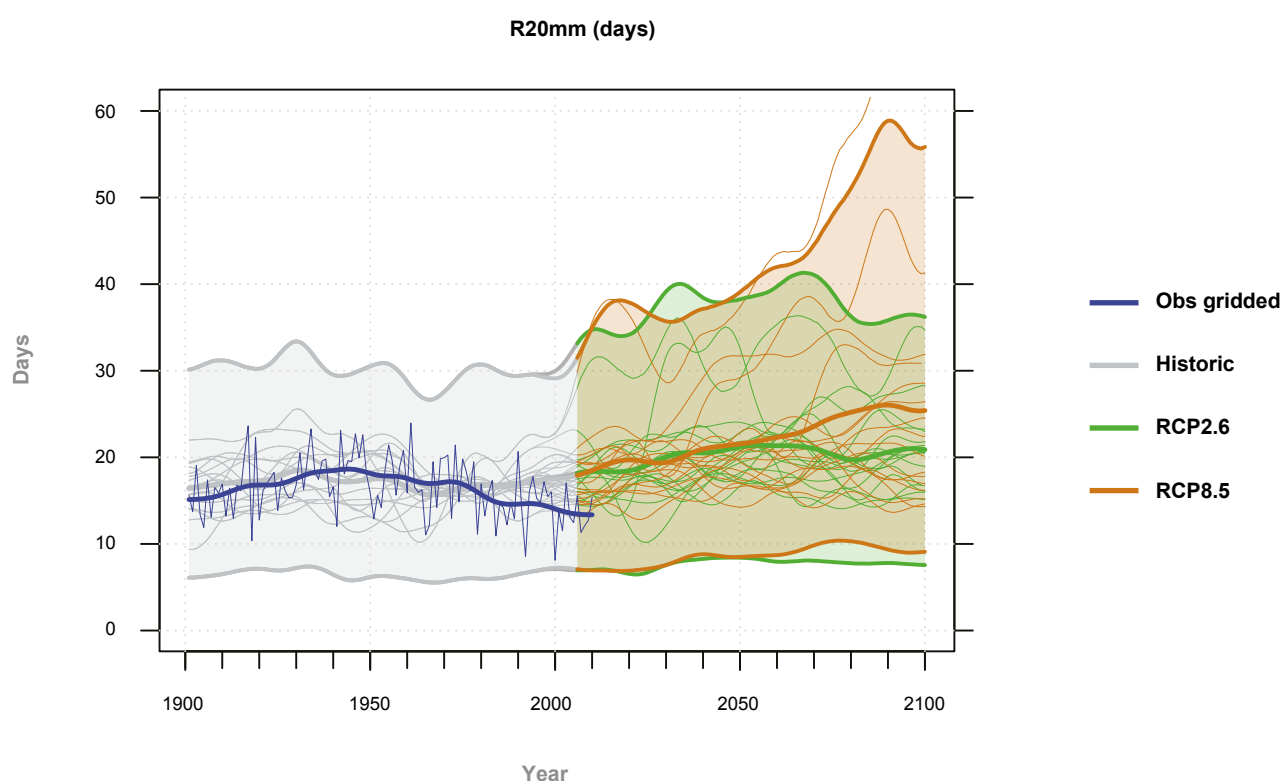
The number of days per year with a rainfall greater than 20mm (shown in the Figure 8) is projected to increase by about 8 days on an average from 1981-2010 to 2071-2100 under a high emissions scenario.

Table 2 shows the projected changes in 30-year averages, with respect to a present-day baseline of 1981-2010, for the '2030s' (2021-2050), the '2050s' (2035-2064) and the '2080s' (2071-2100). The average of gridded observations is also shown for 1981-2010. The average change is shown in each case, together with an indication of the uncertainty range across the models (in brackets – the 90% range).

For temperature, the lower end of the range is always positive – indicating a robust pattern of change towards

higher temperatures. For rainfall, the lower end of the range is negative, with larger positive changes at the upper end of the range. This indicates greater uncertainty in the direction as well as the magnitude of rainfall change than in the case of temperature.

For the 2030s and 2050s, only projections for the higher RCP8.5 emissions scenario are given. As the time series plots show, there is very little difference between the two scenarios for the next couple of decades. By the 2080s, changes under the lower RCP2.6 emissions scenario (final column) are considerably reduced compared to the high emissions scenario¹⁵.

Figure 8: Number of heavy rainfall days for Bhopal (Source: CEEW)**Table 2:** Observed and projected changes for temperature and rainfall for Bhopal (Source: CEEW)

	Observed 1981-2010	2030s RCP8.5	2050s RCP8.5	2080s RCP8.5	2080s RCP2.6
Temperature					
Mean Temperature	25°C	+1.4 (0.9 to 1.7) °C	+2.1 (1.5 to 2.7) °C	+4.3 (3.0 to 5.4) °C	+1.2 (0.5 to 1.8) °C
Warm Days	13 days	+13 (7 to 20) days	+21 (9 to 32) days	+47 (27 to 64) days	+11 (4 to 23) days
Warm Nights	13 nights	+21 (14 to 28) days	+33 (24 to 46) days	+62 (51 to 75) days	+16 (6 to 27) days
Rainfall					
Total Rainfall	1048 mm	+7 (-4 to +17) %	+8 (-7 to +18) %	+13 (-8 to +29) %	+6 (-6 to +19) %
Heavy Rainfall Days	14 days	+3 (-1 to +9) days	+4 (-1 to +14) days	+8 (0 to +27) days	+3 (-1 to +10) days
Consecutive Dry Days	98 days	+3 (-11 to +21) days	+4 (-14 to +23) days	+5 (-17 to +29) days	0 (-13 to +9) days

Key messages and implications for climate change risk assessment for Bhopal:

- Bhopal's climate is subject to large year-to-year variability, particularly for rainfall. Thus, even in the absence of anthropogenic climate change, the city needs to be resilient to this natural variability.
- Observed data shows emerging trends in temperature over the last few decades in particular, a clear trend towards higher temperatures and more frequent high temperature extremes.
- Climate projections show a strengthening of the observed temperature trends, particularly with higher greenhouse emissions, as well as a tendency towards somewhat higher rainfall totals and more intense and frequent rainfall extremes.
- If global warming can be constrained to 2°C or less with respect to pre-industrial conditions, the impacts of climate change would be substantially reduced for Bhopal, particularly in the second half of the century.

Table 3: Climate change and potential risks for Bhopal (Source: CEEW)

Projected Climate Changes	Potential Impacts and Risks
Warmer conditions, including more intense and frequent high-temperature extremes and heat wave days.	<ul style="list-style-type: none"> • Data indicates a clear trend towards higher temperatures and more frequent high temperature extremes, potentially leading to human heat stress and other negative health effects including potential increase in mortality. • Negative impacts on labor productivity, particularly on outdoor workers and increase in cooling demand are also likely.
Higher annual rainfall totals and change in frequencies	<ul style="list-style-type: none"> • Total rainfall can increase by an average of 8% in 2050 with the number of heavy rainfall days increasing by an average of four days. This can lead to a potential increase in flood risk.

Socio-economic Profile of Bhopal

The sex ratio of Bhopal municipal corporation stands at 920 females per 1,000 males as per Census 2011, which is less than the state's average of 931 and the national average of 940 per 1,000 males. The city has a literacy rate of 73.44%, with a male literacy rate of around 54% and female literacy rate of around 46%¹⁰.

There were 350 slums in Bhopal with a population of 4,78,650 as per a 2015 survey. This is around 26.6% of the total population of Bhopal city with higher vulnerabilities to climate risks like heat waves, urban flooding, and health impacts¹⁰. Hence Bhopal has to ensure that the climate actions have positive impacts across all these vulnerable groups in an inclusive manner. Bhopal houses the regional headquarters of numerous public sector banks, multinational corporations including insurance, financial services, and other service providers. Bhopal is also home to some of the most renowned institutions of national repute such as Maulana Azad National Institute of Technology, National Law Academy, School of Planning and Architecture, and Indian Institute of Science Education and Research (IISER) making it one of the largest educational hubs in the country. It houses various institutions and establishments of national importance such as BHEL, and the Master Control Facility of Indian Space Research Organisation (ISRO).

Bhopal has a leading media house, Dainik Bhaskar Group. Tourism is also a thriving industry, with several spots open for tourists like the Van Vihar National Park, upper lake, Birla Museum, etc.¹⁶. With 14 lakes, Bhopal is popularly known as the city of lakes, making it a tourist attraction. Plenty of heritage buildings and centers for art and culture such as the Bharat Bhavan and National Museum of Man draws many tourists. Three UNESCO sites including the famous Sanchi Stupa within 50 km of the city further add to the tourism potential.

Bhopal is industrially well-developed since it has a number of small and medium scale enterprises. Bhopal provides excellent overall quality of life and moderate cost of living (25% lower compared to the other metros) which has ensured availability of senior professionals and skilled workforce at competitive rates. The economy of Bhopal is mainly dependent on industries such as cotton, electrical goods, jewelry, and the chemical industry. Public sector enterprise BHEL has a unit in Bhopal. As a major manufacturer of electrical equipment, BHEL serves as an important employment provider for Bhopal and nearby areas. Bhopal's economy is essentially divided into modern and traditional industries. Over 1,200 Micro, Small and Medium enterprises (MSMEs) exist in Bhopal currently. MSMEs which account for more than Rs 7,100 crore of exports, needs a special focus as they can generate employment opportunities and enable skill development. The Madhya Pradesh State Electronics Development Corporation Ltd. is developing a software & hardware technology park in Bhopal. Multinational companies (MNCs) such as Taurus Microsystems, Fujitsu and Genpact are planning to set up their centers in this technology park¹⁶.

City Typology

To ensure that the CAP identifies relevant actions for vulnerable groups, a socioeconomic profile of the city has been developed. The methodology is adapted from the World Resources Report "Towards a More Equal City"¹⁷ and contextualized for the cities in MP. The method uses the following parameters to categorize the cities:

- Decadal population growth
- Decadal income growth
- Ratio of income growth to population growth

Cities are classified based on their current income and projected population and economic growth, which helps in identifying the cities that are likely to face the greatest challenges in providing urban services, as well as the cities that have the opportunity to avoid locking in unsustainable patterns of urban development.

Based on the above three parameters, the cities are classified into four categories as shown in the Figure 9.

- **Aspiring Cities** have a low GDP per capita today, and a low ratio of projected income growth to projected population growth during 2021-2030, compared to other cities. We classify these as aspiring cities because, in the near future, they are likely to experience more rapid population growth than economic growth, pointing to an impending resource gap.
- **Emerging Cities** have a low income today, and a high ratio of income growth to growth in population during 2021-2030, compared to other cities. While their economic strength is low today, their projected economic growth is greater than their projected population growth, indicating increases in economic productivity. These cities are more likely to have the capacity to overcome current resource constraints and strengthen their position globally.
- **Thriving Cities** are not only economically strong today, but their economic growth is also projected to outpace their urban population growth during 2021-2030. These cities are growing and thriving.
- **Stabilizing Cities** are economically strong today, but their economic growth is expected to be lower relative to their population growth during 2021-2030 when compared to emerging or thriving cities. In that sense, these cities are starting to stabilize, and in some cases, their economies are starting to shrink.

Figure 9: City Typology (Source: Adapted from World Resources Institute, 2016)



Figure 10: 2030 Transition of Bhopal city (Source: WRI India)

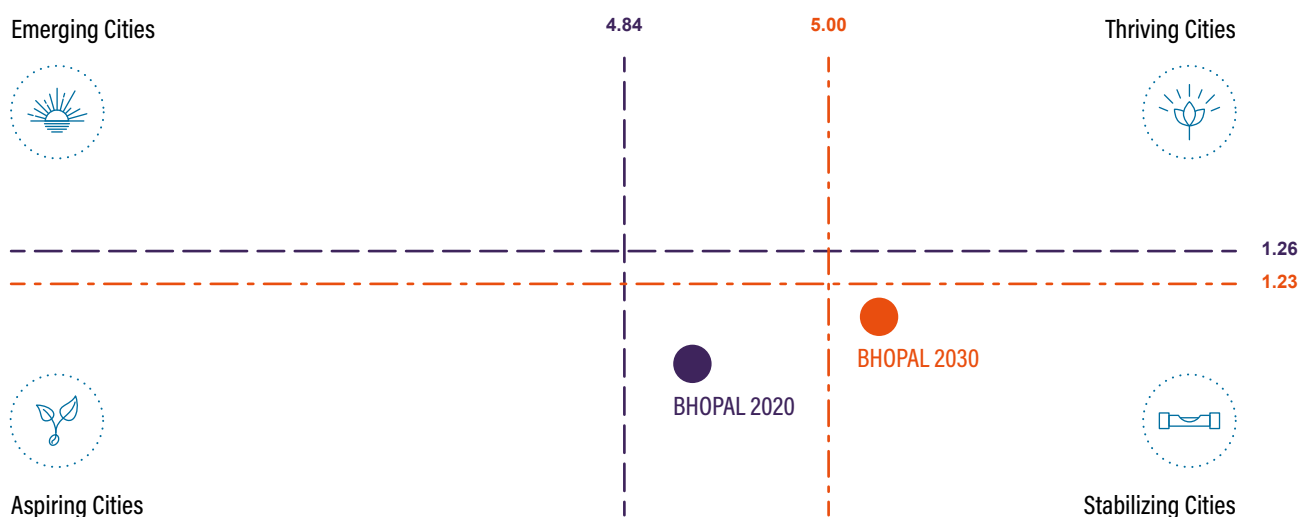


Figure 10 shows the socioeconomic transition of Bhopal city from the decade 2011-2020 to 2021-2030.

On the x-axis we have per capita GDP for the base year and on the y-axis the ratio of GDP growth to population growth. We have used logarithmic scale to respond to skewness towards the larger values. The point where both the axes cross is India's value.

Bhopal stays in the stabilizing city category in the decade till 2030. Bhopal has a high income today and will continue to have higher income levels compared to the national average till 2030. The city can capitalize on its current economic strength to implement actions proposed in this plan on a mission mode and simultaneously engage in awareness and capacity building towards optimal utilization of resources to inculcate behavioral change in its citizens.

BASELINE ASSESSMENT



CSCAF 2.0 Analysis

Bhopal has performed above average in the first two rounds under CSCAF. The city has been performing extremely well in the waste management sector, which is also reflected in its Swachh Survekshan rankings as one of the cleanest capitals in the country. However, the city

must focus on improving its score and performance for indicators under the other sectors. Some of the current initiatives and possible areas of improvement have been highlighted in the table below.

Table 4: CSCAF 2.0 Scores for Bhopal (CSCAF 2.0 submission for city)

Overall Score as per CSCAF 2.0	Energy and Green Buildings	Urban Planning, Green Cover and Biodiversity	Mobility and Air Quality	Water Management	Waste Management
★ ★ ★	★ ★	★ ★ ★	★ ★ ★	★ ★	★ ★ ★ ★ ★
CSCAF 2.0 Score	205.5	244	201	145	567
Current measures being undertaken in the city	<ul style="list-style-type: none"> 37.35% of street lighting is LED and energy efficient City is promoting green buildings. Six Energy Conservation Building Code (ECBC) /Eco Niwas Samhita (ENS) compliant buildings have obtained construction approval through 2019-20. 5MW solar rooftop energy projects have been set up in the city as part of the city's solar energy project with lake front solar¹. 	<ul style="list-style-type: none"> >18% of the municipal area is under green cover Miyawaki plantation in place at various locations like Bhopal Water and Land Management Institute². Ankur program – where citizens are awarded for tree plantation – has been launched in the state and Pradhan Mantri Awas Yojana (PMAY) has been linked to it. Bhopal has initiated a city level biodiversity management committee, calculated its city biodiversity index, developed a people's biodiversity register and identified measures within the green and blue master plan to increase biodiversity. 	<ul style="list-style-type: none"> 18% of buses run on CNG³. Metro under construction⁴. Clean Air Action Plan of the city is in place and under implementation. Monitoring daily air quality index levels and making it public. 215 low floor buses are in use, 275 more planned as of 2022³. Plans of electrifying public bike sharing system- 94 stations installed with 480 cycles in operation and currently 30000+ users registered⁵. Placemaking projects in certain areas such as New Market, Subhash school area, Alkpuri park, etc⁵. 	<ul style="list-style-type: none"> Conducted water resource assessment for future demand & supply for 5 years. Bhopal has carried out rapid flood/water stagnation risk assessment City has completed a project on 100% consumer metering through Supervisory control and data acquisition (SCADA)⁵. 	<ul style="list-style-type: none"> Bhopal city has authorized and integrated waste pickers⁶. 100% of segregated domestic waste is collected at doorstep⁶. 96% of the wet waste is recycled in the city using four composting pits⁶. Six MRFs (material recovery facilities) for dry waste processing⁶. 100% C&D waste is being processed in a 100 TPD plant and used in low lying areas and paving blocks⁶.

