



ADVANCING CITY CLIMATE ACTION IN MADHYA PRADESH

Transforming **SATNA** into a low-carbon and climate-resilient city



Satna City Climate Action Plan

© State Knowledge Management Centre on Climate Change (SKMCCC), EPCO,
Department of Environment, Government of Madhya Pradesh, 2023

DISCLAIMER

This document is prepared by WRI India in partnership with Environmental Planning & Coordination Organisation (EPCO), Department of Environment, Government of Madhya Pradesh to support Satna city in developing its Climate Action Plan. The data and information used for preparing this report have been sourced from Satna 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: Satna Smart City Development Corporation Ltd.



**GULSHAN BAMRA (IAS)
PRINCIPAL SECRETARY**



Department of Environment
Government of Madhya Pradesh
Mantralaya, Vallabh Bhawan, Bhopal

Preface

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

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

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

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

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

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

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



(Gulshan Bamra)



Foreword

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

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

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

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

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

(Mujeebur Rehman Khan)



Acknowledgements

Environmental Planning and Coordination Organization (EPCO) is grateful to Mr Gulshan Bamra, Principal Secretary, Government of Madhya Pradesh, Environment Department; Mr Mujeebur Rehman Khan, Executive Director EPCO; and other team members from EPCO for their continuous support and guidance at various stages of developing the inclusive-climate action plan for Satna 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, Satna Municipal Corporation and Chief Executive Officer of Satna Smart City Development Corporation Limited for constant support in providing valuable city level inputs and facilitating data collection across all departments and parastatal agencies. We would also like to thank all officers and city experts from concerning line departments and external agencies who contributed to the development and refinement of this plan through timely provision of data and valuable insights during stakeholder consultations.

EPCO would like to thank World Resources Institute (WRI) India, especially Mr. Madhav Pai, CEO, Dr. OP Agarwal, Senior Advisor and Former CEO, Ms. Ulka Kelkar, Director Climate Program for providing technical support to EPCO and Satna 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 Baipai, Mr. Prateek Barapatre, Ms. Ramya MA, Ms. Faiza Solanki and Ms. Avni Agarwal 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 **SATNA** into
a low-carbon and climate-
resilient city



Table of Contents

List of Figures & Tables	II	Sectoral Priorities	29
Abbreviations	III	• Sectoral Assessment	30
Executive Summary	1	• Sectoral Goals	32
• Satna and its Vulnerability to Climate Change	2	• Mainstreaming Inclusivity in the Satna Climate Action Plan	33
• Climate Action Planning Process	2	Sectoral Climate Actions	35
• Baseline Assessment	3	• Goal 1: Satna's Transition to a Clean Energy Economy & Climate Resilient Infrastructure	36
• Goals and Sectoral Strategies	6	• Goal 2: Low-Carbon Transport in Satna	41
Introduction	9	• Goal 3: Water-Resilient Satna	48
• Vision of Satna Climate Action Plan	10	• Goal 4: Satna as the Sustainable Cement Capital	52
• Climate Action Plan Development Process	11	• Goal 5: Rejuvenate Green & Blue Spaces in Satna	55
City Profile	13	• Goal 6: Towards a Climate-Smart & Circular Waste Economy in Satna	58
• Demography	15	Implementation & Governance of Satna	
• Climate Profile	16	Climate Action Plan	61
• Socio-Economic Profile of Satna	18	• Creation of Satna Climate Change Cell	62
Baseline Assessment	20	• Creating a Satna City-level Climate Budget in Municipal Finance	63
• CSCAF 2.0 Analysis	21		
• Greenhouse Gas Emissions Profile	22		
• Critical Emissions Sources	22		
• Energy Sector Emissions	24		
• Transportation Sector Emissions	26		
• Waste Sector Emissions	26		
• Vulnerability Assessment	27		

List of Figures & Tables

| Figures

ES Figure 1: CAP development process	3
ES Figure 2: GHG Emissions Profile for Satna	5
ES Figure 3: Projected emissions for Satna	6
Figure 1: Vision for Satna	10
Figure 2: CAP development process	11
Figure 3: Map of Satna	14
Figure 4: Population growth in Satna from 1981-2020 ..	15
Figure 5: Trend of projected maximum temperature for Satna district.....	16
Figure 6: Trend of projected minimum temperature for Satna District	17
Figure 7: Trend of projected daily rainfall	18
Figure 8: City typology	18
Figure 9: 2030 transition of Satna city	19
Figure 10: GHG emissions profile of Satna	23
Figure 11: Emissions contribution by sector	23
Figure 12: Projected emissions for Satna.....	24
Figure 13: Satna percentage electricity consumption by sub-sectors	24
Figure 14: Liquefied petroleum gas (LPG) consumption ..	25
Figure 15: Stationary energy emissions by sub-sector...	25
Figure 16: Split up of emissions from stationary energy sector for Satna.....	25
Figure 17: Municipal solid waste composition in Satna in tonnes per day.....	26
Figure 18: Percentage distribution of waste sector emissions in Satna	26
Figure 19: Sectoral vulnerability profiles for Satna	27
Figure 20: Modal split for transport in Satna	31
Figure 21: Sectoral goals for Satna	33
Figure 22: Inclusive climate action planning	34

| Tables

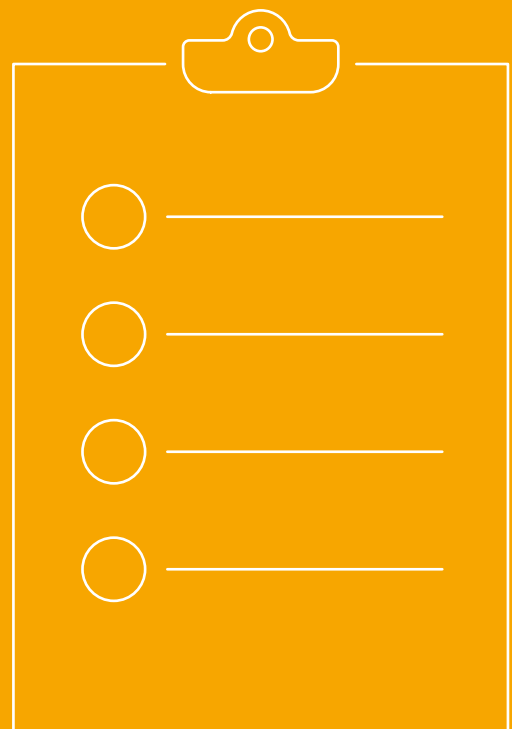
ES Table 1: CSCAF analysis	4
ES Table 2: Summary of goals and actions for Satna ...	6
Table 1: City statistics	15
Table 2: CSCAF analysis for Satna	18
Table 3: Fuel consumption in Satna.....	30
Table 4: State vulnerability score and financial expenditures	63

Abbreviations

ABD	Area Based Development	EPR	Extended Producer Responsibility
ADB	Asian Development Bank	EV	Electric Vehicle
AFR	Alternative Fuel and Raw material	FAME	Faster Adoption and Manufacturing of (Hybrid) and Electric Vehicles
AMRUT	Atal Mission for Rejuvenation and Urban Transformation	FSI	Financial Sector Incentive
AJAY	Atal Jyoti Yojana	GHG	Greenhouse Gas
AR5	Assessment Report 5	GI	Green Infrastructure
BAT	Best Available Technology	GIDC	Gujarat Industrial Development Corporation
BRTS	Bus Rapid Transit System	GoMP	Government of Madhya Pradesh
BL	Baseline	HFAPoA	Housing for All Plan of Action
BOD	Biological Oxygen Demand	HFL	High Flood Level
C&D	Construction and Demolition	ICT	Information and Communications Technology
CAAQMS	Continuous Ambient Air Quality Monitoring System	IEC	Information, Education and Communication
CCAM	Conformal Cubic Atmospheric Model	IGBC	Indian Green Building Council
CGWB	Central Ground Water Board	IoT	Internet of Things
CH₄	Methane	IPCC	Intergovernmental Panel on Climate Change
CNG	Compressed Natural Gas	IPT	Intermediate Public Transport
CO₂	Carbon Dioxide	IT	Information Technology
COD	Chemical Oxygen Demand	ITS	Intelligent Transport Service
CORDEX	Coordinated Regional Climate Downscaling Experiment	JV	Joint-Venture
CPWD	Central Public Works Department	kWh	Kilo Watt Hour
CPCB	Central Pollution Control Board	kL	Kilo Litre
CSCAF	Climate Smart Cities Assessment Framework	LBSAP	Local Biodiversity Strategies and Action Plans
CSIRO	Commonwealth Scientific and Industrial Research Organisation	LCB	Low Carbon Buildings
CSO	Civil Society Organization	LED	Light Emitting Diode
CPHEEO	Central Public Health and Environmental Engineering Organisation	LEED	Leadership in Energy and Environmental Design
DEP	District Environmental Plan	LPCD	Liters Per Capita per Day
DEWATS	Decentralized Waste-Water Treatment System	LPG	Liquefied Petroleum Gas
DISCOM	Electricity Distribution Companies	MC	Mid-Century
EC	End- Century	MCD	Municipal Corporation of Delhi
ECBC	Energy Conservation Building Code	MJ	Mega-Joule
EESL	Energy Efficiency Services Limited	MLD	Million Liters per Day
EPCO	Environmental Planning and Coordination Organization	MNRE	Ministry of New and Renewable Energy
ESCO	Energy Service Company	MoHUA	Ministry of Housing & Urban Affairs
ESG	Environmental Social and Governance	MPPKVVCL	MP Poorva Kshetra Vidyut Vitaran Company Limited
ENS	Eco-Niwas Samhita	MSMEs	Medium and Small-Scale Industries

MTPA	Million Tonnes per Annum	SCTSL	Satna City Transport Services Limited
MP	Madhya Pradesh	SHG	Self Help Group
MPI	Max-Planck Institut für Meteorologie	SLB	Service Level Benchmark
MPPCB	Madhya Pradesh Pollution Control Board	SMC	Satna Municipal Corporation
MPPHED	Madhya Pradesh Public Health Engineering Department	SMNP	Satna Smart City Development Limited
MPPWD	Madhya Pradesh Public Works Department	SSCDL	Smart Meter National Programme
MPUVN	Madhya Pradesh Urja Vikas Nigam	SPA	School of Planning and Architecture
MPWRD	Madhya Pradesh Water Resources Department	STP	Sewage Treatment Plant
MRV	Monitoring Reporting and Verification	SWH	Solar Water Heater
MSW	Municipal Solid Waste	SWM	Solid Waste Management
MSME	Micro, Small and Medium Enterprises	T&D	Transmission and Distribution
Mt	Metric Tonnes	TOD	Transit Oriented Development
mt	Million Tonnes	TPD	Tonnes Per Day
NAAQS	National Ambient Air Quality Standards	ULB	Urban Local Bodies
N₂O	Nitrous Oxide	UDD	Urban Development Department
NDC	Nationally Determined Contribution	UNESCO	United Nations Educational, Scientific and Cultural Organization
NDMA	National Disaster Management Authority	UNFCCC	United Nations Framework Convention on Climate Change
NGT	National Green Tribunal	W2E	Waste to Energy
NMT	Non-Motorized Transport	WRA	Water Resources Assessment
NMV	Non-Motorized Vehicle	WTP	Water Treatment Plant
NUTP	National Urban Transport Policy	WBTC	West Bengal Transport Corporation
NRW	Non-Revenue Water	ZCB	Zero Carbon Buildings
OMCs	Public sector Oil Marketing Companies		
PMAY	Pradhan Mantri Awas Yojana		
PSP	Private Sector Participation		
PNG	Piped Natural Gas		
PPP	Public Private Partnership		
PT	Public Transport		
PULSE	Providing Uber Living and Sustainable Economy		
PWD	Public Works Department		
RCA4	Rosby Centre Regional Atmospheric Model		
RCM	Regional Climate Model		
RCP	Representative Concentration Pathways		
RDF	Refuse Derived Fuel		
REMO	Regional Model		
RWH	Rainwater Harvesting		
RWA	Resident Welfare Association		
RFID	Radio Frequency Identification		
RTS	Roof Top Solar		
SAPCC	State Action Plan on Climate Change		
SBTi	Science- Based Targets Initiative		
SCP	Smart City Proposal		
SCADA	Supervision, Control and Data Acquisition		

EXECUTIVE SUMMARY



Satna and its Vulnerability to Climate Change

Satna, “the cement capital of India”, lies in the Baghelkhand region of the Vindhya Mountain ranges, in the state of Madhya Pradesh. It was selected as a smart city in 2017, among the hundred cities to be developed as a smart city under the Smart Cities Mission. Satna has also been recognized as an open defecation free (ODF) city under the Swachh Bharat Mission Urban¹. As a rich reservoir of chemical grade limestone, the city is also known as the “commercial and industrial capital of Baghelkhand”² and contributes to 9% of India’s cement production.

Satna is likely to witness extreme warm days with high incidences of heat waves leading to human and animal stress, negative impacts on labor productivity and high stress on resources like energy and water. According to the climate change vulnerability assessment of Madhya Pradesh carried out by Environmental Planning and Coordination Organization (EPCO), Satna has a high composite vulnerability, determined by social indicators, economic indicators, water indicators, agriculture indicators and forest indicators, which indicates that Satna is likely to face higher impacts of climate change for different sectors. In terms of water resources, Satna faces high vulnerability, showing a high risk of decreasing availability of water, increasing crop water stresses and increase in frequency of extreme events such as floods and droughts. In terms of climate, the city goes from being highly vulnerable in baseline scenario to very highly vulnerable in mid-century projections, with a very high risk of decrease in average annual rainfall, increase in precipitation intensity and rise in heat index.

Given the challenges that Satna 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 the smart cities in India. 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 resources 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, Environmental Planning and Coordination Organization, and the Madhya Pradesh State Government Departments of Environment and Urban Development and Housing, as a technical partner, in planning adaptation and mitigation strategies and developing a city-level Climate Action Plan (CAP) for the seven smart cities in MP. These climate action plans are based on the GHG emissions profile and vulnerability assessment of cities. They identify existing gaps through a review of data submitted by cities under CSCAF 2.0 to identify key entry points in terms of recommendations to achieve the sectoral priorities of cities through a low-carbon and climate-resilient pathway. The CAP identifies action points based on the current sectoral gaps to address future climate risks across five thematic areas. It also proposes an institutional framework that is necessary to implement the recommendations outlined in the CAP.

Climate Action Planning Process

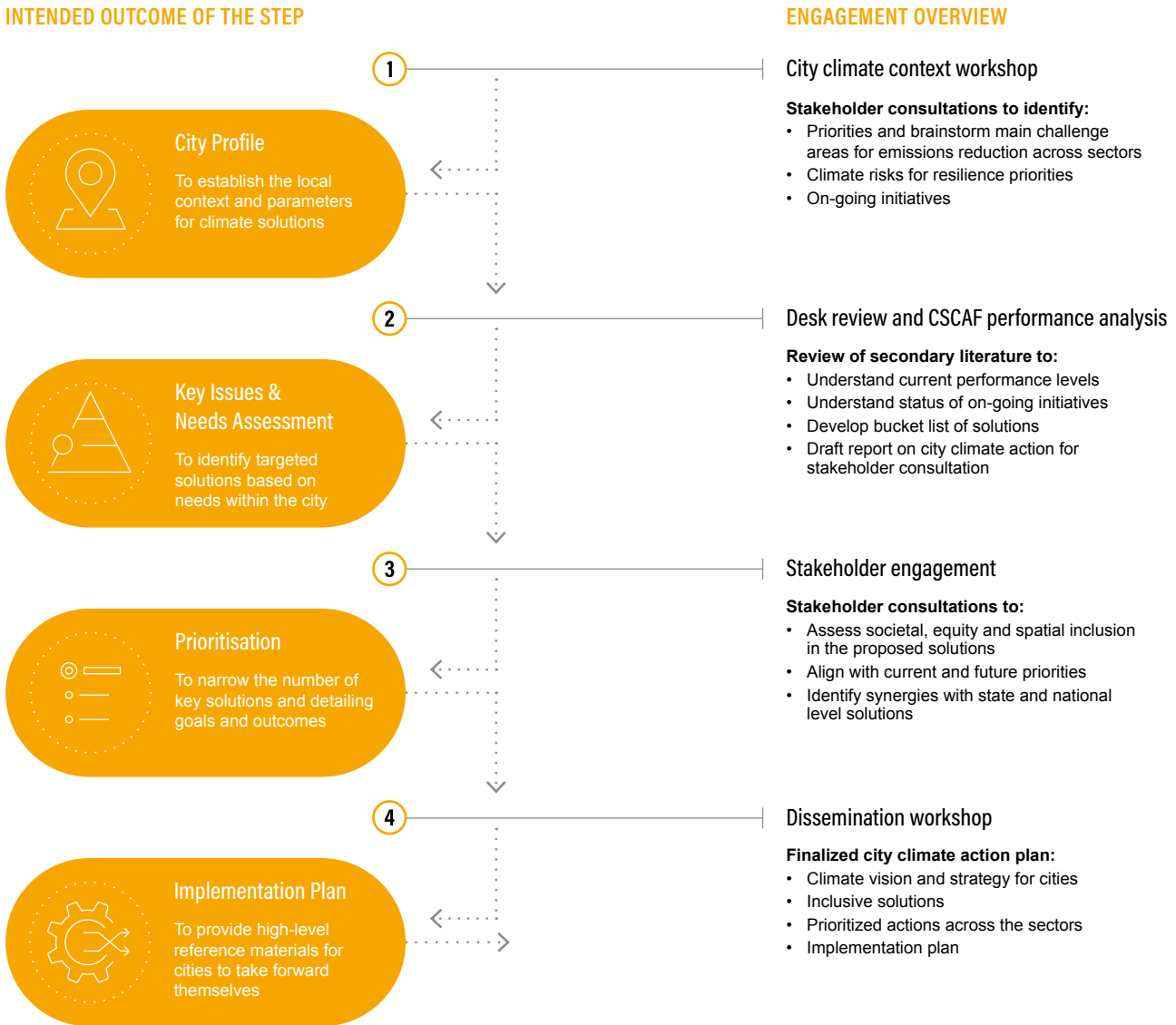
WRI India adopted a 4-pronged approach in the entire process of preparing the Climate Action Plan (CAP) as illustrated in the figure below.

