ADVANCING CITY CLIMATE ACTION IN MADHYA PRADESH

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

Jabalpur City Climate Action Plan

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 Jabalpur city in developing its Climate Action Plan. The data and information used for preparing this report have been sourced from Jabalpur 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.

Design credits: Manasi Nandakumar (*Senior Communications Associate, WRI India*) and Ronak Naik

Image credits: Jabalpur Smart City Ltd.

GULSHAN BAMRA (IAS)
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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 CO_2 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.

(Gulshan Bamra)

MUJEEBUR REHMAN KHAN (IAS)
EXECUTIVE DIRECTOR

Environmental Planning &
Coordination Organisation

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 impeding 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 Jabalpur 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, Jabalpur Municipal Corporation and Chief Executive Officer of Jabalpur Smart City 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 Jabalpur 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.

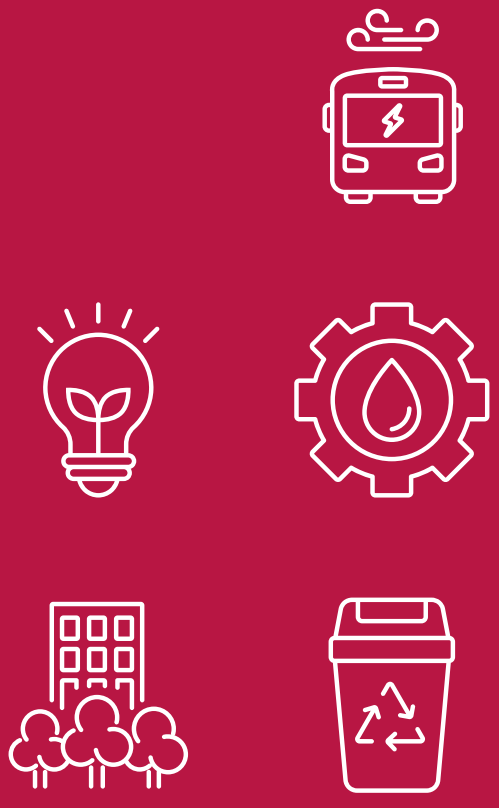
Lastly, we would like to thank the internal reviewers from WRI India including Ms Marie Duraisami, Ms Sumedha Malaviya, Mr Dhilon Subramanian, Ms Azra Khan, Ms Chaitanya Kanuri and Ms Sahana Goswami for providing valuable feedback to strengthen the sectoral strategies in the plan

(Lokendra Thakkar)

Coordinator,
State Knowledge Management
Centre on Climate Change, EPCO

ADVANCING CITY CLIMATE ACTION IN MADHYA PRADESH

Transforming **JABALPUR** into a low-carbon, climate-resilient city



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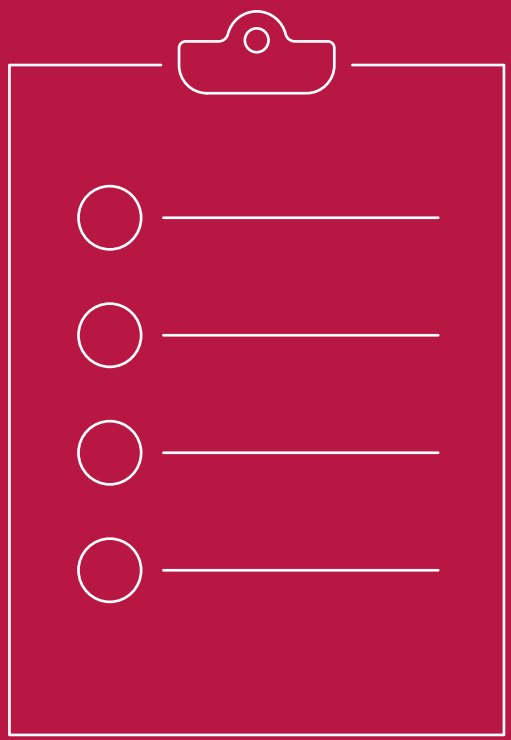
Abbreviations

ABD	Area Based Development
ADB	Asian Development Bank
AHP	Affordable Housing Project
AMRUT	Atal Mission for Rejuvenation and Urban Transformation
AJAY	Atal Jyoti Yojana
BRTS	Bus Rapid Transit System
BOD	Biological Oxygen Demand
C&D	Construction and Demolition
CAAQMS	Continuous Ambient Air Quality Monitoring Station
CH_4	Methane
CFL	Compact Fluorescent Lamp
CNG	Compressed Natural Gas
CO_2	Carbon Dioxide
COD	Chemical Oxygen Demand
CORDEX	Coordinated Regional Climate Downscaling Experiment
CPWD	Central Public Works Department
CPCB	Central Pollution Control Board
CSCAF	Climate Smart Cities Assessment Framework
CSO	Civil Society Organization
CPHEEO	Central Public Health and Environmental Engineering Organisation
DEWATS	Decentralized Waste-Water Treatment System
DISCOM	Power Distribution Companies
DWTP	Drinking Water Treatment Plant
ECBC	Energy Conservation Building Code
EESL	Energy Efficiency Services Limited
EPCO	Environmental Planning and Coordination Organisation
ESCO	Energy Service Company
ENS	Eco-Niwas Samhita
EPR	Extended Producer Responsibility
EV	Electric Vehicle
EWS	Economically Weaker Section
FAME	Faster Adoption and Manufacturing of (Hybrid) and Electric Vehicles
FSI	Financial Sector Incentive
GHG	Greenhouse Gas
GI	Green Infrastructure
GIDC	Gujarat Industrial Development
GoMP	Corporation
GRIHA	Government of Madhya Pradesh Green Rating for Integrated Habitat Assessment
HFAPoA	Housing for All Plan of Action
HFL	High Flood Level
ICT	Information and Communications Technology
IGBC	Indian Green Building Council
IoT	Internet of Things
IPT	Intermediate Public Transport
IT	Information Technology
ITS	Intelligent Transport Services
JCTSL	Jabalpur City Transport Services Limited
JMC	Jabalpur Municipal Corporation
JSCL	Jabalpur Smart City Limited
JV	Joint Venture
kWh	Kilo Watt Hour
LBSAP	Local Biodiversity Strategies & Action Plan
LCB	Low Carbon Buildings
LED	Light Emitting Diode
LEED	Leadership in Energy and Environmental Design
LIG	Lower Income Group
LPCD	Liters Per Capita per Day
LPG	Liquefied Petroleum Gas
MLD	Million Liters per Day
MNRE	Ministry of New and Renewable Energy
MoHUA	Ministry of Housing & Urban Affairs
MIG	Middle Income Group
MP	Madhya Pradesh
MPPCB	Madhya Pradesh Pollution Control Board
MPPHED	Madhya Pradesh Public Health Engineering Department
MPPKVVCL	MP Poorva Kshetra Vidyut Vitaran Company Limited
MPPWD	Madhya Pradesh Public Works Department
MPUVN	Madhya Pradesh Urja Vikas Nigam

MPWRD	Madhya Pradesh Water Resources Department
MPLADS	Member of Parliament Local Area Development Scheme
MTD	Metric Tons per day
Mt	Metric tonnes
mt	Million tonnes
MSL	Mean Sea Level
MSME	Micro, Small and Medium Enterprises
MRV	Monitoring Reporting and Verification
MSW	Municipal Solid Waste
MW	Mega Watt
NAAQS	National Ambient Air Quality Standards
N_2O	Nitrous Oxide
NDC	Nationally Determined Contribution
NDMA	National Disaster Management Authority
NGO	Non-Governmental Organization
NGT	National Green Tribunal
NMT	Non-Motorized Transport
NMV	Non-Motorized Vehicle
NUTP	National Urban Transport Policy
PMAY	Pradhan Mantri Awas Yojana
PBS	Public Bicycle Sharing System
PSP	Private Sector Participation
NRW	Non-Revenue Water
PNG	Piped Natural Gas
PPP	Public Private Partnership
PT	Public Transport
PWD	Public Works Department
RCP	Representative Concentration Pathways
RE	Renewable energy
RWH	Rainwater Harvesting
RWA	Resident Welfare Association
RFID	Radio Frequency Identification
RTSPs	Roof Top Solar Panels
SAPCC	State Action Plan on Climate Change
SCP	Smart City Plan
SCADA	Supervisory Control And Data Acquisition
SHG	Self Help Group
SKMCCC	State Knowledge Management Centre on Climate Change
SPA	School of Planning and Architecture
STP	Sewage Treatment Plant
SWH	Solar Water Heater
SWM	Solid Waste Management
T&D	Transmission and Distribution
TDS	Total Dissolved Solids
TOD	Transit Oriented Development
TPD	Tonnes Per Day
ULB	Urban Local Bodies
UDD	Urban Development Department
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
W2E	Waste to Energy
WRA	Water Resources Assessment
WTP	Water Treatment Plant
ZCB	Zero Carbon Buildings

EXECUTIVE SUMMARY



Jabalpur and its Vulnerability to Climate Change

Jabalpur is the third largest urban agglomeration in the state of Madhya Pradesh, central India and ranked 43rd among the 100 cleanest urban local bodies (ULBs) in India in 2020 with more than 1 lakh population[1]. In 2020, Jabalpur Smart City Limited also received the 'Smart City Empowering India Award' in the smart mobility category for non-motorized transport[2]. Located in the eastern part of the state and on the banks of River Narmada, Jabalpur is also known as the 'marble city' because of the white marble rocks at Bhedaghat. The city has the famous Dhuandhar Falls, well-known educational institutions and defense-related manufacturing industries. The city is also home to 2600 acres of forested land – the Dumna Nature Reserve (DNR), within the Jabalpur municipal corporation area. Jabalpur is also surrounded by 800 acres of Khandari lake[3]. Lying within this unique physiography, the city falls under the humid-tropical climatic zone, which contributes to its micro-climatic variabilities to a great extent.

The city has 37 lakes and ponds[3] including hanuman tal, ranital, khandari lake, etc. However, the city's lakes have ben drying up and also face the issue of contamination[4]. As per the vulnerability assessment conducted by Environmental Planning & Co-ordination Organization (EPCO), Jabalpur has a very low composite vulnerability, driven largely by the socioeconomic indicators. In terms of water resources, Jabalpur falls under low vulnerability owing to River Narmada flowing through the city. Jabalpur fares well in the forest sector owing to the large green cover. However, the projected higher temperatures and rainfall extremes are likely to result in increased climate risks.

Given the challenges that Jabalpur 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. 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 management and waste management. By taking appropriate measures, cities can make a significant contribution to mitigating climate change and becoming resilient to its impacts.

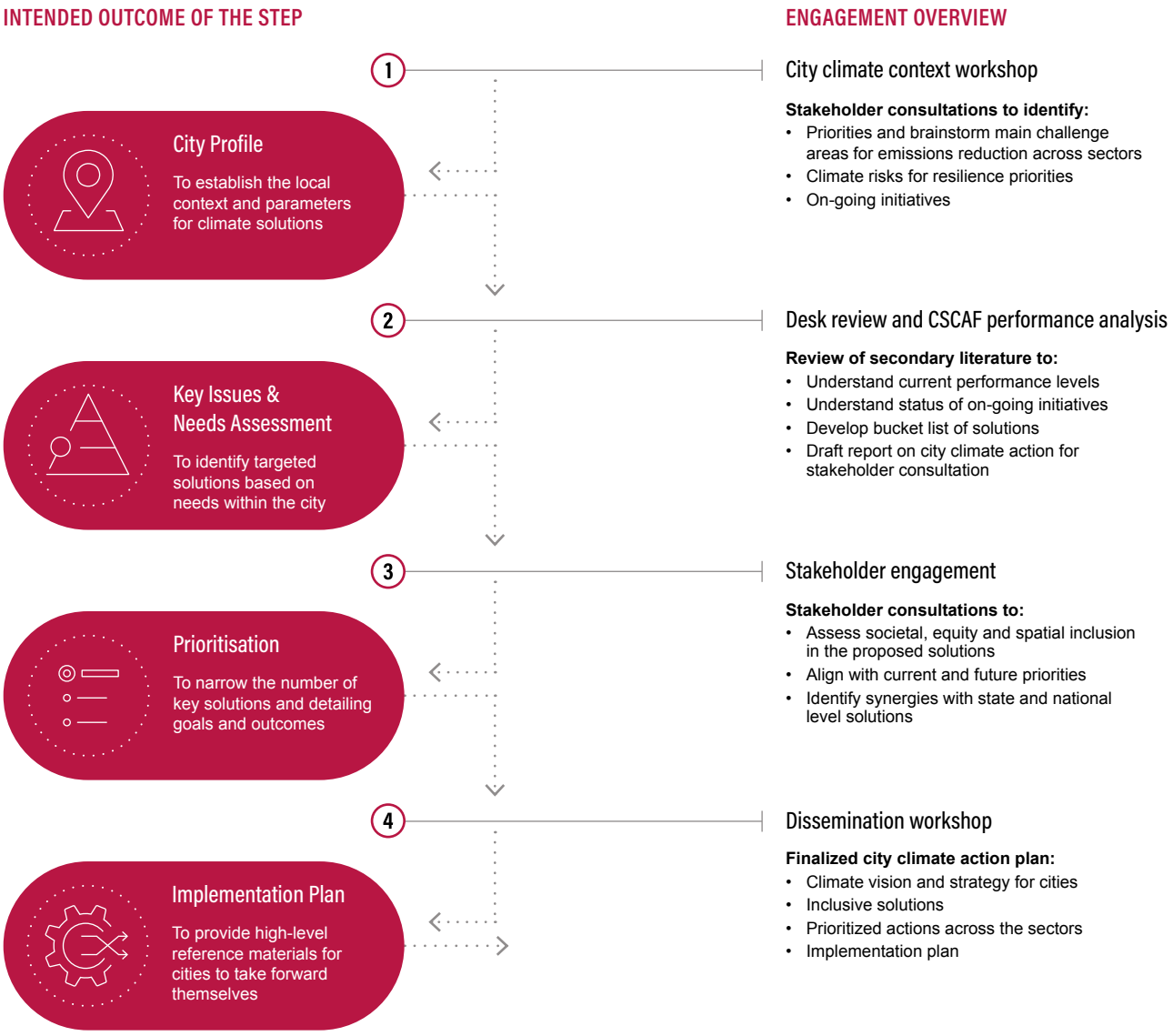
In this context, WRI India is supporting EPCO, Department of Environment, and Department of Urban Development and Housing, Government of Madhya Pradesh as a technical partner, in planning adaptation and mitigation strategies and building a city climate action plan (CAP). The climate action plan is based on the GHG emissions profile and vulnerability assessment of cities. It identifies 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 actions to address future climate risks across the five thematic areas. It also proposes an institutional framework which is necessary to implement the recommendations outlined.

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 them about the importance and relevance of developing these city-level plans and identify development challenges and climate risks in MP's urban areas.
- This was followed by an extensive desk review of submissions made by Jabalpur as a part of CSCAF 2.0, sectoral plans, government reports and other documents to identify key gaps in achieving the sectoral priorities, develop a climate profile and greenhouse gas (GHG) emissions inventory. This review and analysis have led to developing a bucket list of sectoral goals and actions which have been enumerated in the climate action plan.
- As the next step, in order to narrow down the number of sectoral actions and detailing goals and outcomes, a stakeholder consultation workshop was organized in Jabalpur in September 2021, with participation from city officials, sectoral experts and civil society representatives.
- The final CAP provides prioritized sectoral actions along with an implementation plan and CAP governance mechanism for effective coordination and monitoring of the CAP's implementation.

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



Baseline Assessment

Climate Smart Cities Assessment

Jabalpur has been a moderate performer in the first two rounds under CSCAF. The city has been doing well under the waste management sector. 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 ES table 1.

Greenhouse Gas Emissions Inventory

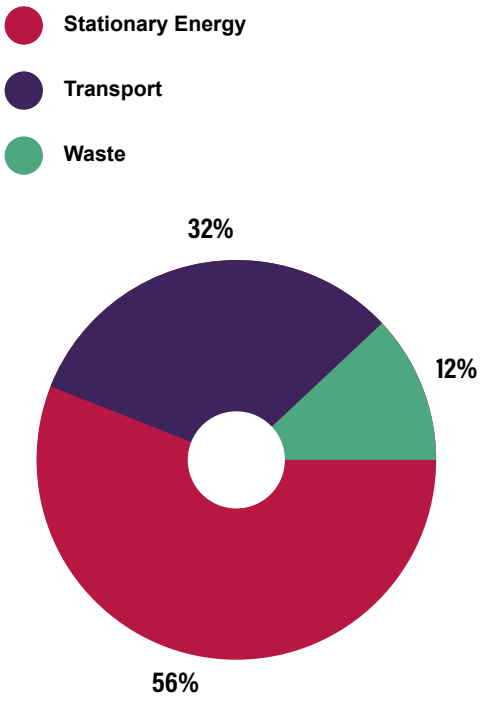
In 2019, Jabalpur's GHG emissions were 1.5 mtCO_2e which was 1.3 tCO_2e per person. The emissions inventory was compiled as per the Global Protocol for Communities (GPC) BASIC standards using C40's City Inventory Reporting and Information System (CIRIS) tool. Majority of the emissions comes from energy and electricity use in residential buildings followed by the industrial sector. The contribution of the three sectors to total emissions in the city is given in the ES Figure 2. Stationary energy contributes 56% to the city's total emissions, followed by 32% from transportation. Waste sector contributes 12% to the city's total emission.

ES Table 1: CSCAF 2.0 analysis *(Source: CSCAF 2.0 submission of 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	213.5	74	89	25	579
Current measures being undertaken in the city	• 790 kW rooftop solar power plant established with net metering on water treatment plants[5].	• Ankur program – where citizens are awarded for planting trees – has been launched in the state, and PMAY has been linked to it. • Prepared GIS maps of water bodies and open spaces. • City has collated disaster related loss and damage data. • Working on Dumna nature reserve development phases 1 and 2[5].	• 7% of city's shared mobility run on clean fuels, including 1107 e-rickshaws. • City has introduced intelligent traffic management system[5]. • Working on redesigning Omti Nalla with footpaths and street furniture[3]. • 450 kW solar electric chargers for e-rickshaws installed at nine locations with capacity to charge 15 rickshaws in each location[5]. • Feasibility study completed for electric public bike sharing system and 6km cycle track constructed[5]. • Prepared a clean air action plan. The city has 2 manual and one continuous ambient air quality monitoring station. • Introduced a multipurpose smart card for use in city transport and other purposes[5].	• Completed development of Gulauaa talab as a tourist attraction[5]. • Revitalization of Ranital lake is ongoing[5]. • Installing rainwater harvesting at various locations[5].	• 100% door to door collection of segregated waste • Operational waste-to-energy plant of 600-tonnes capacity generating 11.5 MW energy[6]. • Radio Frequency Identification (RFID) tags on household dustbins and solid waste vehicle tracking system in place[5]. • Work order issued for biomining of waste at Rani Taal dumping site[5].

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	▪ Increasing energy efficient streetlighting (currently 28.53%). ▪ Need for promotional or penalty schemes for code compliance, pre-certification and certification of green buildings. ▪ Need to create a green building cell ▪ Increasing the energy coming from renewables. Currently, 1957 MWh out of 1021126 MWh comes from renewables, amounting to 0.09%.	▪ Increasing urban green cover (currently 11.74% of total area). ▪ Should set up a disaster management cell and should conduct Ward level Hazard Risk, Vulnerability and Capacity Assessment and prepare a disaster management plan. ▪ City is not taking measures to conserve biodiversity. Setting up a city-level biodiversity management committee can be the first step	▪ Increasing the number of buses (currently 0.1 buses/1,000 population). ▪ Increasing the % of roads with footpaths and cycle tracks (currently 3%) ▪ City needs to install more continuous air quality monitoring stations to capture PM_{10}, $PM_{2.5}$, NO_x and SO_x.	▪ Reducing Non-Revenue Water (NRW) which is currently more than 40%. ▪ Jabalpur needs to assess current water resources and future demand and prepare a water resources management plan with short-, medium- and long-term actions. ▪ Should measure the amount of wastewater recycled. ▪ Need to prepare a flood risk management plan. ▪ Need to conduct energy audits of water supply and wastewater management systems.	▪ Waste deposition center for domestic hazardous waste is needed[6]. ▪ City needs to involve more NGOs in waste management[6]. ▪ Need for plastic waste collection centers[6]. ▪ Methane capture from landfill and sewage treatment plants is needed.