Overall Score as per CSCAF 2.0	Energy and Green Buildings	Urban Planning, Green Cover and Biodiversity	Mobility and Air Quality	Water Management	Waste Management
Areas of improvement	<ul style="list-style-type: none"> Reducing transmission and distribution losses from 28% in 2019⁷. Increasing power generation from RE sources (0.05% currently). Promoting and adopting green buildings. Increasing energy efficient streetlighting. 	<ul style="list-style-type: none"> City should monitor the impact of the biodiversity strategies. There is a need to monitor, update & mainstream the disaster management plan within departmental plans. 	<ul style="list-style-type: none"> Increasing the number of buses, only 0.09 buses are available per 1000 population. Increasing the NMT coverage of road length (15.56% currently). Increasing uptake of clean fuel vehicles (less than 15% of shared mobility vehicles run on clean fuels) City should strengthen the institutional capacity to implement the clean air action plan and conduct an impact assessment of actions. 	<ul style="list-style-type: none"> Reducing NRW (currently between 20-30%). Increasing the access to drinking water to more than 90% citizens (currently 82%⁸) Increasing the percentage of wastewater recycled (<5% currently) Bhopal needs to prepare a water resources management plan with short-, medium- and long-term actions. City should prepare and implement a flood management plan. Should conduct an energy audit of the water supply system and wastewater pumping stations and treatment plants. 	<ul style="list-style-type: none"> Capturing of methane gas from scientific landfill and sewage treatment plants. Need for more waste transport infrastructure, 41 new vehicles for collecting garden waste and construction and demolition waste are needed⁶. Need to increase capacity for bio-methanation to treat remaining 4% of organic waste⁶.

Greenhouse Gas Emissions Profile

The greenhouse gas inventory for Bhopal includes an analysis of all the sectors/ sources that emit GHGs into the atmosphere including transport, waste and energy. A citywide GHG inventory forms a critical piece of any

climate action plan, by establishing the activities that contribute towards emissions, and allows the city to develop mitigation policies and strategies.

Critical Emission Sources

In 2019, Bhopal's GHG emissions were 2.5 mtCO₂e which was 1.1 tCO₂e per person (including manufacturing and industrial sector emissions). The emissions inventory was compiled to the Global Protocol for Communities (GPC) BASIC standards using C40's City Inventory Reporting and Information System (CIRIS) tool. Stationary energy contributes 56% to the city's total emissions, followed by 28% from transportation. Waste sector contributes 16% to the city's total emissions (Figure 11). The inventory includes scope 1 emissions (GHG emissions from sources located within the chosen boundary), scope 2 emissions from grid supplied electricity. Waste sector alone includes scope 3 emissions as well (GHG emissions that occur outside the city boundary as a result of activities taking place within the city boundary).

The business-as-usual emissions are projected to increase by 18.6 % by 2025 and 40% by the end of the decade till 2030 compared to the baseline emissions of 2019. This creates an urgent need for the city to implement measures presented in the report for achieving its vision of low carbon and climate resilient development (Figure 12).

Figure 11: Percentage Distribution of Emissions by Sector
(Source: WRI India analysis using primary data)

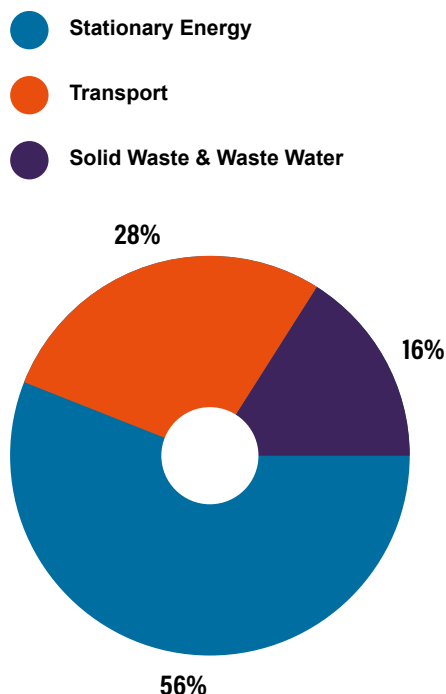
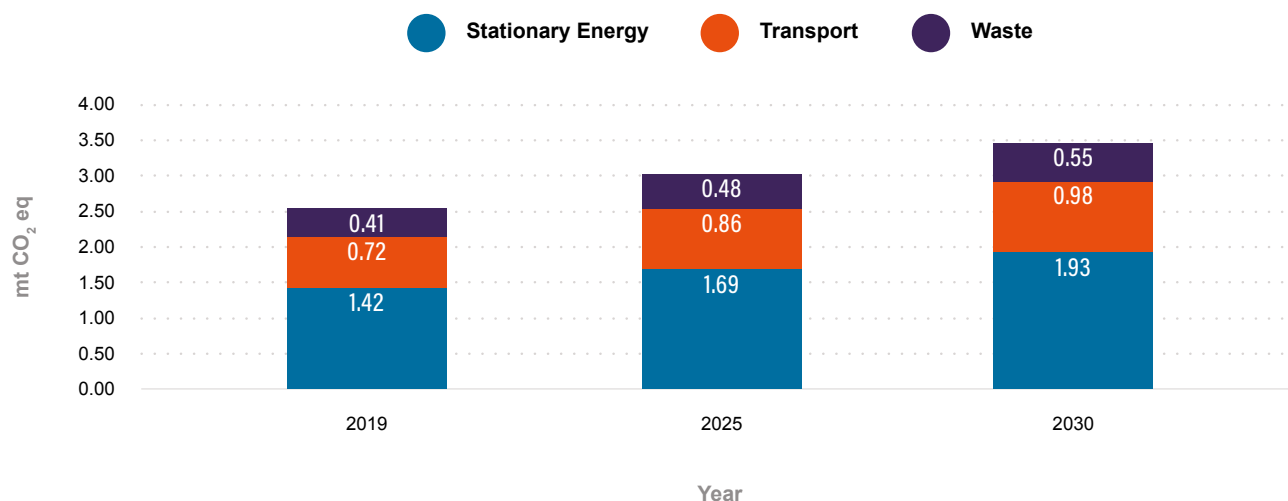


Figure 12: Projected emissions for Bhopal (Source: WRI India analysis using primary data)



Energy Sector Emissions

Stationary energy sector comprises of electricity and fuel consumption from (i) residential buildings (ii) commercial and institutional buildings (iii) manufacturing industries and

construction and (iv) urban agriculture. As per city level electricity consumption data obtained from the state distribution company (DISCOM), the total electricity

consumption in Bhopal city was 17,12,311 MWh in 2019, out of which residential consumption was the highest with 877,573 MWh, followed by commercial consumption of 512,522 MWh. The city had a per capita electricity consumption of 722 kWh. LPG fuel consumption totals 70,014 Mt for the residential sector and 8,195 Mt for the commercial sector (Figure 13)

This sector accounts for 1,423,204 tCO₂e emissions out of which residential buildings account for the highest (52%), followed by commercial buildings (30%), manufacturing industries (13%), public water works (3%) and streetlights (2%), as shown in Figure 14.

Figure 13: Liquified petroleum gas (LPG) consumption in tonnes (Source: WRI India analysis using primary data)

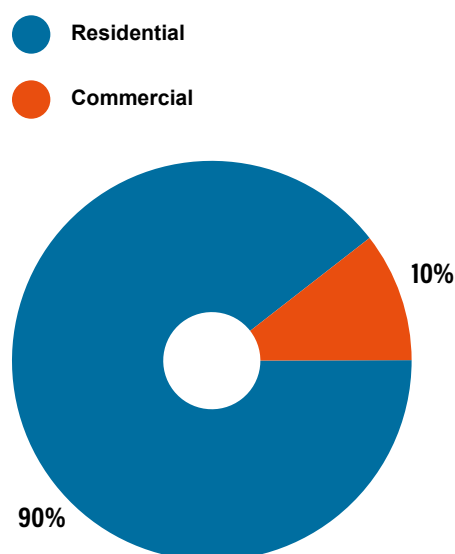
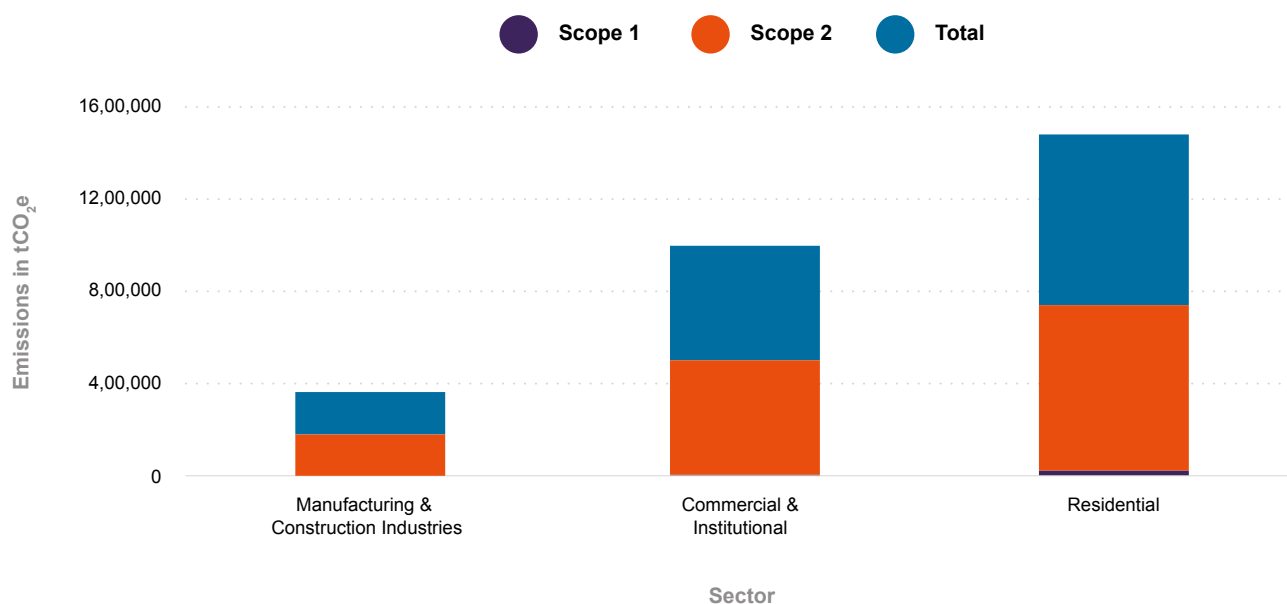


Figure 14: Stationary energy emissions for Bhopal by sub-sector (Source: WRI India analysis using primary data from DISCOM)



The Figure 15 shows the distribution of sub-sectoral stationary energy emissions by scope 1 and 2.

Figure 15: Stationary energy emissions by sub-sector and scope (Source: WRI India analysis using primary data)



Transport Sector Emissions

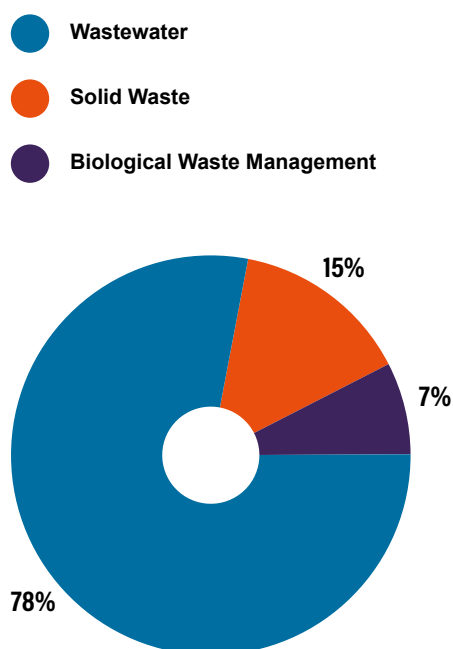
The transport sector accounts for 722,219 tCO₂e emissions, coming from the consumption of petrol and diesel from on-road transport. Data was obtained from fuel

agencies Indian Oil Corporation Limited (IOCL), Bharat Petroleum Corporation Limited (BPCL) and Hindustan Petroleum Corporation Limited (HPCL).

Waste Sector Emissions

Waste accounts for 406,956 tCO₂e emissions, coming mainly from emissions due to management of wastewater in the city (78%). About 7% of emissions is due to composting of biological waste while the remaining 15% can be attributed to the landfilled solid waste. The inventory should also include emissions due to incineration of waste; but the city could not provide any data on the same and hence this has not been included (figure 16).

Figure 16: Distribution of waste sector GHG emissions by sub-sectors (Source: WRI India analysis using primary data)

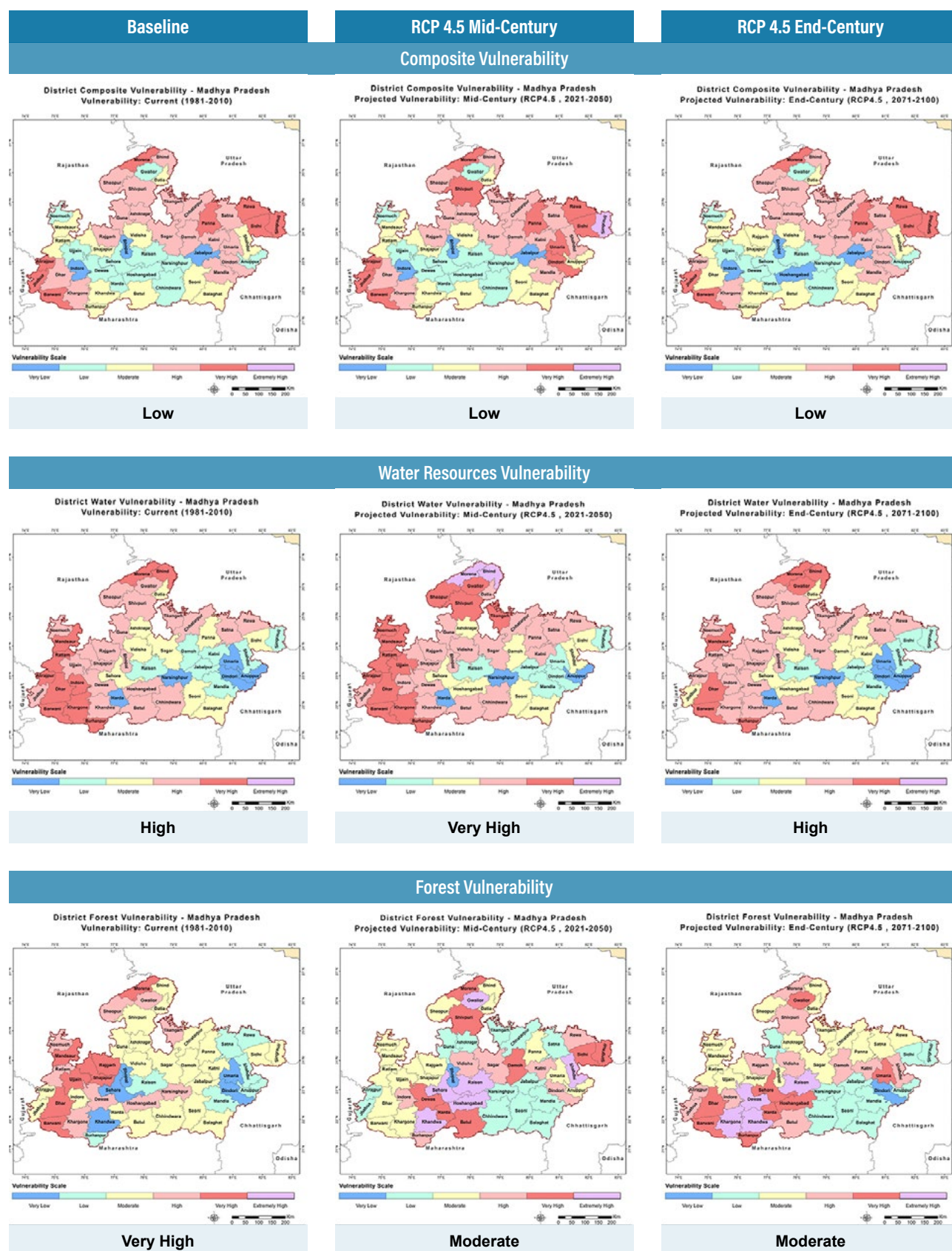


Vulnerability Assessment

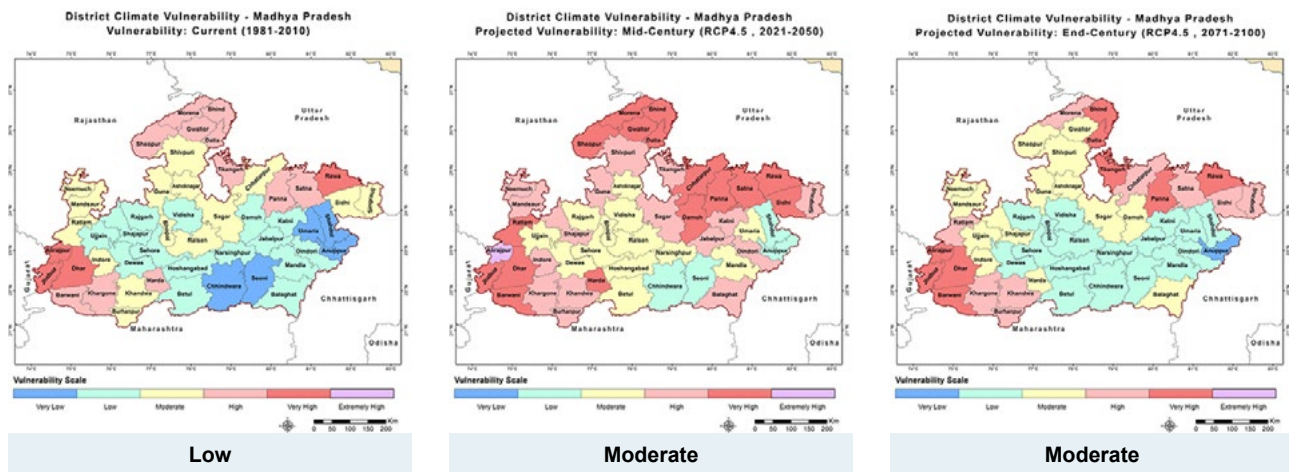
EPCO assessed climate change impacts and the vulnerability assessment of water, forest, agriculture, and health sectors for all the 52 districts in the state of Madhya Pradesh. The analysis was carried out for projected climate in the state over the periods 2021-2050 (mid-

century, MC) and 2071-2100 (end-century, EC), using a multi-model ensemble from Coordinated Regional Climate Downscaling Experiment (CORDEX) for RCP4.5 scenarios (Figure 17).