- A planning-cum-launch workshop was organized in Bhopal on 20 February 2020, with participation from state and city officials, academicians, and civil society organizations. The idea of the workshop was to apprise the participants and cities about the importance and relevance of developing these city-level plans as well as understand the ongoing initiatives in order to establish a local context for climate solutions.
- This was followed by an extensive desk review of the smart city proposal to identify the vision and key sectoral priorities envisaged by Satna city. A thorough review of submissions made by Satna as part of CSCAF 2.0, sectoral plans and government reports and other documents was done to identify key issues and gaps in achieving the sectoral priorities. A detailed climate profile of Satna city has been developed including temperature and rainfall projections and a GHG inventory. This review and analysis helped in drawing up a list of sectoral goals and actions which are outlined in the climate action plan.
- As the next step, a stakeholder consultation workshop was organized to present the preliminary findings and seek inputs on the goals and actions proposed for a low-carbon and climate-resilient development pathway for Satna.

- 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 analysis)



Baseline Assessment

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

Climate Smart Cities Assessment

Satna has been a moderate performer in the first two rounds under CSCAF 2.0. The city has fared well under the waste management sector. However, the city has performed below average for indicators under other sectors. Some of the current initiatives and possible areas of improvement have been highlighted in the table below.

Greenhouse Gas Emissions Inventory

In 2019, Satna’s GHG emissions were 6,57,688 tCO₂e with per capita emissions of 2.0 tCO₂e (including emissions from manufacturing and industrial electricity consumption). Of the total emissions attributed to the three sectors, stationary energy accounts for 67%, transport for 23% and waste accounts for 10% as presented in ES Figure 2.

Under stationary energy sector, majority of the emissions come from electricity and fuel consumption use in manufacturing industries and construction (49%) followed by residential buildings (34%) and commercial and institutional buildings (17%).

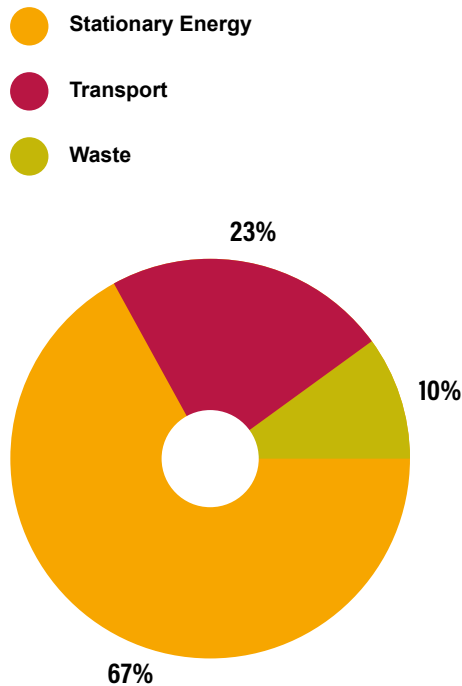
ES Table 1: CSCAF analysis (Source: CSCAF 2.0 data from the city)

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	175	90	124	50	475
Current measures being undertaken in the city	<ul style="list-style-type: none"> Satna has 100% energy efficient LED streetlights. 	<ul style="list-style-type: none"> Ankur program - which rewards citizens for free plantation - has been launched in the state and PMAY has been linked to it. 1.39 % of the municipal area has green cover. Implementing a “Save the seeds” campaign to increase greenery and citizen awareness³. The city has a disaster management plan and a disaster management cell. 	<ul style="list-style-type: none"> City has 130 e-rickshaws which constitute 1.69% of total shared vehicles in the city.. 0.03 buses are available per 1,000 population. Satna is monitoring air pollution and publishing daily air quality index levels on the public domain. Completed development of a 5.5 km cycle track in Rewa Road and Nagaud Panna Marg⁴. 	<ul style="list-style-type: none"> <5% of wastewater is recycled. The city has conducted an energy audit for water supply system. The city is also undertaking a project for intelligent water management with SCADA data⁵. 	<ul style="list-style-type: none"> 100% door to door collection of solid waste and segregation of waste at source⁶. The city has a Cluster based Integrated Solid Waste Management (ISWM) facility operated by Satna MSW Energy Solutions Ltd (Ramky)⁶ where windrow composting is done.
Areas of improvement	<ul style="list-style-type: none"> Increasing power generation from RE sources in the city. Satna currently does not generate power from renewable sources. Promoting rooftop solar in residential, commercial and government buildings. 	<ul style="list-style-type: none"> Increasing green cover within the municipal limits (1.39% currently). Needs to set up a biodiversity committee and identify measures to increase urban biodiversity and allocate resources. 	<ul style="list-style-type: none"> Non-Motorized Transport (NMT) supported by Non-Motorized Vehicle (NMV)-oriented design of roads and intersections. Increasing the coverage of roads with cycle lanes and footpaths (currently 0.75% of roads are covered). 	<ul style="list-style-type: none"> Increased recycling and reuse of the wastewater Introducing metering policy and installation of smart water meters. City needs to conduct a flood and water stagnation risk assessment. 	<ul style="list-style-type: none"> Awareness is required for better response of residents along segregation at source⁶. Authorization of waste pickers is to be completed⁶. Setting up a bio methanation plant for managing the wet waste⁶.

Overall Score as per CSCAF 2.0	Energy and Green Buildings	Urban Planning, Green Cover and Biodiversity	Mobility and Air Quality	Water Management	Waste Management
	<ul style="list-style-type: none"> Increasing the green building adoption and compliance of NBC/ ECBC codes in the city. The city does not have a green building cell and has not implemented any measures to promote green buildings 	<ul style="list-style-type: none"> Increasing green cover within the municipal limits (1.39% currently). Needs to set up a biodiversity committee and identify measures to increase urban biodiversity and allocate resources. 	<ul style="list-style-type: none"> Augmenting the public transport fleet. Increasing the share of clean fuels run vehicles especially buses and taxis. 	<ul style="list-style-type: none"> City needs to conduct a water resources assessment to assess status of existing water resources, its uses, along with projected future demand and availability. City should then develop a water resources management plan with short-, medium- and long-term actions. City needs to conduct an energy audit of its wastewater treatment system. 	<ul style="list-style-type: none"> Strengthening the Extended Producer Responsibility (EPR) of producers⁵. Implementing measures for re-use of construction and demolition waste in building and road construction⁶. Reducing greenhouse gas emissions from waste transport by shifting to alternate fuels.

The business-as-usual projected emissions for Satna are presented in ES Figure 3. The emissions are projected to increase by 10.1% by 2025 and 17.7% 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.

ES Figure 2: GHG Emissions Profile for Satna
(Source: WRI India analysis using primary data)



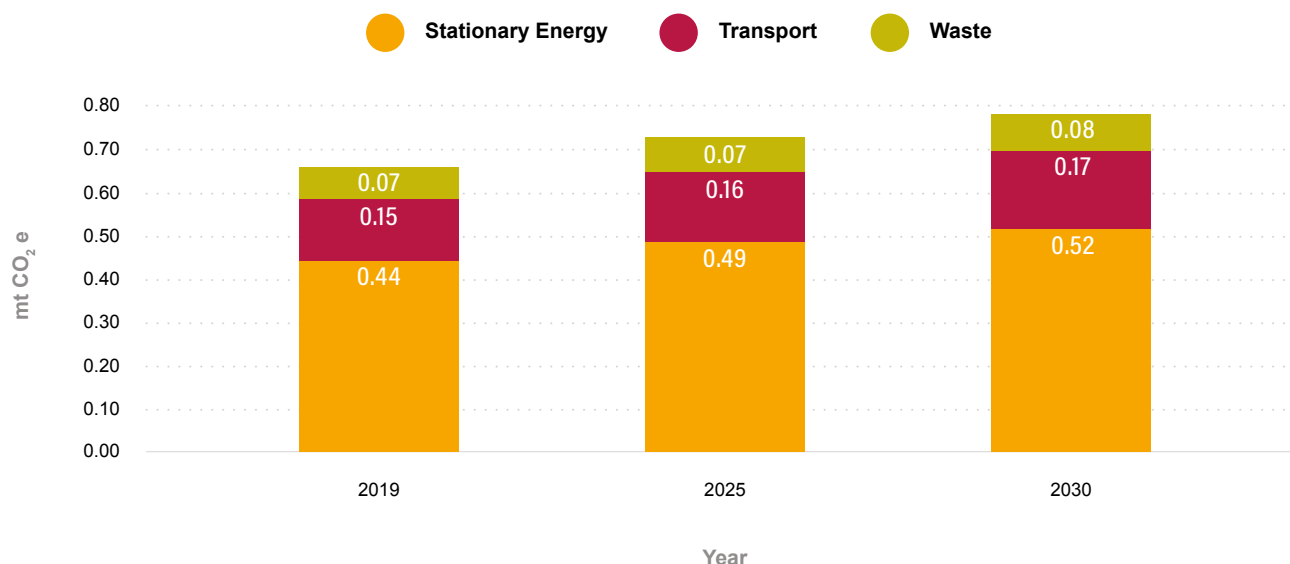
Vulnerability Assessment

The climate projections for Satna show that the annual maximum temperature is likely to increase by 2.1°C in moderate emissions scenario and by 4.4°C in high emissions scenario towards the end of the century. Similarly, annual minimum temperature is likely to increase by 2.5°C in moderate emissions scenario and by 5.2°C in high emissions scenario towards the end of the century. In a moderate emissions scenario, mean annual rainfall is projected to decrease by about 9% by mid-century.

According to the vulnerability assessment analysis done by EPCO, Satna is under high composite vulnerability, which indicates that the city is likely to face higher impacts of climate change in different sectors. In terms of water resources, Satna faces high vulnerability, showing a high risk of decrease in availability of water, increase in crop

water stresses and increase in frequency of extreme events like floods and droughts. In terms of climate, the city goes from high vulnerability in baseline scenario to very high vulnerability in mid-century projections, with a very high risk of decrease in average annual rainfall, increase in intensity of precipitation and rise in heat index.

ES Figure 3: Projected emissions for Satna (Source: WRI India analysis using primary data)



Goals and Sectoral Strategies

The table below summarizes the goals and actions which the city may adopt to develop into a low-carbon and

climate-resilient city while also addressing concerns of inequality and inclusivity in development.

ES Table 2: Summary of goals and actions for Satna (Source: WRI India)

Goals	Actions	Outcomes
Goal 1 Satna's transition to a clean energy economy & climate resilient infrastructure	<ul style="list-style-type: none"> Incentivize installation of rooftop solar panels and solar water heaters in all new residential constructions Piloting zero-carbon building components in upcoming municipal development projects Piloting solar-powered streetlighting in the city 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. Piloting solar bus stops Upgrading to solar-powered sewage treatment plants 	<ul style="list-style-type: none"> Long term reduced overall electricity consumption and costs. Improved air quality Increased job opportunities 100% RE-powered public educational campuses PPP engagement for efficient RE distribution Reduction in emissions from the consumption of grid supplied electricity. Improved access to clean energy for low-income households and affordable housing units Improved health benefits Better market for RE technologies

Goals	Actions	Outcomes
Goal 2 Low-carbon transport in Satna	<ul style="list-style-type: none"> Conduct a water resources assessment and implement a demand management plan Capacity building for smart water governance Implementing an integrated flood and storm water management plan incorporating nature-based solutions Initiatives to promote wastewater recycle and reuse in Satna 	<ul style="list-style-type: none"> 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 usage of recycled and treated wastewater, reduction in demand for fresh water – lesser stress on existing water sources Increase in groundwater table
Goal 3 Water-resilient Satna	<ul style="list-style-type: none"> Conduct a water resources assessment and implement a demand management plan Capacity building for smart water governance Implementing an integrated flood and storm water management plan incorporating nature-based solutions Initiatives to promote wastewater recycle and reuse in Satna 	<ul style="list-style-type: none"> 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 usage of recycled and treated wastewater, reduction in demand for fresh water – lesser stress on existing water sources Increase in groundwater table
Goal 4 Satna as the sustainable cement capital	<ul style="list-style-type: none"> Develop a low-carbon roadmap for Satna’s cement industries. Business models to use alternative fuels and raw materials (AFR) in cement production. Promoting use of fly ash in all new constructions, cement roads and flyover embankments 	<ul style="list-style-type: none"> Economic growth and job creation Reduction in emissions from cement industry – especially due to electricity usage Decoupling growth from cement sector emissions Improved air quality
Goal 5 Rejuvenate green & blue spaces in Satna	<ul style="list-style-type: none"> Engaging citizens in the conservation and management of the green and blue spaces in the city Developing local biodiversity strategies and action plans for Satna (LBSAP) Implementing green walls and terrace gardens 	<ul style="list-style-type: none"> Improved air quality and climate resilience due to green cover in the city Will help the city achieve higher progress under water management and urban green cover indicators within the CSCAF Foster citizen engagement in management of green and blue spaces in the city
Goal 6 Towards a climate-smart & circular waste economy in Satna	<ul style="list-style-type: none"> Increasing collection of e-waste in the city by including the marginalized/ informal sector Upgrading waste collection and transportation infrastructure to electric vehicles Planning for efficient recycling of construction and demolition waste 	<ul style="list-style-type: none"> Economic growth and job creation Reduction in emissions from cement industry – especially due to electricity usage Decoupling growth from cement sector emissions Improved air quality

The city’s 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.



INTRODUCTION



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

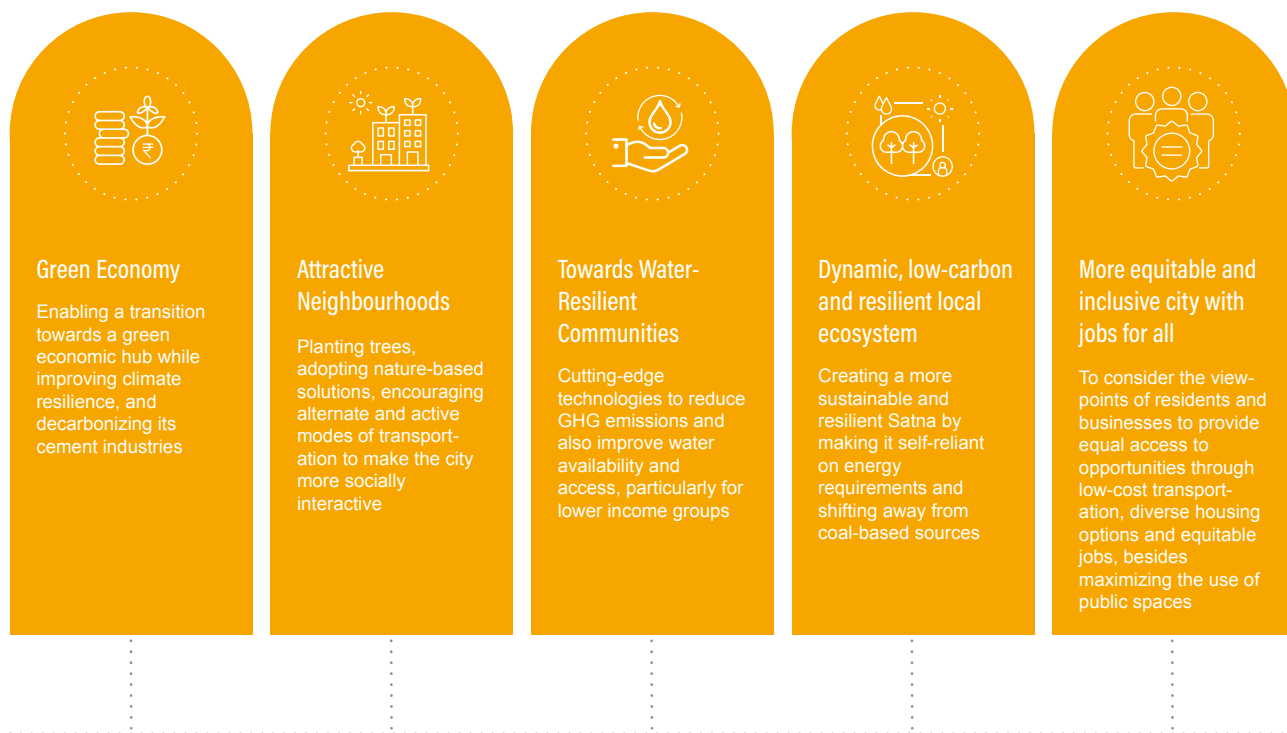
In this context, World Resources Institute India has partnered with State Knowledge Management Centre on Climate Change, EPCO, Department of Environment, Government of Madhya Pradesh, to support Department of Urban Development and Housing, Government of MP and seven Smart Cities in MP to build their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

Vision of Satna Climate Action Plan

The Satna 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 encompasses a low-

carbon, climate-resilient and adaptive society. The role of the Satna City Climate Action Plan is not only about reducing negative effects on the environment, but it is also about making holistic improvements to Satna’s community and way of life.