ES Figure 2: Percentage distribution of emissions by sector for 2019 *(Source: WRI analysis using primary city data)*

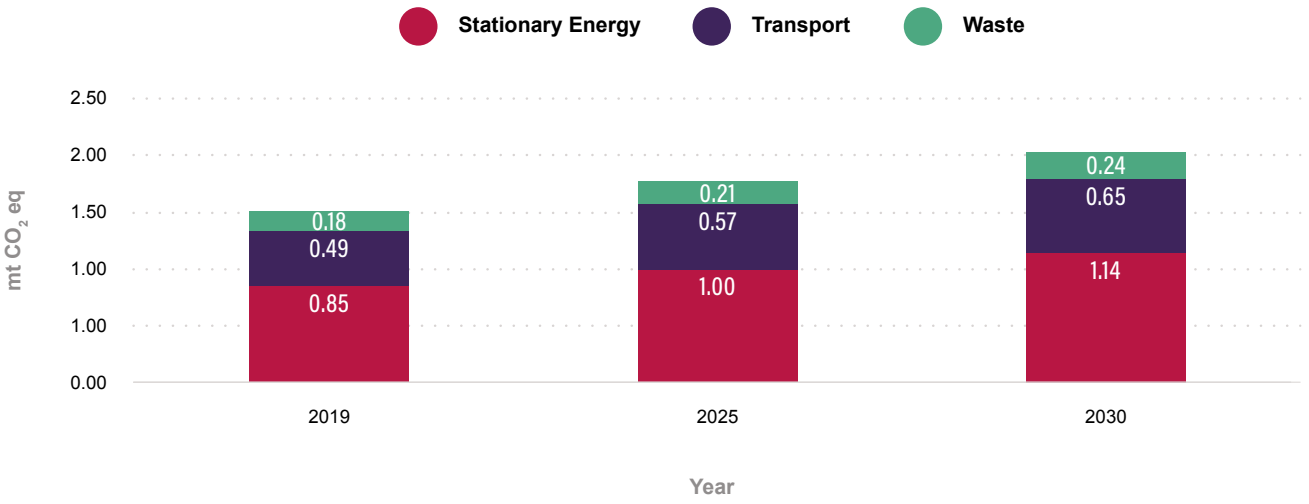


The business-as-usual projected emissions for Jabalpur is presented in ES Figure 3. The emissions are projected to increase by 18% by 2025 and 35% by the end of the decade till 2030 compared to the baseline emissions of 2019. This creates an urgent need for the city to implement measures presented in the report for achieving its vision of low carbon and climate resilient development.

Vulnerability Analysis

As per the vulnerability assessment for Jabalpur, the climate of Jabalpur is subject to large year-to-year variability, particularly for rainfall. Observed records for the Jabalpur region indicate a clear trend towards higher temperatures and more frequent high temperature extremes[7].

ES Figure 3: Projected business as usual emissions for Jabalpur *(Source: WRI India analysis using primary data)*



ES Table 2: Projected climate change and risks *(Source: CEEW)*

Projected Climate Changes	Potential Impacts and Risks[8]
Warmer conditions, including more intense and frequent high-temperature extremes and heat wave days.	• Number of warm days can increase by an average of 23 days by 2050 with a 4.4°C rise in mean temperature. This can lead to increased human heat stress, potential increase in mortality and decreasing labor productivity particularly for outdoor workers.
Higher annual rainfall totals and change in frequencies	• As per the assessment, the number of days per year with rainfall greater than 20 mm, is projected to increase by about 10 days on an average from 1981-2010 to 2071-2100. This can increase the risk of flooding and can impact water balance.

Strategic Goals and Sectoral Actions

The ES Table 3 summarizes the goals and actions which the city may adopt to become climate resilient while also addressing concerns of inequality and inclusivity in development.

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

Goals	Actions	Outcomes
Goal 1 Power Jabalpur through renewables & climate-resilient infrastructure	• Developing a long-term renewable energy procurement plan • Promoting energy efficiency improvements and renewable energy use in MSMEs • Expanding the use of bio-CNG from dairy waste for residential and commercial consumption • Incentivizing installation of rooftop solar panels and solar water heaters in all existing and new residential buildings • Implementing low carbon components in municipal buildings and projects	• Reduced emissions from MSMEs • Reduction in overall long-term electricity consumption and costs • Benefits for MSMEs due to reduced power bills • Increased job opportunities • Reduction in emissions from the consumption of grid supplied electricity • Improved access to energy

Goals	Actions	Outcomes
	• Solar powered bus stops and parking lots • Implementing institutional measures to increase adoption of green buildings in the city • Promotion of green and cool roofs in residential projects/ colonies/apartments to reduce cooling demand • Energy efficient retrofits and common solar PV projects for low-income housing under PMAY scheme	
Goal 2 Towards low-carbon mobility in Jabalpur	• Augmenting Jabalpur's bus fleet and conducting feasibility studies for bus rapid transit system • Ensuring multistakeholder-driven action through Jabalpur's recently formed NMT cell • Jabalpur non-motorized transport policy • NMT-focused urban street design guidelines for Jabalpur • Promoting electric two wheelers for freight and passenger fleets • Incentivizing municipal employees to travel by low-carbon modes and making government offices EV ready	• Increase in NMT infrastructure • Decreased air pollution due to transport • Increased availability and accessibility of public transport • Increase in low-carbon and non-motorized transport modal share • Reduced GHG emissions due to transport
Goal 3 Make Jabalpur a climate-smart tourist destination	• NMT friendly tourist areas with electric hop-on-hop-off bus services • Installing reverse vending machines and collection centers for plastic waste and wet waste compost units at major tourist areas • Providing a platform for sustainable tribal products, artifacts, and culture	• Economic growth and job creation • Reduction in emissions from tourism sector – waste, buildings, transport
Goal 4 Sustainable & circular waste management in Jabalpur	• Innovative model for managing electronic waste in Jabalpur • Efficient disposal of religious waste and idol immersion to prevent contamination of Jabalpur's lakes • Conversion of municipal solid waste management fleet into electric vehicles	• Formalization of informal e-waste sector • Skill development and capacity building among the marginalized • Creation of jobs for self-help groups • Reduced emissions from waste transport • Reduced pollution in lakes
Goal 5 Revitalize green & blue spaces in Jabalpur	• Engaging citizens and private sector in urban green cover conservation • Mapping green and blue spaces in the city • Action plan for increasing Jabalpur's green cover • Participatory model with involvement of resident welfare associations • Bioremediation and riparian zones for conservation of water bodies in Jabalpur • Institutionalizing a tree cell to prevent illegal logging and protect heritage trees • Developing a local biodiversity strategies and action plan (LBSAP) for the city • Disaster management cell and plan for Jabalpur	• Improved water security • Reduced flood risk • Improved air quality and climate resilience due to the city's green cover • Increased access to affordable drinking water through groundwater recharge • Equitable access to green and open spaces

Goals	Actions	Outcomes
Goal 6 Water-wise Jabalpur	• Conduct a water resources assessment and implement a demand management plan • Reusing water for gardens and defense and textile related manufacturing industries • Inter-linking of water bodies, wherever feasible, within city limits • Developing and implementing an integrated flood and storm water management plan • Implementing energy-efficient water supply and wastewater management systems	• Increased access to potable water • Increased flood resistance • Better sewage management • Reduced water costs and improved equitable access • Reduced emissions from energy consumption for water treatment • Better demand management • Increased water table

The city 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 from ULB departments concerned, smart city, citizens' forums, academic institutions, and civil society becomes necessary to lead and coordinate this process. Organizing periodic stake-holder consultations would help in strengthening the plan as per the evolving requirements of the city.

INTRODUCTION

State Knowledge Management Centre on Climate Change, Environmental Planning and Coordination Organisation (EPCO), Department of Environment, Government of Madhya Pradesh has entered into a collaboration with World Resources Institute India, the Indian arm of a global think tank on environmental issues, to support the Department of Urban Development and Housing, Government of Madhya Pradesh and seven smart cities in MP to develop their city-level Climate Action Plans in line with the Climate Smart Cities Assessment Framework launched by the Ministry of Housing & Urban Affairs, Government of India. A project launch-cum-planning workshop was convened on 20 Feb 2020 in Bhopal with participation from the smart cities and the line departments concerned, to initiate a dialogue between the stakeholders and seek their inputs on the modalities for developing the plans.

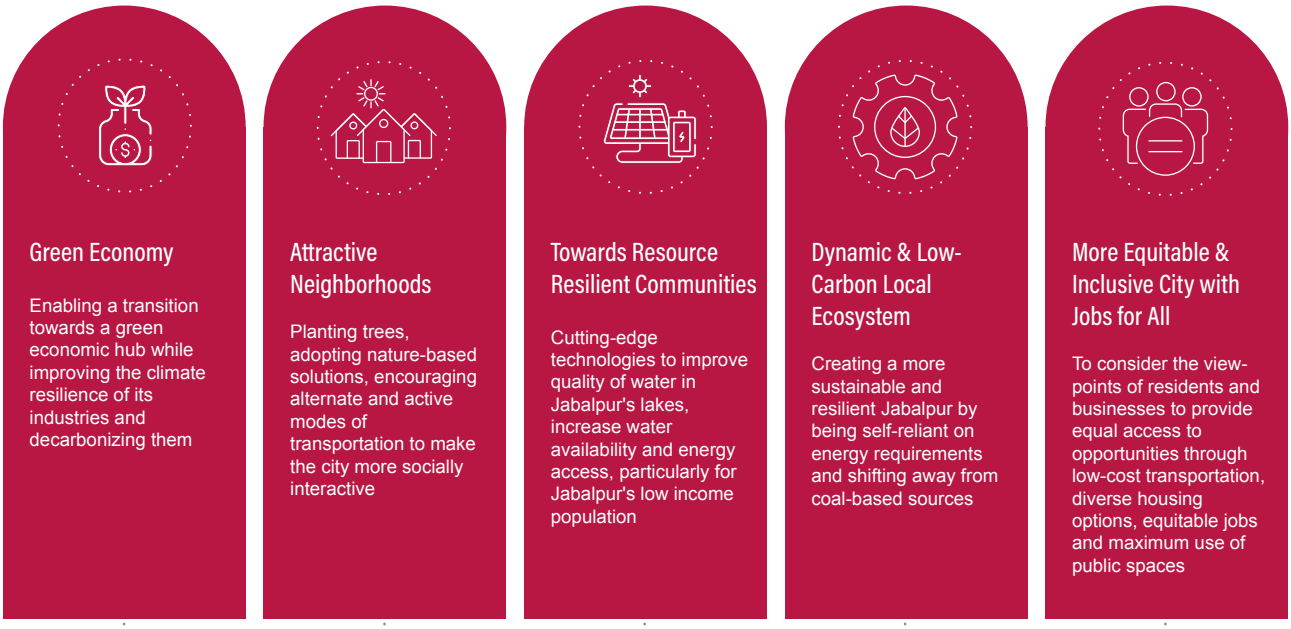
Against the backdrop of the Smart Cities Mission, the Ministry of Housing and Urban Affairs has initiated the "Climate Smart Cities Assessment Framework (CSCAF)" for the existing 100 smart cities, which is a "first-of-its-kind public assessment framework on climate relevant parameters". The framework in its current form aims to provide a roadmap for smart cities, hoping to expand to all of urban India 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 – energy & green buildings, urban planning, green cover & biodiversity, mobility & air quality, water resource management and waste management.

In its Nationally Determined Contributions (NDCs), India has pledged to improve the emissions intensity of its GDP by 33 - 35% below 2005 levels by 2030. It has also pledged to increase the share of non-fossil fuel-based electricity to 40% by 2030. State Action Plans for Climate Change (SAPCCs) have served as the primary policy document at the sub-national level in the Indian context. However, 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. Therefore, any city climate action must be in synergy with MP's state-level plan. The actions that cities take would help India meet its international commitments.

With the above background, EPCO, Department of Environment, Government of Madhya Pradesh has partnered with WRI India to build the capacity of smart cities in terms of planning adaptation and mitigation strategies and building a city climate action plan.

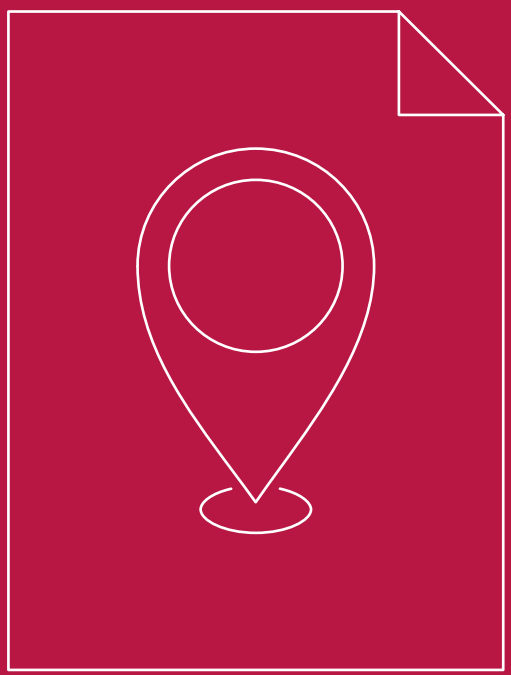
Vision of Jabalpur Climate Action Plan

Figure 1: Vision for Jabalpur *(Source: WRI India)*



The Jabalpur Climate Action Plan envisions a world class city of the future – a vibrant, equitable city, strengthened through its diversity; a city that provides real quality of life and diverse, sustainability-driven economic opportunities for varied skill levels; a city that provides a low-carbon, climate-resilient and adaptive society. The role of the Jabalpur Climate Action Plan is not just about reducing the negative effects on the environment, but it is also about making holistic improvements to Jabalpur's community and way of life.

CITY PROFILE



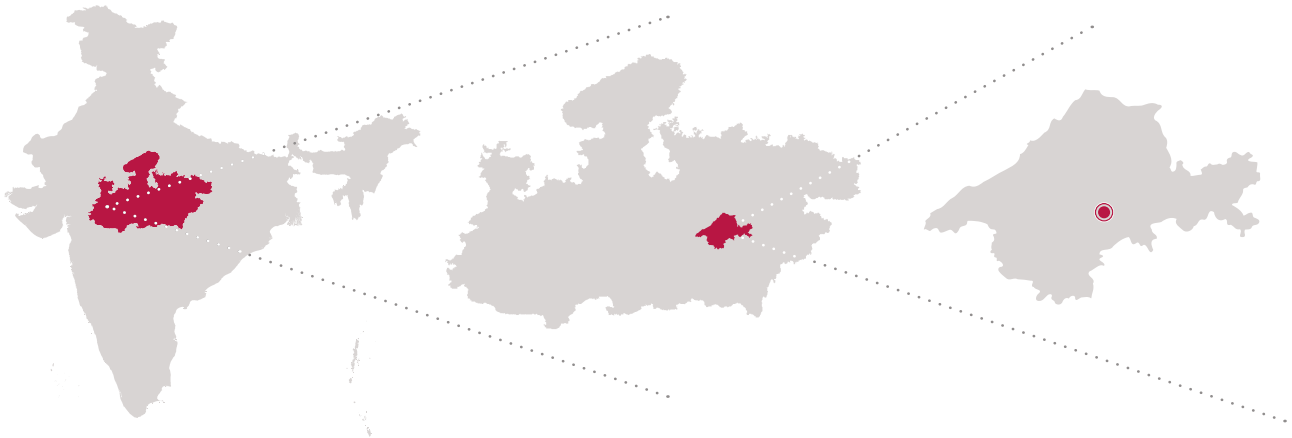
Jabalpur is the third largest urban agglomeration in the state of Madhya Pradesh, central India and is ranked 25th amongst the 100 cleanest ULBs in India with more than one lakh population[1]. In 2020, Jabalpur Smart City Limited also received the 'Smart City Empowering India Award' for the smart mobility category for non-motorized transport corridor[2]. Located in the eastern part of the state and on the banks of River Narmada, Jabalpur is also known as the 'marble city' because of the white marble rocks at Bhedaghat. The city has the famous Dhuandhar Falls, well-known educational institutions and defense-related manufacturing industries. Jabalpur is also known for its ordnance factory, an ammunition depot, and the central gun carriage factory. As per the smart cities profile, the city is categorized as a tier-2 city. Being an important administrative, industrial, educational, and business center of the state, housing the High Court of Madhya Pradesh and the headquarters to several departments, the city is also well connected by road, rail, and air routes.

Geographically, the city is located at 23˚ 10' north and 79˚ 57' east, at an altitude of 393 meters above mean sea level (MSL) and surrounded by rocky hillocks and low hills that are dotted with lakes, ponds, reservoirs, and canals. The city is also home to 2600 acres of forested land – the Dumna Nature Reserve (DNR), within the Jabalpur municipal corporation area. Jabalpur is also surrounded by 800 acres of Khandari lake. The city also has the perennial Narmada river which serves its water needs and is home to 37 lakes and ponds[3].

With respect to infrastructural services, Jabalpur has been recognized for its door-to-door waste collection and waste-to-energy plant of 600 TPD capacity which generates 11.5 MW electricity per day[8]. A study identified that 90% of ground water samples in Jabalpur were of poor quality and not suitable for drinking[9]. Lakes face pollution due to solid waste dumping driven by unplanned urbanization. Disposal of untreated sewage and religious waste like idol immersion are other key concerns for the city[10].

With 44.7% of its total population living in slums, mainly located in the old Jabalpur area[4], the positive impacts must be equitably distributed in an inclusive manner while designing climate actions. It must be ensured that municipal services such as public transport, water, waste disposal, electricity, education, health, etc. are accessible to vulnerable communities, while also serving the co-benefits of reducing city-level climate impacts. Thus, it is important to advance and prioritize a set of actions towards low-carbon development in the city in an inclusive manner.

Figure 2: Map of Jabalpur (*Source: WRI India*)



Demography

The population of Jabalpur city was 12 lakhs in 2020 within the municipal area of 264 sq.km, making it a populated city with 4545 people residing per sq.km. The population of Jabalpur city increased from approximately 0.96 million to 1.08 million between 2001 and 2011. The decadal growth rate of 13% during that period is lower than the state figure of 20.3%. The city's population growth rate has remained stagnant over the last 2 decades (Figure 3).

The demographic indicators, based on the last two census rounds, are presented in the Table 1

Figure 3: Population growth in Jabalpur between 1981-2020 (*Source: Census of India*)

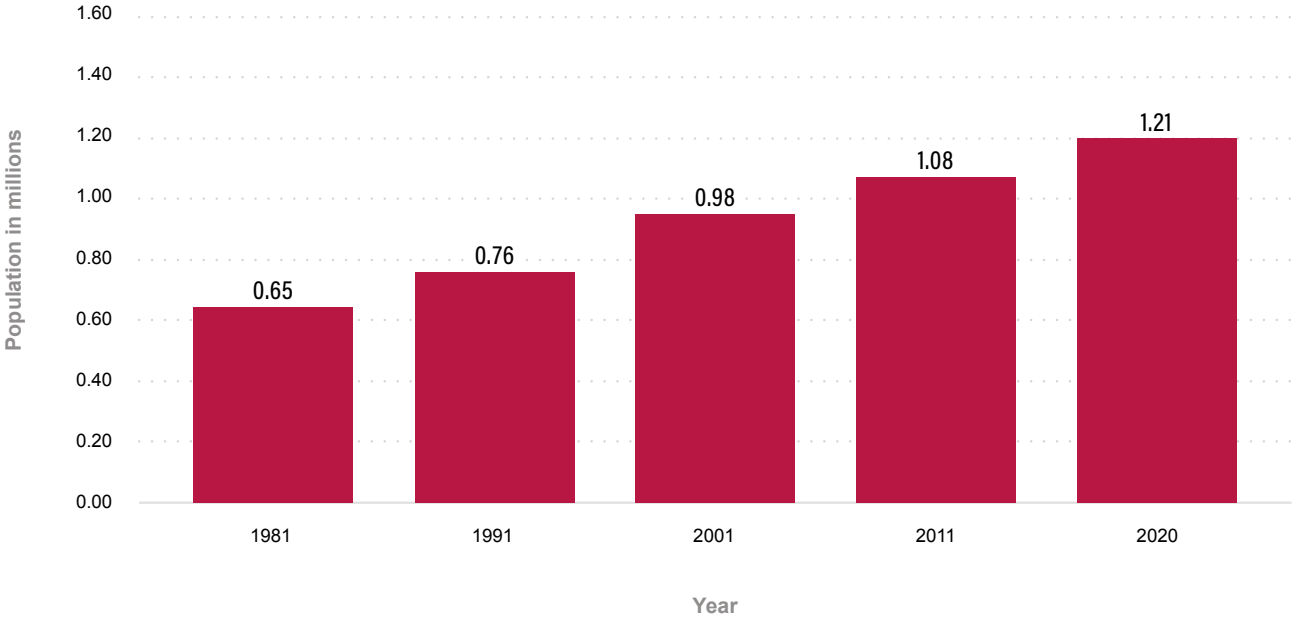


Table 1: City statistics *(Source: Census of India)*

Particulars	2001[11]			2011[12]		
	Total	Males	Females	Total	Males	Females
Population	9,56,107	5,00,952	4,55,155	10,81,677	559,361	522,316
Literates	7,06,546	3,94,192	3,12,354	84,4121	452,907	391,214
SC Population	1,23,832	64,575	59,257	1,54,828	79,937	74,891
ST Population	41,778	22,243	19,535	4,769	24,540	22,729
Total Workers	2,61,481	2,16,529	44,952	3,92,048	2,98,241	93,807
Number of Households	1,81,886			2,25,340		

Climate Profile

Jabalpur lies in the central plateau and is a hilly region i.e., zone 8 as per the agro-climatic zones identified by the Planning Commission of MP. The lowest minimum temperature that the city experiences is about 1˚C and the highest maximum temperature is about 49˚C, with an average minimum temperature of 19.7˚C and maximum of 31.7˚C. It receives an average rainfall of 1,315 mm per annum with the minimum and maximum being 500 mm and 2,100 mm respectively in the last three decades. The city has a very linear distribution of seasons throughout the year, three months of summer, three months of winter and three months of rainy season. Rest of the months are moderately warmer or transitions between seasons[4].