Figure 17: Sectoral and Temporal vulnerability profile of Bhopal (Source: Madhya Pradesh Climate Change Knowledge Portal)

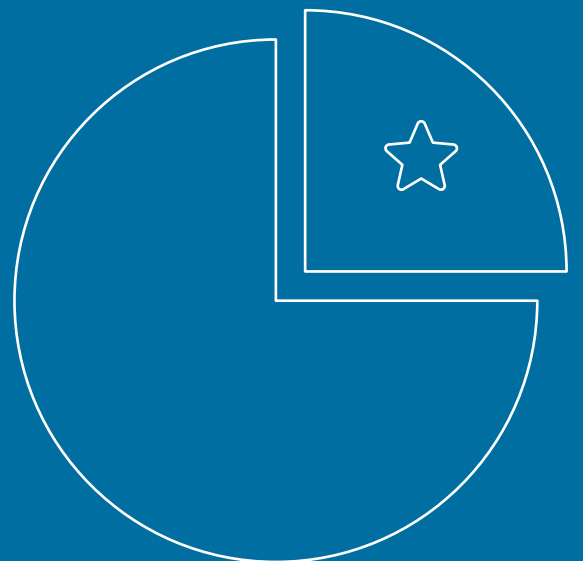


Climate Vulnerability



According to this analysis, Bhopal has a low composite vulnerability, driven largely by the socioeconomic indicators. In terms of water resources, Bhopal falls under high vulnerability, with a very high risk of decreasing availability of water, increasing crop water stresses and increase in frequency of extreme events such as floods and droughts in the RCP4.5 mid-century and end-century scenarios. Bhopal fares well in the forest sector, owing to the large green cover. However, the projected changes in temperature and rainfall as well as variability in both would likely result in increased climate risks as highlighted in the above analysis.

SECTORAL PRIORITIES



This section provides a detailed description of the current performance of Bhopal city on different indicators under CSCAF. Based on these, the sectoral goals have been

identified to address the gaps and challenges towards making Bhopal a low-carbon and climate-resilient city.

Sectoral Assessment

Energy and Buildings

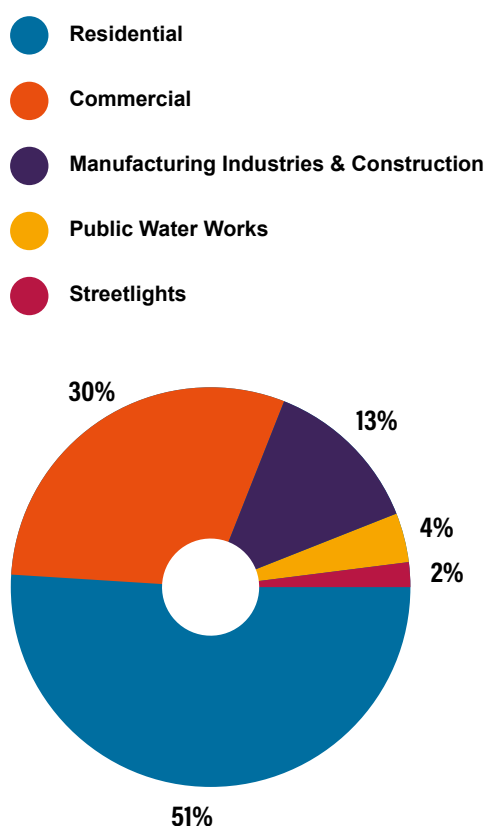
Bhopal aims to be a solar city and capitalize on its potential, particularly for solar rooftop installations. Although they are taking several steps towards the same, only 0.05% of the city's energy demand is being met by renewables. About 43 MW of solar energy and 15 MW of wind energy projects (four RE projects generating 58 MW)¹⁸ are being set up in the city. Bhopal has completed a 500-kW solar project by the side of Upper Lake, with 1540 panels running along 1.2km. This installation produces around 750,000 units annually which is supplied to the Karbala pumping station. The project is expected to offset 15,375 tCO₂e over its entire duration¹. The city has some green buildings, the key ones being EPCO, the New Secretariat and the forest department building in Tulsī Nagar. BSCDCL has also implemented the intelligent street lighting project with HPCL where 400 Smart poles and 20,000 LED streetlights with remote monitoring were installed on a PPP basis in 2018¹⁹. The city is currently conducting an energy audit of this project and has appointed a nodal agency for the same⁵. Bhopal Smart City and Energy Efficiency Services Limited (EESL) have also signed an agreement in 2021 to install 40,000 LED streetlights in the city, with an expected energy savings of 1.3 crore units per year²⁰. Bhopal has installed 120 kW solar power plant in ISBT bus stop, 35 kW in BMC office and 35 kW at Mata Mandir⁵.

As per the data obtained from city-level electricity consumption reports provided by the state distribution company (DISCOM), the total electricity consumption in Bhopal city was 1,712,311 MWh in 2019, out of which domestic consumption of 877,573 MWh was the highest, followed by commercial consumption of 512,522.055 MWh (Figure 18).

Buildings - Affordable Housing

Bhopal Smart City Development Corporation Ltd. is working towards making Bhopal a smart and highly developed city. Under this plan, multistorey government houses are being constructed in the ABD area under TT Nagar. Of the 3,000 flats planned, 688 flats in the first phase have been completed. They are in the process of implementing phase 2, which includes 1344 flats⁵ and the work order has been issued.

Figure 18: Electricity consumption by sub-sectors (Source: primary data on electricity consumption data from state distribution company (DISCOM)).



Urban planning, green cover, and biodiversity

Bhopal's green cover reduced from 92% in 1977 to 7% in 2021 and is expected to reduce to 4% by 2030²¹ signaling the need for an increased focus on forest restoration and conservation of water bodies. Bhopal has also started developing Miyawaki forests². The city is also implementing a biodiversity park at Shahpura²² and has recently developed and released a city biodiversity index with ICLEI-Local Governments for Sustainability. According to the index, Bhopal scored 44 out of 72 points across 23 indicators, scoring the least in number of biodiversity projects implemented by the city annually and institutional capacity for biodiversity conservation²³.

As per the Smart city proposal, the ABD area is planned as a compact, green, walkable, and cycle-friendly sub city. It will create a variety of open spaces that flow into and out of the built form. The primary design theme aims to create an eco-loop connecting major open spaces and water bodies of the city. Gardens at E-1 Arera colony have already been completed. Bhopal Smart city is also planning landscaping of Smart roads MR02 and MR03⁵. Despite conservation efforts like identifying full tank level (FTL) on the Bhoj wetland and no-construction buffer zones, a lot of illegal colonization is happening in the catchment area. Bhoj wetland has been notified as a Ramsar site but that was recently challenged in court²⁴. Bhopal must work towards curtailing development around the zone of influence chosen for the Bhoj wetland, which can range from 50-500m²⁴.

Mobility & Air Quality

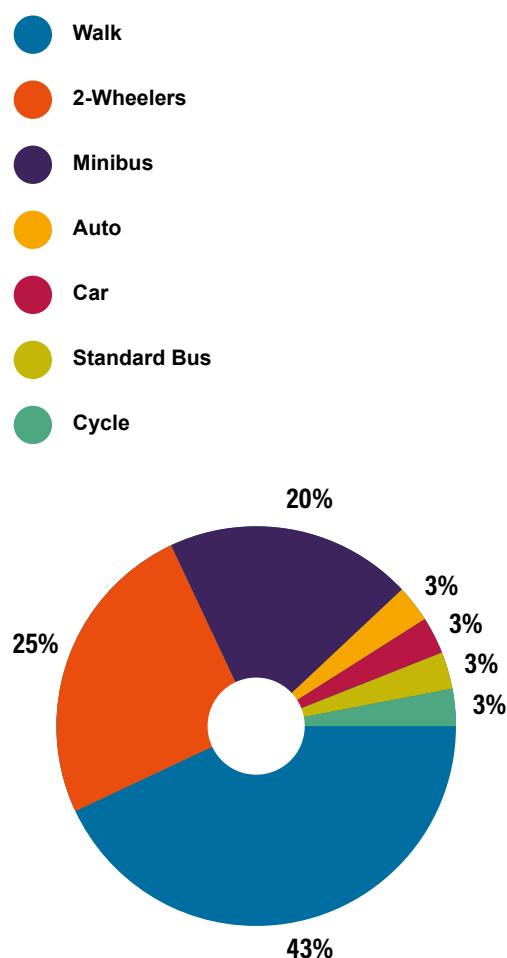
Bhopal has 215 low floor buses in use as of 2020¹² run by Bhopal City Link Limited (BCLL). In 2019, buses operated 900 trips daily amounting to 46,937 km with an average daily ridership of 165,000. The Bus Rapid Transit System (BRTS) in Bhopal has a length of 24km. The mode share in Bhopal for 2019 indicated a high mode share for walk (43%), followed by 2 wheelers (25%). Buses had a mode share of 3% and cars also constituted 3%²⁵ (Figure19). This in turn demands reforms so that the IPT and non-motorized transport have an appeal for the people. The city seeks to improve last mile connectivity through transit-oriented development and improved public transport¹⁶.

Bhopal has seen an annual average vehicular growth of 10% since 2002²⁵. The city has been focusing on increasing its fleet of low-carbon public transport and had recently introduced 40 CNG buses in 2022³. Fuel efficiency management trainings were also conducted for certain private buses in the city run by Prasanna Purple Mobility Solutions which saw a 31% improvement in fuel efficiency after the trainings²⁶. The city has a public bike sharing system with 94 stations installed, 480 cycles in operation and currently 30000+ users registered. A tender has been floated to electrify the same⁵. Bhopal has also implemented intelligent transport systems (ITS) in all bus stops, allowing authorities to track routes and provide real time information to passengers. ITS includes features like Automatic Vehicle Location, Public Information System, Management Information System, etc⁵.

Water management

The main surface water resources in Bhopal include Upper and Lower lakes, Kaliasot reservoir, Hataikheda, Laharpur Reservoir, Shahpura lake, Charimali pond, Motia tank, Sarangpani Lake, rivers and its tributaries, canals, and wetlands²⁷. Upper lake serves 40% of Bhopal's water

Figure 19: Modal split in Bhopal for 2019 (Source: UNES-CAP, 2019).



needs²⁸. Bhopal is working on increasing water harvesting efforts through the adoption of a sustainable urban drainage system in which use of the city's green spaces will be optimized by taking advantage of natural slopes in the city. Bhopal has introduced 100% consumer metering through supervisory control and data acquisition (SCADA) and is working towards repairing the existing water supply network in the ABD area⁵. The development in the ABD area will have dual piping system which will provide 24x7 potable water supply from the municipality as well as reclaimed water which will be supplied from the central STP for irrigation/ flushing purposes⁵. As per the CSCAF 2.0, Bhopal has a non-revenue water of around 20-30% which has to be reduced further. Moreover, less than 5% of treated water is currently recycled and reused.

Waste management

Bhopal generates 850 Mt of waste per day. This consists of 76.4 Mt of plastic waste, 49.3 Mt of construction and demolition waste⁶, 6.4 Mt of sanitary waste and 412 Mt of organic waste²⁹. The city of Bhopal currently has a waste collection and landfill system for solid waste management

at Adampur. Approximately 42% of daily waste gets land-filled. Earlier, Bhanpur was the landfill site, but now it has been reclaimed. The total area of Bhanpur site was 37 acres, out of which 16 acres have been bio-capped and 21 acres have been reclaimed. A leachate treatment plant of 50 kiloliter per day was also installed in the land that was bio-capped³⁰.

The city has a primary wastewater treatment system at the Adampur site. The city also has MP's first bio-methanation plant that uses waste from the Bittan Market to generate biogas to power streetlights³¹. The district is not covered fully by underground sewerage system, but the municipal corporation has seven STPs (five aerobic and two anaerobic) with a total capacity of 90 MLD³² to treat domestic liquid waste. BMC has six Material Recovery Facilities (MRFs), eleven material transfer stations and five biodegradable waste processing plants, including three windrow composting and two biogas facilities. They deploy 469 auto tippers with partition for source segregation. Monitoring of these vehicles is supervised at each zone

by assistant health officers³³. The city also has 120 Smart underground dustbins in 70 places, with LED indicators displaying live waste capacity, monitored through an integrated command and control center. This has resulted in better waste disposal awareness and management⁵.

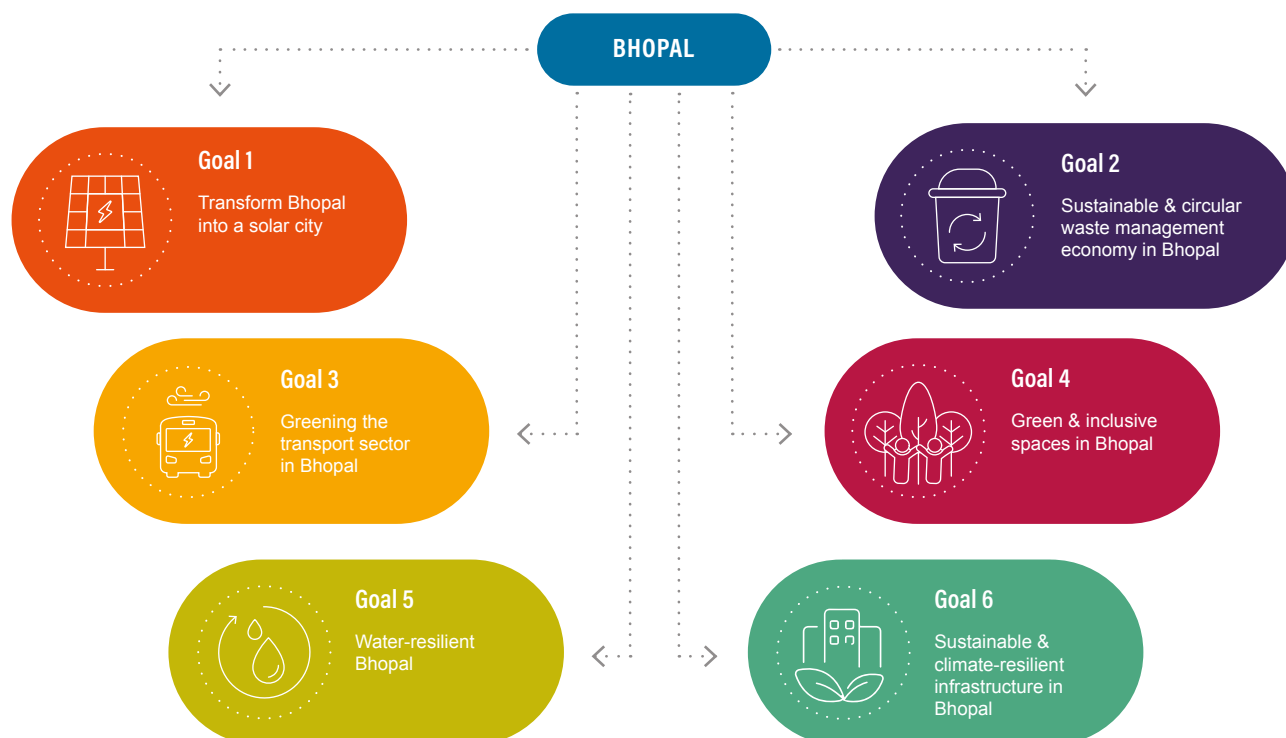
Bhopal had also signed a memorandum of understanding with NTPC and Bhopal RNG Private Limited for setting up a 200 TPD wet waste to bio-CNG plant and 400 TPD dry waste torrefied charcoal plant. Bhopal RNG Private Limited will give an amount of Rs 83 lakh to Bhopal Municipal Corporation as royalty every year for 20 years and bio-CNG will be provided at the rate of Rs 5 less than the market rate. The Bio-CNG is proposed to be used for city buses. With this plant, BMC is expected to save Rs. 2 crore 43 lakh 9 thousand each year on solid waste disposal. The torrefied charcoal plant will be established and operated by NTPC for 25 years. The charcoal will be used in their power plants and would be saving BMC Rs. 4 crore 86 lakh 18 thousand each year³⁴.

Sectoral Goals

The sectoral goals identified for Bhopal city are aligned with the priorities of existing sectoral departments to ensure efficient implementation of the Bhopal CAP. However, there is considerable scope to establish

convergence and dove-tailing across sectors, establish collaborations across departments and reap the co-benefits of holistic solutions. The six goals identified are as follows:

Figure 20: Sectoral goals for Bhopal (Source: WRI India)



Mainstreaming Inclusivity in the Bhopal Climate Action Plan

Bhopal's climate action planning process emphasizes the importance of inclusive planning. An inclusivity analysis has been included for each sectoral action to ensure that the action has equitable benefits for all the identified impact groups. The analysis has been adapted from the guidance document on "How to tackle climate change and inequality jointly: practical resources and guidance for cities" prepared by World Resources Institute Ross Centre for Sustainable Cities and C40 cities in 2019³⁵. As the first step towards mainstreaming inclusivity, cities must ensure that inclusivity is embedded in processes, policies,

and impacts (Figure 21). Inclusivity of process ensures that each policy making process involves engagement with stakeholders, especially the ones most vulnerable to climate change. Inclusivity of policies should ensure that policies are designed with people at the center of decision making. Finally, the actions proposed should include clear indicators and monitoring frameworks to measure the inclusivity of impacts across each impact group. Impact groups can include the elderly, children, disabled, religious minorities, informal communities, temporary workers, etc.