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

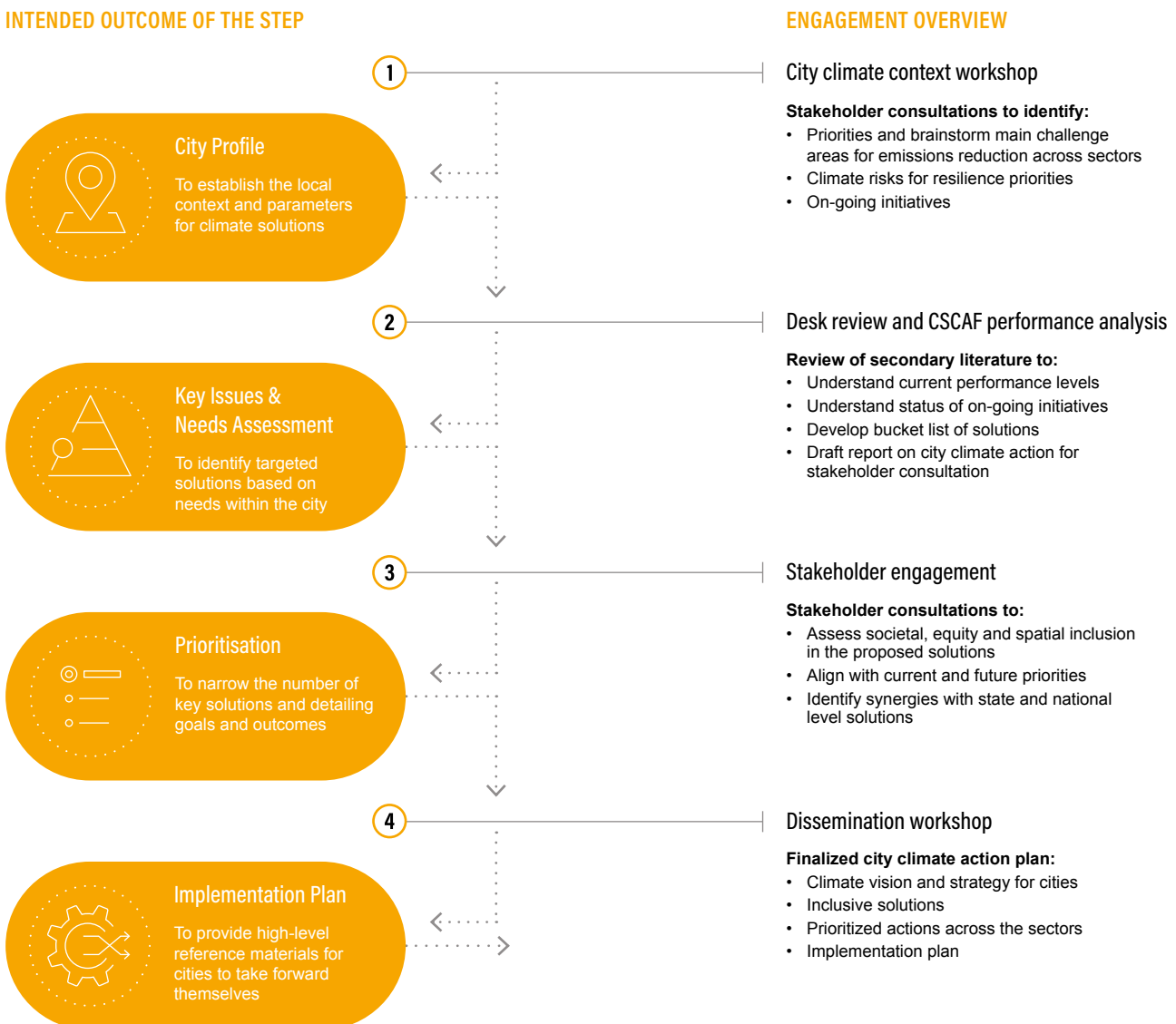


Climate Action Planning Process

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

- To kick-start the process of developing the CAP, a planning-cum-launch workshop was organized in Bhopal on 20 February 2020 with participation from state and city officials, academicians, and civil society organizations. The idea of the workshop was to apprise the participants and cities about the importance and relevance of developing these city-level plans, to brainstorm and identify prominent development challenges and key climate risks in urban areas in MP. It was also to understand the ongoing initiatives in order to establish a local context for the climate solutions.
- This was followed by an extensive desk review of the smart city proposal to identify the vision and key sectoral priorities envisaged by Satna city. A thorough review of submissions made by Satna as part of CSCAF 2.0, sectoral plans and government reports and other documents was done to identify key issues and gaps in achieving the sectoral priorities. A detailed climate profile of Satna city has been developed, which includes temperature and rainfall projections, baseline and projected GHG inventory. The climate vulnerability assessment carried out by EPCO has been referred to identify future climate risks. This review and analysis helped in drawing up a list of sectoral goals and actions which are outlined in the climate action plan.

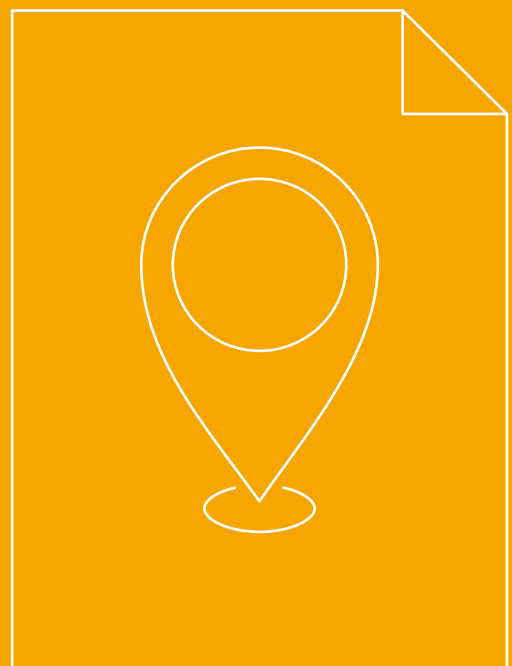
Figure 2: CAP development process (Source: WRI India)



- 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 Satna in September 2021, with participation from city officials, sectoral experts and civil society representatives. The purpose was to present the preliminary findings and seek inputs on the goals and actions proposed for Satna to adopt a low-carbon and climate-resilient development pathway. These consultations also provided inputs for bringing inclusion principles in the actions, aligning the actions with current and future priorities of Satna city as well as with state and national programs.
- 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.



CITY PROFILE



Satna, “the cement capital of India”, lies in the Baghelkhand region of the Vindhya Mountain ranges, in the state of Madhya Pradesh, and was selected as a smart city in 2017 under the Smart Cities Mission. The city has also been recognized as an open defecation free (ODF) city under the Swachh Bharat Mission Urban. Being a rich reservoir of chemical grade limestone and dolomite, the city is known as the “commercial and industrial capital of Baghelkhand” and contributes 9% to India’s cement production. Universal Cables is another prominent industry operational in Satna. Satna also acts as tourist transit center for places such as Khajuraho, Maihar and Chitrakoot. Located at about 192 km from Allahabad in Uttar Pradesh and 200 km from Jabalpur, and serving as a major connecting node, the city has an established regional connectivity by road, rail, and air routes.

Geographically situated at approx. 24.16°N 80.83°E, with an average elevation of 317m above mean sea level, the city has a unique physiography, and is surrounded by scenic Jain and Buddhist temples. Satna has an undulating terrain, dotted with mountains and small hills. Besides the Satna river and its few tributaries, the city boasts of lake Maitri Baug, Jagat Dev talab, lake nectar, etc. The city also has two protected forests – the Naru protected forest, at about 4.5 km in the southeast, and Maihar protected forest at about 8.5 km towards the southwest of Satna smart city, contributing to improved air quality. But due to increasing air pollution mainly from cement industries, the suspended particulate matter (SPM) and respirable suspended particulate matter (RSPM) were observed to be 387.6 and 263.5 microgram/cum respectively in 2017, double the CPCB limits².

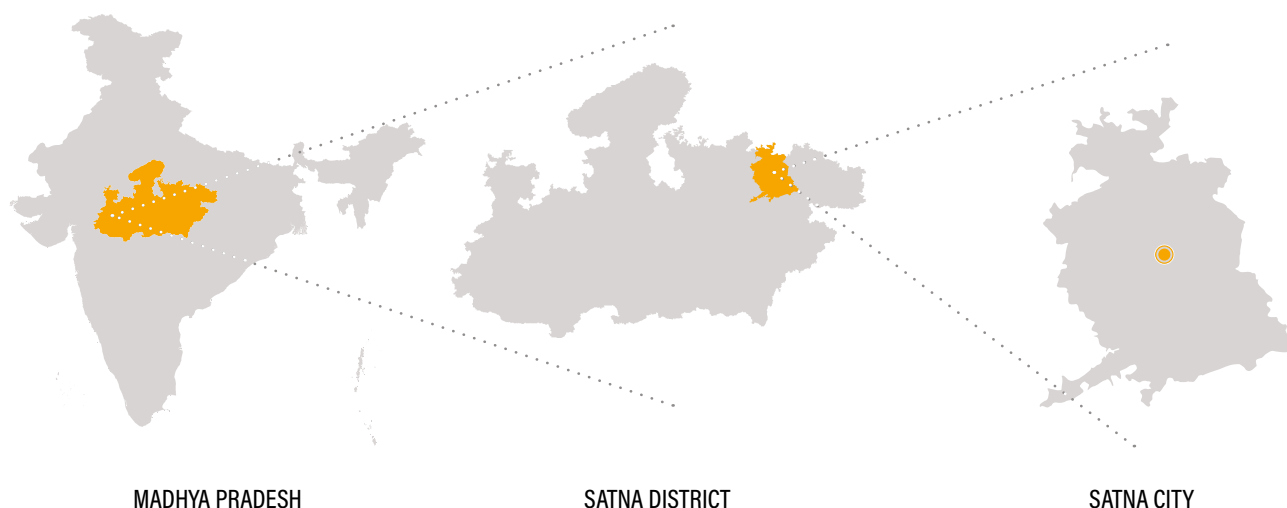
Satna is a tier III city with a population of 3.14 lakhs in 2019 spread across its municipal area of 72 sq.km as per the CSCAF 2.0 data. As of 2014, Satna had 55 slums with a population of 0.5 lakhs, constituting 16% of the total population. Most slums were along major drains and

nallahs, exposing them to high risk of urban flooding⁸. The city has a high literacy rate of 85% and serves as a prime educational and medical hub in the region. But despite the high literacy rate, strong industrial base and an agriculture-based economy, the city has a low workforce participation rate of 32.77%. From the above data, it is evident that the city houses major vulnerable groups, thus increasing the impact of social vulnerability and the need to address the aspects of inclusivity and equity in the city’s climate actions.

Satna experiences both ‘pull & push’ factors of migration and a huge challenge of out-migration of literate youth and skilled/ semi-skilled workforce, due to better quality of life and opportunities in MP’s larger cities such as Jabalpur, Bhopal, and Indore. At the same time, it attracts unskilled workforce from regional rural hinterland due to opportunities in its industries. Immigration of the unskilled workforce is putting a huge stress on the available housing and infrastructure in the city. As per the smart city stage II proposal by the city in 2016², the city faced a challenge in door-to-door piped water supply coverage, with only 42% of households having municipal water supply service connection. Moreover, the city has a weak wastewater management due to the absence of a sewerage system.

The city also aspires to diversify its economy by infrastructural urbanization, rather than being a single-engine natural resource-based economy. Considering the city’s slum population and the increasing immigration of unskilled workforce, the positive climate impacts must be embedded in an inclusive manner within urban development policies while designing the climate actions. Thus, access to municipal services such as public transport, water, waste collection, electricity, education, health etc., must be ensured by the city, so that it meets the needs of vulnerable communities, while also serving the co-benefits of reducing negative impacts of climate change. The city has a huge potential to do this, due to a smaller municipal

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



administration area and a lower population density compared to the other cities of MP. As Satna experiences a rapid urbanization, along with the planning the future

development, it is important to prioritize and mainstream climate action within its urban development.

Demography

The population of Satna city increased from approximately 0.23 million to 0.45 million between 2001 and 2011. The decadal growth rate of 94% during that period is higher than the state figure of 20.3%. As Figure 4 below shows, population growth has seen a slight dip in the last decade, indicating outward migration to bigger cities in MP due to

better economic opportunities outside the city. In 2020, Satna's population within the 72 sq.km. municipal area was 3.5 lakh.

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

Figure 4: Population growth in Satna between 1981-2020 (Source: Census of India)

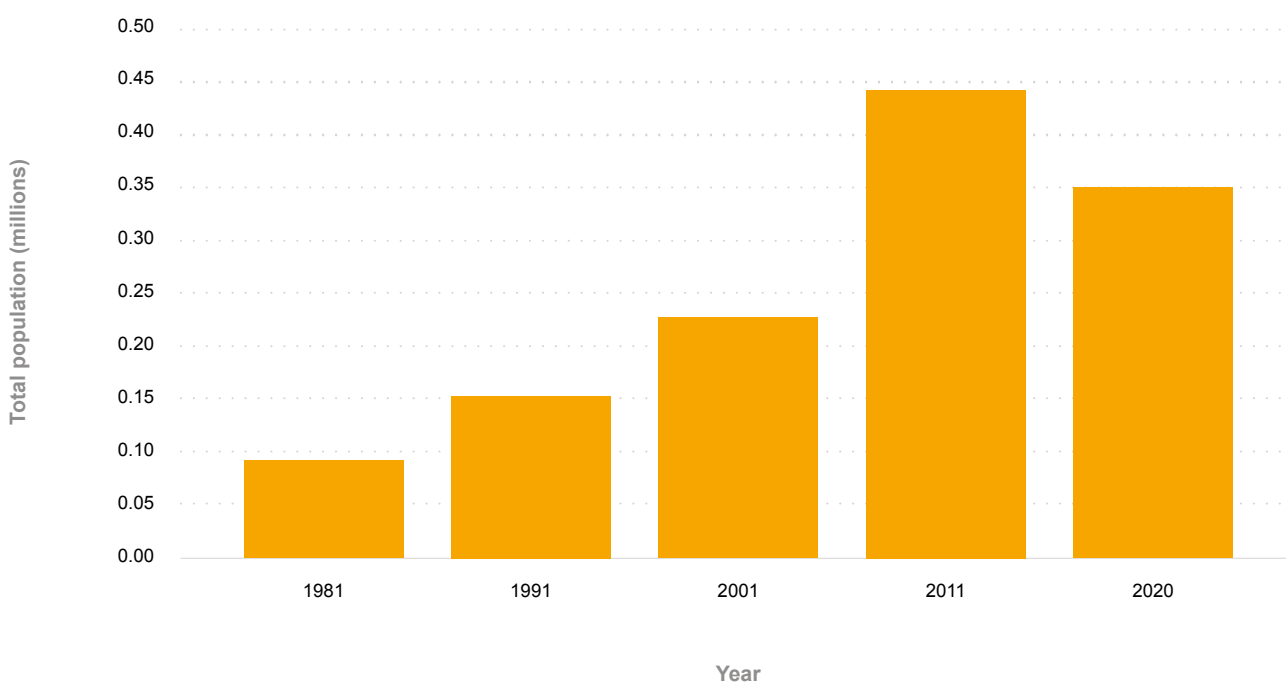


Table 1: City statistics (Source: Census of India)

Particulars	2001			2011		
	Total	Males	Females	Total	Males	Females
Population	229,307	122,401	106,906	282,977	149,415	133,562
Literates	155,413	90,791	64,622	211,970	118,828	93,142
SC Population	27,204	14,166	13,038	39,297	20,401	18,896
ST Population	8,614	4,518	4,096	9,508	5,003	4,505
Total Workers	62,273	53,674	8,599	92,746	74,299	18,447
Number of Households	43,423			55,379		
Slum Households	4716 (10.86% of total population)			10,905 (19.69% of total population)		

Climate Profile

The climate of Satna district is characterized by a hot summer with general dryness, except during the southwest monsoon season. The year can be divided into four seasons. The cold season from December to February is followed by the hot season from March to mid-June. The period from the middle of June to September is the southwest monsoon season. October and November form the post-monsoon or transition period. The normal annual rainfall of the district is 1,092.1 mm with maximum rainfall during the southwest monsoon period (i.e., June to September). Only 12.3% of the annual rainfall takes place between October and May. Rainfall is the sole source of natural groundwater recharge and southwest monsoon is the period when rainwater is available for ground water recharge.