The climate risk profile of Jabalpur 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)[7]:

- 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).

Temperature

Observations as well as simulations show an upward trend in the mean annual temperature (Figure 4). Under a high emissions scenario (RCP 8.5), this trend is projected to continue until the end of the century, with a rise of 4.4°C on an average from 1981-2010 to 2071-2100. If emissions decrease rapidly in the low emissions scenario (RCP 2.6), this rise is limited to about 1.2°C on an average.

Figure 4: Increase in mean temperature for Jabalpur *(Source: CEEW)*

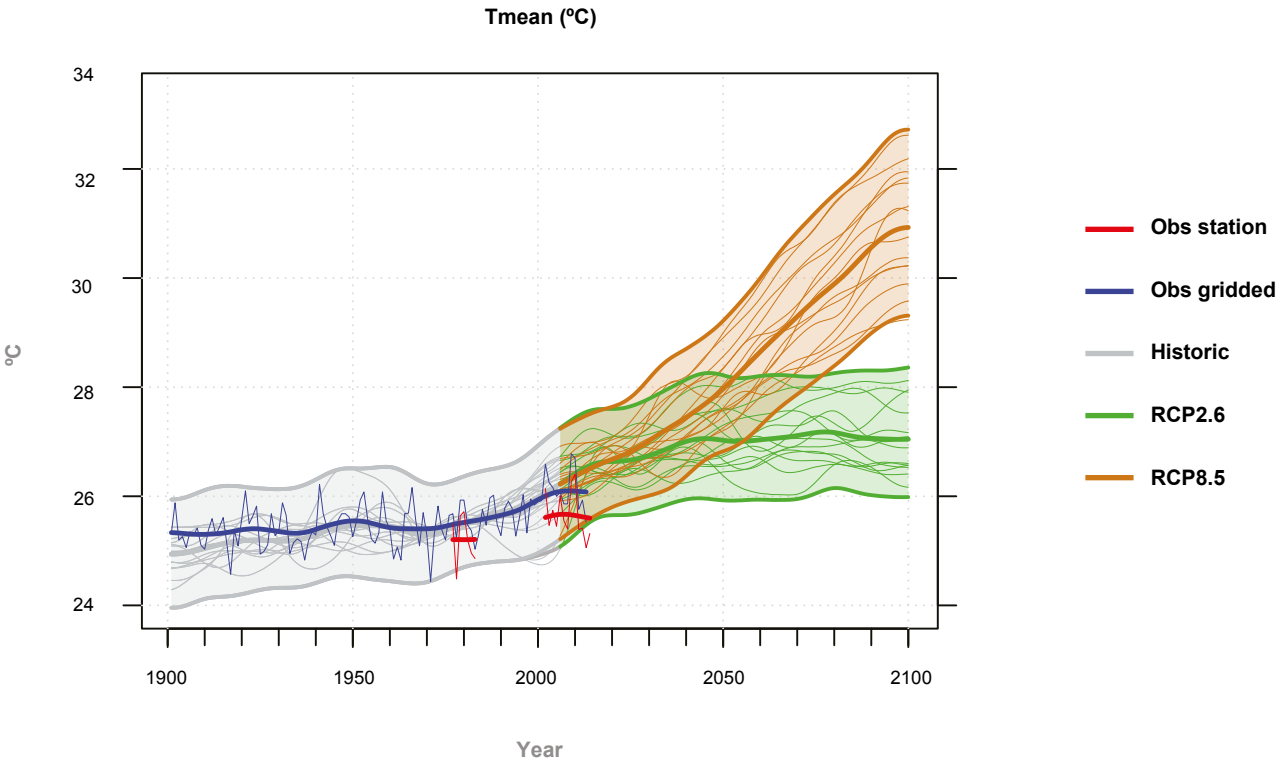
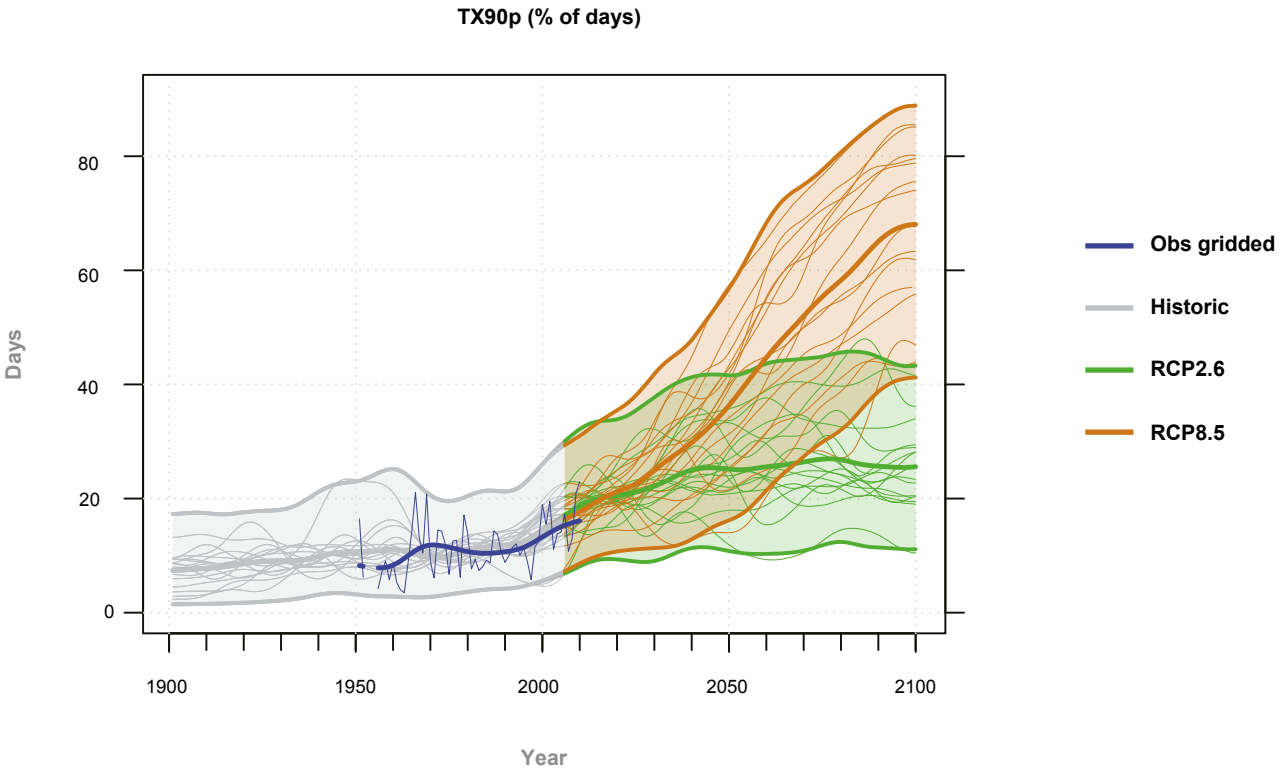


Figure 5: Increase in temperature extremes for Jabalpur *(Source: CEEW)*

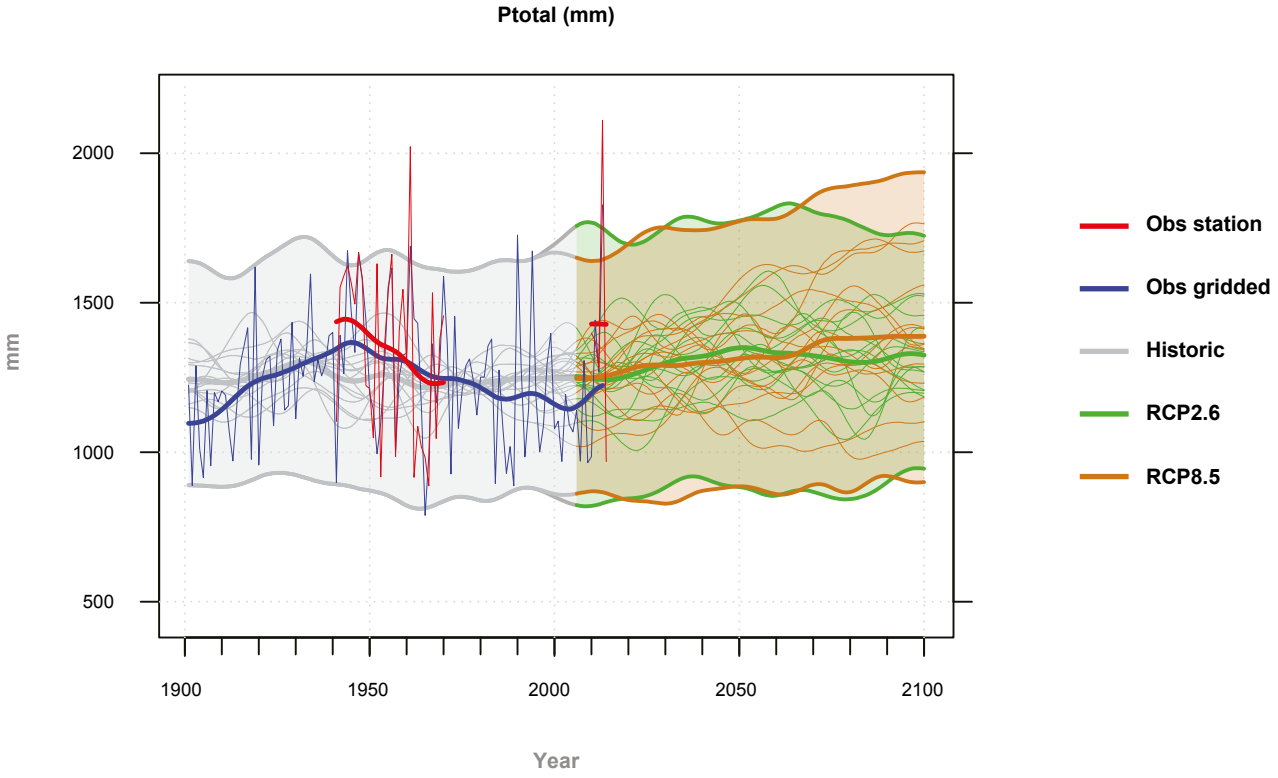


The observations indicate more high temperature extremes (warm days and warm nights, days of heat wave) and fewer cold temperature extremes (cold days and cold nights, days of cold wave). The number of warm days (Figure 5), for example, is projected to increase by about 50 days on an average from 1981-2010 to 2071-2100 under a high emissions scenario; and the number of heat wave days are likely to increase by around 175 days on an average. If emissions decrease rapidly, the rise in number of warm days is limited to about 15 days on an average; and the rise in heat wave days is about 35 days on an average.

Rainfall

The observations are dominated by large decade-to-decade and year-to-year variability (Figure 6). The simulations show a general tendency towards increasing total annual rainfall, although variability is large. Under a high emissions scenario, total annual rainfall is projected to increase by about 11% (about 140 mm) on an average from 1981-2010 to 2071-2100. If emissions decrease rapidly, this rise is limited to about 70 mm on an average.

Figure 6: Increase in mean precipitation for Jabalpur *(Source: CEEW)*



The observed record of heavy rainfall events tends to be dominated by decade-to-decade and year-to-year variability. For the projections, there is a tendency towards more frequent heavy rainfall events. The number of days per year with rainfall greater than 20 mm (Figure 7) is projected to increase by about 10 days on an average from 1981-2010 to 2071-2100 under a high emissions scenario.

The 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.

Figure 7: Number of heavy rainfall days for Jabalpur *(Source: CEEW)*

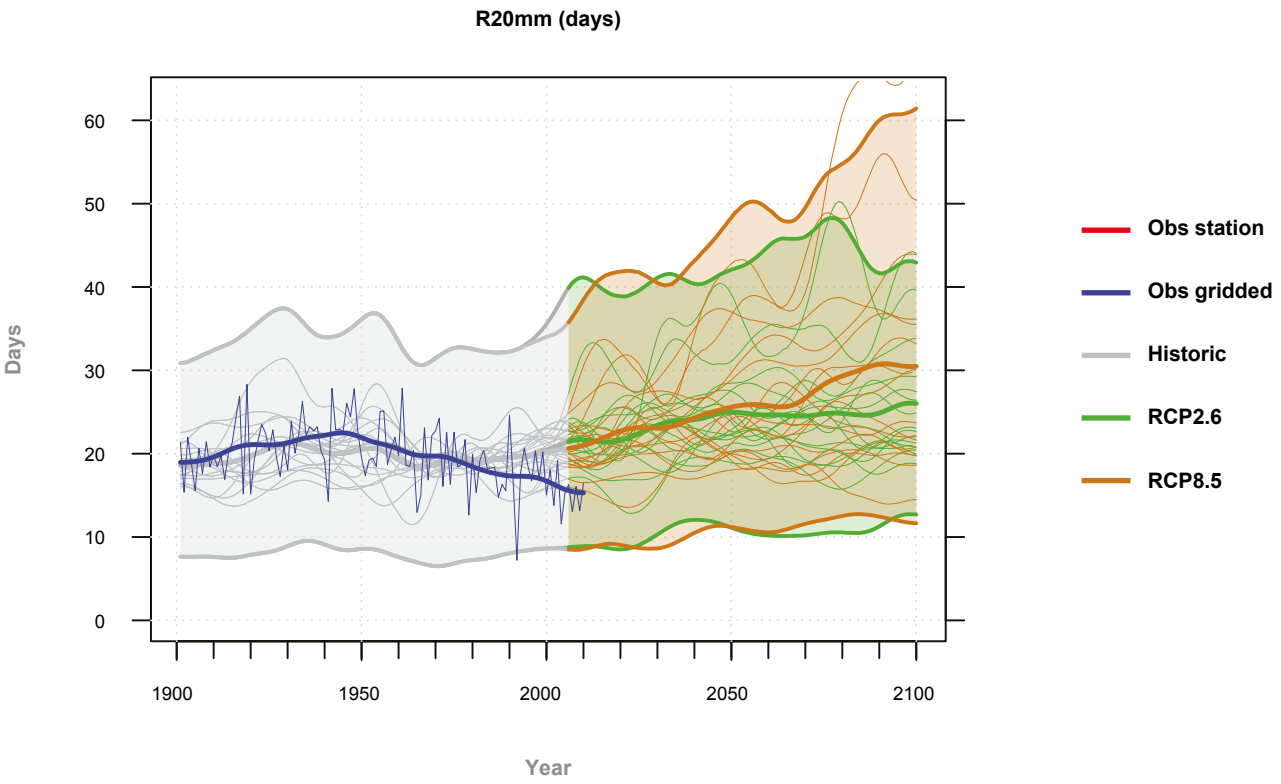


Table 2: Observed and projected changes for temperature and rainfall for Jabalpur *(Source: CEEW)*

	Observed 1981-2010	2030s RCP8.5	2050s RCP8.5	2080s RCP8.5	2080s RCP2.6
Temperature					
Mean Temperature	25.8°C	+1.4 (0.9 to 1.8) °C	+2.1 (1.4 to 2.7) °C	4.4 (3.2 to 5.4) °C	+1.2 (0.6 to 2.0) °C
Warm Days	12 days	+14 (7 to 22) days	+23 (9 to 36) days	+49 (28 to 66) days	+13 (6 to 26) days
Warm Nights	13 days	+22 (14 to 30) days	+34 (24 to 47) days	+62 (52 to 74) days	+17 (8 to 27) days
Rainfall					
Total Rainfall	1,315 mm	+4 (-10 to +13) %	+5 (-9 to +20) %	+11 (-12 to +31) %	+5 (-4 to +17) %
Heavy Rainfall Days	17 days	+4 (-1 to +12) days	+5 (-1 to +16) days	+10 (-1 to +33) days	+5 (-1 to +17) days
Consecutive Dry Days	78 days	+2 (-6 to +13) days	+2 (-7 to +17) days	+5 (-15 to +23) days	0 (-11 to +9) days

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 both the direction and magnitude of rainfall change than is the case for temperature.

For the 2030s and 2050s only projections for the higher RCP 8.5 emissions scenario are given. There is very little difference between the two scenarios for the next couple of decades. By the 2080s, changes under the lower RCP 2.6 emissions scenario (final column) are considerably reduced, compared to the high emissions scenario.

Key messages and implications for climate change risk assessment for Jabalpur[7]:

- The climate of Jabalpur 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 records for the Jabalpur region indicate 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 gas emissions, as well as a tendency towards higher total rainfall and more intense and frequent rainfall extremes.
- If global warming can be limited to 2°C or less with respect to preindustrial conditions, the impacts of climate change would be substantially reduced for Jabalpur, particularly in the second half of the century.

Table 3: Projected climate change and potential risks *(Source: CEEW)*

Projected Climate Changes	Potential Impacts and Risks
Warmer conditions, including more intense and frequent hot extremes and heat wave days	▪ Human heat stress and other negative health effects including potential increases in mortality, particularly if the air quality also decreases ▪ Negative impacts and constraints on labor productivity, particularly on outdoor workers ▪ Potential increased demand for air conditioning – which would increase energy demand
Higher annual rainfall totals and more frequent/ heavy rainfall events	▪ Potential increase in flood risk ▪ Possible implications for water balance and the quantity and quality of water resources (also taking into consideration the likely persistence of long dry spells and increased evaporation with warmer conditions)

Socio-Economic Profile of Jabalpur

According to the Census of India 2011, the population of Jabalpur city (the area under Jabalpur Municipal Corporation) was 10.5 lakhs with 545,510 males and 510,015 females. The sex ratio in Jabalpur Municipal Corporation is 934 per 1000 males, which is lower than national average rate value of 943. The population was 12 lakhs in 2020 within a municipal area of 264 sqkm. The total work force participation rate of 36.2% is distributed as 89.6% main workers and 10.4% marginal workers. Out of the 89.6% main workers only 11.63% form the female work force. From the above data, a gender biased workforce participation is evident. As this increases the social vulnerability, there is a need to address the aspects of inclusivity and equity in the city. Due to employment and informal job opportunities in the railway cantonment areas, there has been an increase in slum population who reside mostly along the north of the railway tracks, contributing to 44.71% of the city's total population[4].

The agriculture sector and ordinance factories have a fair share in Jabalpur's economy. The alluvial soil of the Narmada basin in the district is very favorable for agriculture. The chief agricultural produce grown in Jabalpur include paddy, maize, pulses, ginger, wheat, gram, pea, lentil, mustard, soybean, linseed, spices, mango and guava.

The ordnance factories in Jabalpur include Vehicle Factory Jabalpur, Grey Iron Foundry, Gun Carriage Factory Jabalpur, and Ordnance Factory Khamaria that manufacture bullets, rockets, howitzers, bombs, mortars, grenade, shells, bulletproof vehicles, etc. The ordnance factories provide enormous employment opportunities to the local people. Other principal industries in Jabalpur include electrical goods, limestone industries, bidi manufacturing, food processing industries, sawmills, and commercial automobiles.

City Typology

To ensure that CAP identified relevant actions for the 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[13]" 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 8.

Figure 8: City Typology Framework *(Source: Adapted from World Resources Institute and C40 Cities, 2016)*

x-Axis:
Income Today

y-Axis:
Income Growth Relative to Population

Growth base year: 2021-30

- **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.

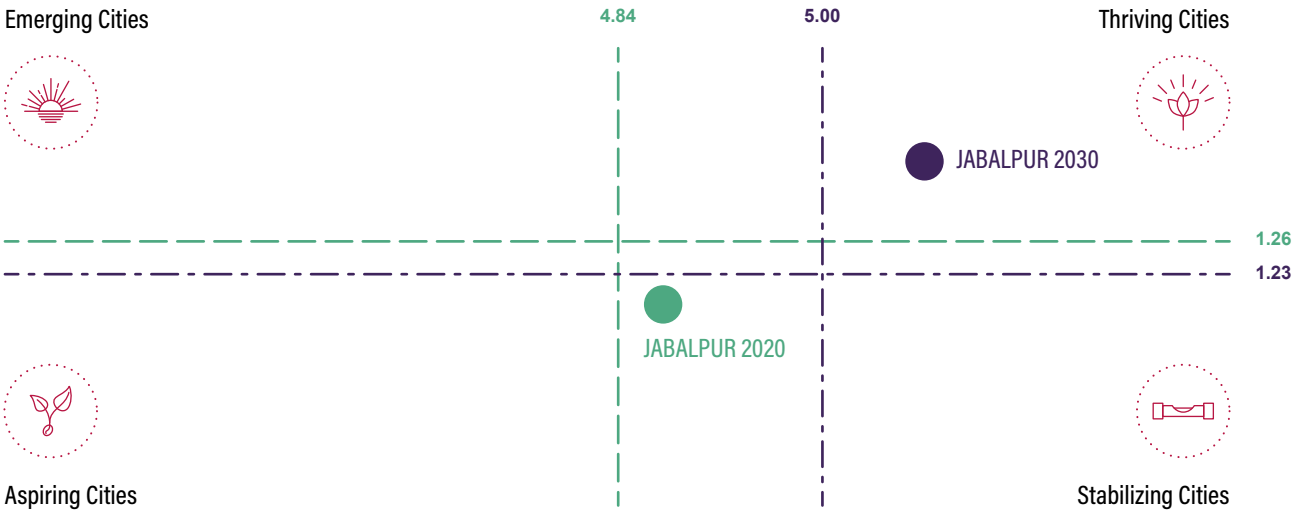
- **Emerging Cities** have a low income today, and a high ratio of income growth to growth in population during 2021-2030, compared to other cities. While their economic strength is low today, their projected economic growth is greater than their projected population growth, indicating increases in economic 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.