Figure 21: Inclusive climate action planning (Source: WRI Ross Centre and C40 cities)



SECTORAL CLIMATE ACTIONS



Goal 1: Transform Bhopal into a Solar City

The transition away from fossil fuels and towards renewable energy is critical to achieve a low-carbon future. In line with this, MP announced a Policy for implementation of solar based projects in 2012 to encourage participation of private sector to set up solar projects in the state³⁶. The state also introduced the MP Renewable energy policy in 2022 with a goal to achieve 50% energy from renewables by 2030. Incentives for renewable energy generation projects include exemption in electricity duty and energy development cess, reimbursement of stamp duty, waiver of wheeling charges, etc³⁷. As per the MP Solar Net Metering Policy 2020, a net metering system will reflect the use of green energy and feed the surplus to the grid. Consumer is paid back in terms of energy credits and adjustments in bill against power transferred to the grid³⁸. Lack of awareness about the scheme among residents as well as the DISCOM officials, and financial feasibility for the DISCOMs to install bi-directional meters have been some of the major challenges to its implementation in cities like Bhopal. Despite a good momentum and push from state policies, only 0.05% of Bhopal Municipal Corporation's energy demand comes from renewable sources¹². This gap demands that Bhopal prioritizes the renewable energy sector and takes actions to ensure the RE sector's contribution towards a low-carbon future.

Identified Actions

Action 1: Promote energy efficiency improvements and renewable energy use in MSMEs

- **Challenges addressed at the city level:** 56% of city's GHG emissions comes from stationary energy sector, mainly due to electricity consumption from fossil fuels. Only 0.05% of energy demand in the city comes from renewable sources. 13% of city's electricity consumption comes from manufacturing and industrial sector, which includes large scale industries as well as medium and small enterprises.
- **Description:** MSMEs account for more than Rs 7,100 crore of exports and contribute significantly to Bhopal's economy¹⁶. Taking steps to ensure energy efficiency and the use of renewable energy in MSMEs becomes key to reduce GHG emissions from this sector. As per MP's MSME policy, the state will reimburse 50% of the cost of conducting an energy audit for an MSME with a maximum limit of Rs.50,000 and 25% of the cost up to a maximum of Rs.5 Lakhs for adoption of energy efficient equipment and machinery. The MSME policy also encourages local startups working on renewable energy/green energy/clean technology and water/waste recycling³⁹. Bhopal can collaborate with industry associations to sensitize

MSMEs about these incentives, provide trainings on energy efficiency practices, organize workshops with equipment manufacturers to promote new products for MSMEs and link MSMEs with third party organizations conducting energy audits. The city can also promote collaboration between DISCOMs and MSME cluster associations to identify barriers and associated solutions to renewable energy adoption. Bhopal can also promote startups to develop new innovative technologies, through competitions and provision of funds.

- **Inclusivity analysis:** The installation and maintenance of rooftop solar panels and energy efficient equipment is labor-intensive, thus generating many jobs particularly for low-income workers, who can be given the training for operation and maintenance of solar PV systems⁴⁰. The city can also provide training for women workers around maintenance and operations of energy efficient equipment.
- **Implementing stakeholders:** BMC (lead), MPUVN, MPMKVCL, MP MSME department, Bhopal smart city, MSME associations, private technology manufacturers and suppliers
- **Timeframe:** Medium term (3-5 years)
- **Mainstreaming with policies and schemes:** MP Renewable energy policy 2022, Policy for implementation of solar based projects in MP 2012, MP MSME development policy 2021
- **Monitoring Indicators:** % of energy derived from renewable sources, % of MSMEs with solar PV, reduction in energy bills for MSMEs, % of total emissions coming from manufacturing sector, # (number) of new jobs created
- **Alignment with CSCAF indicators:**
 - Indicator 1: Electricity consumption in the city
 - Indicator 2: Total electrical energy in the city derived from renewable sources under Energy and Green buildings

Action 2: Pilot solar bus stops

- **Challenges addressed at the city level:** Only 0.05% of total energy demand comes from renewables as per CSCAF 2.0.
- **Description:** Bhopal has 370 bus stops with 72% of the population living within a 500m buffer area around

bus stops, indicating good public transport access²⁵. The city can consider piloting some of these as solar bus stops. Decentralized solar rooftop can be looked into for bus stops, cities like Trichy⁴¹, Madurai⁴², Delhi⁴³ and Lucknow⁴⁴ have piloted solar bus stops at average costs of 5-7 lakh. Varanasi got its first solar bus stop in 2022 with floor made of recyclable materials, mobile charging facility, LED lights and CCTV surveillance⁴⁵. This action will have multiple benefits including increased passenger comfort and increased use of renewable energy.

- **Inclusivity analysis:** These bus stops should ensure that commuters have shelter, drinking water, toilets and other amenities. Bus stops can also allow wheelchair access. BMC must do a baseline assessment of access to bus stops across wards and ensure that these solar bus stops are equitably distributed across low- and high-income wards.
- **Implementing stakeholders:** Bhopal Municipal Corporation (lead), Bhopal smart city, Bhopal City Link Limited (BCLL), MPUVN, NGOs, MPMKVCL
- **Timeframe:** Medium term (3-5 years)
- **Mainstreaming with policies and schemes:**
 - MP Policy for Decentralized Renewable Energy Systems, 2016
 - MP Renewable Energy Policy 2022
- **Monitoring Indicators:** % of energy from renewables, % of bus stops with solar PV (disaggregated by wards), increase in bus ridership or commuter satisfaction
- **Alignment with CSCAF indicators:**
 - Indicator 1: Electricity consumption in the city
 - Indicator 2: Total electrical energy in the city derived from renewable sources under Energy and Green buildings

Action 3: Explore common solar PV projects for low-income community housing

- **Challenges addressed at the city level:** City has only 0.05% energy coming from renewables as per CSCAF 2.0. Furthermore, residential buildings contribute to 52% of GHG emissions from stationary energy sector
- **Description:** There were 350 slums in Bhopal with a population of 4,78,650 as per a 2015 survey. This is around 26.6% of the total population of Bhopal city¹⁰. Bhopal smart city has also completed two phases of government housing development in the ABD area and are in the process of obtaining site clearance for phase 3⁵. Bhopal can develop models integrating grid

connected solar PV systems for common utilities like pumps, lightings, elevators, etc. within these affordable housing complexes. Here, members of the housing complex will receive monetary compensation after adjusting for grid consumption by the social housing common utilities, through net metering. BMC should first identify a suitable social housing scheme with:

- Fossil fuel-based energy consumption for common utilities
- Use of different types of appliances
- Availability of rooftop area without shadow for solar PV

A similar project has been successfully implemented at Rajkot's Krantiveer Khudiram Bose social housing project. This housing consists of 5 buildings with 140 dwelling units. Common amenities like lifts, pumps and lights consumed 3000 kWh units per month. A 31.5 kWp grid connected solar PV system was installed in the rooftop which generates 3780 units of electricity per month, with a potential to reduce 37 tCO₂e GHG emissions per year. Excess energy is sent to the grid and the residents get approximately Rs 12,000 credited to their accounts by the DISCOM each month. It was set up on a PPP basis for 10 years⁴⁶. Bhopal can consider implementing this in houses within Jai Bhim Nagar, Arjun nagar, Dholak Basti or Quarter Basti area⁴⁷.

- **Inclusivity analysis:** This must be accompanied with training for residents in these low-income areas for management and operation of solar panels. In Rajkot, residents were provided training by ICLEI-Local Governments for Sustainability on periodic cleaning of panels, safety aspects for the inverter and how to read from the bidirectional meter⁴⁸. Similar trainings must be provided by BMC.
- **Implementing stakeholders:** Bhopal smart city (lead), Bhopal Municipal Corporation, MPUVN, MPMKVCL, RWAs, external organizations like ICLEI- Local Governments for Sustainability, solar technology providers
- **Timeframe:** Medium term (3-5 years)
- **Mainstreaming with policies and schemes:** MP Policy for Decentralized Renewable Energy Systems, 2016, MP Renewable Energy Policy 2022, Pradhan Mantri Awas Yojana (PMAY)
- **Monitoring Indicators:** % of electricity from renewables, energy bills for low-income housing, % share of emissions from residential buildings, income generated for low-income communities, # of new jobs created, % of low-income housing with solar PV

- **Alignment with CSCAF indicators:**
 - Indicator 1: Electricity consumption in the city
 - Indicator 2: Total electrical energy in the city derived from renewable sources
 - Indicator 6: Green building adoption under Energy and green buildings

Action 4: Instal solar water heaters and solar photovoltaic panels on rooftops of educational institutions

- **Challenges addressed at the city level:** As per CSCAF 2.0 city is not taking measures to promote green buildings and city has only 0.05% of energy demand derived from renewables
- **Description:** Bhopal is home to some of the nationally renowned research facilities and academic institutions including ISRO's Master Control Facility, All India Institute of Medical Sciences Bhopal, National law academy, Maulana Azad National Institute of Technology and School of Planning and Architecture (SPA) along with 200 other engineering, management and medical institutions¹⁶. These educational buildings in Bhopal have the potential to use renewable energy for their daily heating purposes by installing solar water heaters and generating clean energy by installing rooftop solar panels. For example, Bhabha University in Bhopal has set up a 100-kW solar power plant in the campus to reduce its dependence on non-renewable forms of energy. The plant produces an average of 500 kWh a day and reduces carbon footprint by 136 tonnes annually⁴⁹. Bharata Mata College in Kochi, Kerala is the state's first fully solar-powered campus, producing 400 units of electricity per day and supplying 200 units per day to the power grid of Kerala State Electricity Board (KSEB)⁵⁰. Similar pilots can be scaled up to other educational institutions in Bhopal. Innovative funding models that can be explored include:
 - Revenue sharing: Delhi Municipal Corporation had opened a tender for solar PV in all municipal buildings where revenue is shared between agency and the municipal corporation for over 25 years minimum⁵¹.
 - Green bonds/masala bonds: Bonds issued outside India but in rupees. Investor bears risk rather than the borrower. Similarly, Indore plans to issue green masala bonds for funding floating solar project⁵².
- **Inclusivity analysis:** Institution of solar panels in educational institutions would sensitize students on alternative sources of energy and lesser usage of conventional energy. The teachers can play a role in creating this awareness amongst the students by conducting a site visit to the installed solar rooftop in their campus. Through the knowledge learnt at schools, the students will in turn inform and educate

their families (including middle/low-income households) on how to use energy more efficiently. Low-income workers can also be involved and trained for operating and maintaining the solar panels in these institutions.

- **Implementing stakeholders:** Bhopal Municipal Corporation (lead), Bhopal smart city, MPUVN, MPMKVCL, educational institutions, technology providers
- **Timeframe:** Medium term (3-5 years)
- **Mainstreaming with policies and schemes:** MP Policy for Decentralized Renewable Energy Systems, 2016, MP Renewable Energy Policy 2022
- **Monitoring Indicators:** % of educational institutions with solar PV and solar water heaters, % reduction in energy bills annually, % of energy coming from renewables for the city, % reduction in GHG emissions
- **Alignment with CSCAF indicators:**
 - Indicator 1: Electricity consumption in the city
 - Indicator 2: Total electrical energy in the city derived from renewable sources
 - Indicator 6: Green building adoption under Energy and green buildings

Action 5: Incentivize installation of rooftop solar panels and solar water heaters in all new residential constructions

- **Challenges addressed at the city level:** City has only 0.05% energy demand coming from renewables as per CSCAF 2.0. Furthermore, residential buildings contribute to 52% of GHG emissions from stationary energy sector.
- **Description:** Bhopal Municipal Corporation had issued a tender on 13th March 2023 inviting loans for the installation of solar projects constituting 20 MW in phase 1 and 15 MW in phase 2 and 1 MW rooftop solar⁵³. These projects can be focused mainly on residential solar PV and can be complemented with measures to encourage solar rooftop in new residential buildings. These can include:
 - **Subsidies:** Few cities like the Diu Smart City offers all its residents an installation subsidy of Rs 10,000-50,000 for installing a 1-5 kW capacity roof solar PV. It is observed that this helped reduce power tariffs by 10-15% each year⁵⁴. Karnataka State Govt provides rebate of 50 paise per unit up to Rs 50 per month for installing SWH⁵⁵. Pune also provides a 5% tax rebate for one energy efficiency initiative out of SWH, composting or RWH, 10% for 2⁵⁶. A database on the incentives utilized by citizens and the relative increase in percentage

of households with roof top solar PVs can be monitored via the Integrated Control and Command Centre (ICCC).

- **Mandate:** Bhopal can mandate all new buildings to have solar water heaters. This should be included in the building by-laws. BESCOM in Bengaluru requires developers to install solar water heaters in dwellings with a floor space of 600 ft², i.e., 56 m², or above. The mandatory solar thermal capacity is linked to room size and increases based on the interior space available⁵⁷.
- **Awareness training workshops** for resident welfare associations and large-scale distributors on benefits of implementing solar rooftop, available incentives, etc.
- **Collaborating with NGOs or research students working in the energy space to develop a Do-It-Yourself (DIY) solar tool:** a step-by-step guidance to consumers on how to install solar PV, available financing subsidies, application process and policies. A similar tool was developed by an NGO in Bangalore which has been used by nearly 15000 citizens⁵⁸. This tool can also include a 24x7 helpline number for citizens to call and clarify doubts on the installation process.
- **Inclusivity analysis:**
 - Inability to pay capital costs and lack of credit could be one of the challenges limiting participation from low-income urban households. Bhopal should ensure easy access and availability of financial incentives for RE projects in low-income residential buildings, including cost subsidies, low-interest and long-term loans for property owners, project developers and small-scale purchasers, making it more accessible to low-income communities. Bhopal can also collaborate with NGOs or private companies for CSR driven installation of free solar water heaters or solar cookers in informal areas.
 - The awareness training workshops can also be conducted in local languages to make it more accessible particularly for low-income groups. The app can also include information in native languages.
- **Implementing stakeholders:** Bhopal Municipal Corporation (lead), Bhopal smart city, MPUVN, MPMKVVCL, educational institutions, technology manufacturers, private residential owners, JVs, and citizens, NGOs
- **Timeframe:** The action can begin in the short term (1-2 years) but should be constantly monitored over the long-term period (>5 years)
- **Mainstreaming with policies and schemes:** MP Policy for Decentralized Renewable Energy Systems, 2016, MP Renewable Energy Policy 2022

- **Monitoring Indicators:** % of energy from renewables, % of new residential buildings with solar PV (disaggregated by income type), % reduction in GHG emissions from stationary energy, easy DIY tool, # of awareness training workshops conducted

- **Alignment with CSCAF indicators:**

- Indicator 1: Electricity consumption in the city
- Indicator 2: Total electrical energy in the city derived from renewable sources
- Indicator 5: Promotion of green buildings
- Indicator 6: Green building adoption from energy and green buildings

Action 6: Initiatives towards reduced transmission and distribution losses

- **Challenges addressed at the city level:** 28.7% T&D losses in Bhopal as per CSCAF 1.0 data in 2019
- **Description:** It is important for BMC to coordinate and work with MPUVN and MPMKVVCL to try and reduce transmission and distribution (T&D) losses for efficient electricity supply. Dedicated feeder managers can be appointed to conduct energy audits and account for energy received and energy sold in each ward. Installation of Smart meter and Automated Meter Reading device should be mandated to ensure 100% consumer metering. A time-bound program should be chalked out for checking the meters and replacing defective ones with tested meters. A customer feedback mechanism and 24x7 toll free number can be initiated where consumers can report theft, broken meters, and illegal electricity usage⁵⁹.
- **Inclusivity analysis:** Workers from low-income groups can be trained in installation and maintenance of the smart meters and for manning the 24x7 helpline, thus creating new jobs for them.
- **Implementing stakeholders:** Bhopal Municipal Corporation (lead), MPMKVVCL, MP Urja Vikas Nigam, Bhopal smart city, RWAs, ward officers
- **Timeframe:** Medium term (3-5 years)
- **Mainstreaming with policies and schemes:** Ujwal DISCOM Assurance Yojana (UDAY)
- **Monitoring Indicators:** T&D losses (%), # of meters installed, % of households with meters (disaggregated by income level), setting up of 24x7 call center, # of wards with feeder managers
- **Alignment with CSCAF indicators:** Indicator 1: Electricity consumption in the city under the energy & green buildings sector

Goal 2: Sustainable & Circular Waste Management Economy in Bhopal

Bhopal has been lauded as the cleanest state capital city in India for three consecutive years – 2017, 2018 and 2019⁹. Bhopal is the hub of a few industrial manufacturing centers. A number of Multi-National Companies and electronics corporations are being set up in Bhopal¹⁶. Thus, it has its own set of challenges linked with electronic and industrial waste management and recycling. Bhopal also requires additional waste transport infrastructure (41 new vehicles were needed as of 2021 for collecting garden waste and construction and demolition waste). They also require two more transfer stations and two composting units for managing its waste⁶. The actions in this goal aim to further enhance Bhopal's existing initiatives in the waste and wastewater management sector.