The normal maximum temperature observed during the month of May is 41.9°C and the minimum observed during the month of January is 8.7°C. The normal annual mean maximum and minimum temperature of Satna district are 32.2°C and 19°C respectively. During the southwest monsoon season, the relative humidity generally exceeds 86% (August). The rest of the year is drier. The driest part of the year is the summer season, when relative humidity is less than 29%. May is the driest month of the year⁹. The analysis below assesses the historical climate variability and trends in mean climate (maximum temperature, minimum temperature, and precipitation) and climate indices of extremes in Satna district, including Satna city, over the period 1951-2013 (63 years), using historical gridded observations from the India Meteorological Department (IMD). Rainfall data grid resolution of

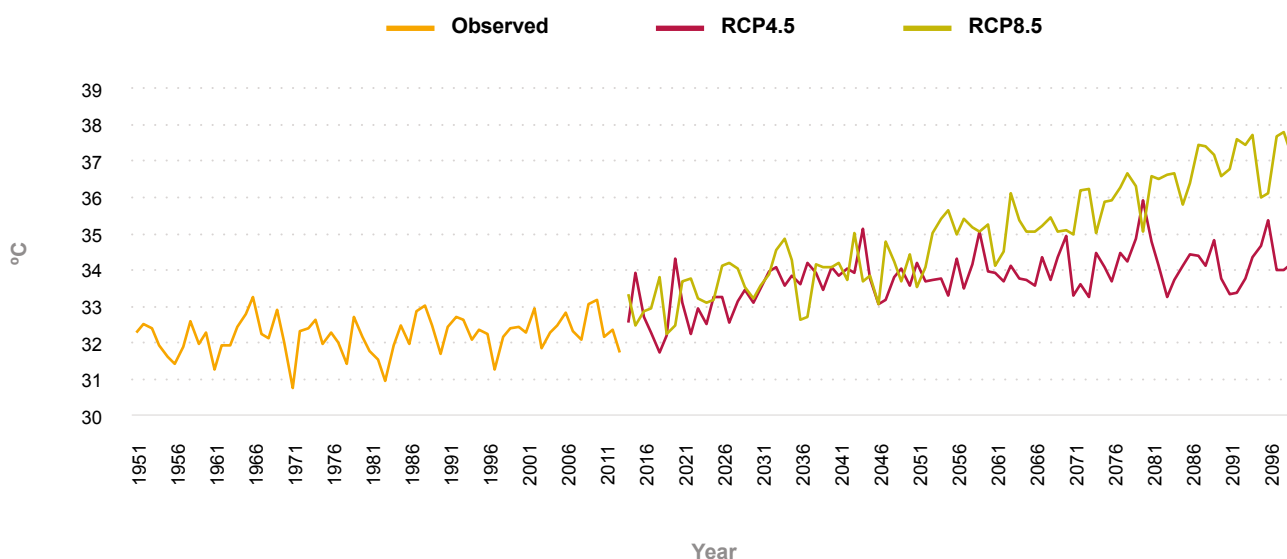
0.25°x0.25° and temperature data grid resolution of 1°x1° have been used. The Coordinated Regional Climate Downscaling Experiment (CORDEX) South Asia modelled climate data on precipitation, maximum temperature, minimum temperature was analyzed for Satna for baseline (1981-2010), mid-century, MC (2021-2050) and end-century, EC (2071-2100) periods.

Climate grid resolutions for the climate projection are 0.5°x0.5° (50km x 50km). Three regional climate models (RCMs), namely REgional MOdel (REMO of Max Planck institute for meteorology), Rossby Centre regional atmospheric model, (RCA4 of Swedish Meteorological and Hydrological Institute) and Conformal Cubic Atmospheric Model (CCAM of Commonwealth Scientific and Industrial Research) - for IPCC AR5 climate scenarios-RCP4.5 (moderate emissions scenario) and RCP8.5 (a scenario of comparatively high greenhouse gas emissions) have been used to calculate the ensemble mean for precipitation, maximum temperature, minimum temperature and climate extreme indices. Ensemble mean is chosen to reduce model related uncertainties and ensemble mean climate is closer to observed climate than any individual model.

Temperature Projections

The projected annual and seasonal maximum temperature changes towards mid-century (MC) and end-century (EC) with respect to baseline (BL) for Satna for IPCC AR5 RCP4.5 and RCP8.5 scenarios were analyzed.

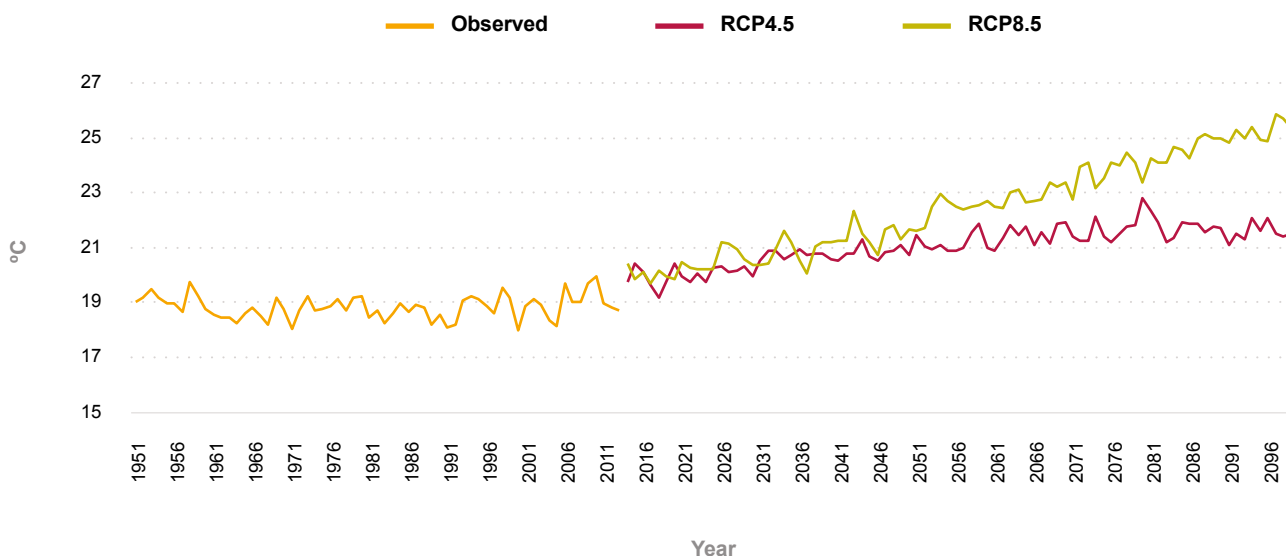
Figure 5: Trend of projected maximum temperature for Satna district (Source: WRI India analysis using CORDEX data)



The projected change in annual maximum temperature from baseline to mid-century for IPCC AR5 RCP4.5 scenario shows an increase of nearly 1.4°C. Similarly, the projected change in annual maximum temperature from baseline to end-century shows an increase of nearly 2.1°C.

Under IPCC AR5 RCP8.5 scenario, the projected change in annual maximum temperature from baseline to mid-century is nearly 1.8°C, while the projected change from BL to EC is 4.4°C.

Figure 6: Trend of projected minimum temperature for Satna District (Source: WRI India analysis using CORDEX data)



The projected change in annual minimum temperature from BL to MC for IPCC AR5 RCP4.5 scenario shows an increase of nearly 1.5°C. Similarly, the projected change in annual minimum temperature from BL to EC for IPCC AR5 RCP4.5 scenario shows an increase of nearly 2.5°C. Under IPCC AR5 RCP8.5 scenario, the projected change in annual minimum temperature from BL to MC is nearly 1.8°C, while the projected change from BL to EC is 5.2°C. The analysis of temperature shows that Satna is likely to witness extreme warm days with high incidences of heat waves leading to human and animal stress, negative impacts on labor productivity and higher stress on resources like energy and water.

Rainfall Projections

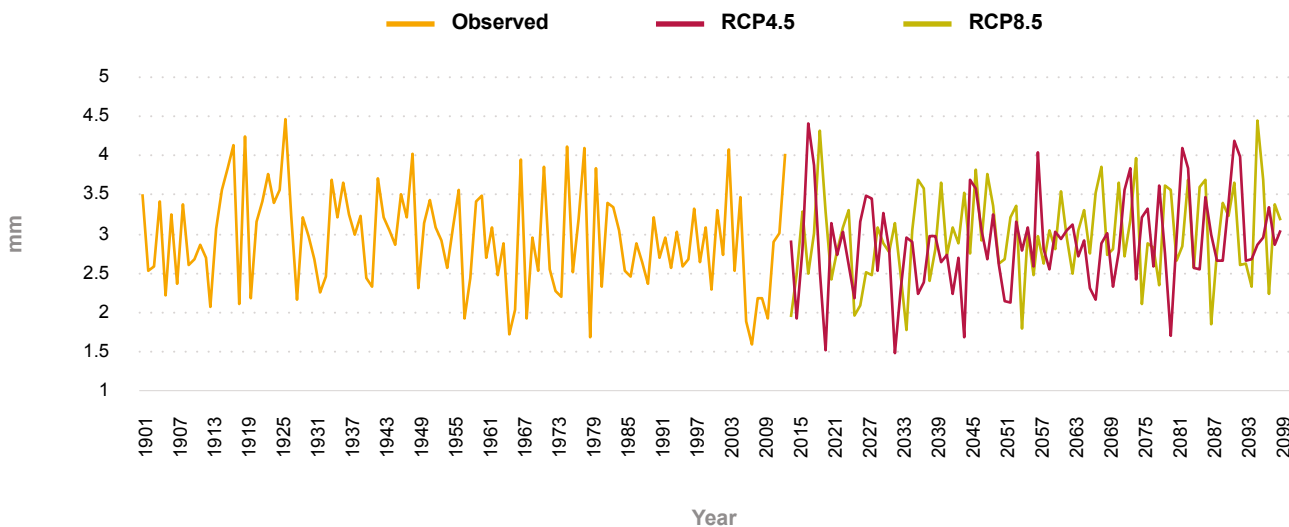
Ensemble mean of the Coordinated Regional Climate Downscaling Experiment (CORDEX) South Asia climate data for IPCC AR5 RCP4.5 and RCP8.5 scenarios for Satna's daily precipitation were analyzed. The projected daily precipitation changes towards MC and EC with respect to BL for Satna for IPCC AR5 RCP4.5 and RCP8.5 scenarios are given in the analysis below.

Average daily rainfall for IPCC AR5 RCP4.5 scenario is projected to decrease by about 9% towards mid-century and increase marginally by about 0.5% towards end-century while for IPCC AR5 RCP8.5 scenario it is projected to decrease by about 4% towards mid-century and increase marginally by about 1% towards end-century compared to the baseline scenario.

Key inferences that can be drawn from the above observations and projections for temperature and rainfall are:

- The climate of Satna, particularly for rainfall, is subject to large year-to-year variability. Thus, even in the absence of anthropogenic climate change, the city needs to be resilient to this natural variability.
- Observed records for the Satna region show emerging trends in temperature over the last few decades – in particular, a clear trend towards higher temperatures and more frequent high temperature extremes.
- Climate projections show a strengthening of the observed temperature trends, particularly with higher greenhouse emissions.

Figure 7: Trend of projected daily rainfall (Source: WRI India using CORDEX data)



Socio-Economic Profile of Satna

Though the industrial sector contributes to the economy to a large extent, the agrarian sector remains an important pillar of Satna’s economy and will continue to have a strong influence over its economy even in the coming years. Wheat and peanut are the major crops grown in the area.

The sex ratio of Satna city stands at 926 females per 1,000 males as per census 2011, which is less than the state average of 931 and national average of 940 per 1,000 males.

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: Framing the Challenges and Opportunities¹⁰” 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

Figure 8: City typology (Source: World Resources Institute Ross Center, 2016)



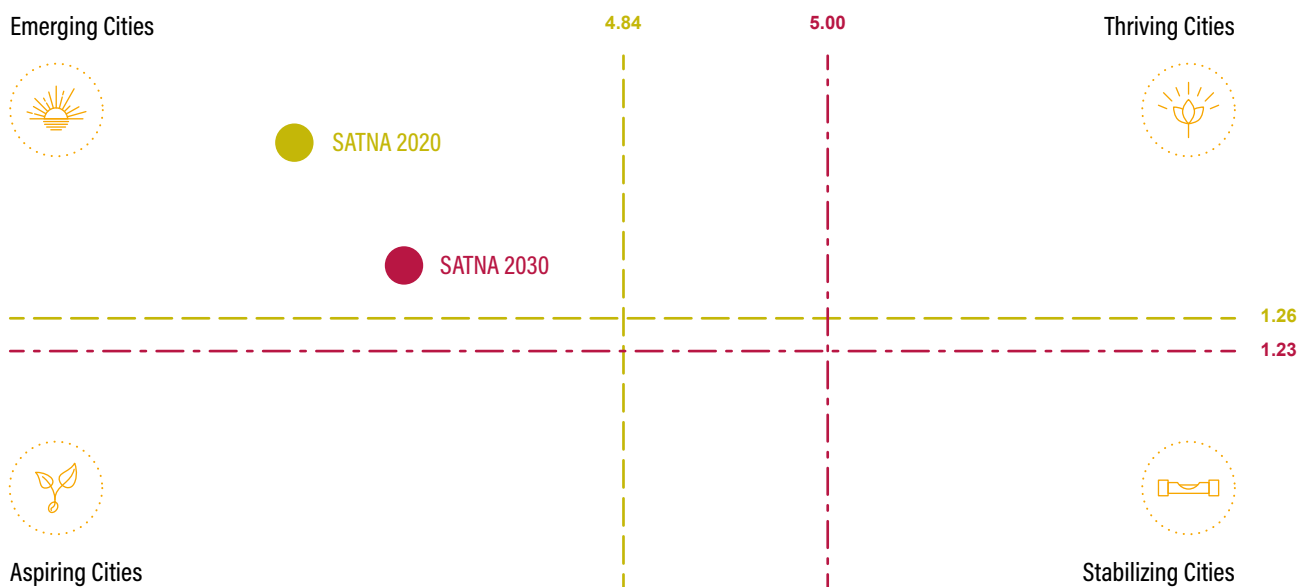
Based on the above three parameters, the cities are classified into four categories as shown in Figure 8:

- **Aspiring Cities** have a low GDP per capita today, and a low ratio of projected income growth to projected population growth during 2021-2030, compared to other cities. We classify these as aspiring cities because in the near future they are likely to experience more rapid population growth than economic growth, pointing to an impending resource gap.
- **Emerging Cities** have a low income today, and a high ratio of income growth to growth in population during 2021-2030, compared to other cities. While their economic strength is low today, their projected economic growth is greater than their projected population growth, indicating increases in economic productivity. These cities are more likely to have the capacity to overcome current resource constraints and strengthen their position globally.

- **Thriving Cities** are not only economically strong today, but their economic growth is also projected to outpace their urban population growth during 2021-2030. These cities are growing and thriving.
- **Stabilizing Cities** are economically strong today, but their economic growth is expected to be lower relative to their population growth during 2021-2030 when compared to emerging or thriving cities. In that sense, these cities are starting to stabilize, and, in some cases, their economies are starting to shrink.

Figure 9 shows the socioeconomic transition of Satna city from the decade 2011-2020 to 2021-2030. On the x-axis we have log of per capita GDP and on the y-axis ratio of per capita GDP growth to population growth. We have used logarithmic scale to respond to skewness towards the larger values. The point where the axes cross is India's value.

Figure 9: 2030 transition of Satna city (Source: WRI India analysis using primary city data)



Satna stays in the emerging city category in both the decades i.e., 2011-2020 and 2021-2030. However, by 2030, the population growth will outpace the income growth in the city. This will create a need to provide essential services to the rising population with limited resources. The city needs to improve efficiency in service delivery and also engage with citizens and other stakeholders for optimal consumption of resources. Satna also needs to explore avenues to increase the city's GDP by promoting energy efficient manufacturing clusters and creating service hubs.

BASELINE ASSESSMENT



CSCAF 2.0 Analysis

Satna has been a moderate performer in the first two rounds under CSCAF. The city has scored fairly well under the waste management sector. However, the city has performed below average for indicators under the other

sectors. The analysis from the CSCAF 2.0 analysis, the current city initiatives and possible areas of improvement have been highlighted in the table 2 below.

Table 2: CSCAF analysis for Satna (Source: CSCAF 2.0 data from the 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	175	90	124	50	475
Current measures being undertaken in the city	<ul style="list-style-type: none"> Satna has 100% energy efficient LED streetlights. 	<ul style="list-style-type: none"> Ankur program - which rewards citizens for free plantation - has been launched in the state and PMAY has been linked to it. 1.39 % of the municipal area has green cover. Implementing a "Save the seeds" campaign to increase greenery and citizen awareness³. The city has a disaster management plan and a disaster management cell. 	<ul style="list-style-type: none"> City has 130 e-rickshaws which constitute 1.69% of total shared vehicles in the city.. 0.03 buses are available per 1,000 population. Satna is monitoring air pollution and publishing daily air quality index levels on the public domain. Completed development of a 5.5 km cycle track in Rewa Road and Nagaud Panna Marg⁴. 	<ul style="list-style-type: none"> <5% of wastewater is recycled. The city has conducted an energy audit for water supply system. The city is also undertaking a project for intelligent water management with SCADA data⁵. 	<ul style="list-style-type: none"> 100% door to door collection of solid waste and segregation of waste at source⁶. The city has a Cluster based Integrated Solid Waste Management (ISWM) facility operated by Satna MSW Energy Solutions Ltd (Ramky)⁶ where windrow composting is done.
Areas of improvement	<ul style="list-style-type: none"> Increasing power generation from RE sources in the city. Satna currently does not generate power from renewable sources. Promoting rooftop solar in residential, commercial and government buildings. 	<ul style="list-style-type: none"> Increasing green cover within the municipal limits (1.39% currently). Needs to set up a biodiversity committee and identify measures to increase urban biodiversity and allocate resources. 	<ul style="list-style-type: none"> Non-Motorized Transport (NMT) supported by Non-Motorized Vehicle (NMV)-oriented design of roads and intersections. Increasing the coverage of roads with cycle lanes and footpaths (currently 0.75% of roads are covered). 	<ul style="list-style-type: none"> Increased recycling and reuse of the wastewater Introducing metering policy and installation of smart water meters. City needs to conduct a flood and water stagnation risk assessment. 	<ul style="list-style-type: none"> Awareness is required for better response of residents along segregation at source⁶. Authorization of waste pickers is to be completed⁶. Setting up a bio methanation plant for managing the wet waste⁶.