The Figure 9 shows the socioeconomic transition of Jabalpur 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.

Figure 9: 2030 Transition of Jabalpur city *(Source: WRI India)*



Jabalpur moves from the stabilizing city category to the thriving city category in the decade till 2030. Jabalpur 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

Jabalpur has been a moderate performer in the first two rounds under CSCAF. The city has been doing fairly well under the waste management sector. 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 4

Table 4: CSCAF 2.0 analysis for Jabalpur *(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	213.5	74	89	25	579
Current measures being undertaken in the city	• 790 kW rooftop solar power plant established with net metering on water treatment plants[5].	• Ankur program – where citizens are awarded for planting trees – has been launched in the state, and PMAY has been linked to it. • Prepared GIS maps of water bodies and open spaces. • City has collated disaster related loss and damage data. • Working on Dumna nature reserve development phases 1 and 2[5].	• 7% of city's shared mobility run on clean fuels, including 1107 e-rickshaws. • City has introduced intelligent traffic management system[5]. • Working on redesigning Omti Nalla with footpaths and street furniture[3]. • 450 kW solar electric chargers for e-rickshaws installed at nine locations with capacity to charge 15 rickshaws in each location[5]. • Feasibility study completed for electric public bike sharing system and 6km cycle track constructed[5]. • Prepared a clean air action plan. The city has 2 manual and one continuous ambient air quality monitoring station. • Introduced a multipurpose smart card for use in city transport and other purposes[5].	• Completed development of Gulauaa talab as a tourist attraction[5]. • Revitalization of Ranital lake is ongoing[5]. • Installing rainwater harvesting at various locations[5].	• 100% door to door collection of segregated waste • Operational waste-to-energy plant of 600-tonnes capacity generating 11.5 MW energy[6]. • Radio Frequency Identification (RFID) tags on household dustbins and solid waste vehicle tracking system in place[5]. • Work order issued for biomining of waste at Rani Taal dumping site[5].

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	• Increasing energy efficient streetlighting (currently 28.53%). • Need for promotional or penalty schemes for code compliance, pre-certification and certification of green buildings. • Need to create a green building cell • Increasing the energy coming from renewables. Currently, 1957 MWh out of 1021126 MWh comes from renewables, amounting to 0.09%.	• Increasing urban green cover (currently 11.74% of total area). • Should set up a disaster management cell and should conduct Ward level Hazard Risk, Vulnerability and Capacity Assessment and prepare a disaster management plan. • City is not taking measures to conserve biodiversity. Setting up a city-level biodiversity management committee can be the first step	• Increasing the number of buses (currently 0.1 buses/1,000 population). • Increasing the % of roads with footpaths and cycle tracks (currently 3%) • City needs to install more continuous air quality monitoring stations to capture PM_{10}, $PM_{2.5}$, NO_x and SO_x.	• Reducing Non-Revenue Water (NRW) which is currently more than 40%. • Jabalpur needs to assess current water resources and future demand and prepare a water resources management plan with short-, medium- and long-term actions. • Should measure the amount of wastewater recycled. • Need to prepare a flood risk management plan. • Need to conduct energy audits of water supply and wastewater management systems.	• Waste deposition center for domestic hazardous waste is needed[6]. • City needs to involve more NGOs in waste management[6]. • Need for plastic waste collection centers[6]. • Methane capture from landfill and sewage treatment plants is needed.

Greenhouse Gas Emissions Profile

The greenhouse gas inventory for Jabalpur 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 sources of activity that contribute towards emissions; and it allows the city to develop mitigation policies and strategies. The inventory includes scope 1 emissions which are emissions due to activities in the city (for all the sectors), scope 2 emissions which are emissions from electricity consumption in the city and scope 3 emissions from waste, which are emissions outside the city due to activities originating within the city (example, if waste generated inside the city is treated elsewhere outside municipal limits).

Critical Emission Sources

In 2019, Jabalpur's GHG emissions were 1.5 $mtCO_2e$ which was 1.3 tCO_2e per person. The emissions inventory was compiled as per the Global Protocol for Communities (GPC) BASIC standards using C40's City Inventory Reporting and Information System (CIRIS) tool. Majority of the emissions comes from energy and electricity use in residential buildings followed by the industrial sector. Stationary energy contributes 56% to the city's total

emissions, followed by 32% from transportation. Waste sector contributes 12% to the city's total emissions (Figure 10).

The business-as-usual projected emissions for Jabalpur are presented in Figure 11. The emissions are projected to increase by 18% by 2025 and 35% 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 10: Percentage Distribution of Emissions by Sector for 2019 *(Source: WRI India analysis using primary data)*

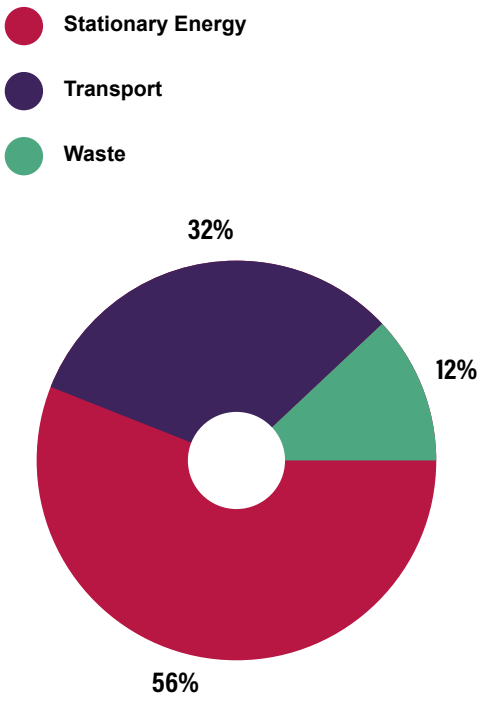
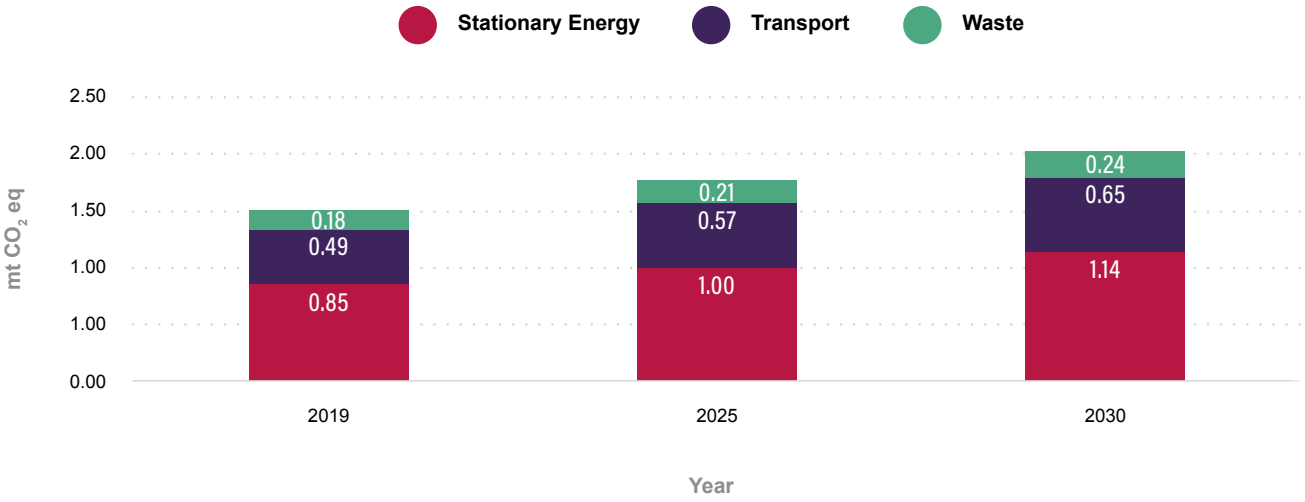


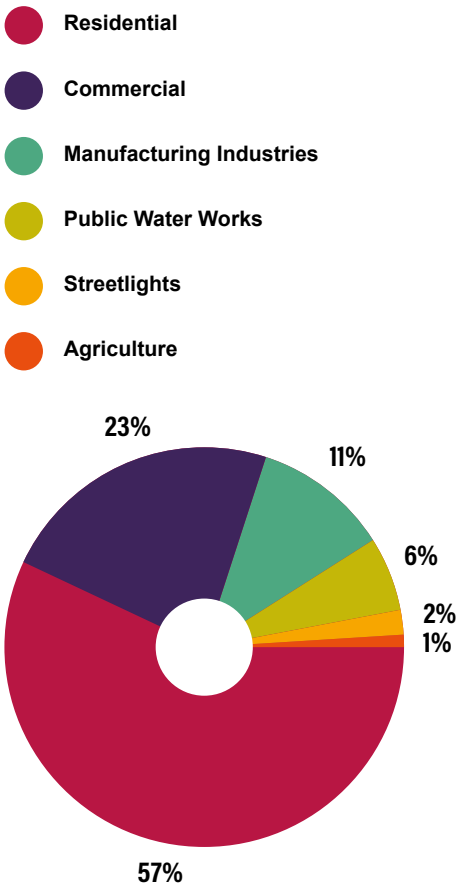
Figure 11: Projected business as usual emissions for Jabalpur *(Source: WRI India analysis using primary data)*



Stationary Energy Sector Emissions

Stationary energy sector comprises of emissions from 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, the total electricity consumption in Jabalpur city was 1,021,127.55 MWh in 2019, out of which, consumption by residential buildings was 581,621.21 MWh, which was the highest (Figure 12). Per capita electricity consumption was 845 kWh in 2019.

Figure 12: Percentage electricity consumption by sub-sectors (*Source: WRI India analysis using primary city data)*



Domestic LPG fuel consumption totals 61,674 tonnes and commercial consumption is 2,629 tonnes. Only around 33 tonnes are used for manufacturing and industrial purposes. There was no recorded data on PNG consumption in the city (Figure 13).

This sector accounts for 849,197 tCO_2e of emissions. Residential buildings accounted for 58% followed by commercial buildings with 23% of total emissions. Industries accounted for 11% (Figure 14).

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

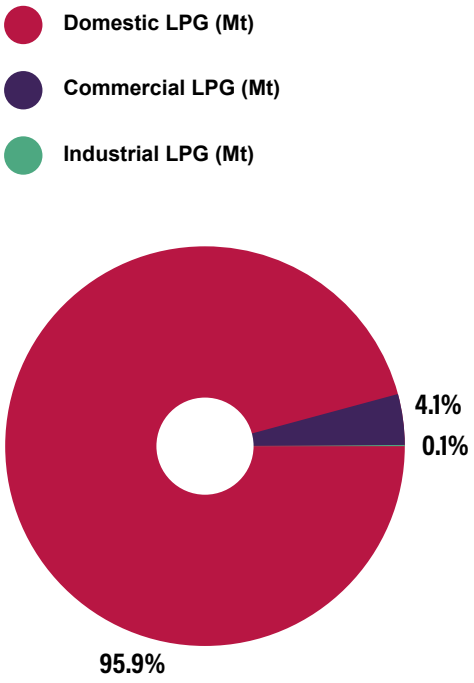
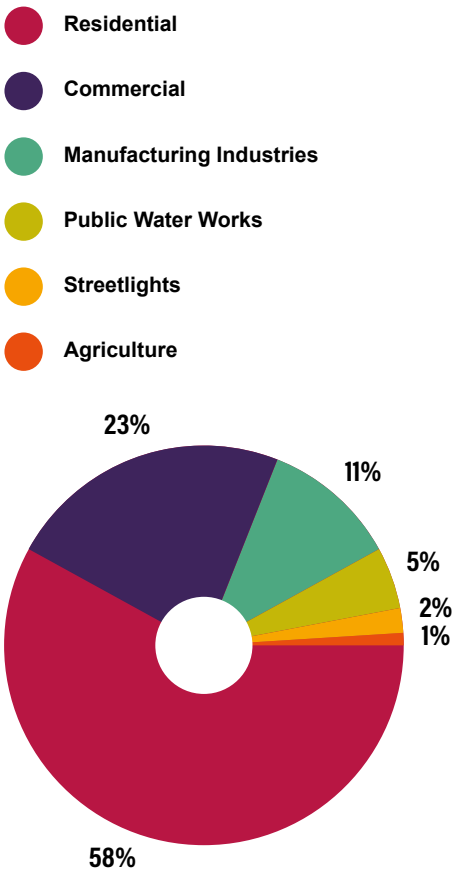


Figure 14: Percentage of Stationary energy emissions by sub-sector *(Source: WRI India analysis using primary data)*



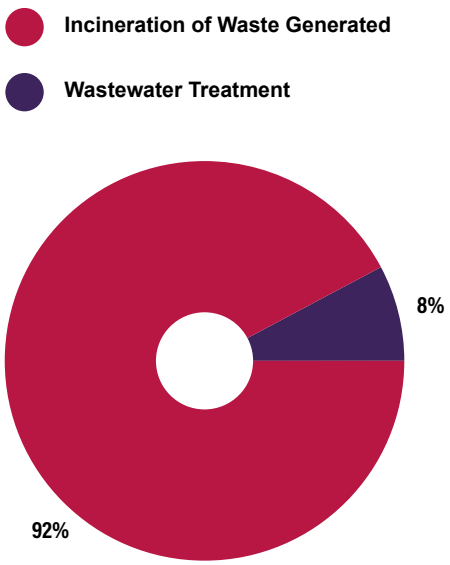
Transport Sector Emissions

The transport sector accounts for 485,089 tCO_2e of emissions, coming from the consumption of petrol and diesel in on-road transport. Data was obtained from fuel agencies such as Indian Oil Corporation Limited (IOCL), Bharat Petroleum Corporation Limited (BPCL) and Hindustan Petroleum Corporation Limited (HPCL).

Waste sector emissions

Waste accounts for 175,385 tCO_2e of emissions. While 92% of emissions is due to the wastewater generation, the remaining 8% can be attributed to the incineration of solid waste. No solid waste is landfilled as the entire waste is sent for incineration in the waste-to-energy plant based in Kathonda (Figure 15).

Figure 15: Percentage spit up of waste sector emissions for 2019 *(Source: WRI India analysis using primary data)*



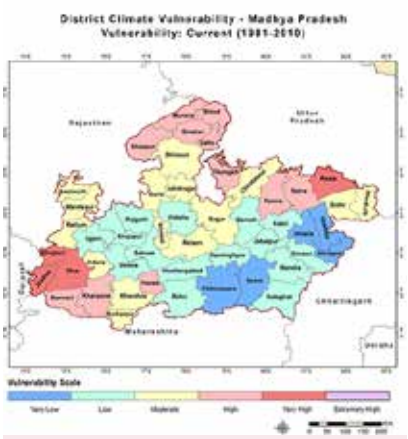
Vulnerability assessment

EPCO has 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 the Coordinated Regional Climate Downscaling Experiment (CORDEX) framework for RCP 4.5 and RCP 8.5 scenarios (Figure 16).

Figure 16: Sectoral and Temporal vulnerability profile for Jabalpur *(Source: Madhya Pradesh Climate Change Knowledge Portal)*

Baseline	RCP 4.5 Mid-Century	RCP 4.5 End-Century
Composite Vulnerability		
		
Very Low	Very Low	Very Low
Water Resources Vulnerability		
		
Low	Low	Low
Forest Vulnerability		
		
Moderate	Low	Low

Climate Vulnerability



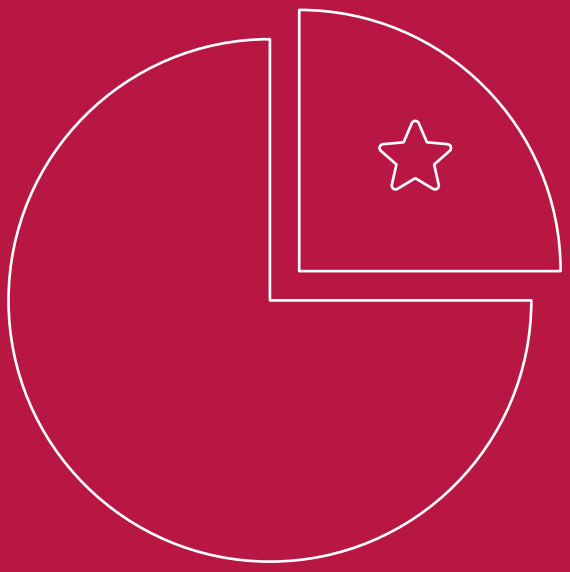
Low

High

Low

According to this analysis, Jabalpur has a very low composite vulnerability, driven largely by the socio-economic indicators. In terms of water resources, Jabalpur has low vulnerability owing to River Narmada flowing through the city. Jabalpur fares well in the forest sector because of 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 as highlighted in the above analysis.

SECTORAL PRIORITIES



This section provides a detailed description of the current performance of Jabalpur city on different indicators under CSCAF 2.0. Based on this, the sectoral goals have been identified to address the gaps and challenges to make Jabalpur a low-carbon and climate-resilient city.

Sectoral Assessment

Energy and Buildings

Based on the data received from MP Poorva Kshetra Vidyut Vitaran Company Limited (MPPKVVCL), the total electricity consumption in Jabalpur city was 1,021,127,550 kWh in calendar year 2019, with the per capita electricity consumption being 845 kWh. This is less than the national average per capita electricity consumption of 1,208 kWh[14]. The city has a total of 42,543 streetlights, of which 12,136 (28.53%) are energy efficient streetlights. JSCL is working with Energy Efficiency Services Ltd (EESL) to implement more LED streetlights[5]. As per CSCAF 2.0, less than 1% of the city's electricity demand is met by renewables. The city is taking steps to increase this, such as, installing a 790 KW solar rooftop plant in Ramnagara, Lalapur and Ranjhi water treatment plants. They are also installing solar rooftops on government schools and zonal offices of Municipal Corporation[15]. According to the data shared by the department/ agency concerned, the city has not implemented any measures to promote green buildings and there are no certified green buildings in Jabalpur.

Urban Planning, Green Cover, and Biodiversity

About 4% of the total area of the city is covered by water bodies and 11.74% of the municipal area is covered by green spaces[16]. However, a temporal analysis of green spaces in ABD area from the year 2000 to 2019 highlighted that most of the green spaces have undergone construction of new buildings above them. Although, Jabalpur has mapped water bodies and open spaces, they should also capture attributes such as area, depth, volume and current status for water bodies and area, foliage cover, type of land, ownership of land, current status etc. for open areas. A study in 2017 highlighted the need for stronger policies and frameworks to conserve ecologically rich zones in the city and preserve natural habitats[17]. Dedicated budget should also be provided for increasing green cover[17]. The total estimated carbon sequestered by all the trees in the city of Jabalpur is 9,767,898.14 tCO_2e per year. This highlights the importance of increasing green cover from a climate mitigation perspective[4].

In terms of biodiversity, Jabalpur needs to take steps such as initiating a biodiversity committee at the city level and developing actions for biodiversity conservation. The Dumna nature reserve boasts of 296 species of birds, 125 species of moths, 1300 species of butterflies and 109 varieties of trees[18]. This along with other lungs of the city such as Madan mahal hill[18] must be conserved.

With Jabalpur facing the risk of increasing flooding, the city needs to initiate a disaster management cell and conduct a ward-level hazard risk, vulnerability and capacity assessment based on NDMA guidelines. In 2020, water entered into residential houses after intense rains in the city, causing flash floods[19]. The city also needs to establish early warning systems for priority risks/ hazards, develop a comprehensive disaster management plan and regularly update the same.