Identified Actions

Action 1: Innovative models for managing electronic waste in Bhopal

- **Challenges addressed at the city level:** Bhopal generated 20,000 Mt of e-waste annually but only 1% of electronic waste in Bhopal was collected each year as of 2017⁶⁰.
- **Description:** As of 2017, only 1% of the city's e-waste was collected and accounted for across the 5 government run collection centers in the city amounting to 150 Mt capacity per year. The collection agents highlighted that only 10-12% of their total capacity of waste was collected due to lack of awareness amongst citizens⁶⁰. As of 2021, the city had not linked producers and brand owners for monitoring extended producer responsibility compliance and were planning to do so⁶. To improve the collection and recycling of e-waste, Bhopal can consider public-private partnership models, similar to the case of Jamshedpur³³. Jamshedpur had hired a single recycling company (Hulladek Recycling Private Limited) dedicated for e-waste management and working as a producer responsibility organization (PRO), an organization authorized or financed collectively or individually by producers to collect and recycle e-waste from end-of-life products. The following are some key aspects that worked in this system:
 - Collection and segregation: Monthly collection was done by two Hulladek e-rickshaws with 2 staff members for collection and awareness creation. 80 municipal vehicles also collected e-waste in a segregated compartment along with regular dry and wet waste. 200-250 households were covered by door-to-door e-waste collection. Bhopal has already set up an e-waste clinic, first of its kind in the country in collaboration with the NGO Sarthak Sanstha, where people can deposit e-waste in exchange for payment and certificate. They also offer pick up facility⁶¹. Bhopal can scale this up, by increasing the e-waste collection centers through collaborations with platforms such as Sanshodhan⁶² and Karo Sambhav⁶³.
 - Awareness campaigns and tie ups with educational institutions: Awareness campaigns were conducted in collaboration with institutes and major commercial complexes which served as drop-off points for e-waste. 5 such locations were identified, and a toll-free number was provided so citizens can schedule pickups in bulk. Bhopal can also tie up with educational institutions like All India Institute of Medical Sciences Bhopal, National law academy, Maulana Azad National Institute of Technology and School of Planning and Architecture for the same.
 - Storage, transportation, processing, and disposal: The e-waste management center by Hulladek has a capacity of 35 Mt from where it is transported to a warehouse in Kolkata with a capacity of 160 Mt. From there, it is sent to six authorized recyclers. BMC can identify such recycling agents and can provide incentives in coordination with the state government. For example, Telangana's e-waste management policy provides 25% subsidy on lease rentals for first three years of operation, reimbursement of municipal taxes for three years and capital investment subsidies of Rs 1 crore for a minimal investment of Rs. 5 crores for first 5 recyclers⁶⁴. This would boost recycling and refurbishing of e-waste in Bhopal and reduce the carbon emissions released by this sector.
- **Inclusivity analysis:** This action should help in the formalization of the informal e-waste sector in the city through job creation and skill development for low-income groups. For example, Jamshedpur has employed more than 20 people under the e-waste management initiative³³. BMC can employ informal workers in managing the e-waste collection and recycling centers and ensuring smooth transportation and provide them with ID cards, health insurance and regular wages. While monitoring e-waste collection and recycling, BMC should collect data ward wise to ensure equitable access to collection and recycling facilities across low- and high-income wards.

- **Implementing stakeholders:** Bhopal Municipal Corporation (lead), Bhopal smart city, informal waste pickers, private organization for waste management, educational institutions, industries, commercial establishments, RWAs
- **Timeframe:** Start in the short term but continue implementation and monitoring over long term (>5 years)
- **Mainstreaming with policies and schemes:** Swachh Bharat Mission Urban 2.0, CPCB E-waste management rules 2022
- **Monitoring Indicators:** % of e-waste collected in the city, % e-waste recycled in the city, % GHG emissions from waste sector, # of new jobs created, # of recycling and collection centers in the city
- **Alignment with CSCAF indicators:**
 - Indicator 1: Waste minimization initiatives undertaken by the city
 - Indicator 2: Extent of dry waste recovered and recycled under waste management

Action 2: Pilot fuel generation from plastic waste

- **Challenges addressed at the city level:** 56% of GHG emissions from stationary energy sector including emissions from fuel combustion like LPG, petrol, and diesel.
- **Description:** Bhopal is already achieving 100% processing of dry waste including plastic through 10 material recovery centers⁶. 14% of Bhopal's solid waste generated per day consists of plastic waste. Plastic that cannot be recycled (less than 40 microns) is used by cement manufacturers as alternate fuel for combustion. In this manner, nearly 32000 Mt of waste has been sold to cement plants and 500 Mt used in developing rural roads as of 2019⁶⁵.

In terms of recyclable plastic, currently it is being sent to dedicated recycling agencies. In addition to recycling, Bhopal can try and pilot Indore's model of generating diesel from plastic waste. Currently, Indore generates 3000 liters of fuel from 6 tonnes of plastic waste, which is used by small hotels and eateries. They are planning to come up with a plant to convert 50 tonnes of waste to 30,000 liters of fuel and a tender was floated in 2019. Indore Municipal Corporation provides land and plastic waste to the private entity who in turn pays a monthly rent to produce the diesel. The municipality then sells the diesel at a cost of Rs. 35 per liter to industries⁶⁶. BMC can study this pilot and consider implementing it, given a vast number of industries in the city including BHEL and over 1200 MSMEs¹⁶. They can include companies which have a patented process already, such as Indore's Trimurthi Production⁶⁷.

- **Inclusivity analysis:** The livelihood of informal workers and waste pickers who collect waste from public spaces or from dumpsites/landfills may be at risk with increased segregation and recovery. BMC has made it compulsory for private companies to involve ragpickers in the MRFs and has employed 40 ragpickers across its MRFs³³. Similarly, the plastic to fuel plant can involve informal workers for plastic waste collection, drivers for transportation and for daily operation and maintenance. This action would also help in spreading awareness amongst industries and including them in the waste management process.
- **Implementing stakeholders:** Bhopal Municipal Corporation (lead), Bhopal smart city, industries, informal workers, MSMEs, hotel association, private entities, financial agencies, technology providers
- **Timeframe:** Medium term (3-5 years)
- **Mainstreaming with policies and schemes:** Swachh Bharat Mission Urban 2.0
- **Monitoring Indicators:** % of plastic waste converted to fuel, amount of fuel generated annually in liters, # of new jobs created in the waste management sector, # of industries and hotels using fuel from plastic, reduced emissions from fuel combustion
- **Alignment with CSCAF indicators:**
 - Waste management
 - Indicator 6: Waste minimization initiatives undertaken by the city
 - Indicator 2: Extent of dry waste recovered and recycled
 - Energy and buildings
 - Indicator 3: fossil fuel consumption in the city

Action 3: Connect all the vegetable and fruit markets in the city with the proposed 200 TPD bio-CNG plant

- **Challenges addressed at the city level:** MP's first bio-methanation plant was setup at Bhopal's Bittan Market⁶⁸, where the waste-to-energy project uses MSW and produces biogas that is used to generate electricity to power streetlights in the area. This project has not been connected to waste from other vegetable markets.
- **Description:** Currently, the plant uses biodegradable waste, mostly from nearby vegetable market and adjacent colonies, converting them into biogas. The facility can be used to its fullest potential by transporting wet waste from other vegetable and fruit markets and residential areas. Bhopal had also signed a memorandum of understanding with NTPC and Bhopal RNG Private Limited for setting up a 200 TPD wet waste to bio-CNG plant³⁴. BMC can connect waste

from other mandis like karond mandi, Nav bahar sabji mandi, Tiraha mandi, etc. to this proposed plant. The Bio-CNG produced is to be used to run buses as per the proposal.

- **Inclusivity analysis:** BMC can integrate informal waste pickers as paid service providers, for example to run the bio-methanation facility or to undertake collection and transportation of waste from the markets to the plant. Bio-CNG can also be bottled and sold to industries as fuel, this can also employ women from self-help groups or other members from local communities. The compost can also be sold to farmers at a subsidized rate or for free.
- **Implementing stakeholders:** BMC (lead), Bhopal smart city, informal workers, mandi shop owners, farmers, self-help groups, RWAs
- **Timeframe:** Medium term (3-5 years)
- **Mainstreaming with policies and schemes:** Swachh Bharat Mission Urban 2.0
- **Monitoring Indicators:** # of vegetable mandis providing waste to the bio-CNG plant, % of wet waste composted, liters of bio-CNG generated, kg of manure generated per day, # of farmers provided with manure, # of new jobs created
- **Alignment with CSCAF indicators:**
 - Indicator 6: Waste minimization initiatives undertaken by the city
 - Indicator 4: Extent of Wet Waste Processed under the waste management sector

Action 4: Upgrade waste collection and transportation infrastructure to electric vehicles

- **Challenges addressed at the city level:** 28% of city's GHG emissions comes from transportation sector, including waste transportation
- **Description:** Bhopal had a fleet size of 451 door to door collection vehicles and is planning for 41 new vehicles for construction and garden waste and 191 new vehicles with separate compartments⁶. BMC can convert its waste collection vehicles into electric vehicles through public private collaboration in a phased manner. This has already been adopted by states such as Andhra Pradesh⁶⁹ and Tamil Nadu⁷⁰. For example, Tamilnadu has 1700+ battery operated waste pickup vehicles with 3 bins for segregated waste, they have a range of 50km and can run for 6 hours on a single charge⁷¹. BMC can provide incentives like higher tipping fees or issuing a mandate that a certain percentage of the fleet should be electric in new tenders. Other incentives can include designated

parking spots, no parking fees, road tax exemptions, scrappage incentives, etc. for electric waste pickup vehicles. BMC should also ensure adequate charging infrastructure, for example in vacant lands, transfer stations, MRFs, vegetable markets, BMC offices, etc.

- **Inclusivity analysis:** BMC should ensure that the drivers of these new electric waste pick-up trucks, who are usually from low-income communities are provided training and capacity building on operating and managing the fleet. New jobs for low-income groups can also be created for the setting up and management of charging infrastructure through sufficient training.
- **Implementing stakeholders:** BMC (lead), Bhopal city link limited (BCLL), Bhopal smart city, informal workers, private agencies, financing agencies, RTOs, vegetable mandis
- **Timeframe:** Medium term (3-5 years)
- **Mainstreaming with policies and schemes:** Solid Waste Management Rules 2016, Swachh Bharat Mission Urban 2.0, MP Electric Vehicle Policy 2019
- **Monitoring Indicators:** % of solid waste management vehicles converted to electric vehicles, # of charging stations available per 1000 people, # of transfer stations with charging stations, % reduction in GHG emissions from waste transport, # new jobs created, # of incentives provided for electric vehicles
- **Alignment with CSCAF indicators:**
 - Indicator 1: Clean technologies shared vehicles
 - Indicator 4: Level of air pollution within the mobility & air quality sector
 - Indicator 3: Fossil fuel consumption in the city, under the energy and green buildings sector

Action 5: Public-private partnership models for managing construction and demolition waste

- **Challenges addressed at the city level:** Bhopal has 4 collection centres for C&D waste in the city and collects user fee from bulk waste generators. They have a 100 TPD C&D waste processing plant which gets waste from the entire district. However, the waste is mostly used in low lying areas, paving blocks and in new roads⁶. This system can be made more efficient through public private partnership models.
- **Description:**
 - Public private partnership for managing recycling facility: In Gurugram, considered as a best practice, the municipal corporation appointed two agencies: Pragati for primary collection and transport and IL&FS Environmental Infrastructure and Services

Limited (IEISL) for secondary collection and processing. Pragati also manages the collection centres, maintains a database and customer interface. They also have the authority to fine generators for not providing challan on waste generated. IEISL is also the nodal agency for managing waste in Delhi. Separate vehicles were also deployed to transport C&D waste with geotagging and colour coding. Bhopal can consider entering into a public-private partnership for managing its C&D waste. Municipal staff was appointed in each ward to monitor waste collection and recycling. Regular night patrolling is also done to prevent illegal dumping. In Delhi, the junior engineer manages each waste collection centre to monitor waste collected and recycled. A penalty is fined if the generator does not disclose the waste generated³³.

- **24x7 toll free number to complain about C&D waste:** Gurugram has also initiated a toll-free number where citizens can register complaints about illegal dumping of C&D waste³³.
- **Inclusivity analysis:** This action would incorporate effective public and private agencies' coordination and stakeholder engagement for collection and disposal of C&D waste. Jobs can be provided for informal workers from low-income groups to manage the recycling facility, monitor the waste, etc. For example, Municipal Corporation of Gurugram had provided ID cards and uniforms for the employees in these centers along with authorization letters for collection and enforcement.
- **Implementing stakeholders:** Bhopal Municipal Corporation (lead), MPPCB, Bhopal Smart City Development Corporation Limited, private builders and real estate agencies, private technology providers, informal waste pickers, citizen forums, RWAs
- **Timeframe:** Short term (1-2 years), require long term monitoring (>5 years)
- **Mainstreaming with policies and schemes:** Swachh Bharat Mission Urban 2.0, National Clean Air Action Plan
- **Monitoring Indicators:** % of C&D waste recycled, % new jobs created, reduction in air pollution due to construction waste, % of new buildings with recycled construction waste, % of waste trucks dedicated for C&D waste, # of agencies involved
- **Alignment with CSCAF indicators:**
 - Indicator 1: Waste minimization initiatives undertaken by the city
 - Indicator 3: Construction & demolition (C&D) waste management under waste management



Source: Paulose NK

Goal 3: Greening the Transport Sector in Bhopal

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). Other major public transport options are radio taxis, auto-rickshaws and in some parts shared commercial passenger vehicles such as TATA MAGIC vans which replaced diesel rickshaws¹⁶. The BRTS was implemented in 2013 and the metro is under construction⁴. The city has a public transport modal share of 3%²⁵ and currently only 0.09 buses are available for 1000 population¹². Only 18% of the fleet run on clean fuels (CNG)³ and National Thermal Power Corporation (NTPC) is planning for 100 electric buses in Bhopal⁷². This signals an urgent need to augment the public transport fleet and introduce low carbon buses. Moreover only 15.56% of the road network in the city has walking or cycling paths¹², despite a 43% mode share for walk and 3% mode share for cycling²⁵. Thus, this calls for measures to decarbonize the transport sector and improve non-motorized transport infrastructure to create people friendly, active streets.

Identified Actions

Action 1: Improve last mile connectivity of planned metro in Bhopal

- Challenges addressed at the city level:** Only 3% mode share for public transport²⁵ and only 15.56% of road network has walking or cycling paths, indicating poor last mile connectivity.
- Description:** Bhopal is planning for its metro which is expected to begin operations in September 2023⁷³. Data⁷⁴ shows that the average ridership of Chennai's metro was 900 riders/km as of 2017, which was only 4.8% of actual ridership planned. These figures were in line with global trends, with average metro ridership well below the projected figures. One important factor leading to low ridership was poor last mile connectivity. The stakeholder consultations in Bhopal also highlighted that there were limited last mile options in residential areas. As metro rail systems are expanding across India, the Ministry of Housing and Urban Affairs (MoHUA) has shifted its focus to improving the last mile connectivity⁷⁵, one of the goals stated in the Metro Rail Policy, 2017. Thus, Bhopal should ensure that the metro has good intermodal connectivity during its planning stages. Examples of initiatives can be:
 - Linking metro routes with BRTS stations⁷⁶ (E.g.: Ahmedabad metro)
 - Public bike sharing rentals outside metro stations
 - Autorickshaw depots close to starting and ending stations of metro routes
 - Feeder bus services (e.g: Delhi)⁷⁷
 - Linking it with rental scooter services with park and ride facilities
 - Collaboration with cab aggregators to offer parking close to metro stations. These can also be facilitated through collaboration with ola and uber rentals.
- Inclusivity analysis:** While working on this action, BMC should ensure that footpaths and cycle tracks integrate facilities for the disabled and the elderly through ramps and street furniture, have adequate lighting to ensure women's safety at night, have utilities like drinking water and have adequate shading through tree cover⁷⁸. Women's safety should also be addressed in feeder buses and other last mile access modes through women-only compartments, helpline numbers, seats reserved for women and the use of panic buttons. Linking metro stations with cab service stands or autorickshaw stands can also ensure more passenger trips for low-income drivers managing these intermediate public transport modes.
- Implementing stakeholders:** MP Metro Rail Corporation Limited (lead), Bhopal City Link Limited (BCLL), Star-bus and Red bus services, Bhopal Municipal Corporation, autorickshaw unions, Bhopal smart city, RWAs, NGOs
- Timeframe:** Short term (1-2 years) in line with the inauguration of the metro
- Mainstreaming with policies and schemes:** AMRUT-Funding for non-motorized urban transport projects, FAME Phase 2 for electric last mile services
- Monitoring Indicators:** Mode share for public transport (metro), daily ridership for metro (disaggregated by gender and income), % of road length with footpaths and cycle paths, % of metro stations with last mile access
- Alignment with CSCAF indicators:**
 - Indicator 2: Availability of public transport
 - Indicator 3: Percentage of NMT coverage within the mobility & air quality sector

Action 2: Pilot electric buses as part of Mybus (Bhopal BRTS)

- **Challenges addressed at the city level:** The air quality in Bhopal remains moderate to unhealthy for sensitive groups and the PM 2.5 levels are 7-8 times above WHO guidelines⁷⁹. Transport contributes to 28% of total GHG emissions in the city.
- **Description:** During consultations, stakeholders highlighted the need to convert all public buses into electric or CNG fleets. Bhopal has already piloted 40 CNG buses in 2022³. NTPC Vidyut Vyapar Nigam Ltd (NVVN) is also planning to procure 100 electric buses for Bhopal and a tender was issued in 2019. Tender includes design, manufacturing and supply of buses including operating in given routes, adhering to NVVN's time schedules and regular day to day maintenance⁷².

Before rolling out the electric buses proposed by NTPC, Bhopal should consider the following factors in order to choose whether a route is feasible for electrification: average daily kilometers travelled on the route, time between shifts per bus, number of stops, average driving speed, maximum halting time and availability of space and electricity at the depot. Separate bus implementation plans can be prepared for each route. BMC should plan for number of e-buses to be deployed in each route, estimate budget, plan for charging infrastructure at terminals or bus stops, consult with DISCOMS regarding sanctioned load at each charging station and conduct pre-feasibility checks⁸⁰. Proper trial runs need to be conducted for these buses before they are formally inaugurated. The Ahmedabad BRTS also introduced 18 new e-buses in 2019 after trial runs for six months⁸¹. This was also accompanied by a public battery swapping station for buses with a capacity to charge 12 batteries at a time. Once the pilots have been assessed, they can be scaled up after addressing the barriers, and the city can aim for long term conversion of the entire bus fleet into EVs.