Overall Score as per CSCAF 2.0	Energy and Green Buildings	Urban Planning, Green Cover and Biodiversity	Mobility and Air Quality	Water Management	Waste Management
	<ul style="list-style-type: none"> Increasing the green building adoption and compliance of NBC/ ECBC codes in the city. The city does not have a green building cell and has not implemented any measures to promote green buildings 	<ul style="list-style-type: none"> Increasing green cover within the municipal limits (1.39% currently). Needs to set up a biodiversity committee and identify measures to increase urban biodiversity and allocate resources. 	<ul style="list-style-type: none"> Augmenting the public transport fleet. Increasing the share of clean fuels run vehicles especially buses and taxis. 	<ul style="list-style-type: none"> City needs to conduct a water resources assessment to assess status of existing water resources, its uses, along with projected future demand and availability. City should then develop a water resources management plan with short-, medium- and long-term actions. City needs to conduct an energy audit of its wastewater treatment system. 	<ul style="list-style-type: none"> Strengthening the Extended Producer Responsibility (EPR) of producers⁶. Implementing measures for re-use of construction and demolition waste in building and road construction⁶. Reducing greenhouse gas emissions from waste transport by shifting to alternate fuels.

Greenhouse Gas Emissions Profile

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

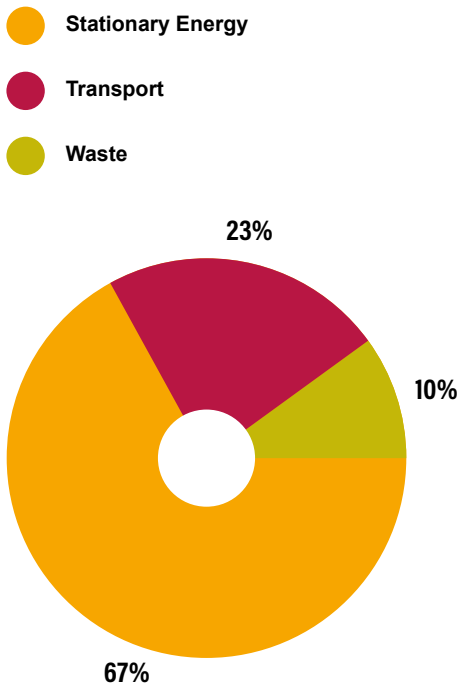
piece of any climate action plan by establishing the sources of activity that contribute towards emissions and allows the city to develop mitigation policies and strategies.

Critical Sources

In 2019, Satna's GHG emissions were 6,57,688 tCO₂e with per capita emissions of 2.0 tCO₂e (Including emissions from Manufacturing and Industrial electricity consumption). 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 come from electricity and fuel consumption in stationary energy sector (predominantly from manufacturing and construction, followed by residential buildings). The contribution of the three sectors to total emissions in the city is given in Figure 10.

Figure 10: GHG emissions profile of Satna (Source: WRI India analysis using primary city data)



Stationary energy contributes to 67% of the city’s total emissions, followed by transportation that contributes 23%. Waste sector contributes to 10% of Satna’s total emissions. This is because the city’s electricity is generated predominantly from fossil fuels. The inventory includes scope 1 emissions which are emissions due to activities in the city (for all sectors), scope 2 emissions which are emissions from electricity consumption in the city (for energy and transport) 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).

The emissions are projected to increase by 10.1% by 2025 and 17.7% by the end of the decade till 2030, compared to the baseline emissions of 2019. This creates an urgent need for the city to implement measures presented in the report for achieving its vision of low carbon and climate resilient development (Figure 12).

Figure 11: Emissions contribution by sector (Source: WRI India analysis using primary data)

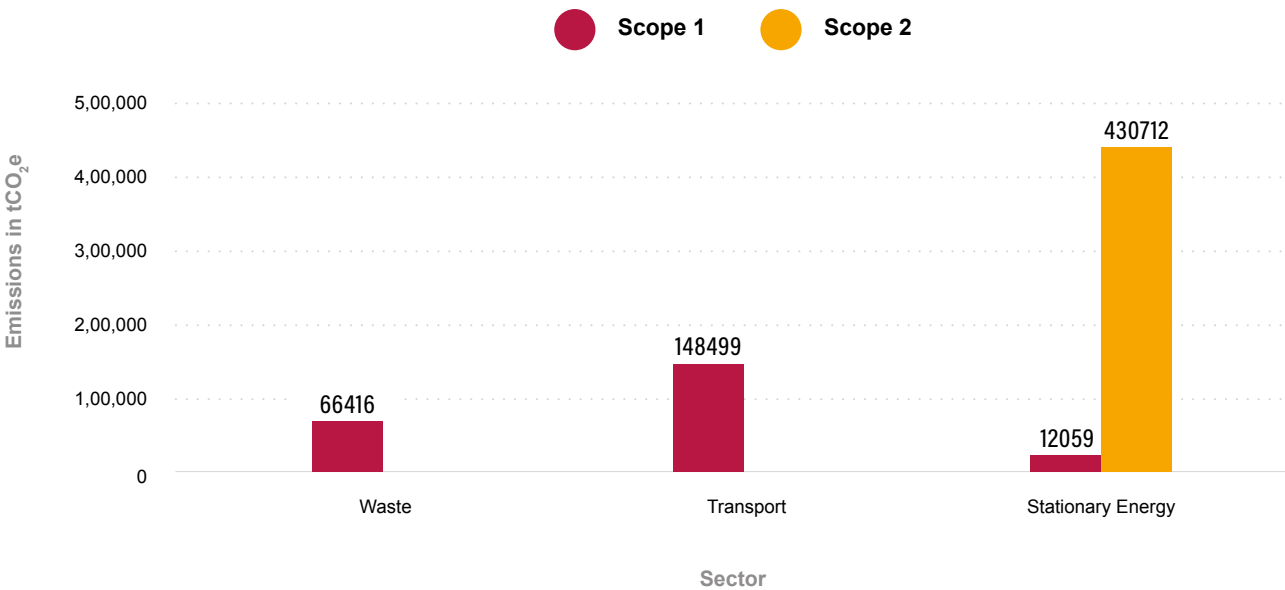
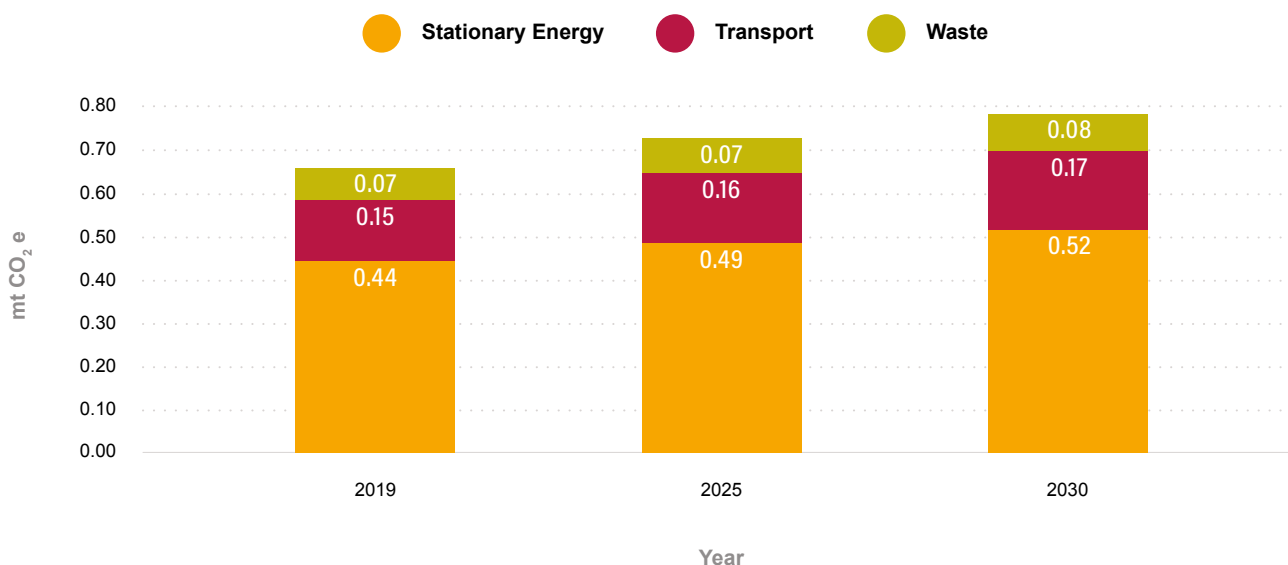


Figure 12: Projected emissions for Satna (Source: WRI India analysis using primary data)



Energy Sector Emissions

Stationary energy sector comprises of electricity and fuel consumption from (i) residential buildings (ii) commercial and institutional buildings and (iii) manufacturing industries and construction and (iv) urban agriculture. As per city level electricity consumption data obtained from the state distribution company (DISCOM), the total electricity consumption in Satna city was 544,808.48 MWh in 2019, out of which industrial consumption was the highest with 265,503.59 MWh, followed by domestic consumption of 169,333.22 MWh (Figure 13).

LPG fuel consumption totals 27,106 metric tonnes (Mt), out of which 26,334 Mt is from the domestic sub-sector. Kerosene consumption in the domestic sector is 26,731,422 Mega-Joule (MJ). There is no data available on coal consumption within the city (Figure 14).

The stationary energy sector accounts for 442,773 tCO₂e of Scope 1 and Scope 2 emissions of the city's total emissions. These include emissions from electricity consumption and fuel consumption including kerosene and LPG. Majority of emissions (49%) came from manufacturing industries and construction, 34% from residential buildings and 17% from commercial and institutional buildings. Figure 15 presents the distribution of scope 1 and scope 2 stationary energy emissions.

Figure 13: Satna percentage electricity consumption by sub-sectors (Source: Electricity consumption data from state distribution company)

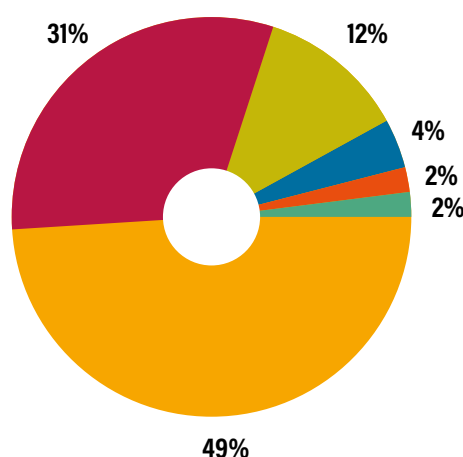


Figure 14: Liquefied petroleum gas (LPG) consumption
 (Source: Consolidated primary data from public sector oil marketing companies)

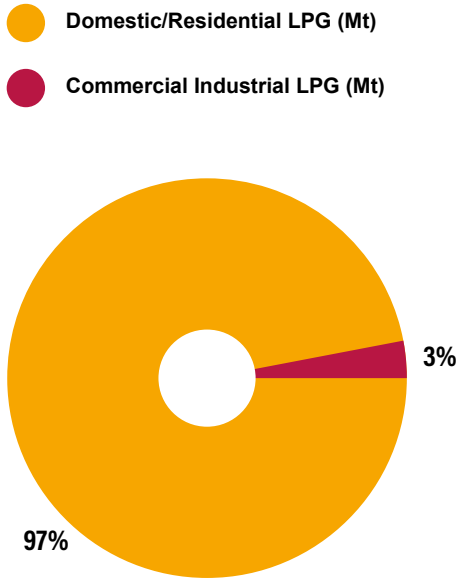


Figure 16: Split up of emissions from stationary energy sector for Satna
 (Source: WRI India analysis using primary data)

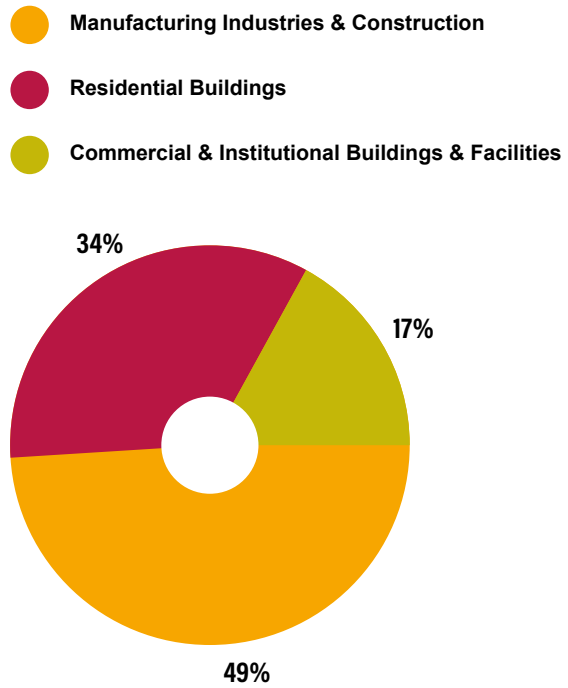
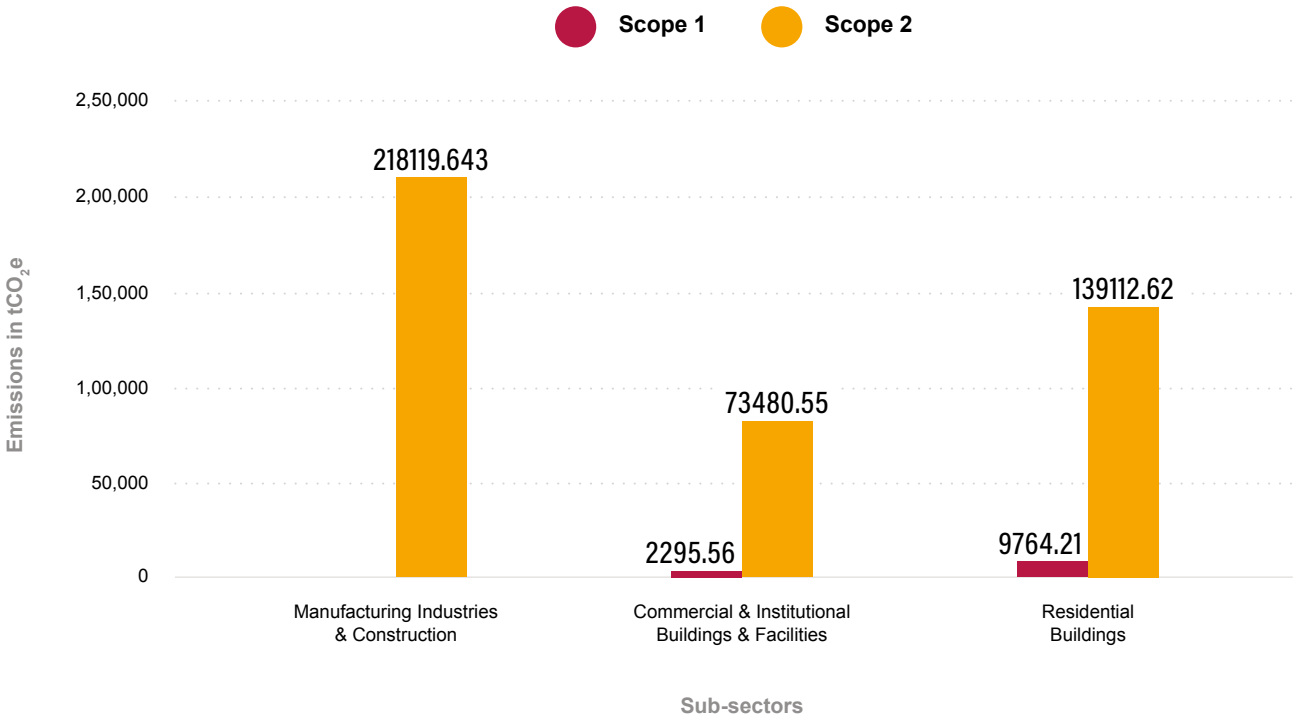


Figure 15: Stationary energy emissions by sub-sector
 (Source: WRI India analysis using primary data)



Transportation Sector Emissions

The transport sector accounts for 148,499.43 tCO₂e emissions, coming from the consumption of petrol and diesel in on-road transport. Data was obtained from fuel

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

Waste Sector Emissions

Waste accounts for 66,416 tCO₂e emissions, coming mainly from emissions of the city's wastewater (76%). About 1% of emissions comes due to composting of biological waste while the remaining 23% can be attributed to landfilled solid waste (Figure 18). Satna's waste composition includes a majority of food waste followed by paper and garden waste (Figure 17).