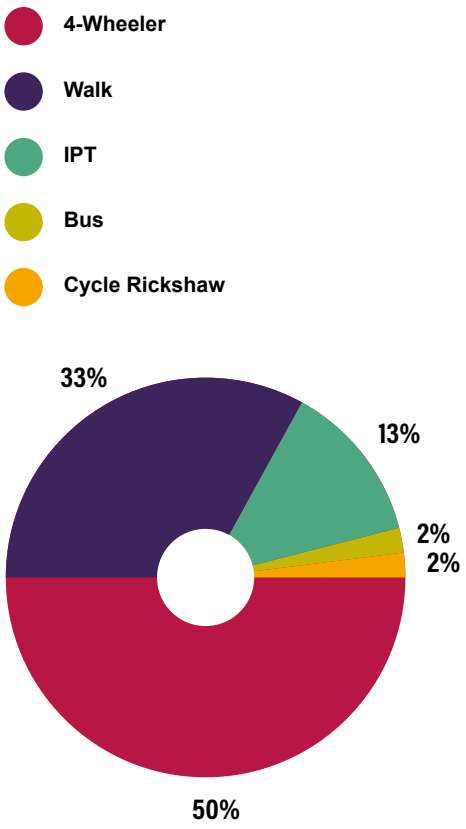
Mobility & Air Quality

Jabalpur City Transport Services Limited (JCTSL) is the primary stakeholder in providing public transport and manages 116 city buses. This amounts to only 0.1 buses per 1000 population, which is at the lowest service level as per MoHUA's service level benchmarks for urban transport[20]. Although major roads are covered by the public transport system, feeder roads are yet to be covered by the same. Last mile connectivity needs to be improved, as only 3% of the total road network consists of footpaths and cycle tracks[16]. JCTSL is working on installing passenger information systems (PIS) in 86 bus stops[3]. JSCL is also working on increasing non-motorized transport from Gorakhpur to Gwarighat (6km), Nav Bharat to Madan Mahal Omti nala (1.2km), Naudra bridge to Ghoda hospital and Madan Mahal to Damoh Naka[5].

Jabalpur had also launched a public bike sharing system in 2018, with 400 bicycles and 40 smart stations in phase 1. It saw a tremendous uptake of 50000 rides by 38,000 users in the first month[5]. However, it has not been seeing good ridership recently as per stakeholder's inputs. The modal split for Jabalpur for 2017-18 is shown in Figure 17. Private vehicles (4 wheelers) had the highest modal share of 50%, indicating the need to shift away from private modes of transport towards NMT and public transport[21].

7% of city's shared mobility run on clean fuels, including 1107 e-rickshaws. Jabalpur has also set up solar e-rickshaw charging stations at nine locations[5]. Similarly, the city can take steps to promote electric taxis, private vehicles, and buses. JCTSL had issued a Request For Proposal (RFP) for 50 electric buses in 2019[22], but it is still in the tender stages[5].

Figure 17: Modal split for Jabalpur in 2017-18 *(Source: open data portal, MoHUA)*



The city has a clean air action plan and monitors air quality in 2 manual ambient air quality monitoring stations at Regional office MPPCB and industrial area at Richhai and one CAAQMS at Malviya Chowk. Jabalpur's air quality index is 94 and its PM 2.5 levels are 1.8 times above the recommended levels. Jasuja city has a poor air quality index, while marhatal and Ranipur are at moderate levels[23].

Water management

Jabalpur is bestowed with the perennial river Narmada and has 37 lakes and ponds, making it a water rich city. Total capacity of all sources of water supply is 409 MLD while demand was 221 MLD in 2016[3]. However, the city had around 52 lakes in the past and many have vanished and continue to disappear due to rapid urbanization and encroachment. For example, rani tal lake was 48 hectares and has been reduced to 10.2 hectares due to reclamation and construction of a sports complex. Jabalpur's water bodies also face the threat of pollution mainly from dumping of religious waste and sewage[10]. A large stretch of the Omti nallah also got concretized after 2011, affecting the quality of the stream[4].

The city has to take measures to conserve its water resources. A survey in 2015 highlighted that 43% of households face water scarcity in summer and 13% of households do not have access to municipal water sources[24]. As a first step, they should conduct a water resource assessment to study the current water resources, its uses for various sectors (domestic, agriculture and industrial); projected future water demand and water availability (for domestic, agriculture and industrial demand) for at least five years using reference standards.

As per the CSCAF 2.0, the city has more than 40% non-revenue water. The city was able to achieve a major reduction in NRW after execution of ADB/AMRUT funded projects of augmentation, replacement of old pipelines and installation of bulk meters[3]. JSCL is working on 24x7 water supply with SCADA in the ABD area and design of a water supply scheme[5].

According to CSCAF 2.0 data, the city does not measure the amount of wastewater reused and should take measures for the same. With Jabalpur facing the risk of increasing rainfall and urban flooding, it should prepare a risk assessment for flood/ water stagnation. Jabalpur has also not conducted energy audits for water supply and wastewater pumping stations, and treatment plants.

Waste management

Jabalpur Nagar Nigam generates 526 TPD of solid waste, including 14 TPD of plastic waste and 261 TPD of wet waste[6]. The city has 100% door-to-door collection of segregated waste. The city has a waste to energy plant of 600 TPD capacity generating 11.5 MW of energy. The bulk waste generators process the wet waste they generate, including kitchen / garden / organic waste on site. The remaining wet waste along with the dry waste is sent to the waste to energy plant.

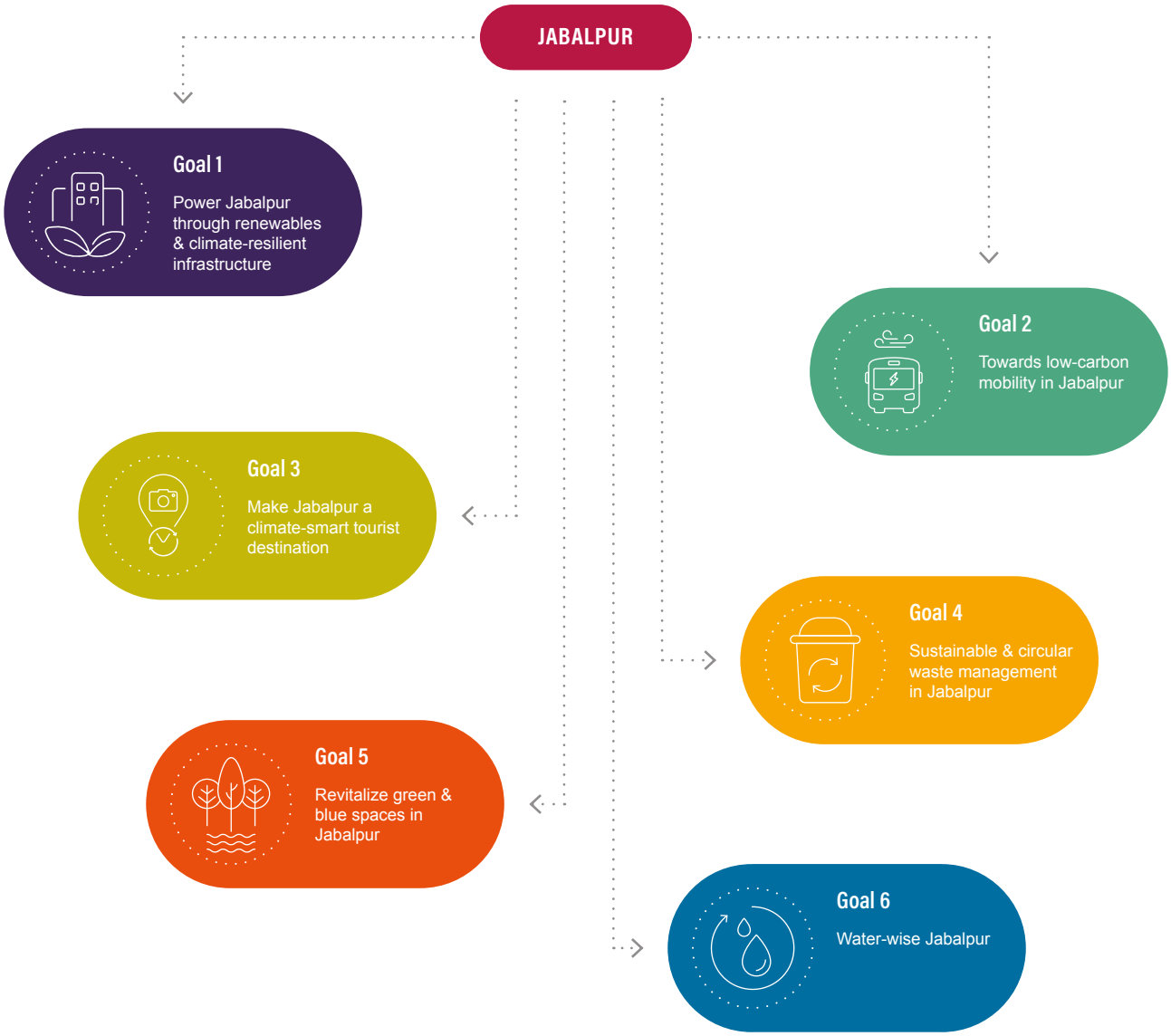
The city needs a plastic waste collection center. Jabalpur also has a 50 TPD construction and demolition waste plant at Kathonda. The city involves some NGOs in plastic waste collection, but more need to be involved[6]. JSCL has completed projects on geo-tagging bins and is currently working on a vehicle tracking system[5].

Jabalpur's waste was earlier disposed at the Rani Taal dumping site, which is a scientific landfill[25]. However, since the start of the waste-to-energy plant, no waste is dumped there. The city submitted a proposal for bio-mining of legacy waste in 2021. As per the proposal, 1.5 lakh metric tonnes of garbage will be cleared from the Rani Taal garbage dumping site by bio-mining. So far 1.8 MT of waste from 10 acres of the landfill has been bio-mined, and it is being used to fill gardens and construction sites. Complete landfill remediation is expected to take place in the near future, with plans of converting the area into an urban forest or park[26].

Sectoral Goals

The sectoral goals identified for Jabalpur city are aligned with the priorities of existing sectoral departments to ensure efficient implementation of the Jabalpur 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 18: Sectoral goals for Jabalpur *(Source: WRI India)*

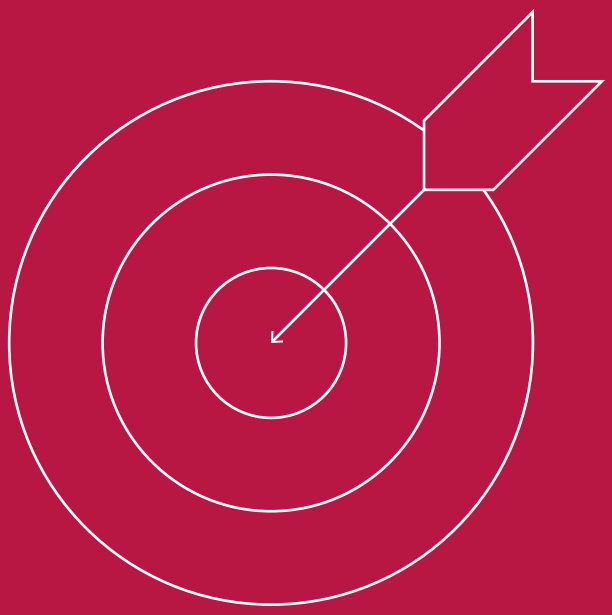


Mainstreaming Inclusivity in the Jabalpur Climate Action Plan

Jabalpur's climate action planning process stresses 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 Center for Sustainable Cities and C40 Cities in 2019[27]. As the first step towards mainstreaming inclusivity, cities must ensure that inclusivity is embedded in processes, policies, and impacts (Figure 19). 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 19: Inclusive climate action planning *(Source: WRI Ross Centre and C40 cities)*

SECTORAL CLIMATE ACTIONS



Goal 1: Power Jabalpur through Renewables & Climate-Resilient Infrastructure

The transition from fossil fuels towards renewable energy is critical to achieve a low-carbon development and to reduce climate impacts. MP ranked 4th in 2020 with a solar energy potential of 61.66 GWp[28]. To support the transition to renewables, 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 state[29]. 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, etc . Jabalpur needs to harness the incentives from these policies and increase the share of renewable energy across residential, commercial, industrial, and municipal buildings, currently 0.09% of total consumption.

Identified Actions

Action 1: Develop a long-term renewable energy procurement plan

- **Challenges addressed at the city level:** As per the CSCAF 2.0 and DISCOM data, only 0.09% of the electricity consumption in the city is from renewable energy sources. During the stakeholder consultations, it was learnt that the city does not have a renewable energy procurement plan.

- **Description:** Jabalpur is already working on increasing the installed capacity of solar power in the city through a 790 KW solar rooftop plant in the 3 water treatment plants. It also aims to install solar rooftop on all municipal buildings and schools[15]. Stakeholders also highlighted the need to include solar in all new residential buildings.

  Preparing a long-term renewable energy procurement plan would mitigate risks from fluctuating market prices through retail contracts. A Renewable Energy Procurement plan should encompass detailed, time bound and feasible solutions to help the city government invest in large scale, long-term renewable energy projects. Jabalpur must first assess its energy needs and future energy requirements, identify appropriate governance structures for procurement planning and decision making and collaborate with key stakeholders. For example, as part of Melbourne's Renewable Energy Project, the city hired energy market advisors to track risks due to changing markets, analyze tender structures and advise on a structure with least cost and risk[31].

  Some criteria to consider for procurement can include:
  - Access to land or rooftops for large installations and use of existing grid network. Jabalpur can conduct a study to assess rooftop and ground mounted solar potential in vacant lands, schools, municipal buildings, stadiums, etc.
  - Feasibility of floating solar in existing lakes or Narmada river should also be explored. Robertson lake was also highlighted as a potential area for solar. JMC can collaborate with organizations like the World Bank or National Thermal Power Corporation (NTPC) to conduct these studies. For example, World Bank had conducted the feasibility study for the world's largest 600 MW floating solar plant which is proposed in Omkareshwar dam on Narmada river in Khandwa district of MP. Madhya Pradesh Power Management Company will be purchasing 400 MW power from the plant[32].
  - Availability of funds for building renewable energy assets and long-term operation and maintenance. JMC can consider innovative funding like green bonds or masala bonds, similar to Indore[33].

- **Inclusivity analysis:** Low-income communities may be excluded from participating in distributed renewable projects due to potentially high upfront installation and operating costs. Inflexible payment schemes can aggravate this issue. Utilities, developers, and investors may not opt for distributed projects in low-income areas of the city for fear of a low rate of return on their investment. The city should create institutional and policy mechanisms to make renewable energy projects easily accessible and affordable for such segments[34].

- **Implementing stakeholders:** Jabalpur Municipal Corporation (lead), Jabalpur Development Authority, MPPKVVCL, MPUVN, JSCL, RWAs, private players

- **Timeframe:** Short term (1-3 years)

- **Alignment with schemes:** Policy for implementing solar power projects in Madhya Pradesh (2012), Madhya Pradesh Policy for Decentralized Renewable Energy Systems 2016, MP Renewable Energy Policy 2022

- **Monitoring Indicators:** Renewable energy procurement plan, total solar potential in the city, % of energy coming from renewables

- **Alignment with CSCAF indicators:**
  - Indicator 2: Total electrical energy in the city derived from renewable sources under the energy and green buildings sector.

Action 2: Promote energy efficiency improvements and renewable energy use in MSMEs

- **Challenges addressed at the city level:** As per the GHG emissions inventory, industries account for 11% of the total stationary energy emissions. Only 0.09% of the electricity consumption in the city is from renewable energy sources. Jabalpur is also home to a booming garment manufacturing sector, employing more than 50000 skilled workers and also houses many military related manufacturing factories like the Vehicle Factory Jabalpur, Grey Iron Foundry, Gun Carriage Factory Jabalpur, and Ordnance Factory Khamaria[3].

- **Description**: Jabalpur has power-intensive units in the defense products manufacturing and textile manufacturing sectors and related supply chain and can take measures to improve energy efficiency and renewable energy use in these units.

  Textile: Jabalpur has witnessed a phenomenal growth of garment manufacturing and related MSMEs in the last 10 years, where more than 50,000 workers are employed[3]. Looking from an energy and climate angle, this sector is power intensive with its pre-processing activities for ginning, spinning, dyeing, and finishing. Processing and finishing operations consume more of thermal energy whereas spinning and weaving and other utilities consume more of electrical energy. Solar energy can cater to textile industries' need for thermal as well as electrical energy[35]. Jabalpur can work with manufacturers to promote appliances like electric solar powered reeling machines, power looms, etc.

  Ordnance factories: JMC can work with Ordnance factories in the city to install decentralized solar. Many ordnance factory boards are installing solar across the country. For example, the Ordnance Factory Varangaon (OFV), had invited an Expression of Interest (EoI) for solar power projects of 5 MW in 2019 while the Muradnagar Ordnance Factory had invited similar EoI for a 15 MW plant in its premises[36]. Use of solar power had reduced energy costs for the Ordnance Factory Board from Rs 463.22 lakh during 2015-16 to Rs 163.78 lakh during 2018-19[37].

  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[38]. Jabalpur 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. Jabalpur can also promote startups to develop new innovative technologies, through competitions and provision of funds.

  The municipal corporation along with JSCL can also issue municipal solar bonds[39] for upscaling roof top solar, wherein JSCL can play the role of a financial aggregator. The ULBs of Delhi and Surat[40] have also raised similar solar municipal bonds and have recognized a widespread uptake in RTSPs. While in Surat, the bonds have attracted a lot of industrial consumers, in Delhi potential gains are seen across all consumer segments.

- **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 systems[41]. The city can also provide training for women workers around maintenance and operations of energy efficient equipment.

  Solar power for textile production can improve worker productivity and revenue for small scale weavers. For example, The Energy Resources Institute (TERI) helped a weaver from a village in Varanasi to link his looms to decentralized solar powered machines with surplus power being stored in lithium batteries. This helped him work without the risk of delays due to power cuts[42].

- **Implementing stakeholders:** Jabalpur Municipal Corporation (lead), Jabalpur Smart City Limited, technology providers, NGOs, RWAs, Ordnance Factory Board, MSME associations, MPUVN, MPPKVVCL

- **Timeframe:** Short term (1-2 years)

- **Alignment with schemes:**
  - MP Policy for Decentralized Renewable Energy Systems, 2016
  - MP Solar Net Metering Policy 2020, MP MSME development policy 2021, MP RE policy 2022

- **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 3: Expand the use of bio-CNG from dairy waste for residential and commercial consumption

- **Challenges addressed at the city level:** As per CSCAF 2.0 and DISCOM data, only 0.09% of the electricity consumption in the city is from renewable energy sources.

- **Description**: Jabalpur Municipal Corporation, along with Jabalpur Sahakari Dugdh Sangh Maryadit (Jabalpur Milk Union), had invited tenders for a bio-CNG plant from buffalo/ cow dung at Imaliya village, Panagar Tehsil, Jabalpur district[43]. The plant is expected to be commissioned by May 2023 and will produce 2,400 kg of bio-CNG daily. JMC plans to procure the dung from large dairy farms run by Jabalpur Milk Union to produce Bio-CNG. The Bio-CNG is mainly to be used for running buses. In phase 1, a 50 TPD plant is proposed to be set up at the Jabalpur Milk Corporation[44].

  In addition, JMC could consider supplying a part of the produced bio-CNG to affordable housing units in the city for cooking purposes. The city could also promote its usage amongst hotels by conducting sensitization drives to shift to clean fuels for their cooking and lighting purposes. Alternatively, they can offer incentives like tax rebates or subsidies for hotels who purchase bio-CNG. In Chennai, the Bio-CNG generated by the Greater Chennai Corporation from the wet waste processed in its bio-CNG plants is purchased by hotels for their cooking purposes[45]. Similarly, the gas generated at the Bio-CNG plant located in Malur in Kolar District, Karnataka is used to supply to eight restaurants and commercial establishments in Bengaluru, which use an average of three units of Bio-CNG in four weekdays[46].

- **Inclusivity analysis:** Purchasing LPG cylinders might be unaffordable for low-income households and middle-income hotel owners. Supplying the bio-CNG at subsidized costs might help them to meet their fuel demand for cooking and lighting purposes, thus ensuring equitable impacts on all groups. Ensuring training and acceptance of women in the use of clean fuels like bio-CNG for cooking is important. The residue compost can also be given to farmers for free.

- **Implementing stakeholders:** JMC (lead), Jabalpur Milk Corporation, JSCL, hotels associations, RWAs, informal communities, NGOs, MPUVN

- **Timeframe:** Medium term (3-5 years) with long-term monitoring

- **Alignment with schemes:** MP RE Policy 2022

- **Monitoring Indicators:** Increased percentage of energy derived from renewable sources, % of households that use bio-CNG for cooking/heating fuel (disaggregated by income level and informality status), % of hotels using bio-CNG, cost of bio-CNG

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

Action 4: Incentivize installation of rooftop solar panels and solar water heaters in all existing and new residential buildings

- **Challenges addressed at the city level:** As per the data obtained from state energy distribution company reports, the total electricity consumption in the city is 845.89 kWh per capita. Of this only 0.09% is from renewable energy sources.