- **Inclusivity analysis:** Proper training is needed on operating, driving, and maintaining electric buses for bus operators and drivers who may be from low-income communities. Regarding bus infrastructure, BMC should ensure that new buses have ramps for disabled access, separate seats for elderly, women and disabled and panic buttons to support women's safety. Training can also be provided for women drivers⁷⁸. Jobs and training can also be provided for low-income workers in setting up and maintaining charging stations.
- **Implementing stakeholders:** Bhopal City Link Limited (lead), Bhopal Municipal Corporation, Bhopal

Development Authority, Bhopal smart city, bus operators, charging infrastructure providers, NVVN, MPMKVCL

- **Timeframe:**
 - Trial period short term (1-2 years)
 - Implementation medium term (3-5 years)
- **Mainstreaming with policies and schemes:** AMRUT- Funding for non-motorized urban transport projects, FAME phase 2, MP EV policy, National Urban Transport Policy
- **Monitoring Indicators:** # of e-buses introduced, % of e-buses in total fleet, ridership numbers for the BRTS, # of chargers per 1000 population, public transport mode share (disaggregated by income and gender), % emissions from transport
- **Alignment with CSCAF indicators:**
 - Indicator 2: Availability of public transport and indicator 1: clean technologies shared vehicles under the mobility & air quality sector
 - Indicator 3: Fossil fuel consumption in the city under the energy & green buildings sector

Action 3: NMT focused street design guidelines for Bhopal

- **Challenges addressed at the city level:** The stakeholder consultations highlighted the need for dedicated cycling and walking lanes. Bhopal boasts of a good public bike sharing system and the longest cycle track in India. However, the track was seen to be dumped with rubble and construction waste⁸². Only 15.56 % of the road length has footpaths which can be improved¹².
- **Description:** Bhopal can implement urban street design guidelines to define and initiate a process to ensure that appropriate pedestrian friendly street types and street design elements are implemented in street design to create streets that support both non-motorized and private transport modes. These can include guidelines on road width, segregated cycle tracks, bus stops, BRT lanes, carriage way, pedestrian crossing, signages, streetlights, street furniture, street trees, permeable pavements, etc. Cities like Pune⁸³, Delhi⁸⁴ and Mumbai⁸⁵ have already implemented such guidelines. These guidelines act as binding documents that mandate all urban professionals involved with street planning and urban renovation to integrate them in the design process.

For example, Pune has mandated that footpaths should provide clear and unobstructed minimum walking zone of 2m horizontally with 2.4m vertical clearance. They should also have a uniform height of

150m above road level. Cycle tracks should be at least of 2m width for one way movement and at least 3m for two-way movement with vertical clearance of 2.4 m⁸³. BMC has issued a work order for the construction of 45m, 18m, 12m and 6m wide smart roads in ABD Area – Phase III and construction of 30m, 24m, 18m and 6m wide smart roads in ABD Area – Phase IV. Site clearance has also been obtained for phase V. A 12m wide smart road is also planned in north and south TT Nagar⁵. These guidelines can be incorporated into these projects. The NMT design guidelines can be implemented and monitored by the NMT cell that was recommended in the detailed project report for Bhopal's public bicycle sharing system. This cell should be headed by the Commissioner and include different departments within BMC. Along with the PBS, it can also be tasked with the implementation of all other NMT related projects⁸⁶.

- **Inclusivity analysis:** BMC should ensure that these footpaths and cycle paths have suitable ramps at entry and exit points for providing access to disabled, similar to that mandated in Pune. Cycle tracks should also be separated by a verge (strip of plantations or trees), like in Delhi, to ensure safety of cyclists and prevent encroachment by private vehicles. This will also provide shade for cyclists and pedestrians. Street furniture should also be placed in roads to ensure comfort of pedestrians, especially the elderly. The Pune guidelines mandate that benches should be provided at the building edge of the footpath with shade⁸³.
- **Implementing stakeholders:** Bhopal Municipal Corporation (lead), Bhopal smart city, Bhopal Development Authority, BCLL, Bhopal NMT cell, NGOs, RWAs
- **Timeframe:** Short term (1-2 years)
- **Mainstreaming with policies and schemes:** AMRUT – Funding for non-motorized urban transport projects, Smart cities mission (Cycles 4 change and Streets for people challenges), National Transit Oriented Development Policy
- **Monitoring Indicators:** Creation of street design guidelines, % of road network with footpaths and cycle tracks, % mode share for walking and cycling (disaggregated by gender and income groups), % of roads with tree shade, % roads with street furniture, % reduction in GHG emissions from transport sector
- **Alignment with CSCAF indicators:**
 - Indicator 3: Percentage of non-motorized transport coverage network (pedestrian and bicycle) in the city, under the mobility & air quality sector

Action 4: Promote electric two wheelers in Bhopal

- **Challenges addressed at the city level:** 28% of total GHG emissions comes from transport while 2 wheelers account for 25% of mode share²⁵, making it an important segment to decarbonize.
- **Description:** The city can implement an electric 2-wheeler sharing system, leveraging India's booming scooter sharing economy. This can be done by leveraging private players such as Ola, Bounce and Vogo⁸⁷. Charging infrastructure at public places, hotels and offices can be incentivized through tax rebates. The new e-scooter sharing system must be promoted effectively and should have accompanying repair stations and mechanisms to prevent theft or manage breakdowns. BMC can also ensure that the electric scooter rental stands are available near metro stations and BRTS stations. Bhopal can also partner with companies like Yulu, a shared electric mobility start-up with a fleet of 10,000 units running across Bangalore, Delhi and Mumbai to provide last mile personal mobility service. In Bangalore, one can find a yulu bike within 250m, a density that becomes necessary to induce habitual change⁸⁸.

In addition, or as an alternative, BMC can also look at implementing a program for taking back old petrol or diesel scooters and selling subsidized e-scooters for college students and working professionals. For example, Gujarat has a subsidy scheme for e-scooters and e-rickshaws. Under the scheme, the state government gives a subsidy of Rs 12,000 each to students to buy e-scooters. It will aid students from class IX to college, to purchase battery-powered two wheelers⁸⁹. BMC can promote similar incentives provided by the state in the MP Electric Vehicle Policy, including exemption of vehicle registration fees and reduction in motor vehicle tax⁹⁰. Additionally, BMC can provide incentives like parking fee exemption, dedicated parking spaces, etc.

- **Inclusivity analysis:**
 - Loans and subsidies for vehicle purchase can be made more easily available for low-income groups and small businesses.
 - Increased awareness campaigns targeted at low-income groups, particularly the youth, on the environmental and economic advantages of e-scooters compared to ICE scooters can be conducted, mainly in local languages
 - Bhopal should also ensure equitable access to scooter stands in low- and high-income wards and ensure that usage of scooters can be done through digital and non-digital modes to account for those without mobile phones.

- **Implementing stakeholders:** Bhopal Municipal Corporation (lead), Bhopal City Link Limited, private companies, Bhopal Development Authority, Bhopal smart city, RTO, RWAs, colleges
- **Timeframe:** Medium term (3-5 years)
- **Mainstreaming with policies and schemes:** MP EV policy
- **Monitoring Indicators:** # of e-scooters registered by regional transport office, # of public shared e-scooters initiated by BMC if any, % of electric 2-wheeler fleet in the city, ridership numbers for e-scooters, availability of reliable charging infrastructure in key areas of the city, # of shared bike stations in each ward, daily use by low-income communities, % reduction in emissions from the transport sector
- **Alignment with CSCAF indicators:**
 - Indicator 1: Clean technologies shared vehicles under the mobility & air quality sector
 - Indicator 3: Fossil fuel consumption in the city under the energy & green buildings sector

Action 5: Fuel efficiency training and management for public and private bus operators

- **Challenges addressed at the city level:** 28% of emissions come from transport sector.
- **Description:** Bhopal should conduct fuel efficiency improvement trainings for the BRTS bus fleet. Bhopal is home to many prestigious educational institutions¹⁶. Fuel efficiency training and management programs can also be conducted for college and school bus operators. These trainings were previously conducted for buses in Bhopal, run by Prasanna Purple Mobility Solutions, which saw a 32% increase in fuel efficiency²⁶. This can be scaled up to the entire fleet. This program consists of:
 - Driver training to help drivers understand the vehicle technology and external factors affecting efficient operation.
 - Management systems which involve data collection and monitoring of driver performance through bus malfunction reports, refresher trainings and driver consistency in the same route.
 - Vehicle maintenance using Key Performance Indicators (KPIs) such as fuel efficiency, missed mileage, fleet utilization and cost per bus per day. Incentives can also be provided to drivers based on annual improvements in fuel efficiency.
- **Inclusivity analysis:** This action will help increase awareness and instill a sense of responsibility amongst drivers, who may usually belong to informal

communities. These trainings must be conducted in regional language as well.

- **Implementing stakeholders:** Bhopal Municipal Corporation (lead), Bhopal City Link Limited, private companies / colleges / universities/ schools, private organizations for technical expertise
- **Timeframe:** The action can begin in the short term (1-2 years) but should be constantly monitored over the long-term period (>5 years).
- **Mainstreaming with policies and schemes:** None
- **Monitoring Indicators:** # of workshops conducted along with participation numbers, % increase in fuel efficiency before and after trainings, % reduction in annual fuel consumption for bus fleet
- **Alignment with CSCAF indicators:**
 - Indicator 3: Fossil fuel consumption in the city under the energy & green buildings sector

Action 6: Increase the spatial network of PUC and AAQ stations in the city

- **Challenges addressed at the city level:** Bhopal's air quality is in the moderate level with PM 2.5 levels being 5 times higher than the World Health Organization benchmark⁷⁹. The city has only five manual monitoring stations and but needs at least 18 to analyze pollution statistically, spatially, and temporally in the city⁹¹. This was also highlighted during stakeholder consultations.
- **Description:** The city should first assess the availability and accessibility of Pollution Under Control (PUC) and Ambient Air Quality (AAQ) stations in Bhopal to understand if and where there is a need for increasing the network and public access. PUC check points can also be increased at key entry points, especially for freight. Bhopal also needs to increase the number of AAQ monitoring stations, particularly near schools and hospitals.
- **Inclusivity analysis:** Ensure AAQ stations in low-income areas and close to industries to monitor the air quality around the most vulnerable populations. Awareness around permissible and dangerous air quality levels and associated health impacts must be increased particularly to low-income groups, in local languages
- **Implementing stakeholders:** MP Pollution Control Board Regional Office (lead), Bhopal Municipal Corporation, private companies, Bhopal smart city, PUC center owners

- **Timeframe:** Medium term (3-5 years)
- **Mainstreaming with policies and schemes:** National Clean Air Action Plan
- **Monitoring Indicators:** # of AAQ stations in the city, # of PUC stations in a 3x3 grid, reduced fatalities, or hospitalizations due to air pollution, % of AAQ stations in low-income wards
- **Alignment with CSCAF indicators:**
 - Indicator 4: Level of air pollution under the mobility & air quality sector



Source: Bhopal Smart City Development Corporation Ltd.

Goal 4: Green & Inclusive Spaces in Bhopal

More than 18% of Bhopal's municipal area is under green cover¹². A survey conducted by Indian Institute of Science (IISc), Bengaluru, has revealed that Bhopal's green cover has shrunk by 44% in just two decades, turning the city into a heat chamber⁹². Bhopal also has 11% of forest cover of its geographical area, and it is much below the state average of 25%⁹³. Wetlands are a prominent feature defining Bhopal's urban fabric. The upper and lower lakes in Bhopal constitute the Bhoj wetland, a Ramsar site. Despite conservation efforts, this site is threatened by urban development⁹⁴. Thus, there is a need to implement actions to increase green cover and enable wetland conservation in a sustainable, inclusive, and climate-resilient manner.

Identified Actions

Action 1: Engage citizens in urban green cover conservation

- **Challenges addressed at the city level:** Limited community involvement in increasing green cover¹² as per the assessment under CSCAF 2.0.
- **Description:** The recommendations under CSCAF 2.0 encourages Bhopal to implement community driven initiatives to increase green cover. The Bhoj wetlands and Bhopal's dwindling green cover require public support and involvement to ensure their conservation and rejuvenation. The city stakeholder consultations also stressed upon the need for better citizen awareness to participate in greening the city. For this, Bhopal Municipal Corporation can organize events like collective citizen-driven mapathon to map out potential areas for new urban forests, gardens, or parks. This will engage citizens and tourists in the mapping and conservation of urban green spaces and will also instill a sense of responsibility and ownership amongst citizens. Kochi did something similar within the Cities4forest project implemented by WRI India⁹⁵. Mapathons were regarded as a good idea to understand new areas for plantations, as per the consultations.

Bengaluru also has an open-source platform providing guidance and tools for mapping trees in the city⁹⁶. Bhopal can also introduce apps to help citizens map trees and also identify the best type of trees to plant, based on the location. Examples include Kerala⁹⁷, where an app was launched to help citizens identify the types of trees to plant based on their location and Goa⁹⁸, which helps citizens geotag trees and monitor their health. Household surveys can also be used as a method to build a resilience roadmap for urban forestry initiatives, like in Kochi⁹⁹. Technical organizations can

also be involved in helping BMC prepare GIS based maps of urban green cover on a yearly basis to understand decrease or increase with time. Bhopal can examine the case of Nagpur, which has prepared a methodology to map urban green spaces using GIS¹⁰⁰.

- **Inclusivity analysis:** Bhopal should first create a GIS based map of ward level access to green and open spaces to understand the spatial distribution of green cover in the city. Slums usually are exposed to high heat stress due to poor vegetation, like in Mumbai where slums were 5-6 degrees hotter than their neighboring localities¹⁰¹.

Engaging citizens is an important measure to increase the social inclusivity of urban greening projects. When practitioners work with communities, they can choose methods that intentionally involve diverse stakeholder groups, providing a space for their opinions, needs and knowledge before/ during the project implementation. A social and vulnerability analysis can be conducted to identify all relevant stakeholders for these initiatives, particularly the vulnerable sections⁷⁶.

- **Implementing stakeholders:** Bhopal smart city and Bhopal Municipal Corporation (lead), Bhopal Development Authority, councilors, citizens, local experts, NGOs, technology providers
- **Timeframe:** Short term (1-2 years) with long term implementation
- **Mainstreaming with policies and schemes:** AMRUT – 2.5% of project cost is funded for development of parks, with children- and elderly-friendly features, Nagar van scheme
- **Monitoring Indicators:** Number of communities represented in the community engagement initiatives, % increase in area of urban green cover, # of mapathons conducted, GIS based maps on ward level access to green cover within 500m to identify wards with low access to green cover
- **Alignment with CSCAF indicators:**
 - Indicator 2: Proportion of green cover within the urban planning, green cover & biodiversity sector

Action 2: Promote green terraces and kitchen gardens in residential buildings and schools

- **Challenges addressed at the city level:** As per CSCAF 2.0, Bhopal is recommended to encourage

community level activities such as tree plantations, developing community gardens, urban agriculture or terrace gardening, and vertical gardening wherever possible.

- **Description:**

- Urban green terraces are an efficient way to integrate greening into existing urban infrastructure while also helping residents reduce food costs by cultivating their own produce. Bhopal Municipal Corporation along with the state government can take steps to increase awareness and interest in green terraces. An example is the case of Madurai, where the government is selling subsidized terrace garden kits¹⁰². The kits contain 10 seed varieties, bags, and manure. The government of Tamil Nadu also provides 50% subsidy for procuring materials to start a green terrace under the “do it yourself” kit program. Each buyer can avail the subsidy five times¹⁰³. Bihar has also started a similar program along with training workshops for farmers and residents¹⁰⁴. Further incentives to reduce costs can be tax rebates for residential communities with terrace gardens. Bhopal can first pilot terrace gardens in all municipal buildings for ensuring increased public awareness and uptake.

- Kitchen gardens can be promoted in residential buildings as well as in schools. Innovative greening initiatives like portable farming systems (PFS) can be piloted in schools. For example, Mumbai Corporation of Greater Mumbai has collaborated with WRI India and Living Greens Organics Pvt Ltd to pilot portable farming systems with soil less growing, leak proof containers and integrated drip system. They can grow many seasonal vegetables. Teachers were also trained to manage the same¹⁰⁵.

- **Inclusivity analysis:** Low-income areas may lack adequate rooftop infrastructure for such initiatives. In these cases, common community terrace gardens or kitchen gardens can be explored in community spaces like schools, public gardens, Anganwadis, etc. Children can also be involved in managing these gardens, thereby increasing awareness from a young age.

- **Implementing stakeholders:** Bhopal smart city and Bhopal Municipal Corporation (lead), Bhopal Development Authority, citizens, Horticulture and food processing department, Government of Madhya Pradesh

- **Timeframe:** Medium term (3-5 years)

- **Mainstreaming with policies and schemes:** Nagar van scheme

- **Monitoring Indicators:** Percentage and spatial distribution of houses with green terraces

disaggregated by income type, number of kits sold, # of common community gardens in low-income wards, % green cover out of total municipal area

- **Alignment with CSCAF indicators:**

- Indicator 2: Proportion of green cover within the urban planning, green cover & biodiversity sector.

Action 3: Bioremediation for the conservation of the Bhoj wetland (upper and lower lakes)

- **Challenges addressed at the city level:** The water bodies in Bhopal have been facing contamination, dumping of waste and encroachment, and the city has limited water treatment capacities¹⁰⁶.