Figure 17: Municipal solid waste composition in Satna in tonnes per day (Source: Primary data)

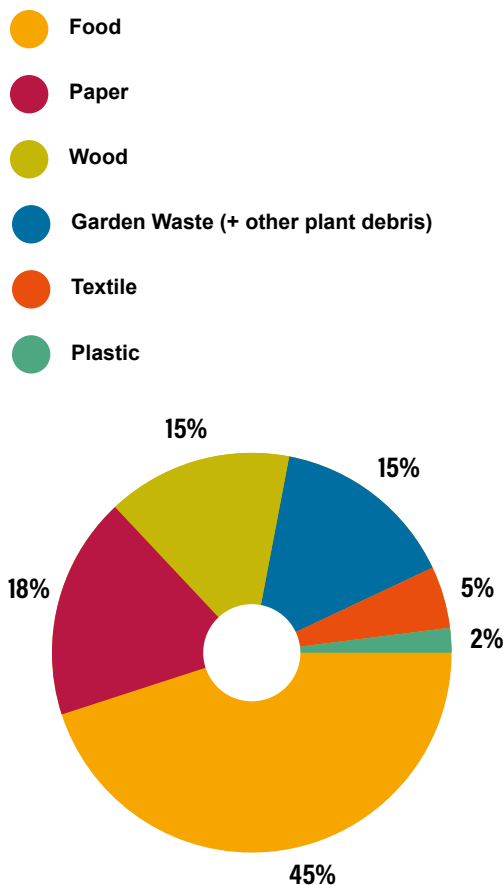
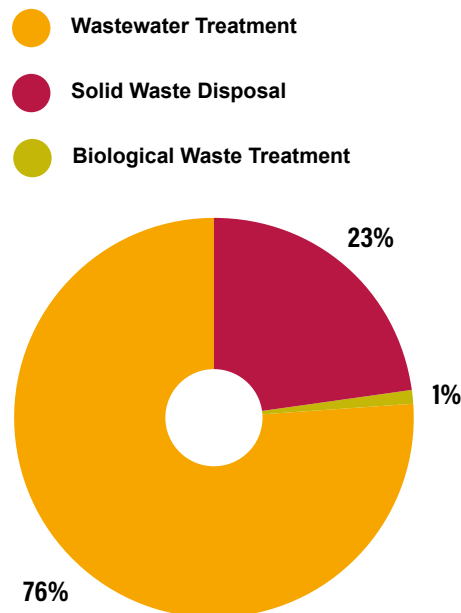


Figure 18: Percentage distribution of waste sector emissions in Satna (Source: WRI analysis using primary city data)



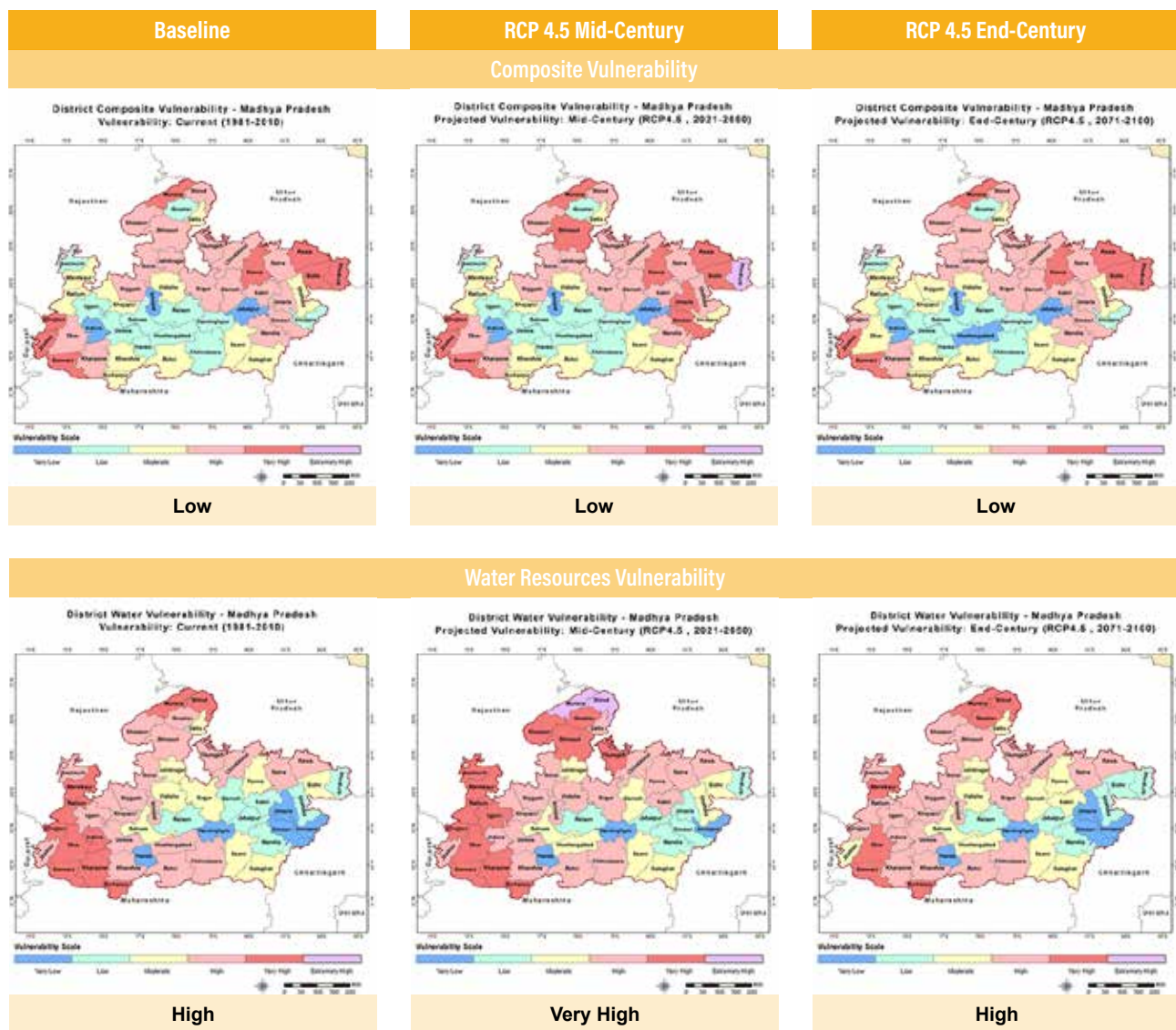
The inventory should also cover emissions due to incineration of waste, but the city could not provide any data on the same and hence this has not been included.

Vulnerability Assessment

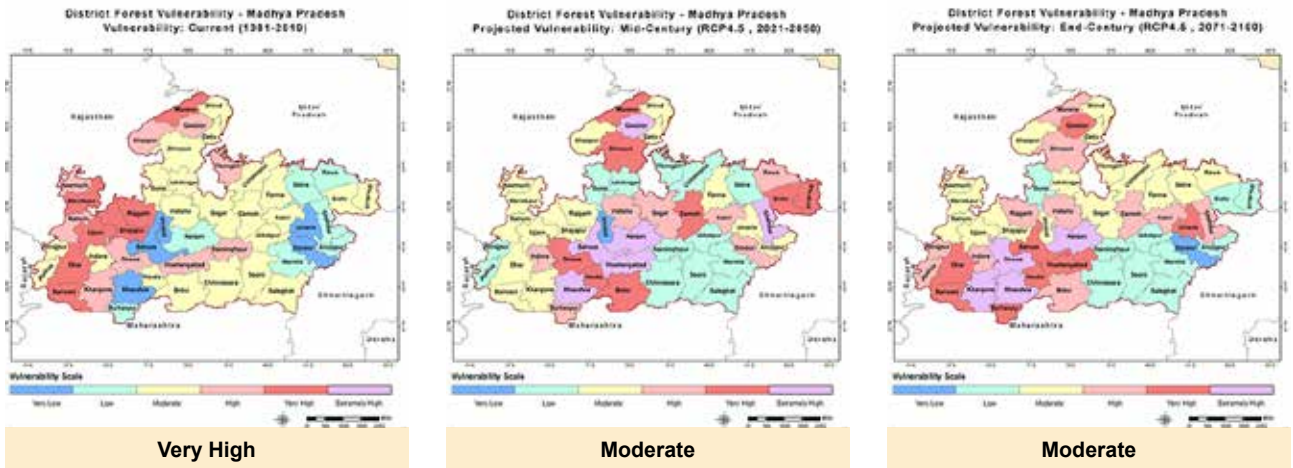
EPCO has assessed the climate change impacts and the vulnerability assessment of water, forest, agriculture, and health sectors for all the 52 districts in the state of Madhya Pradesh. The analysis was carried out for projected climate in the state over the periods 2021-2050 (mid-century, MC) and 2071-2100 (end-century, EC) using a multi model ensemble from the Coordinated Regional Climate Downscaling Experiment (CORDEX) experiment for RCP4.5 and RCP8.5 scenarios. A glimpse of the vulnerability assessments of different sectors is given below.

According to this analysis, Satna has a high composite vulnerability, determined by social indicators, economic indicators, water indicators, agriculture indicators and forest indicators for all the three time slices, which indicates that Satna is likely to face higher impacts of climate change for different sectors. In terms of water resources, Satna faces high vulnerability in all the three time slices, showing a high risk of decreasing availability of water, increasing crop water stress, and increasing frequency of extreme weather events like floods and droughts.

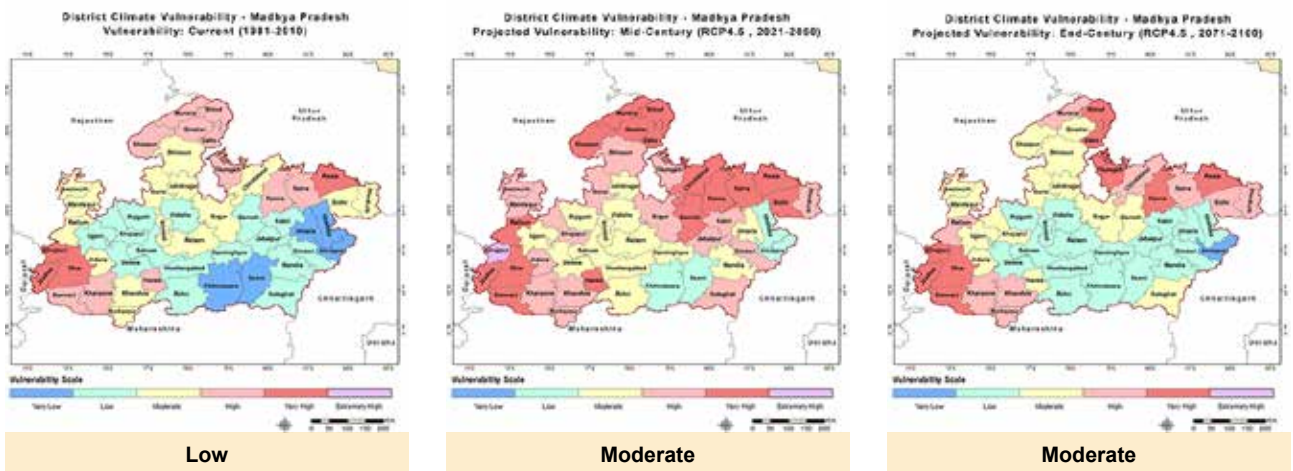
Figure 19: Sectoral vulnerability profiles for Satna (Source: Madhya Pradesh Climate Change Knowledge Portal)



Forest Vulnerability

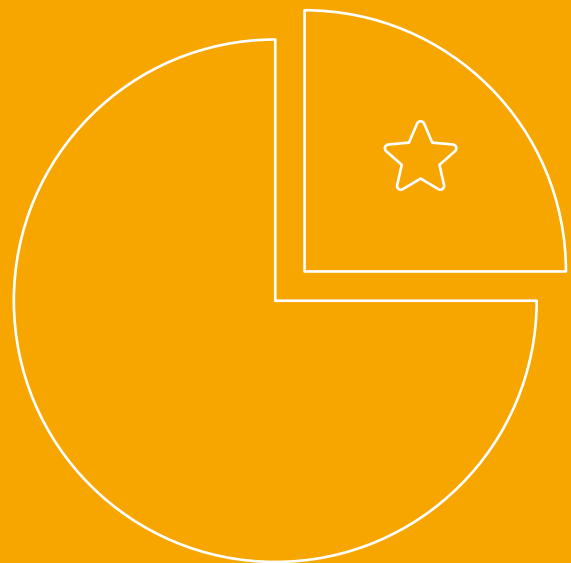


Climate Vulnerability



In terms of climate, the city goes from being highly vulnerable in the baseline scenario to very highly vulnerable in mid-century projections, with a very high risk of decrease in average annual rainfall, increase in precipitation intensity and rise in heat index.

SECTORAL PRIORITIES



This section provides a detailed description of the current performance of Satna city on different indicators under CSCAF 2.0, based on which the sectoral goals have been

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

Sectoral Assessment

Energy and Green Buildings

As per the primary data obtained from the state distribution company, the total electricity consumption was 544,808.478 MWh in FY 2019-20. As per the data from CSCAF 2.0, there is 0% of the total electrical energy in the city derived from renewable sources. In terms of consumption of fossil fuel, the breakup for FY 2019-20 is shown in table 3.

The city has the ambition to promote renewable energy for greater energy security. As per the smart city priorities, the city envisions 24 X 7 power supply to all with a smart energy grid, smart metering and promoting solar power

through net metering policy². As per the CSCAF 2.0 data, 100% of streetlights in the city are energy efficient as of 2020. The city also has completed the development of the Integrated Control and Command Centre (ICCC) and the installation, commissioning, and testing for installation of 3 solar trees in its premises⁷. The city does not have a green building cell and has not undertaken any implementation measures to promote green buildings. There are also no certified green buildings in Satna¹¹. As per the data from smart city⁷, the city has completed the repair, maintenance, and renovation of government schools in pan city area. However, the schools are not retrofitted for increased energy efficiency.

Table 3: Fuel consumption in Satna (Source: Primary sector oil marketing companies)

Type of Fuel	Consumption
Diesel	33,248 kl
Petrol	15,389 kl
Domestic LPG	26,333.77 Mt
Commercial/Industrial LPG	771.76 Mt
Kerosene	26731422 MJ

Urban Planning, Green Cover and Biodiversity

Satna had 1 sq.km of green cover - which is 1.39% - of the total municipal area of 72 sq.km in 2020¹¹. As per the data from the smart city, Satna has completed the redevelopment of Lake Nectar and Lake Bhima in 2023, by conducting de-silting, dredging, stone pitching of existing water body, installing aeration fountains, boating jetty, light and sound show, lake side pedestrian pathways and with landscape inclusions. Satna has also nearly completed constructing and developing the Amodha talab (lake) and the Jagat dev talab. The city is currently undertaking the construction and redevelopment of Narayani talab (lake), and Dhawari talab (lake) and is developing the Santoshi mata talab (lake) to convert it into an active recreational center. The city has also completed the development of smart city office park while the landscaping and improvement of major roads, junctions, and city entry-exit points is ongoing⁷.

The city has implemented an initiative where residents adopt parks for maintenance. An 80 sq.m area of parks has been developed in Sumit Bazaar and Virat Nagar. The city is already implementing "save the seeds" campaign to collect seeds from schools and housing societies and increasing green cover by planting those⁹.

Along the urban biodiversity lens, the city does not have an established city-level biodiversity management committee and has not conducted a baseline assessment for urban biodiversity in the city. It has also not identified measures to increase urban biodiversity by allocating sufficient resources for implementation. Satna does have a city-level disaster management plan and has also instituted a disaster management cell or emergency operation center (EOC). The plan includes ward-level hazard risk, vulnerability and capacity assessment based on NDMA guidelines. As a next step, Satna should conduct capacity building exercises to develop a trained

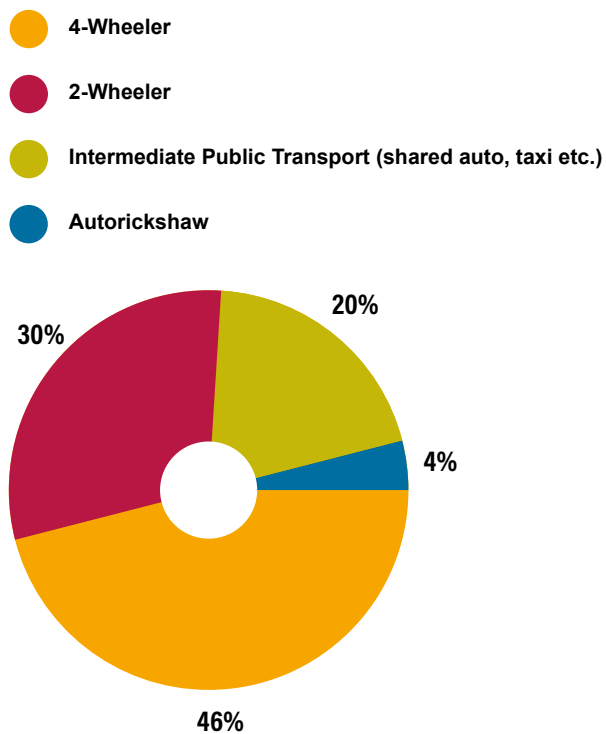
task force and volunteers for disaster response. The city is yet to establish early warning systems and should allocate resources to link this with the integrated command and control center. Satna is also recommended as per the CSCAF 2.0, to regularly monitor, update, and maintain the city disaster management plan and the early warning system. They should also try and ensure that the city building bylaws incorporate measures to address the identified climate risks¹¹.

Mobility and Air Quality

Satna envisions the integration of transit-oriented development (TOD) principles into all urban planning initiatives, promoting compact, mixed use, mixed income, walkable and connected developments. It also envisions reducing reliance on private vehicles, with a focus on reduced congestion, pollution, and accidents².

The mode share of Satna was as follows in FY2017-18¹²: Public transport auto (4%), intermediate public transport like shared autos, autorickshaw, taxi (20%), private 2-wheeler (30%), private four-wheeler car (46%). This indicates a negligible share for bus (Figure 20).