- **Description:** JMC should take measures to increase the uptake of rooftop solar amongst residential consumers.
  - 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 PVs. It is observed that this helped reduce power tariffs by 10-15% each year[47]. Karnataka State Govt provides rebate of 50 paise per unit up to Rs 50 per month for installing SWH[48]. Pune also provides a 5% tax rebate for one energy efficiency initiative out of SWH, composting or RWH, 10% for 2[49]. 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: Jabalpur 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 available[50].
- 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 citizens[51]. 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. JMC 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 buyers, making it more accessible to low-income communities.
  - JMC 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:** Jabalpur Municipal Corporation (lead), JSCL, MPPKVVCL, MPUVN, technology providers, private residential owners, NGOs working with informal communities

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

- **Mainstreaming with policies and schemes:** MP Policy for Decentralized Renewable Energy Systems, 2016, MP Solar Net Metering Policy 2020, MP RE 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 and number of tool users, # of awareness training workshops conducted

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

Action 5: Implement low carbon components in municipal buildings and projects

- **Challenges addressed at the city level:** As per CSCAF 2.0 and DISCOM data, only 0.09% of the city's energy demand is met by renewables. Moreover, Jabalpur is not taking steps to promote green buildings.

- **Description:** The city has installed a 790-kW solar plant in 3 water treatment plants[15]. Moreover, JSCL is aiming to install solar rooftop in all municipal buildings and schools. As a next step, they can even consider piloting JMC offices, JSCL office or schools as low carbon buildings or zero carbon buildings. JSCL is planning to build sanskruti theatre and Open Air Theatre at Bhawartal and Bhatauli, an incubation center at Udyog Bhavan, renovation of Manas Bhawan auditorium, renovation of government school at Kachpura, conservation of Gandhi library town hall, development of a mini sports complex at Foota Taal and many more such projects[5]. They can consider including zero carbon building components into all these ongoing and proposed projects to reduce the energy bill and reduce overall city level GHG emissions.

  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 adopted include the Delhi's Indira Paryavaran Bhawan, which 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 building[52]. The Indira Paryavaran Bhawan has seen a 40% reduction in energy consumption, 55% reduction in water usage and has achieved a negative annual energy bill due to revenue generation from excess solar generation[53]. Most of the Infosys campuses in the country are LEED platinum buildings and have PV panels, RE electricity and off-site RE plants[54].

- **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/alterative building materials and those in their supply chain. This would also encourage more youth entrepreneurs to explore avenues for green/low-carbon alterative material manufacturing in the city.

- **Implementing stakeholders:** Jabalpur Municipal Corporation (lead), MPPKVVCL, MPUVN, Jabalpur Smart City Limited, technology providers

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

- **Alignment with schemes:** MP Policy for Decentralized Renewable Energy Systems, 2016
- MP Solar Net Metering Policy 2020, MP RE Policy 2022

- **Monitoring Indicators:** Percentage of municipal buildings retrofitted with solar PV, # of green buildings certified, % of total built up area for green buildings, % energy from renewables, # of low carbon building pilots in the city

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

Action 6: Solar powered bus stops and parking lots

- **Challenges addressed at the city level:** As per CSCAF 2.0 and DISCOM data, only 0.09% of the city's energy demand is met by renewables.

- **Description**:
  - Bus stops: Jabalpur has issued a work order for bus stop expansion- phase 1 and phase 2. Moreover, JCTSL had issued a Request For Proposal (RFP) for 50 electric buses in 2019[22], but it is still in the tender stages[5]. Jabalpur can pilot some of these new bus stops as solar bus stops. Cities like Trichy[55], Madurai[56], Delhi[57] and Lucknow[58] 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 surveillance[59]. To power the proposed electric buses, Jabalpur can also pilot solar panels on charging stations at bus stops to charge e-buses during the day. West Bengal Transport Corporation has estimated through a study that replacing 80 conventional public transport fleet to solar-powered e-fleet will reduce annual carbon dioxide emissions by 3,094 tonnes[60], considering a daily round trip of 100 kms per bus. This would be a win-win strategy, resulting in lower electricity cost for charging e-buses and faster implementation, considering the capital expenditures (CapEx) for procurement and operations[61].
  - Parking lots: Jabalpur is planning for multilevel parking lots at various locations like Civic center and Manas Bhawan. These can be powered by solar. Tata solar power commissioned the country's first solar car parking in Delhi in 2017, which was estimated to offset 438 tCO_2e annually[62]. The multilevel car park in freedom park Bangalore was also planned to be run entirely on solar[63].

- **Inclusivity analysis:** The installation of rooftop solar panels is labor intensive and can generate many good quality jobs. Workers from low-income groups can be trained to install and maintain these projects. The bus stops that are planned should also include drinking water facilities, toilets, seating, ramps for disabled, phone charging and other amenities to ensure equal access to all.

- **Implementing stakeholders:** Jabalpur Municipal Corporation (lead), Jabalpur Smart City Limited, JCTSL, MPPKVVCL, MPUVN, JCTSL, technology providers, RWAs

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

- **Alignment with schemes:** MP Policy for Decentralized Renewable Energy Systems, 2016
- MP Solar Net Metering Policy 2020, MP RE Policy 2022, FAME phase 2

- **Monitoring Indicators:** % of energy from renewables, % of bus stops with solar PV, % of parking lots with solar PV

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

Action 7: Implementing institutional measures to increase adoption of green buildings in the city

- **Challenges addressed at the city level:** As per CSCAF 2.0 data, there are no green certified buildings in the city and Jabalpur has not taken any steps to promote green buildings.

- **Description**: To encourage a city-wide implementation of green buildings, the following measures can be adopted[64]:

- The ECBC 2017 codes have been mandated in commercial buildings. However, it lacks compliance. Jabalpur should ensure strict compliance through monitoring permit requirements, calculation methods, regular inspections, monitoring energy bill reductions, etc. Jabalpur can mandate the green building certificate submission for the online building approval system for building approval. JMC has also signed a memorandum of understanding with IGBC for capacity building of senior officials[26].
- Set up a functioning high-level green building committee or equivalent, comprising of ULB's commissioner and representatives of ULB's green building cell, smart city, Urban Development Department, town planner, Public Works Department, green building certification agencies, developers and building professional associations. The committee must provide strategic advice for the promotion and adoption of energy efficient and green buildings in the city as well as set green building promotion targets.
- Set up an operational functioning green building cell for knowledge dissemination, training and capacity building, public sensitization, empaneling green building schemes and their promotions, verification, and faster approvals for green buildings in the city. The cell should have architects, planners, engineers, certified green building professionals and auditors and municipal engineers. The cell should work in close coordination with the committee and provide technical assistance, regular feedback, and recommendations.

- **Inclusivity analysis:** Jabalpur can create tiered building standards, with buildings in richer market areas having to implement more stringent standards compared to those in low-income areas. Jabalpur should set green building adoption targets for affordable housing schemes. Incentives to promote green buildings can also be given for hospitals, schools, etc. with the municipality bearing maximum cost.

- **Implementing stakeholders:** Jabalpur Municipal Corporation (lead), Directorate of Town & Country Planning, JSCL, MPPKVVCL, MPUVN Energy management cell, IGBC city chapter

- **Timeframe:** Short term (1-2 years) with long term implementation

- **Alignment with schemes:**
  - Energy Conservation Building Code
  - Eco Niwas Samhita

- **Monitoring Indicators:** Percentage of energy derived from renewable sources, increase in the number of green buildings and solar installations in the city, reduced residential power costs, energy savings, number of certified and pre-certified green buildings in the city, number of ECBC/ Eco Niwas Samhita compliant buildings, total built-up area of green buildings

- **Alignment with CSCAF indicators:**
  - Indicators 5 and 6: Promotion of green buildings and green building adoption under the energy and green buildings sector

Action 8: Promotion of green and cool roofs in residential projects/colonies/apartments to reduce cooling demand

- **Challenges addressed at the city level:** High energy consumption and emissions from residential buildings. Jabalpur's temperatures reach 44-45 degree Celsius in summers, causing higher need for cooling[65].

- **Description**: To reduce the demand for cooling during summers as well as reduce the impacts of heatwaves on residents, Jabalpur can implement cool roofs and green roofs on residential and commercial buildings:
  - Cool roofs: Promoting measures for evaporative cooling 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 - cools roofs provide access to affordable cooling for those who are most vulnerable to the health effects of extreme heat. This has also been piloted by the Greater Hyderabad Municipal Corporation[66] 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 water[67].
  - Green roofs: These are roofs with a vegetative cover. Jabalpur can pilot this action by retrofitting 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 buildings 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 appeal[68].

- **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. For example, in Mumbai, slums were 5-6 degrees hotter than their neighboring areas[69]. Retrofitting interventions such as – implementing cool roofs or green roofs can significantly impact internal temperatures and provide thermal comfort indoors. Since the city has 44.7% of total households living in slums, this action becomes pertinent to enhance their resilience to heat stress. The city can consider the integration and retrofitting of green and cool roofs in all its upcoming affordable housing units under PMAY.

- **Implementing stakeholders:** Jabalpur Municipal Corporation (lead), Jabalpur Smart City Development Limited, private technology manufacturers and suppliers, NGOs, IGBC chapter

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

- **Alignment with schemes:** PMAY affordable housing scheme

- **Monitoring Indicators:** % of houses with cool roofs/ green roofs (disaggregated by income level), reduced illnesses, or mortality due to heatwaves (disaggregated by gender and ward level), % reduction in energy demand from residential buildings for cooling

- **Alignment with CSCAF indicators:**
  - Indicator 3: Fossil fuel consumption
  - Indicator 6: Green building adoption
  - Indicator 5: Promotion of green buildings under Energy and Green buildings

Action 9: Energy efficient retrofits and common solar PV projects for low-income housing under PMAY scheme

- **Challenges addressed at the city level:** 58% of energy consumption and emissions from residential buildings.

- **Description**: Jabalpur has plans to increase affordable housing under PMAY scheme for its low-income / marginalized population. The city is currently constructing EWS, LIG and MIG houses including development of infrastructure work under Affordable Housing Program at Kudwari and Tilhari[5]. In doing so, they can ensure that the low-cost housing units are fitted with components leading to increased energy efficiency. As per a 2015 survey, 44.7% of the city's population live in slums.

  Jabalpur can also explore 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. JMC should first identify a suitable social housing scheme with fossil fuel-based energy consumption for common utilities, different types of appliances in use and available roof top area. 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 KW grid connected solar PV system was installed in the rooftop which generates 3780 units of electricity per month, with a potential to reduce 37 tCO_2e 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 years[70].

- **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 invertor and how to read from the bidirectional meter[71]. Similar trainings must be provided by JMC.

- **Implementing stakeholders:** Jabalpur Municipal Corporation (lead), Jabalpur Development Authority, builders' associations, affordable housing units, RWAs, MPPKVVCL, MPUVN

- **Timeframe:** Long term (>5 years)

- **Alignment with schemes:**
  - ECBC 2017
  - Madhya Pradesh Policy for Decentralized Renewable Energy Systems 2016
  - MP RE policy 2022

- **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 5: Promotion of green buildings under the energy & green buildings sector

Goal 2: Towards Low-Carbon Mobility in Jabalpur

According to CSCAF 2.0 data, the city has 0.1 buses for a population of 1,000 and is in level 2. Thus, there is a need to improve public transport infrastructure in an inclusive manner to help Jabalpur in its quest to become a vibrant regional economic and cultural hub. Although major roads are covered by the public transport system, feeder roads are yet to be covered by the same[3]. Last mile connectivity needs to be addressed. Of the total shared vehicles in the city 7.71% are clean vehicles, constituting only e-rickshaws. There is a need for low-carbon mobility options to proliferate across other modes such as buses, taxis and two wheelers. This will also play a significant role in improving Jabalpur's air quality, which is currently at an unhealthy level with PM 2.5 levels, 1.8 times above the recommended levels by World Health Organization[23]. NMT infrastructure in the city constitutes only 3.03% of the road network. The city has a strong focus on improving this area through projects such as revamping Omti Nalla with continuous footpaths, separate cycle tracks, recreational and socio-cultural spaces, while integrating street vending, public conveniences, and other street furniture. JSCL is also working on increasing non-motorized transport from Gorakhpur to Gwarighat (6km), Nav Bharat to Madan Mahal Omti nala (1.2km), Naudra bridge to Ghoda hospital and Madan Mahal to Damoh Naka[5].

Identified Actions

Action 1: Augment Jabalpur's bus fleet and conducting feasibility studies for bus rapid transit system

- **Challenges addressed at the city level:** Only 0.1 buses available for 1000 population. As per MoHUA's service level benchmark they should at least increase it to 0.4 (level 3)[20]. In 2017-18 buses only had a mode share of 2%[21].

- **Description**: The city can increase its bus fleet in a phased manner and possibly conduct feasibility studies for introducing a Bus Rapid Transit System like in Bhopal and Indore. They can aim for 480 buses (0.4 buses per 1000 population) in the first phase. The first step is to identify the route structure. This can be done by plotting the major activity centers and determining travel patterns. Next, the city can calculate ridership demand. In the absence of a structured public transport operation, this can also be done by surveying the travel demand met through IPT services to identify main corridors and major bus stops. Next is to develop the operational plan, which is usually either destination oriented (consisting of direct connections between multiple destinations) or direction oriented (combination of interconnected routes). The city must also regularly conduct service rationalization exercises once in 5-10 years. The regular bus routes can also be accompanied by feeder buses or minibuses like in Chennai[72] and Bengaluru[73]. The new buses should be complemented with adequate infrastructure. Bus stops must be in main junctions with assured road safety, sufficient footpath, closed shelters and in proximity to overhead bridges or pedestrian crossings. As per calculations and Indian Road Congress standards, bus bays need to be at least 79m in length and 5m in width to provide sufficient bus docking and need to be of tapering length[74]. Branding of new buses can be done thorough color coding or numbering and can be route wise. For example, front of buses are painted pink in Chennai to denote free fares for women. Bangalore has 4 buses based on fares and route having different colors.

- **Inclusivity analysis:**
  - Buses can be fitted with ramps for disability access. Bus terminals can also be included with toilets, water and other facilities along with elements such as traffic calming measures, speed control and signages for road design.
  - Fare rationalization and multimodal fare integration are important to make public transport accessible for low-income and minority groups.
  - Communication material and apps such as the Chalo app[75] can also be provided in English and native languages to enable better reach. Chalo partnered with Jabalpur City Transport Services Limited (JCTSL) to launch the Chalo App, Chalo Card, and mobile bus passes in Jabalpur.
  - Women's safety is another aspect that must be incorporated in the new buses, perhaps through the training of women drivers, separate seats for men and women and panic buttons[76].

- **Implementing stakeholders:** Jabalpur City Transport Services Limited (lead), Jabalpur Development Authority, Jabalpur Municipal Corporation, JSCL, private operators, citizens

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

- **Alignment with schemes:** AMRUT - Funding for non-motorized urban transport projects

- **Monitoring Indicators:** Increase in % modal share of public transport (disaggregated by gender and income), increase in number of buses per 1,000 people, availability of safe infrastructure like cycle or walking lanes connecting bus stops, increase in

ridership or percentage of income spent on public transport, % buses with panic buttons, % of buses with women drivers and % buses with ramps

- **Alignment with CSCAF indicators:**
  - Indicator 2: Availability of public transport
  - Indicator 3: Percentage coverage of non-motorized transport network (pedestrian and bicycle) in the city, under the mobility & air quality sector.

Action 2: Accelerate the ongoing initiatives of non-motorized transport in Jabalpur

- **Challenges addressed at the city level:** 33% mode share for walk in 2017-18[21], but only 3% of roads have footpaths as per CSCAF 2.0.

- **Description**: Jabalpur aims to increase the accessibility of its streets and has completed the work on laying the 6km NMT network from Gorakhpur, Katanga to Gwarighat, and a 1.2km of NMT- Phase I from Nav Bharat to Madan Mahal along the Omti Nalla. The city is currently implementing NMT- Phase – 2 from Nav Bharat to Naudra Bridge and NMT- Phase - 3 from Naudra Bridge to Ghoda Hospital, also along the Omti Nalla[5].

- To accelerate these ongoing initiatives, the city can implement the following policy actions:
  - Ensuring multistakeholder-driven action through Jabalpur's NMT cell: As per information shared during the stakeholder consultations, Jabalpur has already taken a good step and set up an NMT cell within their transport department. The city should ensure that the cell has representatives from various city agencies, local government departments, academic institutions, NGOs, and the private sector. The cell can also develop a NMT roadmap with short-term, medium-term, and long-term interventions. Examples in the Indian context include Chandigarh[9], which has instituted an NMT cell to facilitate inter-departmental coordination for implementing NMT related initiatives. They also created an NMT database with origin-destination data on existing travel pattern of NMT users and an inventory of existing status of NMT infrastructure.
  - Jabalpur non-motorized transport policy: The city can implement a supporting policy for strengthening and sustaining its efforts to improve NMT planning and implementation in the city. Examples of cities with innovative policies include Chennai's Non-motorized Transport Policy (2014), Pune's Policy for Pedestrian Facilities and Safety (2016) aimed at improving public transport and safety as well as pedestrian infrastructure, and Coimbatore's Street Design and Management Policy (2017)[77].
  - NMT-focused urban street design guidelines for Jabalpur: The city can implement an NMT-focused, inclusive street design to ensure that appropriate street types and design elements are incorporated so that the streets support non-motorized as well as private transport modes. Cities like Pune[78], Delhi[79] and Mumbai[80] already have such guidelines in place. These guidelines are binding documents that mandate urban professionals involved in street planning and urban renovation to include people-friendly aspects within the street design and also to support non-motorized mobility. 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 m.

- **Inclusivity analysis:**
  - There should be strict measures to prevent vendor encroachment, along with relocation measures.
  - The cycle tracks must be physically segregated from roads and there should be clear signages to ensure safety of cyclists[81]. Many cities in India have painted separations which are often encroached upon by cars.
  - The NMT infrastructure should also have ramps for disabled access and street furniture for comfort of elderly.

- **Implementing stakeholders:** JCTSL (lead), Jabalpur Development Authority, Jabalpur Municipal Corporation, JSCL, RWAs, NGOs

- **Timeframe:**
  - Short term (1-2 years):
    Ensuring multistakeholder-driven action through Jabalpur's NMT cell
    Jabalpur Non-motorized Transport Policy
  - Medium term (3-5 years): NMT focused urban street design guidelines for Jabalpur

- **Alignment with schemes:** AMRUT - Funding for non-motorized urban transport projects, National Urban Transport Policy (NUTP), Smart Cities Mission (Cycles4 Change and Streets for People challenges)

- **Monitoring Indicators:** Street design guidelines and NMT policy, length of inclusive and safe cycle and walking paths as a percentage of total road length, reduced emissions from the transport sector, increase in the modal share of NMT modes (disaggregated by gender and income group)

- **Alignment with CSCAF indicators:**
  - Indicator 3: Percentage coverage of non-motorized transport network (pedestrian and bicycle) in the city, under the mobility & air quality sector

Action 3: Initiatives towards low-carbon vehicles for passenger and freight movement

- **Challenges addressed at the city level:** Currently the city has only 7.71% shared vehicles running on clean fuels as per the CSCAF 2.0, comprising only of e-rickshaws. The city should promote electrification of other modes

- **Description**: The city can shift from fossil fuel driven mobility in both public and private transport sectors through three sub actions:
  - Promoting electric two wheelers for freight and passenger fleets: The city currently has no low-carbon scooters in the transport mix. The city can implement an electric two-wheeler sharing system, leveraging India's booming scooter sharing economy[82], involving private players such as Ola, Bounce and Vogo. 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. JMC can also ensure that the electric scooter rental stands are available near bus stops. Jabalpur 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[83]. Jabalpur can also explore incentives and take back programs for promoting electric scooters, especially amongst students or working youth. This can be supported by incentives under the MP EV policy such as 100% waiver on parking charges for electric 2 wheelers in any government run parking facility, exemption of vehicle registration fee and subsidized motor vehicle tax[84].
  - Incentivizing municipal employees to travel by low-carbon modes and making government offices EV ready: Representatives in the city suggested that government vehicles, that currently comply with Bharat Stage Emission Standards (BS VI) can be converted to e-vehicles. JMC can provide incentives like referral coupons, assured parking space, extra leaves, food coupons, etc. to employees who commute to work by electric vehicles or take public transport/ non-motorized modes. All government vehicles can be converted to EVs. Furthermore, a rule can be passed mandating all institutional and government buildings to have at least 50% of parking lots with EV charging infrastructure by 2025[85]. As per the MP EV policy 2019, government buildings have to set up a roadmap for installing charging stations in all government and municipal corporation parking spaces[84].

- **Inclusivity analysis:**
  - Renting electric scooters can lead to significant cost reductions for people who use them occasionally[86] thus increasing low-cost access to micro mobility solutions.
  - Loans for vehicle purchase can be made more easily available for low-income groups and small businesses.
  - There is a need to improve information about the benefits of e-scooters particularly amongst low-income or less educated groups to increase uptake.

- **Implementing stakeholders:** JCTSL and JMC (lead), Jabalpur Development Authority, financial agencies, local government departments, academic institutions, NGOs, and the private sector.