- **Description:** Bhopal can consider implementing bio-remediation to clean and conserve the Bhoj wetland. Bioremediation involves using biological systems for reclamation of the contaminated soil/water by transforming toxic pollutants into less hazardous or completely non-hazardous forms. Examples include the bioremediation of Hauz Khas lake in Delhi¹⁰⁷ and the use of a combined bio-ozolyte and bioremediation process to treat Ooty lake¹⁰⁸. Bhopal can conduct feasibility studies to identify areas for bioremediation. It is a cost-effective method where microbes control odor, reduce the use of energy consuming aerators and control the nutrient levels in the water to help the ecosystem thrive¹⁰⁹. Sewage from nearby settlements and wastewater from industries must be prohibited and STPs must be set up to treat water before letting into the lake. The buffer zone can also be further expanded. Examples from Indore’s plan to rejuvenate the Kanh River can also be adopted¹¹⁰ including, revival of 400 local water bodies and wells, constructing effluent treatment plants to treat industrial wastewater entering the river, preservation of Lasuria Mori lake water body by treating water through artificial floating island with treatment through aeration and Bio-culture media & plantation.

- **Inclusivity analysis:**

- Public consultations are necessary to identify why different communities are motivated to conserve the lakes, particularly those that derive their livelihoods from it. Awareness campaigns, particularly amongst low-income groups, are necessary to prevent contamination and waste disposal in the lakes. Waste collection infrastructure can also be improved in areas close to the lake to prevent illegal dumping.
- Subsidized Drinking Water Treatment Plants (DWTPs) can also be implemented in low-income housing sections close to the lakes to increase access to drinking water.

- **Implementing stakeholders:** Bhopal Municipal Corporation (lead), EPCO, Bhopal Development Authority, Bhopal smart city, councilors, citizens, NGOs
- **Timeframe:** Medium term (3-5 years)
- **Mainstreaming with policies and schemes:** National Water Mission¹¹¹
- **Monitoring Indicators:** Optimal BOD and COD levels of the lakes, % increase in aquatic life forms, % households with drinking water access, # of lakes rejuvenated by bioremediation
- **Alignment with CSCAF indicators:**
 - Indicator 1: Rejuvenation and conservation of water bodies and open areas within Urban planning, green cover, and biodiversity sector.

Action 4: Institutionalize a tree cell to prevent illegal logging and implement policies for scientific transplantation and heritage tree protection

- **Challenges addressed at the city level:** The stakeholder consultations highlighted the need for better monitoring against encroachments of plantations, and for mainstreaming green cover into new urban developments. The CSCAF 2.0 also recommends Bhopal to strengthen its institutional and compliance mechanisms for increasing green cover.
- **Description:**
 - **Tree cell and transplantation:** A 24x7 tree helpline number and a tree cell can be instituted within the gardens department at BMC. Like in Delhi, this cell can oversee scientific transplantations, illegal logging, and strict enforcement of feasibility analysis of tree cutting for all infrastructure projects, especially with respect to impact on heat island effect¹¹². Delhi also has a transplantation policy where agencies have to transplant at least 80% of the trees affected by their development work. The final payment for the development work will be done as per the survival rates of these trees. For each transplanted tree that does not survive, five trees of indigenous species with 15 feet height and at least six-inch diameter will have to be planted¹¹³. Bhopal smart city is planning to transplant 200 trees from the ABD area⁵. A similar cell and policy can be implemented to oversee this transplantation.
 - **Heritage tree conservation:** Mumbai and Haryana have introduced provisions to protect heritage trees. Trees over 75 years are tagged as heritage trees in Haryana. Individuals and companies will be fined or even jailed for logging heritage trees. The owners of such trees will also be provided a pension of Rs 2,500 a year for maintaining the trees¹¹⁴. In Maharashtra, the Maharashtra (Urban

Areas) Protection and Preservation of Trees Act of 1975 was amended to protect heritage trees (older than 50 years). If they are cut, trees equal to the age of the tree must be planted. A census of heritage trees should be conducted every five years¹¹⁵. Bhopal can also introduce such rules to conserve heritage trees.

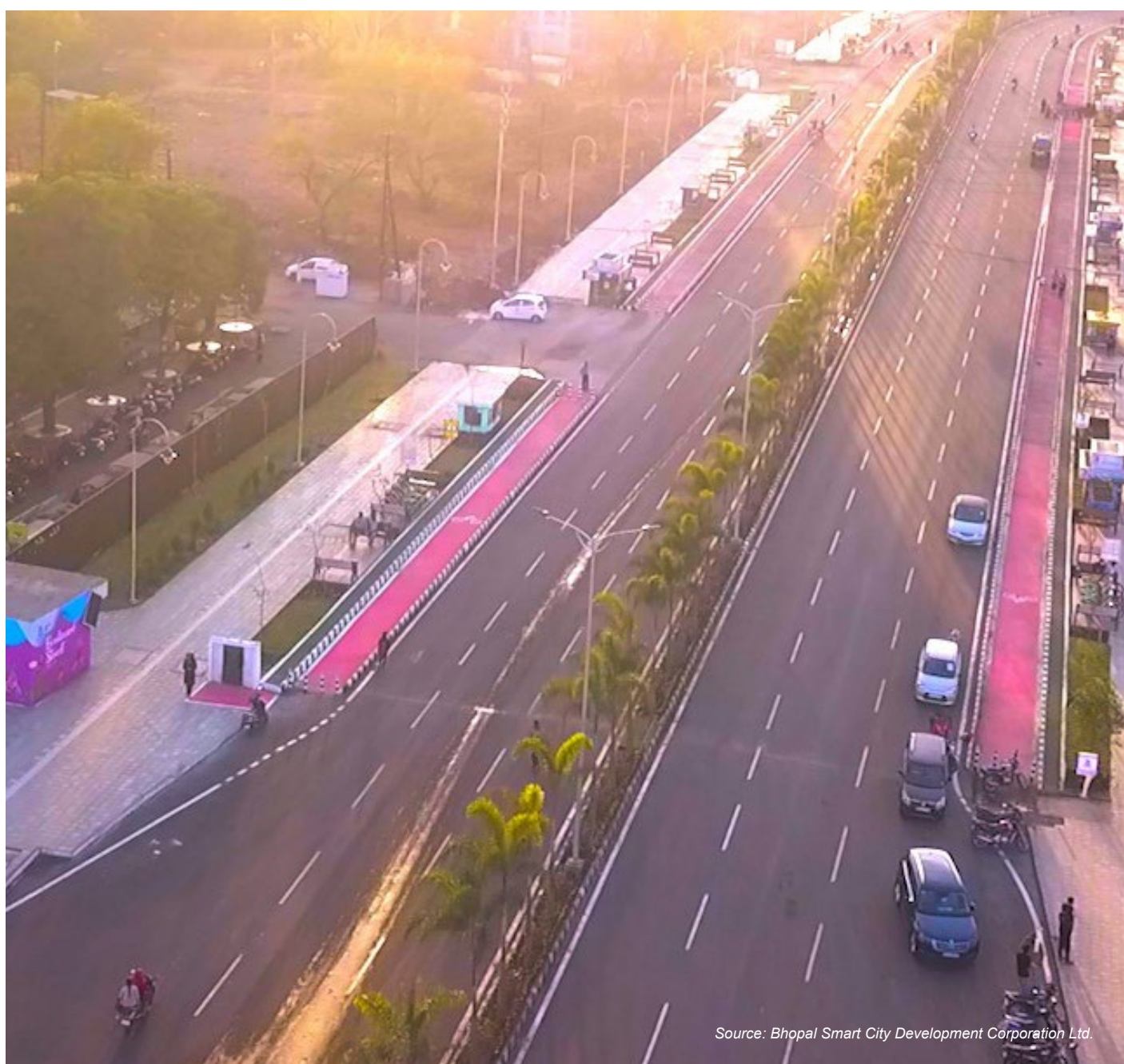
- **Inclusivity analysis:** Neighborhoods with higher incomes, education levels, home ownership and populations of majority ethnic groups may have higher proportions of tree cover. An equity index can be created to help incorporate equity in the spatial distribution of green cover initiatives. The tree cell should also oversee illegal tree logging in low-income areas. The tree cell can also have representation from indigenous groups and NGOs.
- **Implementing stakeholders:** Bhopal smart city and Bhopal Municipal Corporation (lead), Bhopal Development Authority, citizens, NGOs, builders' association, NGOs
- **Timeframe:** Short term (1-2 years)
- **Mainstreaming with policies and schemes:** Nagar Van Scheme
- **Monitoring Indicators:** Formation of a tree cell, number of heritage trees, survival rate of transplantation projects, % increase in green cover out of total municipal area
- **Alignment with CSCAF indicators:**
 - Indicator 2: Proportion of green cover within the urban planning, green cover & biodiversity sector

Action 5: Data, information, and awareness for biodiversity conservation

- **Challenges addressed at the city level:** As per the CSCAF 2.0 recommendations, Bhopal should link biodiversity planning with local/city plans and identify measures to increase biodiversity within the master plan/greening plans/rejuvenation plans
- **Description:** ICLEI has recently developed a city biodiversity index for Bhopal¹¹⁶. The information about this index along with native species in Bhopal should be communicated to the public for increasing awareness and participation. Thiruvananthapuram developed a mobile app which provided the geographical distribution of flora and fauna along with the scientific name from a database populated by people through mobile phone photos of the species¹¹⁷. Bhopal can explore such similar apps for public dissemination. Bhopal can also implement QR codes on trees for information on tree species, age, ecosystem services

and benefits like in Meerut¹¹⁸ and Delhi¹¹⁹. Bhopal can implement similar initiatives in gardens and parks.

- **Inclusivity analysis:** Information should also be provided in the native language. The knowledge of forest-dependent low-income groups or tribal communities should be utilized for such initiatives through job creation to develop QR codes, data collection or organizing walking tours to spread awareness on biodiversity.
- **Implementing stakeholders:** Bhopal smart city and Bhopal Municipal Corporation (lead), Bhopal Development Authority, citizens, MP State Biodiversity Board, local communities, NGOs
- **Timeframe:** Medium term (3-5 years)
- **Mainstreaming with policies and schemes:** Nagar Van Scheme
- **Monitoring Indicators:** % of trees with QR codes or tagging, % increase in number of species in the city, # new jobs created for local communities, improvement along biodiversity index
- **Alignment with CSCAF indicators:**
 - Indicator 2: Proportion of green cover
 - Indicator 3: Urban biodiversity within the urban planning, green cover & biodiversity sector.



Source: Bhopal Smart City Development Corporation Ltd.

Goal 5: Water-Resilient Bhopal

Hailed as the “city of lakes”, the water bodies in Bhopal are under threat of encroachments and improper disposal of waste¹⁰⁶. Moreover, the city is yet to develop a demand management and water resources management plan¹². 82% of the city's population has access to improved drinking water⁸. However, the ground water status in the district was in the semi-critical category in 2017 and must be replenished through better water demand management and use of treated water by industries and in residential areas¹²⁰. The city needs to promote recycling and reuse of treated water which is currently lacking¹². Boasting of MP's only Ramsar site, water resource management is an important aspect that the city must address in a sustainable manner to ensure equitable access to water resources in the future.

Identified Actions

Action 1: Develop and implement a demand management plan for Bhopal city

- **Challenges addressed at the city level:** No water resources plan or demand management plan prepared under CSCAF 2.0. Moreover, the ground water status for Bhopal district was semi-critical in 2017¹²⁰.
- **Description:** A demand management plan must be prepared and implemented for best utilization of available resources. Some of the strategies that can be included are:
 - Improving efficiency of water supply and treatment: Bhopal should first conduct an energy efficiency audit for its water supply and treatment system and undertake improvements like network analysis, supply flow moderation, and terrain 3D modeling to use the gravitational force¹². Historical energy usage data should be collected to identify potential areas for modification for reduced energy usage.
 - Strategies for reuse and recycle of treated water: BMC should include strategies for reusing treated water such as in gardens and public parks or providing it for agricultural irrigation to farmers. The National Green Tribunal had asked Delhi Jal Board (DJB)¹²¹ and park-owning agencies in 2019 to use treated water for parks within 5km of WTPs, failing which they would be fined. This would lead to reduced pumping and supply of freshwater for gardening purposes, which would lead to reduced pressure on water supply system, especially during summer. This has also been encouraged by CPCB¹²². BMC can also consider providing treated water to nearby large and medium scale industries like BHEL, Omega Industries, GEI Industries system, etc. Bhopal has 19 large and medium industries¹²⁴. The example of Nagpur can be considered where the city is supplying treated water to thermal power plants operated by Maharashtra Generation Company Ltd. (MahaGenCo). Nagpur Municipal Corporation (NMC) and Maharashtra Generation Company Ltd had entered into a 30-year agreement where the municipality supplies treated water at a much lower cost. This way, the city recycles 90% of its treated water¹²⁵.
- Installing smart water meters: Bhopal is yet to operationalize around 80,000 water meters installed in the city as of 2022¹²³. BMC can consider converting them to smart water meters or installing new smart meters in areas not yet covered to provide real time water consumption readings to consumers. Consumers in a particular zone or ward using least amounts of water can also be provided incentives like reduced property tax. Similar meters are installed in Hyderabad¹²⁶ and Jaipur¹²⁷.
- Promoting decentralized sewage treatment plants: Decentralized STPs can be feasible solutions for areas not connected to the sewage network. These can be installed at a suburb level, neighborhood level or building level¹²⁸. The plants can be operated with minimal labor and a 500-kL plant needs 500 m² land area. Delhi has installed several STPs to treat water for reuse in parks¹²⁹. Srirangam is also implementing a decentralized STP to cover some houses not coming under the sewage network¹³⁰.
- **Inclusivity analysis:**
 - This action must be accompanied by increased awareness among communities on the need to replenish the ground water and optimize water usage. BMC must also ensure adequate consultations are carried out with representation from NGOs and vulnerable groups while preparing this plan.
 - Low-income and informal communities tend to use the least amount of water per capita but face the highest levels of water stress. The demand management plan must ensure replenishing ground water in low-income wards and installing decentralized STPs in these areas.
 - The process needs to ensure coordination amongst government agencies and active participation from all significant stakeholders through training programs on installation, operation, and maintenance of decentralized STPs. To generate practical awareness, involvement, and participation from local users for the decentralized approach, an online web-based tool — MOUNT (Menu on Un-Networked Technologies for Sewage and Septage

Management) created by the Centre for Science & Environment, India which comprises successfully implemented decentralized wastewater treatment technologies can also be used by the city during the training modules¹²⁸.

- **Implementing stakeholders:** Bhopal Municipal Corporation (lead), water utilities, RWAs and communities, Bhopal Development Authority, farmers, industry associations, private technology providers for smart meters
- **Timeframe:** Medium term (3-5 years)
- **Mainstreaming with policies and schemes:** Smart Cities Mission, Govt. of Madhya Pradesh State Level Policy (2017) for Wastewater Recycle & Reuse and Faecal Sludge Management (FSM), Madhya Pradesh Urban Services Improvement Project
- **Monitoring Indicators:** Creation of a demand management plan, # of decentralized STPs installed in the city (ward wise), # of parks using treated water for maintenance, # of industries using treated water, % reduction in water usage and tariffs for consumers, % houses covered with sewage treatment, % houses covered with water supply (disaggregated by income level), ground water table stress level
- **Alignment with CSCAF indicators:**
 - Indicator 1: Water resources management
 - Indicator 3: Wastewater recycle and reuse
 - Indicator 5: Energy efficient water supply system under water management sector

Action 2: Develop and implement an integrated flood and storm water management plan

- **Challenges addressed at the city level:** In 2020, Bhopal along with other cities in MP witnessed severe urban flash flooding due to heavy showers¹³¹. No flood management plan prepared as per CSCAF 2.0.
- **Description:** An integrated flood and storm water management plan is essential to reduce the risk of urban flooding. A detailed flood and storm water management plan¹³² must include structural and non-structural strategies and is essential to:
 - Reduce flood risks to roads and buildings
 - Incorporate storm water drains into new developments
 - Improve water reuse and water security
 - Reduce infiltration of untreated sewage into water bodies
 - Improve ground water table
 - Improve coordination and planning for flood risk management

Strategies can include early warning systems, setting up rain recording stations, stock of drinking water in case of contamination during floods, creation of flood relief shelters, etc., similar to those suggested in Tripura's flood management plan which can be looked into¹³³. Bhopal must include sustainable urban drainage systems within urban development projects like new roads. In accordance with level 5 under the climate action plan indicator in CSCAF 2.0, water sensitive urban design considerations can also be incorporated into the city's master plan. Examples include green infrastructure permeable paving on driveways and footpaths, garden beds designed for infiltration (rain gardens), lawns and vegetation, swales, soak wells, etc.¹³⁴

- **Inclusivity analysis:** Low-income communities not only typically lack basic infrastructure that mitigates flooding or heat (e.g., trees for shade, proper storm-water drainage channels), but they also lack political representation. Bhopal city needs to regularly collect census data on informal, migrant, and low-income communities in order to capture the magnitude of risk for these communities. This disintegrated data should be utilized for a data-driven informed decision making. Early warning systems, bioswales, relief shelters, etc. should be implemented in low-income areas as well.
- **Implementing stakeholders:** Bhopal Municipal Corporation (lead), Bhopal smart city, Bhopal Development Authority, resident welfare associations and communities, NGOs, Water Resources Department, GoMP
- **Timeframe:** Medium term (3-5 years)
- **Mainstreaming with policies and schemes:** AMRUT – Getting funding under thrust areas like sewerage facilities and septage management and storm water drainage management, Jal Jeevan Mission
- **Monitoring Indicators:** Reduced flooding frequencies, reduced water stagnation, improved vegetation and ground water table, reduced infiltration of untreated sewage into water bodies, % reduction in flood damage related costs
- **Alignment with CSCAF indicators:**
 - Indicator 4: Flood/ water stagnation risk management within the water management sector.