Figure 20: Modal split for transport in Satna, FY 2017-2018
(Source: Open data platform, Smart cities, Ministry of Housing and Urban Affairs)



As per the CSCAF2.0 data, 1.69% of shared vehicles ran on clean technologies in 2020. The city had invited bids to install 10 electric charging stations in 2022¹³. The city has

only 8 buses, and the availability of public transport per 1,000 population is 0.03 as of 2020, the lowest level under MOHUA's service level benchmarks¹⁴. Organized public transport is not up to the mark in the city, hence the Satna City Transport Services Ltd was established in 2017 as the special purpose vehicle to introduce organized public transport on PPP Mode². The city aims to achieve 50% mode share for public transport in the future².

Smart parking system had been proposed for the city to provide accurate information on available parking spaces along with a parking guidance system aimed at saving time and fuel. It is currently at the tender process stage⁷. As per the CSCAF 2.0 data, Satna had 5 kms of footpath out of the total road length of 665km in 2020, constituting 0.75% of the total road network, much less than the lowest level of MOHUA's transport service level benchmark of 15% NMT coverage¹⁴. The city promotes non-motorized transport (NMT) options like walking and cycling, supported by pedestrian-oriented design of roads, intersections, and crossings and has completed the development of a 5.5 km cycle track in 2022⁴.

Satna recognizes air pollution and its associated hazards and monitors PM₁₀, PM_{2.5}, NO_x, and SO_x as per CPCB guidelines and CO, NH₃, Pb and O₃ as per NAAQS. The city also displays the available pollutant data in the public domain. Satna faces problems related to air pollution due to atmospheric wastes of cement factories². The SPM & RSPM are observed to be 387.6 & 263.5 microgram/ cum respectively, which are more than double the CPCB's permissible limits².

The city has air pollutant and ambient air quality monitoring stations. Satna has also performed pollutant source identification. However, the city needs to do a comprehensive mapping exercise of the pollution hotspots in the city.

Water Management

Rivers and ground water constitute the prominent sources of water in the city¹⁵. Satna city derives its name from the River Satna. River Tons, Son, and Paisuni are three important rivers of Satna District. Amongst these Tons River (also known as Tamsa River, a tributary of River Ganga) is the biggest and is therefore the most prominent source of fresh water for Satna city. It is located about 43 kms away from Satna city¹⁶.

Satna needs to conduct a study to assess the current availability of water resources along with future demand and supply for five years. Based on that, a water resources demand management plan must be prepared with short-, medium- and long-term strategies to conserve the city's water resources.

The city aims to have 24x7 water supply with 100% metering and has implemented a water connection application and bill payment module under e-nagarपालिका initiative. Satna also envisions 100% rooftop rainwater harvesting in all the wards in the long term². Existing water treatment plants (18 MLD & 14 MLD) are being augmented, with a 5-year contract for operations and maintenance⁷.

As per the smart city proposal, Satna had reduced NRW to nearly 40% and increased the coverage of houses with service connections to 42% (24000 household connections) as of 2016². However, both are well below service level benchmarks. As per the CSCAF 2.0, Satna needs to undertake a more recent assessment of its non-revenue water and take measures to reduce it. Satna needs to reduce its NRW considerably and bring it below 20% as per the service level benchmarks by Central Public Health and Environmental Engineering Organisation (CEPHEEO)¹⁷. There is also a need to increase serviced connections to 100% households. The city is currently undertaking a project for the extension of water supply pipeline and overhead tank, which is aimed to be completed by Nov 2023. Currently, the city is also implementing a project for intelligent water management with SCADA data⁷.

As per the district environment plan⁶, Satna has a very weak wastewater management with partial underground sewerage network and does not have an installed sewage treatment facility. In 2021, the city had floated a tender for laying sewerage network in Satna municipal area¹⁸ including construction of manholes and sewer components. This is expected to be completed by 2024. As per the smart city data, the city is currently identifying and developing 60 kms of major internal roads in zone 1 for sewerage network. In August 2022, the city had invited bids for construction of three sewage treatment plants (STPs)¹⁹ of 4 MLD, 4 MLD and 3 MLD capacity each, for wastewater flowing through Umri, Gahera and Khermai Nallahs and these are expected to be constructed by 2024. The city has also completed the work on PMAY sewerage network from individual housing blocks to the septic tank (additional septic tanks are required to be constructed) within the existing PMAY area of Uttaili⁷. The city is also working on a project for the construction of a 20km minor *Nallah* (storm water drain)⁷.

Given that Satna is a critical block with respect to ground-water availability as per Central Ground Water Board²⁰, there is a need to increase recycling and reuse of wastewater, which is currently less than 5%. As per the smart city proposal, the city aims to recycle and reuse at least 25% of wastewater. This would be complemented by increased coverage of households connected to the sewerage system and decentralized treatment facilities.

Satna has augmented its water supply system with an installed capacity of 59 MLD, which is sufficient to cater to the water demand till 2031². As per the CSCAF 2.0, the city has conducted an energy audit for wastewater pump-stations. It should do the same for its treatment plants.

| Waste Management

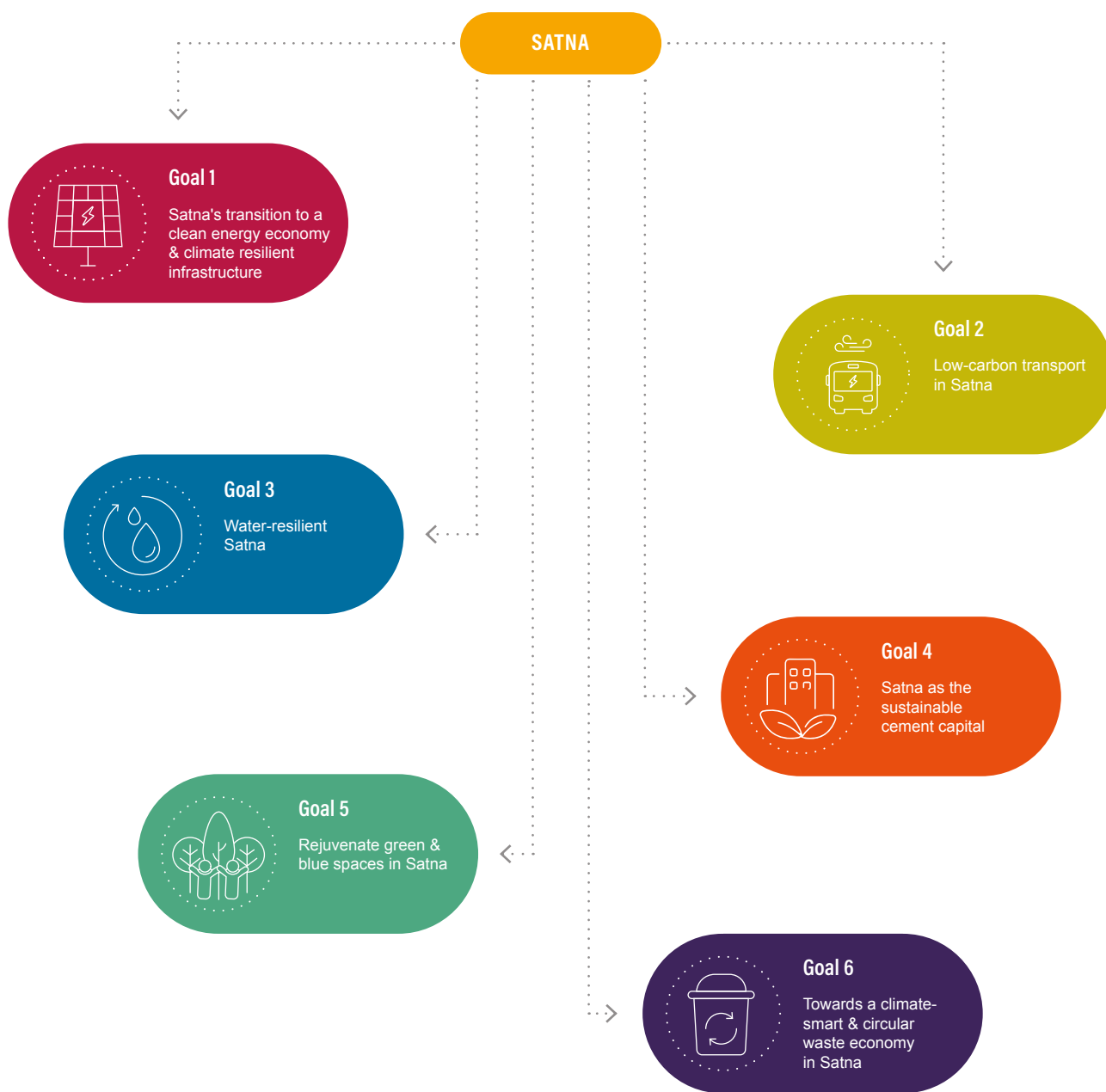
As per the district environment plan 2021⁶, the city generates about 90 TPD of municipal solid waste. The city also has 100% door-to-door collection of segregated waste. About 9 TPD is the estimated quantity of plastic waste generated. The city has a collection point for C&D waste and has fixed a user fee for the same. However, Satna currently reuses C&D waste for filling in low lying areas and there is no C&D waste recycling facility⁶. Cluster based Integrated Solid Waste Management Facility is established at village Pahadiya District where windrow composting is being done. However, there is no bio-methanation plant setup for treatment of wet waste⁶. Satna has also prepared an action plan for bio-remediating the existing legacy waste dumpsite⁶. As per the smart city data, the city is planning for the integration of GPS base SWM Vehicle Tracking Management System (VTMS) for solid waste collection. In terms of integrating informal workers, as per the DEP Satna 2021⁶, there is no authorization of waste pickers in the city yet and the city is working on the same.

Sectoral Goals

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

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

Figure 21: Sectoral goals for Satna (Source: WRI India)



Mainstreaming Inclusivity in the Satna Climate Action Plan

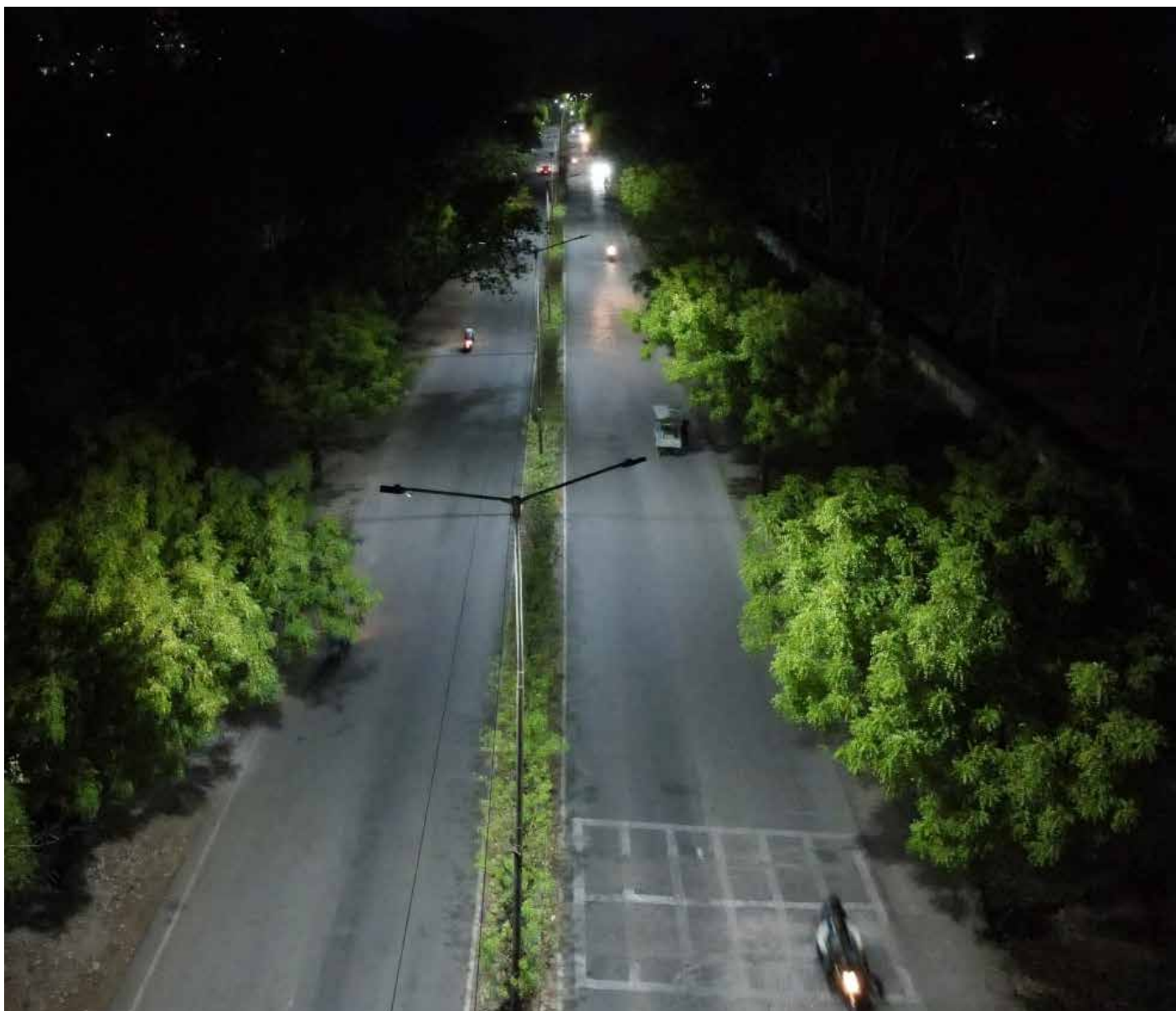
Satna's CAP process stresses the importance of inclusive planning. An inclusivity analysis has been included for each sectoral action to ensure that the action has equitable benefits for all identified impact groups. The analysis has been adapted from the guidance document on "How to tackle climate change and inequality jointly: practical resources and guidance for cities" prepared by World Resources Institute Ross Centre for Sustainable

Cities and C40 cities in 2019²⁴. As the first step towards mainstreaming inclusivity, cities must ensure that inclusivity is embedded in processes, policies, and impacts (Figure 22). 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

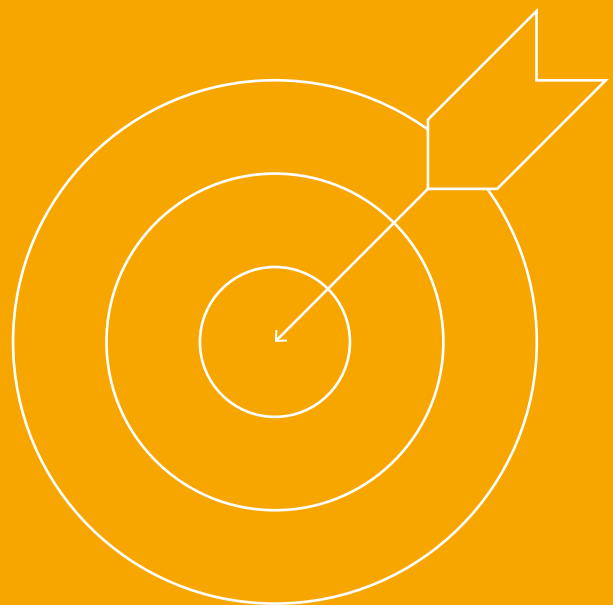
making. Finally, the actions proposed should include clear indicators and monitoring frameworks to measure the inclusivity of impacts across each impact group. Impact

groups can include the elderly, children, disabled, religious minorities, informal communities, temporary workers, etc.