- **Timeframe:** Short term (1-2 years)

- **Alignment with schemes:** FAME Phase 2 scheme, MP EV policy 2019

- **Monitoring Indicators:** Increase in low-carbon shared mobility, reduced air pollution and emissions from transport, number of e-scooters sold, ridership numbers for e-scooters, availability of reliable charging infrastructure in key areas of the city, percentage use by low-income communities, % of municipal vehicles that are electric

- **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

Goal 3: Make Jabalpur a Climate-Smart Tourist Destination

Jabalpur's Smart City Proposal (SCP) highlights tourism and the textile industry as key economic sectors. Jabalpur seeks to "create a gateway to responsible eco and ethnic tourism" by developing infrastructure to support the tourism and hospitality industries. These could include convention and exhibition centers, hotel management institutes, multicuisine culinary schools, finishing school for guides, and institutes for teaching international languages and performance arts. The city is also looking to use ICT extensively to offer more creative and innovative tourist experiences. The city also wants to revitalize the cultural geography by providing innovative spaces to showcase arts and crafts of ethnic and tribal communities and create vibrant spaces, such as Bhanwartal, for lived experiences. The garment manufacturing sector in Jabalpur has also witnessed growth in the last ten years. Presently more than 50,000 skilled workers are employed in the sector. Along with tourism, the textile and garment manufacturing sectors can be developed in a climate-friendly manner[3].

Identified Actions

Action 1: NMT friendly tourist areas with electric hop-on-hop-off bus services

- **Challenges addressed at the city level:** No electric buses plying in the city. Only 3% of roads are NMT friendly as per CSCAF 2.0.

- **Description**: In a step towards tourism-led planning for sustainable urban development, the smart city can develop and link tourist spots such as lakes, forts, museums, temples, ghats and so on by building NMT infrastructure and introducing electric/ public hop-on, hop-off tourist buses. These routes can also be lined with trees/ greenery to make it more pedestrian/ cyclist friendly. These elements can be incorporated into lake restoration projects and construction of new roads near tourist areas. Dedicated hawkers' zones need to be provided, with shade for reducing risk of heatwaves during summers. An example of this can be Pondy Bazar in Chennai. Key components can include:
  - Wide pedestrian walkways with shaded seating, ramps, landscaping, lighting, bicycle sharing facilities, colorful play elements, wall art, etc.
  - Native tree plantations
  - Battery operated feeder vehicles for elderly, disabled or those in need
  - Effective parking management system that utilizes parking slots managed privately, cameras, parking app, online payment, parking personnel and data management.
  - Creating off-street parking spaces in inner streets
  - In Chennai, within the first few months of implementing this project, retailers in the area saw a 15-20% increase in sales[87].

- **Inclusivity analysis:** Poorly designed infrastructure for pedestrians and cyclists may exclude people with disabilities and the elderly. Women and children may also hesitate to use NMT systems due to fear of unsafe areas in the city or choosing to avoid roadways and busy intersections. When implementing this action, the city must consider the needs of people with disabilities, women, children, informal and low-income communities, migrants, and the elderly in designing street space and bike share programs. The city should also provide maps and real-time access to information on safe bicycle routes through the city and key public spaces, ensuring that the information is shared in Hindi as well.

- **Implementing stakeholders:** JCTSL and Jabalpur Municipal Corporation (lead), Jabalpur Smart City Limited, MP Tourism Board, RWAs, vendors

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

- **Alignment with schemes:** Projects under Jabalpur's Smart City Proposal, FAME Phase 2

- **Monitoring Indicators:** % of NMT infrastructure by the total road network length, # of electric hop-on-hop-off buses, % length of footpaths with ramps and furniture

- **Alignment with CSCAF indicators:**
  - Indicator 1: Clean technologies shared vehicles
  - Indicator 3: Percentage coverage of NMT network in the city under the mobility & air quality sector

Action 2: Install reverse vending machines and collection centers for plastic waste and wet waste compost units at major tourist areas

- **Challenges addressed at the city level:** No plastic waste collection centers in the city. Entire wet waste is sent to waste to energy plant[6].

- **Description**: The city currently has no plastic waste collection centers. JMC can consider piloting PET bottle reverse vending machines or collection centers at major tourist places like Madan mahal fort, balancing rock, Dumna, Rani Durgawati Museum, etc. PET bottle vending machines have already been implemented in many cities like Delhi[88], where users get coupons for hotels or other shops.

Compost units can also be set up in gardens, nature reserves, temples, and forts to compost wet waste into manure. The stakeholders also highlighted the need to implement and scale up Ujjain's model of converting flowers and garland waste into incense sticks in Jabalpur. Hanuman temple on Palace Road and the Sampangi Rama temple on Cunningham Road in Bangalore have installed two composting units for managing its daily waste generation and produce compost, which is then used as manure for the trees located on-site[89]. Similar models can be adopted in temples in the city.

- **Inclusivity analysis:** The waste sector provides livelihoods for informal waste pickers and recyclers who collect recyclable waste from the street, waste dumps or landfills. Their livelihoods may be at risk when waste recovery/ recycling booths are put in place. Thus, integrating informal waste pickers as paid service providers - for example to run the reverse vending machines or compost units would enable inclusion in the waste sector.
- **Implementing stakeholders:** Jabalpur Municipal Corporation (lead), Jabalpur Smart City Limited, temple associations, tourist areas, MP Tourism Board, private technology providers for reverse vending machines
- **Timeframe:** Medium term (3-5 years)
- **Alignment with schemes:** Swachh Bharat Mission Urban 2.0
- **Monitoring Indicators:** Increase in % of plastic waste recycled, # of reverse vending machines, # of tourist places with compost units
- **Alignment with CSCAF indicators:**
  - Indicator 6: Initiatives by the city to minimize waste under the waste management sector

Action 3: Provide a platform for sustainable tribal products, artifacts, and culture

- **Challenges addressed at the city level:** Since Jabalpur is in the center of an extensive tribal area, they can provide a market for tribal handicrafts, art, and culture.
- **Description**: Promoting the products and culture of Jabalpur's tribal communities is a key goal under its smart city proposal. The city can explore opportunities to integrate them into the local economy. The city can promote products like plant-based puja thalis, incense sticks from temple waste, jute bags, terracotta pots, etc. made by local artisans and tribal communities in temples and other tourist areas. The prashads (devotional offering) in temple can be distributed in boxes or small bowls or plates made of dry leaves.

  JMC can collaborate with organizations like Tribal Cooperative Marketing Development Federation (TRIFED), who inaugurated a store to showcase tribal handicrafts and handlooms in Jabalpur in 2021[90] and organize exhibitions in educational institutions, community halls, government run events, etc. JMC can also consider providing gifts like traditional handloom sarees or paintings during important government events. JMC can also provide incentives or one-time payments to support local entrepreneurs from tribal or low-income communities who have sustainable business models that enable waste recycling or circular economy.
- **Inclusivity analysis:** These communities must be more closely involved through regular consultations, particularly in local languages. Such initiatives will ensure a regular source of income for these tribal groups and ensure their preservation. It will also promote sustainable businesses.
- **Implementing stakeholders:** Jabalpur Municipal Corporation (lead), Jabalpur Smart City Limited, PWD, MP Tourism Board, MP Handicraft and Handloom Development Corporation, NGOs, Tribal Cooperative Marketing Development Federation
- **Timeframe:** Short term (1-2 years) with long term implementation
- **Alignment with schemes:** None
- **Monitoring Indicators:** # of tribal communities engaged with and promoted, # of such events conducted in a year, revenue generated through promoting tribal work, # of local businesses supported
- **Alignment with CSCAF indicators:** None

Goal 4: Sustainable & Circular Waste Management in Jabalpur

Jabalpur is the center of arms and gun carriage manufacturing, in addition to having various MSMEs in textiles, electronic industries, etc. The city has scored 5 stars in waste management under the CSCAF 2.0 and is known as a best practice city for its waste to energy system. However, there are some small gaps such as the need for plastic waste collection centers, inclusion of NGOs and lack of electronic waste authorized recyclers[6]. There is also the challenge of deterioration of natural waterbodies/ taals due to release of wastewater and dumping of solid waste[10]. Though the city has been recognized for its best waste management practices, these need to be looked at from a climate angle to further reduce carbon emissions from waste collection, transport, and management.

Identified Actions

Action 1: Innovative model for managing electronic waste in Jabalpur

- **Challenges addressed at the city level:** Jabalpur has only one e-waste collection center[6]. A 2019-20 study identified that 90% of Jabalpur's e-waste comes from Gurandi market and Raddi Chowki. The city produced 1.75 lakh kg of e-waste in 2019-20 which was entirely sent to Delhi for recycling[91].

- **Description**: Jabalpur can consider public-private partnership models, similar to the case of Jamshedpur[92]. 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 collectivity 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.
  - 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. Jabalpur can engage similar institutions.
  - 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. JMC can identify such recycling agents and can provide incentives in coordination with the state government. For example, Telangana's -waste management policy provides 25% subsidy on lease rentals for first three years of operation and reimbursement of municipal taxes for three years amongst other incentives[93].

- **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 initiative. Jabalpur Municipal Corporation 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, JMC should collect data ward wise to ensure equitable access to collection and recycling facilities across low- and high-income wards.

- **Implementing stakeholders:** Jabalpur Municipal Corporation (lead), Jabalpur Smart City Limited, informal waste pickers, private organization for waste management, educational institutions, industries, commercial establishments, RWAs

- **Timeframe:** Short term (1-2 years) but implemented over long term

- **Alignment with 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: Efficient disposal of religious waste and idol immersion to prevent contamination of Jabalpur's lakes

- **Challenges addressed at the city level:** Many lakes in Jabalpur such as hanuman taal and dev taal are adjacent to temples suffer from pollution due to immersion of idols and other temple waste[10].

- **Description**: Jabalpur should take steps to minimize pollution due to immersion of idols in lakes. These can include:
  - Artificial ponds: Many cities have created artificial ponds specifically for immersion of idols during festivals, where the idols are taken out soon after immersion. Bhubaneswar Municipal Corporation had constructed 4 such ponds for immersion during Navaratri last year and police force were employed to monitor removal of idols after dumping[94]. Kolkata Municipal Corporation, Delhi[95] and Pune[96] had also prepared such artificial ponds. Moreover, a resident in Kolkata immersed the idol in an artificial tank in his portico, where water jets were used to dissolve the idol and remnants were reused to make a new idol next year. JMC can promote such household practices through a door-to-door awareness campaign and incentives like tax rebates or monetary renumeration[97].
  - Promoting sustainable materials: JMC can take steps to regulate the use of plaster of Paris and synthetic paints in making idols and encourage idols from clay or mud. For example, in Delhi, the civic body registered idol makers and provided guidelines for use of materials and paints, in line with those from the Delhi Pollution Control Committee[95].
  - Do it at home recycling: The National Environmental Engineering and Research Institute (NEERI) in collaboration with Nagpur city police and Municipal Corporation provided ammonium bio-carbonate to citizens, which can dissolve plaster of Paris idols into ammonium sulphate and calcium carbonate, used as fertilizer and construction material. This was also implemented by Pune, which disintegrated 30,000 idols using this method[98].

- **Inclusivity analysis:** JMC can include local artisans and low-income workers to make and sell idols from clay, mud and other items, providing them jobs. They should also engage with citizens, local police, residential welfare associations, etc to ensure awareness creation and push for use of idols from eco-friendly materials

- **Implementing stakeholders:** Jabalpur Municipal Corporation (lead), Jabalpur Smart City Limited, residential/ commercial colonies, city police, municipal SW workers, temple associations, NGOs, research institutions

- **Timeframe:** Short term (1-2 years), this would require long-term monitoring

- **Alignment with schemes:** Swachh Bharat Mission Urban 2.0, Solid Waste Management Rules 2016

- **Monitoring Indicators:** % of idol makers using sustainable materials, % reduction in pollution of lakes due to immersion of idols, % increase in household access to fresh water, % increase in carbon sequestration from lakes

- **Alignment with CSCAF indicators:**
  - Indicator 6: Waste minimization initiatives undertaken by the city under the waste management sector
  - Indicator 1: Water resources management under water management sector.

Action 3: Conversion of municipal solid waste management fleet into electric vehicles

- **Challenges addressed at the city level:** No electric vehicles in municipal fleet, 32% of GHG emissions from transport in 2019.

- **Description**: The city can convert its waste collection tippers into electric vehicles through public private collaboration. This will lead to benefits including reduced emissions from waste transportation, improved air quality and reduced noise pollution, particularly in dense urban areas. This has already been adopted by a few cities in the state of Andhra Pradesh[99] and in Chennai[100] on a PPP basis. Indore Municipal Corporation (IMC)[101] has also deployed a fleet of 25 electric vehicles for waste collection, as part of the clean air initiative. The Greater Chennai Corporation has collaborated with a private company to introduce 14 electric tricycles for garbage collection under the Corporate Social Responsibility project (CSR) of State Bank of India to fund these e-tricycles[102].

  JMC can provide incentives like higher tipping fees or issue a mandate that a certain percentage of the fleet should be electric in new tenders. Other incentives to promote electric vehicles can include designated parking spots, no parking fees, road tax exemptions, scrappage incentives, etc. for electric waste pickup vehicles. JMC should also ensure adequate charging infrastructure, for example in vacant lands, transfer stations, vegetable markets, municipal offices, etc.

- **Inclusivity analysis:** Drivers of SWM fleets should be provided training on operation and maintenance of EV vehicles. New jobs for low-income groups and women can also be created through the setting up

and management of charging infrastructure through sufficient training.

- **Implementing stakeholders:** Jabalpur Municipal Corporation (lead), Jabalpur Smart City Limited, citizens' forums, RWAs, technology providers, MPUVN, MPPKVVCL, funding agencies, corporate companies

- **Timeframe:** Medium term (3-5 years), requires long term implementation and monitoring

- **Alignment with schemes:** Swachh Bharat Mission Urban 2.0, National Clean Air Action Program, FAME phase 2

- **Monitoring Indicators:** % of EV vehicles in total waste collection fleet, % of women EV vehicle drivers for waste collection, % reduction in emissions from transport sector, # of trainings conducted for drivers on EV vehicles

- **Alignment with CSCAF indicators:**
  - Indicator 1: Clean technologies shared vehicles under the mobility and air quality sector
  - Indicator 4: Level of air pollution under the mobility and air quality sector

Goal 5: Revitalize Green & Blue Spaces in Jabalpur

The city is currently in level 3 under CSCAF 2.0, with 11.74% of the total municipal area having green cover. Several of the projects under the Smart City Mission as well as the ABD plan aim to increase green and blue spaces in the city, develop inclusive open spaces for the public, and rejuvenate its water bodies such as the Khandari Lake and Omti Nalla. Jabalpur was also one of the top 10 cities to win the Nurturing Neighborhoods Challenge initiated by MOHUA. The city has a child-friendly public vaccination center, with outdoor play area and waiting space for caregivers and young children, lactation rooms, and ramps for universal accessibility[103]. Other pilots include child friendly waiting spaces in the Inter-State Bus terminal and the revamping of Shivnagar Amrut park and Vikas nagar park and with sensory trails, plantations, play spaces and shaded areas[104]. Despite good initiatives towards people friendly open spaces, the city still needs to improve its efforts in the areas of biodiversity conservation and disaster management.

Identified Actions

Action 1: Steps towards increasing the urban green cover in Jabalpur

- **Challenges addressed at the city level:** 11.74% of total municipal area under green cover as per CSCAF 2.0, which can be increased

- **Description**: The city of Jabalpur can take several steps to increase the share of green cover in the city. These include:
  - Engaging citizens and private sector in urban green cover conservation: During the consultations, representatives suggested the need to mandate biodiversity parks/ urban forests in new residential constructions and mainstream the same in development plans. Incentives like property tax rebates and fast-track procedures, funding or advertising rights for individuals and housing corporations showing initiative in urban greening can be provided. Financial systems such as a tree banking scheme can be piloted where citizens can adopt a tree and get financial aid in return similar to the model in Meenangadi[105]. The city can also introduce apps to help citizens map trees and identify the best type of trees to plant based on the conduciveness of the location, such as those developed by Kerala and Bengaluru[107].
  - Mapping green and blue spaces in the city: As per CSCAF 2.0, Jabalpur has mapped out its water bodies and open areas, but should also capture attributes like area, depth, volume and current status for water bodies and area, foliage cover, type of land, ownership of land, current status etc. for open areas. An urban heat island map should also be prepared for the city. In accordance with action 1.1, Jabalpur can organize a collective citizen-driven mapathon to map out potential areas for new urban forests, gardens, or parks. Kochi did something similar within the Cities4forest project implemented by WRI India[108].
  - Action plan for increasing Jabalpur's green cover: In order to move higher in the CSCAF2.0 levels in urban green cover and biodiversity conservation, there is a need to develop a strategy to enable planned green spaces development. MoHUA's Urban Greening Guidelines[109] (2014) can be used as a guideline for developing this action plan. This strategy can include actions such as green roofs, urban gardens, and urban forests. Cities like Agra[110] and Ujjain[111] amongst others have similar plans.
  - Participatory model with involvement of resident welfare associations: Given Jabalpur's excellent initiatives under nurturing neighbourhoods program, they can increase their engagement with residents for the maintenance and monitoring of new green and open spaces. For example, Chandigarh municipal corporation signs a contract with resident welfare associations annually where the corporation engages the RWA for the upkeep of lawns, trees, shrubs and flowers, play equipment, etc. The RWAs do not have ownership. The corporation takes up a supervisory role and fines RWAs that are not performing well[112]. A similar model can be looked into by JMC.

- **Inclusivity analysis:**
  - The mapping of water bodies and green cover must be done ward wise to develop an equity index and understand which wards have lower access to green and open spaces.
  - In the urban forests, safety and accessibility features like seating, adequate lighting, ramps etc. can be incorporated.
  - In Chandigarh, the municipality trains RWAs in management of parks and has seen a huge interest in women, thus providing them with livelihood opportunities[112]. JMC can implement something similar.

- **Implementing stakeholders:** Jabalpur Smart City Limited and Jabalpur Municipal Corporation (leads), councilors, local experts, Jabalpur Development Authority, citizens, State Forest Research Institute, Jabalpur, RWAs, NGOs working on urban greening

- **Timeframe:**
  - Short term (1-2 years) with long term engagement:
    Engaging citizens and private sector in urban green cover conservation
    Mapping green and blue spaces in the city
    Participatory model with involvement of resident welfare associations
  - Medium term (3-5 years):
    Action plan for increasing Jabalpur's green cover

- **Alignment with 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 data on urban green cover, number of urban forests, increase in percentage of urban green cover, number of incentives for green cover conservation, number of mapathons conducted, action plan for green cover developed

- **Alignment with CSCAF indicators:**
  - Indicator 2: Proportion of green cover under Urban planning, green cover, and biodiversity

Action 2: Bioremediation and riparian zones for conservation of water bodies in Jabalpur

- **Challenges addressed at the city level:** Many lakes in Jabalpur face pollution. Supatal, Balsagar and Maharaj sagar had very high total dissolved solids due to mixing of effluents[10].

- **Description**: As per the smart city priorities, the city aims to rejuvenate the Omti Nalla, Rani Taal and Khandari Lake through green infrastructure. Jabalpur can create riparian zones[113] which can act as a buffer between the water bodies and human encroachment and enable micro-climatic regulation and pollutant removal. Bioremediation is another method which involves using biological systems for reclamation of the contaminated soil/ water. It is a cost-effective method to control the odor, reduce the use of energy-consuming aerators and maintain nutrient levels in the water to help the ecosystem thrive[114]. Examples include the bioremediation of Hauz Khas Lake in Delhi[115], and the combined bio-ozolyte and bioremediation process used to treat Ooty Lake[116]. Jabalpur can conduct feasibility studies to identify areas for bioremediation. These methods will also contribute towards enhancing sustainable tourism in the surrounding areas.

- **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, particularly amongst low-income groups, is necessary to prevent contamination and waste disposal in the lakes.
  - Subsidized drinking water treatment plants (DWTPs) can also be implemented in low-income housing sections close to the lakes to increase access to water either for drinking or domestic uses.

- **Implementing stakeholders:** Jabalpur Municipal Corporation (lead), EPCO, Jabalpur Development Authority, councilors, citizens, local experts, NGOs, MPPCB, educational institutions

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

- **Alignment with schemes:** National Water Mission[117]

- **Monitoring Indicators:** % of water bodies treated, Optimal BOD, TDS, and COD levels of water, increase in aquatic life forms, increase in availability of water for consumption and domestic use

- **Alignment with CSCAF indicators:**
  - Indicator 1: Rejuvenation and conservation of water bodies and open areas within the urban planning, green cover, and biodiversity sector

Action 3: Institutionalize a tree cell to prevent illegal logging and protect heritage trees

- **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 Jabalpur 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 JMC.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 effect[118]. 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 planted[119].

- Heritage tree conservation: Mumbai and Haryana have introduced provisions to protect heritage trees. Trees over 75 years are tagged as heritage trees in Haryana[120]. 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 trees. 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 years[121]. Jabalpur can also introduce such rules to conserve heritage trees.

- **Inclusivity analysis:**
  - The tree cell should include citizen groups and scientific experts amongst others.
  - Neighborhoods with higher incomes, education levels, home ownership, and populations of majority ethnic groups may have higher proportions of tree canopy. An equity index can be created to help incorporate equity in the spatial distribution of transplantations.