Action 3: Implement solar-powered sewage treatment plants

- **Challenges addressed at the city level:** Only 0.05% energy comes from renewables. City has also not conducted energy audit of sewage treatment plants as per CSCAF 2.0.

- **Description:** The city can pilot the use of solar power to run the existing and new STPs in order to reduce emissions and improve the energy efficiency of water treatment systems. A similar pilot is being implemented in Tamil Nadu¹³⁵. Delhi¹³⁶ also inaugurated a solar-powered sewage treatment plant in 2015. The city can use innovative funding mechanisms like in Indore, where Indore Municipal Corporation announced its plan to issue rupee-denominated masala bonds of approximately Rs 450 crore to install a floating solar project, in Jalood and Yashwant Sagar to power pumping stations¹³⁷.
- **Inclusivity analysis:** Training and new jobs can be provided to workers from low-income groups to operate and maintain these plants. The energy costs saved can be utilized to increase access to drinking water in low-income areas.
- **Implementing stakeholders:** Bhopal Municipal Corporation (lead), Bhopal smart city, Bhopal Development Authority, resident welfare associations and communities, Water Resources Department, GoMP, private agencies operating the STPs if any
- **Timeframe:** Medium term (3-5 years)
- **Mainstreaming with policies and schemes:**
 - Policy for implementation of solar power-based projects in Madhya Pradesh
 - Madhya Pradesh Policy for Decentralized Renewable Energy Systems, 2016, Madhya Pradesh Urban Services Improvement Project (ADB).
- **Monitoring Indicators:** Reduced energy costs for sewage treatment, % of energy from renewables, # of new jobs created
- **Alignment with CSCAF indicators:**
 - Indicator 6: Energy-efficient wastewater management system within the water management sector
 - Indicator 2: Total electrical energy from renewable sources under the energy & green buildings sector



Source: Bhopal Smart City Development Corporation Ltd.

Goal 6: Sustainable & Climate-Resilient Infrastructure in Bhopal

Stationary energy sector comprising residential, commercial, and institutional buildings account for the highest percentage of GHG emissions in Bhopal. The aim of promoting low-carbon, energy efficient building and infrastructure is to improve ECBC compliance, promote green buildings in the city, retrofit existing infrastructure with energy efficient appliances and make the buildings sector sustainable in the long run.

| Identified Actions

Action 1: Implement measures to promote green buildings in Bhopal

- **Challenges addressed at the city level:** As per the CSCAF 2.0, Bhopal is not taking any measures to promote green buildings.
- **Description:**
 - Bhopal must include Part 11 of NBC 2016, or ECBC 2017 & Eco-Niwas Samhita 2018 and minimum level of green building rating systems notified in building rules/ bye laws. The Energy Conservation Building Code (ECBC) was published in 2017. The ECBC 2017 codes have been mandated in commercial buildings, however, it lacks compliance. Bhopal should ensure strict compliance through monitoring permit requirements, calculation methods, regular inspections, monitoring energy bill reductions, etc.
 - Bhopal must also have a functioning green building cell for knowledge dissemination, creating public awareness, empaneling green building schemes and their promotions, verification, and faster approvals for green buildings in the city. Bhopal must also have promotional or penalty schemes available for code compliance, pre-certification, and certification of green buildings.
 - Bhopal must have a functioning high-level green building committee or equivalent, comprising of ULB's commissioner and representatives of ULB's green building cell, SPV, UDD, town planner, PWD, green building certification agencies, developers and building professional associations. The committee can provide strategic advice for the promotion and adoption of energy efficient and green buildings in the city in close coordination with the cell.
- **Inclusivity analysis:** Developers may pass on the cost of achieving green building code specifications

to consumers, making it unaffordable for low-income renters, homeowners, or small-scale businesses. Developers would then have less incentive to invest in new building projects if communities cannot afford higher housing prices. Thus, there may be fewer new, efficient buildings constructed for low-income groups, pushing more households into informality. The city should ensure that green building components are included in affordable housing development (government housing phase 3 and phase 2) being planned in Bhopal.

- **Implementing stakeholders:** Bhopal Municipal Corporation (lead), Directorate of Town and Country Planning, GoMP, Bhopal smart city, MP Urja Vikas Nigam, MPMKVCL, IGBC city chapter, developers' association
- **Timeframe:** Short term (1-2 years) with long term implementation
- **Mainstreaming with policies and schemes:** MP Policy for Decentralized Renewable Energy Systems, 2016, Energy Conservation Building Code, MP Renewable Energy Policy 2022
- **Monitoring Indicators:** # of promotional measures implemented, Number of certified & pre-certified green buildings in the city, number of ECBC/ ENS compliant buildings, total built-up area of green buildings, % energy coming from renewables
- **Alignment with CSCAF indicators:**
 - Indicator 5: Promotion of green buildings
 - Indicator 6: Green building adoption
 - Indicator 2: Total electrical energy in the city derived from renewables under Energy and Green buildings

Action 2: Promote low-carbon, ECBC compliant development in the construction of government housing phase II & III under ABD, heritage development of Sadar Manzil and other place making projects

- **Challenges addressed at the city level:** Bhopal had only up to 10% green building adoption during the CSCAF 2.0 assessment period
- **Description:** Bhopal is currently working on constructing government housing in the ABD area, heritage development of Sadar Manzil and place

making projects in various colonies⁵. Developments in these projects can be piloted as zero carbon or low carbon buildings. A (net) zero carbon building (ZCB) can be defined as an energy efficient building that supplies most (but not all) of its annual energy use through on-or near-site renewable energy sources.

Key components of such buildings can include:

- **Energy efficiency:** Ensuring energy efficiency through compliance with local codes and standards through energy efficient equipment use
- **Renewable energy:** Achieving further reductions in building emissions through renewable energy sources through on-site RE generation, off-site RE generation or purchase.
- **Carbon offsets:** Carbon offsets can be used to balance out residual emissions. The emissions reduction benefits must be claimed through a credible mechanism such as carbon credits or a local carbon credit fund.

Best practice examples which can be adapted include the Delhi's Indira Paryavaran Bhawan. It is compliant with local codes and standards, has natural lighting in the daytime, shading, landscaping and uses 70% lesser energy than a conventional building and is India's highest green rated building¹³⁸. Most of the Infosys campuses in the country are LEED platinum buildings and have PV panels, RE electricity and off-site RE plants. More examples and initiatives can be identified from the World Resources Institute study on Eight Attainable Policy Pathways to Net Zero Carbon Buildings for All¹³⁹.

- **Inclusivity analysis:**

- The net-zero transition in such large-scale government projects could open value pools around green building materials and promote business for small start-ups manufacturing green/ alternative building materials and those in their supply chain.
- Bhopal should initiate discussions with third party building certification agencies, planners, architects, engineers, developers and vendors who support the construction of green buildings in the city and ensure their involvement in every step of the process.

- **Implementing stakeholders:** Bhopal Municipal Corporation (lead), Bhopal smart city, MPUVN, MPMKVCL, architects, IGBC, GRIHA, Bhopal Development Authority

- **Timeframe:** Medium term (3-5 years)

- **Mainstreaming with policies and schemes:** MP Policy for Decentralized Renewable Energy Systems, 2016, Energy Conservation Building Code, MP RE policy 2022

- **Monitoring Indicators:** # of zero carbon building pilots in the city, total built-up area of green buildings, % of municipal buildings which have energy efficiency or low carbon building components, % energy coming from renewables

- **Alignment with CSCAF indicators:**

- Indicator 2: Total electricity derived from renewable sources
- Indicator 6: Green building adoption under the energy & green buildings sector

Action 3: Promotion of green and cool roofs in residential projects/colonies/apartments to reduce cooling demand

- **Challenges addressed at the city level:** High electricity consumption from residential buildings. Bhopal has also been experiencing rising temperatures touching 45°C in the summer last year¹⁴⁰.

- **Description:**

- **Cool roofs:** Promoting measures for cool roofing, such as placing wet jute gunny sacks, painting white reflective paint, building highly reflective surfaces that stay cool, coatings and treatments such as lime-based whitewash, white tarp, white China mosaic tiles, acrylic resin coating and so on can provide access to affordable cooling for those who are most vulnerable to the health effects of extreme heat. This measure was an important part of the 2017 Ahmedabad Heat Action Plan¹⁴¹ and has also been piloted by the Greater Hyderabad Municipal Corporation¹⁴² as part of their state building energy efficiency program. Similarly, Surat and Indore had also embarked upon the cool-roof project in which over 100 households were coated with low-cost techniques and green cool-proofing materials such as lime concrete, helping to reduce temperatures and the costs of electricity and water¹⁴³.
- **Green roofs:** These are roofs with a vegetative cover. Bhopal can pilot this action by retrofitting to green roofs in all municipal buildings. This would sensitize the citizens and therefore encourage uptake. In Indian cities like Chennai, Bangalore, Mumbai, and Hyderabad, the concept of green roofs is slowly but steadily becoming the new norm of construction. Some cities are also using treated wastewater to maintain these green roofs which not only reduce ambient temperatures but also improve visual appeal¹⁴⁴.

- **Inclusivity analysis:** Slum residents are more likely to be exposed to heat, since they live mostly in unventilated conditions, and in homes constructed of heat-trapping materials with tin or tarp roofs, and

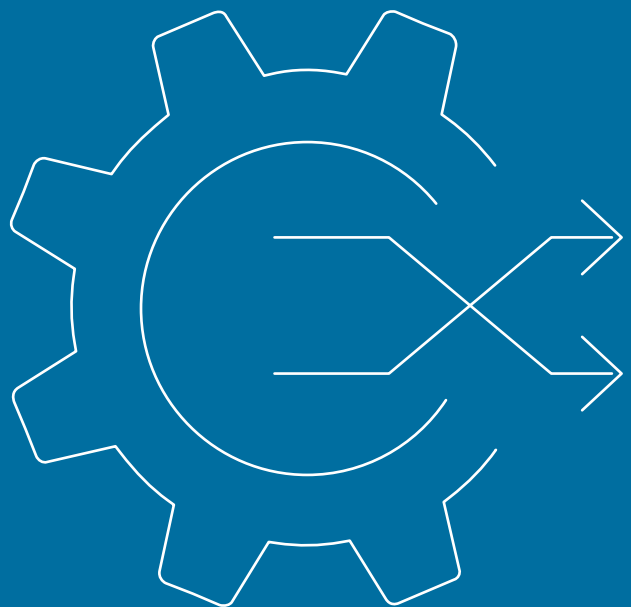
their tenements lack trees and shade. Retrofitting interventions such as – implementing cool roofs or green roofs can significantly impact internal temperatures and provide thermal comfort indoors. Since Bhopal has 26.6% slum households, this action becomes pertinent to enhance their resilience to heat stress.

- **Implementing stakeholders:** Bhopal Municipal Corporation (lead), Bhopal smart city, Directorate of Urban Administration & Development (UADD), RWAs, NGOs, urban rooftop farming, organic farming related organizations
- **Timeframe:** Medium term (3-5 years)
- **Mainstreaming with policies and schemes:** Energy Conservation Building Code
- **Monitoring Indicators:** % of houses with cool roofs/ green roofs (disaggregated by income level), reduced illnesses or mortality due to heatwaves, % reduction in energy demand from residential buildings
- **Alignment with CSCAF indicators:**
 - Indicator 6: Green building adoption
 - Indicator 5: Promotion of green buildings under Energy and Green buildings
 - Indicator 2: Proportion of green cover under Urban planning, green cover, and biodiversity



Source: Bhopal Smart City Development Corporation Ltd.

IMPLEMENTATION AND GOVERNANCE OF BHOPAL CLIMATE ACTION PLAN



Creation of Bhopal Climate Change Cell

Bhopal Municipal Corporation is responsible for infrastructure development and citizen service. On the other hand, Bhopal Smart City is responsible for implementing projects as per the Smart City proposal. However, there is no dedicated cell or staffing capacity to address climate change concerns during the development planning. Effective implementation of the plan requires mainstreaming climate actions within the scope of existing departmental priorities, project plans and future proposals by creating a dedicated cadre/ working cell.

| Priority 1

Creating Bhopal Climate Change Cell

- **Description:** To align with the State Action Plan on Climate Change and implement the Bhopal City Climate Action Plan, there needs to be a dedicated climate cell with representatives or nodal officers from concerning line departments. Many cities including Coimbatore, Mumbai and Aurangabad have developed such a cell which is tasked with the implementation and monitoring of the plans. The climate cell needs to coordinate with State Knowledge Management Centre on Climate Change, EPCO, Department of Environment, Government of MP, which is the state nodal agency for climate change, to implement and report the progress of the actions proposed in the plan. Need and role of the climate cell includes:
 - To facilitate coordination between EPCO and the city on climate change related issues and projects
 - To support and advise on key amendments to statutory policy regulations and liaise with parastatal agencies for data collection and information
 - To build internal capacity for climate knowledge and science
 - To engage and coordinate across departments within the city corporation to mainstream climate resilience in existing and proposed projects
 - To facilitate implementation of the actions proposed in the plan
 - To report implementation and monitoring status of the plan to the state nodal agency
 - To work with sectoral experts and scientists to periodically update the plan including the city GHG inventory for monitoring the GHG emissions and respective causes and challenges
- **Tentative staffing and stakeholders:**
 - Municipal Commissioner, Bhopal Municipal Corporation (Chairman)
 - Officer nominated by Forest Department (Member)
 - Officer nominated by MP Pollution Control Board Regional Office (Member)
 - Chief City Planner (Member)
 - Environment Engineer (Member)
 - Officer from Transport Section (Member)
 - Officer from Water Supply Section (Member)
 - Officer from Swachh Bharat Mission Cell (Member)
 - Officer from Energy/Electricity Section (Member)
 - Officer from Buildings Section (Member)
 - Officer from Gardens Section (Member)
 - Climate Scientist nominated by Chairman (Member)
 - Representatives from citizen forums (Member)
 - Chief Executive Officer, Bhopal Smart City, or nominated official (Member Secretary)
- **Implementation time:** Short term (1-2 years).

Creating a Bhopal City-level Climate Budget in Municipal Finance

Identifying and creating funding streams for climate action has the potential to catalyze climate responsive development. It is estimated that every \$1 spent on flood protection infrastructure¹⁴⁵ in India results in \$248 in avoided damages until 2050 and reduces the likelihood of areas being flooded from 4% to 2%. This will also deliver co-benefits of aligning urbanization in line with the sustainable development goals.

As per the Madhya Pradesh State Budget 2021-22¹⁴⁶, the state has allocated Rs 112 crores for the launch of Mukhya Mantri Swarozgar Yojana to provide loans at low interest rates to encourage self-employment among youth. This can be leveraged by the city in the actions proposed in this plan, particularly in the stationary energy and waste sectors for driving more employment opportunities through a green transition. Rs 2,581 crores which have been allocated to Atal Grah Jyoti Yojana, also align with a few of the actions proposed in the plan. Rs 5,762 crores have been allocated towards the Jal Jeevan Mission, which could be effective for pilot implementation of actions proposed in the water sector. It is important to utilize the budgets provided by the state to tag these to climate responsive development and channelize green economy in the city.

It is prudent that Bhopal creates a City Climate Budget for implementing the city climate action plan. The allocation of municipal level climate budget will create accountability to implement climate actions and to ensure better coordinated outcomes. To achieve this, it is necessary to have this city-level climate action plan approved by the mayor-in-council.

Priority 2

Formulating a City Climate Budget (CCB)

- **Description:** A few states in India have already taken steps to incorporate climate budgeting into their public finance management systems. Gujarat Climate Change Department (CCD)¹⁵⁰ adopted a climate change budget called 'Climate Change Budget Scheme' which earmarks funds for specific climate change programs. Odisha has a climate budget framework¹⁵¹ institutionalized for its cities. Chhattisgarh, Assam and Maharashtra are tracking the climate change relevance of their developmental projects through budget coding¹⁵². Thus, the state of MP and its cities also need to step up in action considering its estimated climate risks, vulnerability score and the climate performance of its Smart cities.

The climate budget should tag project activities for specific purposes in its budget documents by catalyzing a climate finance framework. The city should prepare a climate budget in alignment with the plan. The status of climate actions and achievements should be tracked quarterly and reported annually.

- **Implementation time:** Short term (1-2 years).

Table 5: State vulnerability score and financial expenditures

State	State Vulnerability Score ¹⁴⁷	Overall Average CSCAF Scores of MP's SMART Cities ¹⁴⁸	SDG Progress ¹⁴⁹ (Benchmark Score 66)	Status of Climate Finance/ Climate Budget	Scope of Urbanization and Climate Vulnerability
Madhya Pradesh	Medium Vulnerability	High Vulnerability ★ ★ ★	Performer-62	No climate budget framework institutionalized	7 smart cities

* Priority 1 and Priority 2 should be developed in coordination with State Knowledge Management Centre on Climate Change, EPCO, Department of Environment, Government of MP after the launch of the Climate Action Plan.

The city authorities can select actions and recommendations provided in this plan to develop a detailed implementation plan for pilot projects that can be rolled out in the short-, medium- and long term. The GHG emission profile of the city included in the plan may be used as a guiding analysis to prioritize implementation of actions in different sectors. The plan also provides guidance on mainstreaming actions with existing policies, schemes, and programs to establish convergence of implementation.

Lastly, this plan must be treated as a dynamic document and must be updated regularly with the latest emissions profile of the city. Instituting a climate change cell at the city-level with representation of concerning ULB departments, Smart city, citizen forums, academic institutions and civil society becomes necessary to lead and coordinate this process. Organizing periodic stakeholder consultations would help in strengthening the plan as per the evolving requirements of the city.

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