- **Implementing stakeholders:** Jabalpur Municipal Corporation (lead), Jabalpur Smart City Limited, councilors, local experts, Jabalpur Development Authority, State Forest Research Institute, Jabalpur, RWAs, Educational institutions, builders' association

- **Timeframe:** Short term (1-2 years), and long-term monitoring

- **Alignment with schemes:** NA

- **Monitoring Indicators:** Formation of a tree cell, Number of stakeholders present in the tree cell, number of heritage trees, survival rate of transplantation projects, % increase in green cover in the city

- **Alignment with CSCAF indicators:**
  - Indicator 2: Proportion of green cover within the urban planning, green cover, and biodiversity sector

Action 4: Developing Local Biodiversity Strategies and Action Plan (LBSAP) for the city

- **Challenges addressed at the city level:** In terms of biodiversity, Jabalpur needs to take steps such as initiating a biodiversity committee at the city level and developing actions for biodiversity conservation which is currently minimal. The Dumna nature reserve boasts of 296 species of birds, 125 species of moths, 1300 species of butterflies and 109 varieties of trees. This along with other lungs of the city such as Madan mahal hill[17] must be conserved.

- **Description**: During consultations, stakeholders expressed the need to include a focus on wildlife management in the city, particularly within Dumna. The city can develop Local Biodiversity Strategies and Action Plan like that in Thane[122], Gangtok[123] and Kochi[124]. The LBSAP[125] is a tool, with which local governments, city departments, and the local community can work together to deliver continued action for biodiversity stewardship. The steps include:
  - Identifying relevant institutions and associated policies and programs: This step identifies the institutions that might be suited for further cooperation when designing and deploying the local biodiversity strategy and action plan (LBSAP).
  - Assessing and mapping assets, biodiversity, ecosystem functions and threats: This step can use instruments such as the City Biodiversity Index[126] and Green Infrastructure Assessments. The level 5 under the CSCAF indicator on urban biodiversity also asks cities to calculate the city biodiversity Index. The City Biodiversity Index includes 23 indicators that measure native biodiversity, ecosystem services provided by biodiversity, and governance and management of biodiversity. Indore and Bhopal have prepared their city biodiversity indexes[127] which can be referred to.
  - Formulating the LBSAP: This process generates information regarding the nature and location of measures, the methods and timeframe for implementation.
  - Implementation and management: Innovative implementation and management methods can be developed to incorporate local traditions, with a focus on livelihoods and social inclusion.
  - Monitoring, evaluation, and reporting: The LBSAP process is an ongoing endeavor that can expand over several years. In order to ensure that the original targets are achieved, a mechanism for regular monitoring and evaluation has to be put in place.

- **Inclusivity analysis:** A studio exercise can be conducted to simulate practice and incorporate multiple perspectives towards inclusive biodiversity strategies and plans[128]. The inclusion of not only experts in academia, but also professionals – from governmental and non-governmental agencies, and the local population who possess expertise and knowledge on local flora, fauna, conservation, ecosystems, and land use aspects of the case study area is also suggested. Such a studio exercise for developing LBSAPs was conducted in Bhopal, by the MP State Biodiversity Board in partnership with School of Planning and Architecture. The Bhopal studio not only achieved the target of proposing an LBSAP, but

also raised biodiversity awareness at multiple levels. Jabalpur can adopt a similar approach.

- **Implementing stakeholders:** Jabalpur Municipal Corporation (lead), MP State Biodiversity Board, Jabalpur Smart City Limited, councilors, local experts, Jabalpur Development Authority, citizens, State Forest Research Institute, Jabalpur, organizations like ICLEI

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

- **Alignment with schemes:** Biological Diversity Act 2002, Madhya Pradesh Biological Diversity Rules 2004.

- **Monitoring Indicators:** Development of biodiversity strategies and action plan, developing a city biodiversity index and improvement along the same, increase in species diversity.

- **Alignment with CSCAF indicators:**
  - Indicator 3: Urban biodiversity under the urban planning, green cover, and biodiversity sector

Action 5: Disaster management cell and plan for Jabalpur

- **Challenges addressed at the city level:** Jabalpur faces increasing risk of heat waves and urban flooding and has not developed a disaster management plan as per CSCAF 2.0

- **Description**:
  - As a first step, city should institutionalize a dedicated Disaster Management Cell/Emergency Operation Centre (EOC) within ULB as per the NDMA guidelines. This would involve setting up a communication channel between the city, district, state disaster management cells/authority, district magistrate, revenue departments and technical experts.
  - Next, Jabalpur should provide training for volunteers for disaster response and develop a task force team.
  - Next, Jabalpur should develop a ward level hazard risk, vulnerability and capacity assessment, based on last five years of disaster profiling as per NDMA guidelines covering risk assessment (disaster type, frequency, impact), vulnerability profiling (social, environmental, financial, physical), and also capacity/asset mapping (for quick response).
  - Jabalpur is also encouraged to document annual loss and damage due to disasters to enable identification of vulnerable hotspots, vulnerable communities and to quantify the impacts for more informed action.
  - This should be followed by the preparation of a disaster management plan. Vishakhapatnam and Chennai for example have prepared a comprehensive city disaster management plan for their cities[129].

- **Inclusivity analysis:** The Hazard, Risk and Vulnerability Assessment must be documented spatially as GIS maps at the ward level. This will enable Jabalpur to understand the areas that are most vulnerable to disasters. Given nearly half of the city (44.7%) lives in low-income areas and the city has several lakes, it becomes pertinent to understand the current level of risk amongst low-income groups, particularly to urban flooding. City can also ensure early warning systems in all low-lying areas, particularly informal areas and ensure it is communicated in local languages.

- **Implementing stakeholders:** Jabalpur Municipal Corporation (lead), Jabalpur Smart City Limited, Madhya Pradesh State Disaster Management Authority, councilors, local experts, Jabalpur Development Authority, citizens, State Forest Research Institute, Jabalpur, NGOs, RWAs

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

- **Alignment with schemes:** National Disaster Management Authority guidelines

- **Monitoring Indicators:** Ward level hazard, risk and vulnerability assessment, city level disaster management plan, number of volunteers trained in emergency response, % of wards with early warning systems, reduced frequency in floods and heatwaves, reduced loss, and damage from disasters

- **Alignment with CSCAF indicators:**
  - Indicator 3: Disaster resilience under the urban planning, green cover, and biodiversity sector

Goal 6: Water-wise Jabalpur

Jabalpur is bestowed with the perennial river Narmada and has 37 lakes and ponds, making it a water rich city. Total capacity of all sources of water supply is 409 MLD while demand was 221 MLD in 2016. However, many lakes have dried up or been encroached upon due to rapid urban sprawl[3]. A survey in 2014 identified that 42% of households face water scarcity in summers and 13% of households do not have access to municipal water supply out of which 24% were from slums. Nearly 30 wards needed urgent action to increase access to water supply, such as wards 70, 30, 47, 61, etc[24]. To ensure water security in the future, Jabalpur has to prepare an assessment of current and future water availability and prepare a demand management and water resources management plan. About 71% of the total area of the city has good potential for groundwater[130] retention. Thus, the actions under this goal aim to promote sustainable urban water management and enhance Jabalpur city's water security, improve flood resilience, increase equitable access to potable water, and enable better demand management and monitoring.

Identified Actions

Action 1: Conduct a water resources assessment and implement a demand management plan

- **Challenges addressed at the city level:** The city has not conducted a water resources assessment nor developed a demand management plan as per CSCAF 2.0. They are at the lowest performance level. Jabalpur faces water scarcity in summers. In 2017, despite surplus rains and even flooding in some areas of MP, Jabalpur division was the worst-affected, where water was being supplied twice a week in at least six municipal bodies[131].

- **Description**: In 2015, 42% of municipal households complained of water scarcity in summers[24]. Despite being water rich, Jabalpur has to assess its current and project water demand and availability and plan for efficient demand management through the following measures:
  - Set up a water resources management team within the water utility department in JMC, with executives from other departments including CGWB, gardens department, industries, town planning, etc.
  - The city should then prepare a water resources assessment (WRA) which would consist of an assessment of current water availability, current demand, future water availability and future demand. The WRA needs to be conducted across the entire water supply service chain and should look at water allocations for various sectors being supplied by the municipal services[132].
  - A demand management plan should be developed to reduce losses in the system, promote optimal use of water, ensure equitable distribution of water, increase recycling, and improve financial performance of the ULB.
  - The city should then develop water management strategies. AI-based water meters can be installed in residential and commercial buildings to enable remote readings. These can be installed first in municipal buildings. Standards for meter quality and design must also be established. For example, Pune Municipal Corporation in collaboration with Sensus, had planned to install 275,000 meters by 2023[133].

- **Inclusivity analysis:** The water resources assessment needs to be conducted at the ward level, to analyze the spatial distribution of water resources and identify wards with the lowest access to water. A city-wide initiative to create incentives and techniques to save and store water on a household level (e.g., water metering) should consider that low-income, informal, and migrant communities may lack household connections to the piped water and sewerage network, making them hard to reach. The implementation of demand side management interventions by Jabalpur city needs to incorporate concerns of these communities and ensure common water management solutions such as rainwater harvesting in community buildings in low-income areas, designing streets with rain gardens or water retention ponds, setting up decentralized water treatment facilities, increasing roadside plantations in low-income areas to reduce risk of water logging, etc.

- **Implementing stakeholders:** Jabalpur Municipal Corporation (lead), private agencies, MPPHED, resident welfare associations, water meter suppliers, CGWB, NGOs working in this space

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

- **Alignment with schemes:** Smart Cities Mission, Smart Meter National Programme (SMNP), Madhya Pradesh Urban Services Improvement Project, Jal Jeevan Mission

- **Monitoring Indicators:** Preparation of demand management plan, % reduction in water usage and tariffs for consumers, reduced non-revenue water (%), % of households with water supply (ward wise)

- **Alignment with CSCAF indicators:**
  - Indicator 1: Water resources management within the water management sector

Action 2: Reuse water for gardens and defense and textile related manufacturing industries

- **Challenges addressed at the city level:** No data for recycling of water as per CSCAF 2.0. City also faces acute water shortage every year in summers[131].

- **Description**:
  - Reusing water for gardens: JMC 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)[134] 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 CPCB[135]. With JMC and JSCL developing various parks and gardens especially under the nurturing neighborhoods program, this initiative would help reduce the demand for freshwater for maintaining urban greenery
  - Providing treated water to defense and textile related manufacturing units in the city: Jabalpur has a major military vehicle manufacturing hub (Vehicle Factory Jabalpur), a grey iron factory, a Gun Carriage Factory, and an Ordnance Factory Khamaria[3]. It is also seeing a huge growth as a textile manufacturing hub. These units have significant water demand. On an average, 4000 liters of water can be used in making one car, varying with relation to the size and type of vehicles manufactured[136]. One cotton shirt requires 2700 liters of water, what one person drinks in 2.5 years[137]. Jabalpur can collaborate with these industries to supply treated water at lower costs for their manufacturing needs to avoid use of freshwater. 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 (Rs.3.4 per m^3 as opposed to Rs. 10 for freshwater). This way, the city recycles 90% of its treated water[138] and reduced 47 million m^3 per year of freshwater from being extracted for industrial purposes.

- **Inclusivity analysis:** JMC should ensure adequate consultations with all stakeholders, especially the military related factories, gardens department, NGOs, textile MSMEs etc. on the importance of recycling water and optimal usage.

- **Implementing stakeholders:** Jabalpur Municipal Corporation (lead), Jabalpur Development Authority, JSCL, Ordnance Factory Board, gardens department, NGOs, textile manufacturing MSMEs

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

- **Alignment with schemes:** AMRUT- Water supply thrust area, National Water Mission

- **Monitoring Indicators:** % of industries and textile units using treated water, % increase in freshwater availability for the city, % increase in households with access to drinking water (disaggregated by income and wards), revenue generation for JMC from sale of treated water, decrease in water utility costs for manufacturing units

- **Alignment with CSCAF indicators:**
  - Indicator 1: Water resources management
  - Indicator 3: wastewater recycle and reuse under the water management sector

Action 3: Inter-link of water bodies, wherever feasible, within city limits

- **Challenges addressed at the city level:** Depletion of lakes due to encroachment, reduced water availability and access[4].

- **Description**: Interlinking of water bodies can be done with the help of natural drainage channels or designed green infrastructure such as bioswales. These water bodies may act as potential sites for groundwater collection and recharge, while the green infrastructure can facilitate storm water management. Avenues may be identified to feed this water to the main supply line for non-potable uses. In some places this water could also be used to feed the rejuvenation of Omti Nallah. Some examples of similar approaches include Udaipur, where lakes were earlier interlinked through rainwater conservation and management and connected through catchment areas. In Ahmedabad, the lakes were connected through an underground laid piped network to increase the catchment of stormwater and decrease water logging in urban areas. Neighborhoods reported facing less issue of flooding after this project in 2004. A multicriteria support tool was developed and piloted for interlinking of lakes in Ahmedabad to ensure coordination amongst social, economic, and environmental variables. Such a tool can be explored for Jabalpur[139].

- **Inclusivity analysis:** The intervention needs to give due consideration to the communities living around these water bodies and along the route if interlinking is taken up. This must be accompanied by increasing the awareness amongst communities on the need to conserve and protect the water bodies and on optimized water usage.

- **Implementing stakeholders:** Jabalpur Municipal Corporation (lead), Jabalpur Development Authority, JSCL, councilors, citizens, local experts, NGOs

- **Timeframe:** Long term (>5 years)

- **Alignment with schemes:** AMRUT- Water supply thrust area, National Water Mission

- **Monitoring Indicators:** Number of water bodies interlinked, reduction in groundwater extraction, catchment area (in ha) restored, increase in % of households with drinking water

- **Alignment with CSCAF indicators:**
  - Indicator 1: Water resources management under the water management sector

Action 4: Develop and implement an integrated flood and storm water management plan

- **Challenges addressed at the city level:** Jabalpur faces the threat of increasing urban flooding and has not prepared a flood management plan 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 plan[140] 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 and improve ground water table.

  The flood management plan for Jabalpur needs to be based on a basin-level study. Due to the city's location in the Narmada basin, the catchment area consists of many drains. Hence, the water bodies in Jabalpur would play a more significant role in flood management compared to other cities. Any developments in low-lying areas should follow flood inundation levels/ High Flood Level as per the hydrological / hydraulic studies for the area. The preparation of such plans should take into consideration climate change effects. Nallas (drains) and water bodies should be de-silted regularly to discharge flood waters to their full capacity without overflowing. The city's urban infrastructure such as bridges (road or rail under bridges) need to be revamped, retrofitted, or redesigned considering flood discharges under climate change scenarios. The city can also incorporate sustainable urban drainage systems[141], often regarded as a sequence of management practices, control structures and strategies designed to drain surface water efficiently and sustainably, while minimizing pollution and managing the impact on water quality of local water bodies. Examples include permeable paving on driveways and footpaths, garden beds designed for infiltration (raingardens), lawns and vegetation, bioswales, soak wells, etc. Jabalpur can include them within the proposed street design guidelines as well for new road developments.

- **Inclusivity analysis:** Low-income communities, informal residents and workers, and migrants are highly impacted due to climate change induced urban flooding. Jabalpur needs to regularly collect census data on informal, migrant, and low-income communities to capture the magnitude of risk for these communities. They typically lack basic infrastructure that mitigates flooding. Green infrastructure on public property may also raise nearby real estate prices that outprice low-income residents and unintentionally usher in "green gentrification". While implementing this action, the city must conduct participatory stakeholder meetings in partnership with the low-income communities, city planners, chief engineers, and local NGOs to understand how this action will impact different parts of the urban population, and particularly those most in need.

- **Implementing stakeholders:** Jabalpur Municipal Corporation (lead), JSCL, Jabalpur Development Authority, resident welfare associations and communities, Water Resources Department, MP, NGOs

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

- **Alignment with schemes:** AMRUT – Getting funding under thrust areas like sewerage facilities and septage management and storm water drainage management, conservation of urban water bodies

- **Monitoring Indicators:** Reduced flooding frequencies, reduced water stagnation, improved vegetation and groundwater table, reduced infiltration of untreated sewage into water bodies, % reduction in flood related economic damages

- **Alignment with CSCAF indicators:**
  - Indicator 4: Flood/ water stagnation risk management within the water management sector. In accordance with level 5 under the climate action plan indicator, water sensitive urban design[142] considerations can also be incorporated in the city's master plan.

Action 5: Implementing energy-efficient water supply and wastewater management systems

- **Challenges addressed at the city level:** Jabalpur has not done an energy audit of its water supply or wastewater systems per CSCAF 2.0

- **Description**: As per CSCAF indicators, the city must first conduct an energy audit for its water supply and wastewater pumping stations and treatment plants. The steps are:
  - Collect and analyze historical energy usage.
  - Study pumping systems and their operational characteristics.
  - Identify potential modification that will reduce energy usage and cost.
  - Perform an engineering and economic analysis of potential modifications.
  - Prepare a rank-ordered list of appropriate modifications. As a next step they can also expand their solar sewage treatment plants, similar to the ones already implemented[15].

- **Inclusivity analysis:** JMC can train workers from low-income communities on how to conduct and monitor energy audits, install, and maintain solar panels on STPs and energy efficient meters.

- **Implementing stakeholders:** Jabalpur Municipal Corporation (lead), JSCL, Jabalpur Development Authority, resident welfare associations and communities, Water Resources Department, MP

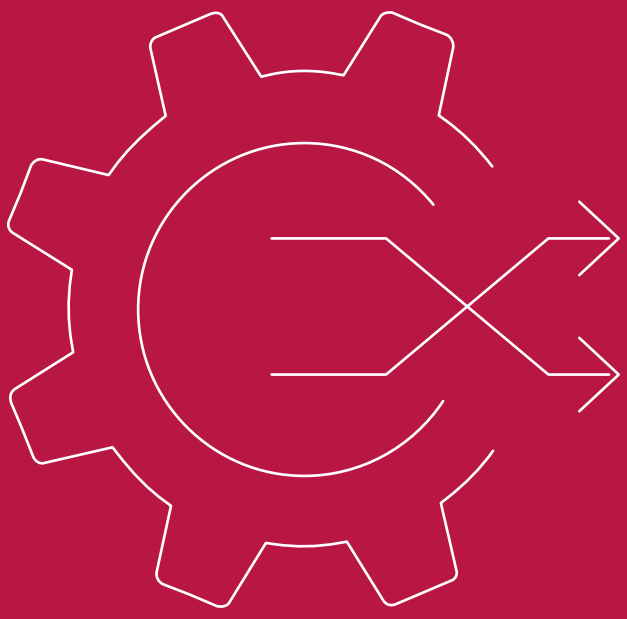
- **Timeframe:** Medium term (3-5 years)

- **Alignment with schemes:** MP Renewable Energy policy 2022

- **Monitoring Indicators:** Energy audit conducted, reduced energy costs for sewage treatment and water supply

- **Alignment with CSCAF indicators:**
  - Indicator 6: (energy-efficient wastewater management system) within Water Management.
  - Indicator 2: Total electricity from renewables under Energy and green buildings

IMPLEMENTATION AND GOVERNANCE OF JABALPUR CLIMATE ACTION PLAN



Creation of Jabalpur Climate Change Cell

Jabalpur Municipal Corporation is responsible for infrastructure development and citizen service. On the other hand, Jabalpur 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 and incorporate them in 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 Jabalpur Climate Change Cell

- **Description:** To align with the State Action Plan on Climate Change and implement the Jabalpur City Climate Action Plan, there needs to be a dedicated climate cell with representatives or nodal officers from line departments concerned. Many cities including Coimbatore, Mumbai and Aurangabad have developed such a cell which is tasked with the implementation and monitoring of the plans. The cells report to the Department of Environment & Climate Change every year to track the progress and request support for further implementation 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. Potential roles of the climate cell include:
  - 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 thinking 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 city GHG inventory for monitoring the GHG emissions and respective causes and challenges
- **Tentative staffing and stakeholders:**
  - Municipal Commissioner, Jabalpur 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, Jabalpur Smart City, or nominated official (Member Secretary)
- **Implementation time:** Short term (1-2 years).

Creating a Jabalpur 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 infrastructure[143] 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 allocation 2021-22[144], the state has allocated INR 112 crore 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 during the green transition. INR 2,581 crore allocated to Atal Grah Jyoti Yojana also aligns with some of the actions proposed in the plan. INR 5,762 crore has 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 the city creates a City Climate Budget for implementation of 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) adopted a budget called 'Climate Change Budget Scheme[148] which earmarks funds for specific climate change programs. Odisha has a climate budget framework[149] institutionalized for its cities. Chhattisgarh, Assam and Maharashtra track the climate change relevance of their developmental projects through budget coding[150]. 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[145]	Overall Average CSCAF Scores of MP's SMART Cities[146]	SDG Progress[147] (Benchmark Score 66)	Status of Climate Finance/ Climate Budget	Scope of Urbanization and Climate Vulnerability
Madhya Pradesh	Medium 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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