Figure 22: Inclusive climate action planning (Source: WRI Ross Centre and C40 Cities)



SECTORAL CLIMATE ACTIONS



Goal 1: Satna's Transition to a Clean Energy Economy & Climate Resilient Infrastructure

The transition away from fossil fuels towards renewable energy is critical. As per the Smart City priorities, the city aims to promote the use of renewable energy for greater energy security and envisions 24 X 7 power supply with advancements in smart energy grid, smart metering and promoting solar power through net metering policy. But as per CSCAF 2.0 data, Satna currently has 0% of total electrical energy derived from renewable sources. Given that Satna's population growth is likely to outpace income growth by 2030, it is important to provide low cost and clean energy services for its growing population. There is also a need to increase renewable energy use for public street lighting and municipal utilities. The city also needs to prioritize institutional and awareness creation measures for promoting green building adoption and ensure a low carbon building stock.

| Identified Actions

Action 1: Incentivize installation of rooftop solar panels and solar water heaters in all new residential constructions

- Challenges addressed at the city level:** As per CSCAF 2.0 data, Satna has currently 0% of total electrical energy derived from renewable sources. Furthermore, 34% of the stationary sector emissions come from electricity and fuel consumption use in residential buildings
- Description:** Residential constructions have a huge potential to reduce emissions through renewable energy sources. This sector should become an immediate priority to avoid the lock-in effect due to inefficient building stock. Incentives or measures to increase uptake of solar panels/solar water heaters include:
 - Subsidies:** Few cities like the Diu Smart City²² offers all its residents an installation subsidy of Rs 10,000-50,000 for installing a 1-5kW capacity rooftop solar PVs. It is observed that this helped reduce power tariffs by 10-15% each year. Karnataka State Govt also provides a rebate of 50 p per unit up to 50Rs per month for installing SWH²³. Pune also provides a 5% tax rebate for one energy efficiency initiative out of SWH, composting or RWH. A 10% rebate is given for implementing two²⁴
 - Mandate:** Satna can mandate all new buildings to have solar water heaters and solar rooftops. This should be included in the building by-laws. BESCO 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 available²⁵.
 - Awareness training workshops for resident welfare associations and large-scale distributors on benefits of implementing solar rooftop, available incentives, operation and maintenance, net metering, 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 can be developed. A similar tool was developed by an NGO in Bengaluru which has been used by nearly 15000 citizens²⁶.
- Inclusivity analysis:** Inability to pay capital costs and lack of credit could be one of the challenges limiting participation from low-income urban households. Providing financial incentives for RE projects, including cost subsidies, low-interest and long-term loans for property owners, project developers and small-scale purchasers would make it more accessible to low-income communities. Satna Municipal Corporation can also ensure integration of solar water heaters or solar rooftop systems in the construction of new affordable housing.
- Implementing stakeholders:** Satna Municipal Corporation (lead), MPUVN, MPPKVVCL, Satna Smart City Development Limited and private agencies, resident welfare associations and citizen forums.
- Timeframe:** Medium term (3-5 years).
- Possible alignment with schemes:** Madhya Pradesh Policy for Decentralized Renewable Energy Systems, 2016. Madhya Pradesh Renewable Energy Policy – 2022, Solar Panel System Subsidy in Madhya Pradesh, 2022.
- Monitoring indicators:** Increase in share of renewable energy from the residential sector, % of domestic consumers availing the subsidy, % of residential houses with installed solar heaters and roof top solar disaggregated by income type.
- Alignment with CSCAF indicators:**
 - Indicator 2: Total electrical energy derived from renewable sources.
 - Indicator 6: Green building adoption under Energy and green buildings

Action 2: Pilot zero-carbon building components in upcoming municipal development projects

- **Challenges addressed at the city level:** As per CSCAF 2.0 data, Satna has currently 0% of total electrical energy derived from renewable sources, 17% of the stationary sector emissions come from electricity and fuel consumption use in commercial and institutional buildings.
- **Description:** As per the smart city project list, Satna is planning to develop shelter homes and women's hostels (ashraya sthal), construct and redevelop a community hall, refurbish the Nagar Nigam building and redevelop the Dharawi cricket stadium. Satna Smart City is also planning for commercial complexes in Transport nagar and Shubhash Mandi. These projects can be envisioned as low carbon or zero carbon buildings. A (net) zero carbon building (ZCB) can be defined as an energy efficient building that supplies most (but not all) of its annual energy use through on-or near-site renewable energy sources. Key components of such buildings can include:
 - Energy efficiency: Ensuring energy efficiency through compliance with local codes and standards through energy efficient equipment use.
 - Renewable energy: Achieving further reductions in building emissions through renewable energy sources through on-site RE generation, off-site RE generation or purchase.
 - Carbon offsets: Carbon offsets can be used to balance out residual emissions. The emissions reduction benefits must be claimed through a credible mechanism such as carbon credits or a local carbon credit fund.

Best practice examples which can be 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 building²⁷. 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 generation²⁸. Most of the Infosys campuses in the country are LEED platinum buildings and have PV panels, RE electricity and off-site RE plants²⁹.

Satna can also aim to get green building accreditation for its nagar nigam office, smart city office or other buildings. For example, the new headquarters of the Navi Mumbai Municipal Corporation building has a LEED gold certification³⁰. They can also install solar water heaters, shaded roofs, LED lighting, etc in new municipal schools.

- **Inclusivity analysis:**
 - Installation of solar panels in government schools would sensitize the students on alternative sources of energy and lesser usage of conventional energy. The teachers can play a role in creating this awareness amongst the students by conducting a site visit to the installed solar rooftop in their campus. Through the knowledge learnt at schools, the students will in turn inform and educate their families (including middle/low-income households) on how to use energy more efficiently.
 - The net-zero transition in such large-scale government projects could open value pools around green building materials and promote business for small start-ups manufacturing green/alternative building materials and those in their supply chain. This would also encourage more youth entrepreneurs to explore avenues for green/low-carbon alternative material manufacturing in the city.
- **Implementing stakeholders:** Satna Municipal Corporation (lead), MP Urja Vikas Nigam Limited, MPPKVCL, Satna Smart City Development Limited (SSCDL), technology suppliers, citizens, school administration.
- **Timeframe:** Medium term (3-5 years)
- **Possible alignment with schemes:**
 - MP Policy for Decentralized Renewable Energy Systems 2016.
 - Madhya Pradesh Renewable Energy 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 Satna.
- **Alignment with CSCAF indicators:**
 - Indicator 1: Electricity consumption in the city
 - Indicator 2: Total electrical energy in the city derived from renewable sources.
 - Indicators 5 and 6: Promotion of green buildings and green building adoption under the energy and green buildings sector.

Action 3: Pilot solar-powered streetlighting in the city

- **Challenges addressed at the city level:** As per CSCAF 2.0 data, Satna has currently 0% of total electrical energy derived from renewable sources. As per CSCAF 2.0, the city has 100% energy efficient lighting in the city, however the city does not have any solar-powered streetlights.

- **Description:** As per the smart city data, the city has completed installation of energy-efficient LED streetlighting in the city. As a next step, Satna can aim to convert them to solar streetlights in phases. The pilot phase I can be by installing solar streetlights in all the public spaces such as gardens, parks and talabs. Example, the Greater Visakhapatnam Municipal Corporation (GVMC) had aimed to set up 12,000 solar streetlights in the city under the Smart City Mission in 2021 in collaboration with Energy Efficiency Services Limited (EESL). Each solar powered pole costed about Rs. 70,000³¹. Similarly, 700 solar streetlights were planned in 32 villages in Uttar Pradesh in November 2022. They were planned at a cost of Rs. 22,300 per unit with auto on-off facility, 13 Ah battery which can run up to 12 hours and a solar panel. The light would automatically turn on and off depending on the available lighting in that location³². Andhra Pradesh is also planning to install solar streetlights in the beach road from coastal battery junction to kurupam junction³³.
- **Possible alignment with schemes:**
 - Madhya Pradesh Policy for Decentralized Renewable Energy Systems, 2016
 - Madhya Pradesh Solar Net Metering Policy 2020
 - Madhya Pradesh Renewable Energy Policy – 2022
 - Atal Jyoti Yojana (AJAY) Phase II
- **Monitoring indicators:** % of energy derived from renewables, # of solar streetlights installed, % of solar streetlights out of total streetlights, distribution of solar streetlights in each ward including low-income/slum households, # of villages with solar streetlights.
- **Alignment with CSCAF indicators:**
 - Indicator 2: Total electrical energy in the city derived from renewable sources.
 - Indicator 4: Energy efficient streetlighting under the energy & green buildings sector.

Action 4: Implement institutional measures to increase adoption of green buildings in the city

- This initiative will reduce the electricity costs incurred by municipality for streetlighting. The city can also utilize support from Atal Jyoti Yojana (AJAY) Phase II³⁴ scheme to scale up the action. As per this scheme, 75% of the cost of streetlights is borne by MNRE AND 25% will come from the Member of Parliament Local Area Development funds (MPLADS) fund.
- **Inclusivity analysis:**
 - SMC can ensure involvement of low-income workers in installation, operation, and maintenance of solar streetlights. Solar panels require regular maintenance including cleaning the surface of panels and the LED light to remove dust, fallen leaves, etc. The battery also needs to be maintained³⁵. SMC can train workers from low-income communities on the same, thus providing job opportunities.
 - SMC can do an assessment of electricity access in urban villages and identify those without adequate electricity access especially at night and set up solar streetlights for these villages. This will reduce their reliance on harmful polluting sources like kerosene or coal. For example, the installation of solar streetlights in Balla, a village in Himachal Pradesh has helped people overcome their fear of stepping out after sunset due to the risk of wild animals. It has helped women and children come out after sunset to play and study³³.
 - **Implementing stakeholders:** Satna Municipal Corporation (lead), Satna Smart City Development Limited (SSCDL), MP Urja Vikas Nigam Limited, MPPKVCL, technology suppliers, citizens.
 - **Timeframe:** Medium term (3-5 years)
 - **Challenges addressed at the city level:** As per CSCAF 2.0 data, there are no green certified buildings in the city and Satna has not taken any steps to promote green buildings.
 - **Description:** To encourage a city-wide implementation, the following measures can be adopted³⁶:
 - The ECBC 2017 codes have been mandated in commercial buildings. However, it lacks compliance. Satna should ensure strict compliance through monitoring permit requirements, calculation methods, regular inspections, monitoring energy bill reductions, etc. Satna can mandate the green building certificate submission for the online building approval system for building approval.
 - 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:** Satna can create tiered building standards, with buildings in richer market areas having to implement more stringent standards compared to those in low-income areas. Satna 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:** Satna Municipal Corporation (lead), Directorate of Town & Country Planning, Satna Smart City Development Limited (SSCDL), MPPKVVCL, MPUVN Energy management cell, IGBC city chapter.
- **Timeframe:** Short term (1-2 years) with long term implementation
- **Possible 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 5: 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. Satna also faces the risk of high temperatures and heat waves, with temperatures touching 48 degrees in summers³⁷.
- **Description:** To reduce the demand for cooling during summers as well as reduce the impacts of heatwaves on residents, Satna 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 Corporation³⁸ 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 water³⁹.

- **Green roofs:** These are roofs with a vegetative cover. Satna 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 appeal⁴⁰.
- **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 areas⁴¹. Retrofitting interventions such as – implementing cool roofs or green roofs can significantly impact internal temperatures and provide thermal comfort indoors. Since the city has 16% 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:** Satna Municipal Corporation (lead), Satna Smart City Development Limited, private technology manufacturers and suppliers, NGOs, IGBC chapter.
- **Timeframe:** Medium term (3-5 years)
- **Possible alignment with schemes:** PMAY affordable housing scheme
- **Monitoring indicators:** % of houses with cool roofs/ green roofs, reduced illnesses, or mortality due to heatwaves, % reduction in energy demand from residential buildings for cooling.
- **Alignment with CSCAF indicators:**
 - Indicator 3: Fossil fuel consumption
 - Indicator 6: Green building adoption under energy and green buildings.

- Indicator 5: Promotion of green buildings under energy and green buildings.

Action 6: Pilot solar bus stops

- **Challenges addressed at the city level:** No energy comes from renewables as per CSCAF 2.0.
- **Description:** Satna is developing 35 Bus-Q-shelters in various locations on Built, Operate and Transfer (BOT) basis with advertising rights under a public-private partnership mode⁷. The city can consider piloting these as solar bus stops. Cities like Trichy⁴², Madurai⁴³, Delhi⁴⁴ and Lucknow⁴⁵ 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 surveillance⁴⁶.
- **Inclusivity analysis:** These bus stops should ensure that commuters have shelter, drinking water, toilets and other amenities. Bus stops should also allow wheelchair access. SMC must do a baseline assessment of access to bus stops across wards and ensure that these solar bus stops are equitably distributed across low- and high-income wards.
- **Implementing stakeholders:** Satna Municipal Corporation and Satna City Transport Services Pvt Ltd (lead), Satna smart city, MPUVN, NGOs, MPPKVVCL.
- **Timeframe:** Medium term (3-5 years)
- **Possible alignment with schemes:**
 - MP Policy for Decentralized Renewable Energy Systems, 2016
 - MP Renewable Energy Policy 2022
- **Monitoring indicators:** % of energy from renewables, % of bus stops with solar PV.
- **Alignment with CSCAF indicators:**
 - Indicator 1: Electricity consumption in the city
 - Indicator 2: Total electrical energy in the city derived from renewable sources

Action 7: Upgrade to solar-powered sewage treatment plants

- **Challenges addressed at the city level:** City has not conducted an energy audit for its wastewater treatment plants. As per CSCAF 2.0 data, Satna has currently 0% of total electrical energy derived from renewable sources.
- **Description:** The city should first conduct an energy audit of all its wastewater treatment plants. Then,

use of solar power can be incorporated in existing or new STPs, including the three sewage treatment plants for treating the wastewater flowing through Umri, Gahera and Khermai Nallas. In July 2022, Indore Smart City Development Limited announced setting up a dedicated solar power plant at the Kabit Khedi treatment plant⁴⁷ to reduce 50% of its electricity consumption and generate around 1,800 carbon credits annually. A similar pilot is coming up in Tamil Nadu⁴⁸. Nearly 170 municipalities across Gujarat⁴⁹ are expected to power up their inoperative and defunct STPs with the help of solar power systems.

In Indore, green bonds were launched by Indore municipal Corporation (IMC) of approximately Rs 450 crore to install a floating solar project, in Jalood and Yeshwant Sagar to power pumping stations⁵⁰. Satna can also consider adopting the above practices to upgrade its upcoming STPs. Once these actions are implemented, a fresh energy audit should be conducted to assess impact on energy emissions from wastewater treatment.

- **Inclusivity analysis:** Solarization of STPs will demand manpower requirements⁵¹ during the pre-qualification, testing, design, erection, and commissioning phases, thus creating more job opportunities in the city. Satna can ensure training for personnel from low-income groups to equip them for the above.
- **Implementing stakeholders:** Satna Municipal Corporation (lead), Satna Smart City Development Limited, resident welfare associations and communities, Water Resources Department MP, private agencies, MPPKVVCL, MPUVN.
- **Timeframe:** Medium term (3-5 years)
- **Possible alignment with schemes:**
 - Policy for implementation of solar power-based projects in Madhya Pradesh
 - Madhya Pradesh Policy for Decentralized Renewable Energy Systems, 2016,
 - Madhya Pradesh RE Policy, 2022
 - Madhya Pradesh Urban Services Improvement Project (ADB)
- **Monitoring indicators:** Reduced energy costs and consumption for sewage treatment, % of STPs running on solar power, % increase in energy from renewables.
- **Alignment with CSCAF indicators:**
 - Indicator 6: Energy-efficient wastewater management system under the water management sector
 - Indicator 2: Percentage of total electrical energy from renewable sources under the energy and green buildings sector

Goal 2: Low-Carbon Transport in Satna

As per CSCAF 2.0 data, the city of Satna remains in the lower levels within the various mobility and air quality indicators, with scope for improvement. The city's transport demand is mainly driven through IPT with only eight public buses, amounting to 0.03 buses per 1,000 population. The city also has only 1.69% of its shared mobility fleet running on alternative fuels. Satna is also working towards its long-term goal of achieving 50% modal share² for reliable, well connected, and cost-effective public transport. This goal will play an important role in helping the Smart City of Satna meet its vision. Given the city's air pollution issues² and growing population, it is important to work towards enabling a low carbon mobility system in the city and encourage the shift towards non-motorized modes.

Identified Actions

Action 1: Augment the bus fleet in Satna

- **Challenges addressed at the city level:** As per the CSCAF 2.0 data, there is a limited availability and accessibility of public transport with only 0.03 buses per 1,000 population.
- **Description:** The city should consider augmenting its fleet by improving its frequency and coverage and increase in new fleet.
 - The first step in planning for introducing new city buses 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 like the rickshaws and autos. Through this, the main corridors and major bus stops can be identified.
 - The third aspect is to identify 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 periodic route and service rationalization exercises at least once in 5-10 years. The regular bus routes can also be accompanied by feeder buses or minibuses like in Chennai⁵² and Bengaluru⁵³. These increase access in parts of the city that are outside the purview of the public transport route and enable better last mile connectivity.
- **Inclusivity analysis:**
 - Passenger safety and convenience must be incorporated in all stages of this action. Disability access can be ensured by fitting buses with ramps.
 - Women's safety is another aspect that must be incorporated in the new buses, perhaps by installing panic buttons, training women drivers, separate seats for men and women, limiting overcrowding in buses or having women-only buses in some routes.
 - While increasing the bus fleet, Satna should also ensure adequate access to last mile connectivity which is inclusive to all. Poorly designed infrastructure for pedestrians and cyclists may exclude people with disabilities and create safety concerns. City should develop adequate footpaths with street furniture, ramps, and shade.
 - Road design plays an important role in ensuring safe use of bus services, while incorporating elements such as traffic calming measures, speed control and signages to ensure safety of commuters.
 - Bus terminals should be provided with toilets, water, and other facilities.
 - Fare rationalization and multimodal fare integration is important to make public transport accessible to low-income and minority groups.
 - Communication material can be provided in English and native languages to enable better reach.
- **Implementing stakeholders:** Satna City Transport Services Pvt Ltd (lead), Satna Smart City Development Limited (SSCDL), SMC, agencies, private operators, citizens.
- **Timeframe:** Medium term (3-5 years), maintenance and route rationalization long term (>5 years).

The new buses should be complemented with adequate infrastructure. Bus stops must be located in main junctions, with sufficient footpath, closed shelters and in proximity to overhead bridges or pedestrian crossings, while also ensuring road safety. As per calculations and Indian Roads Congress 1983 standards, bus bays need to be at least 79m in length and 5m in width to provide sufficient bus docking and of tapering length⁵⁴. Branding can also be done for effective marketing and increasing public uptake, thorough colour coding or numbering and can be route wise. For example, the front of buses is painted pink in Chennai to denote buses which are free for women. Bangalore has 4 buses based on fares and route having different colours⁵⁴.

- **Possible alignment with schemes:** AMRUT
- **Monitoring indicators:** Increase in the modal share of public transport, availability of safe infrastructure like cycle and/or walking lanes connecting bus stops, reduction in congestion and travel time, percentage of income spent on public transport, percentage mode share disaggregated by gender and income.
- **Alignment with CSCAF indicators:**
 - Indicator 1: Clean technologies shared vehicles.
 - Indicator 2: Availability of public transport
 - Indicator 3: Percentage of coverage of non-motorized transport network (pedestrian and bicycle) in the city, under the mobility and air quality sector

Action 2: Pilot bio-CNG and electric buses in Satna

- **Challenges addressed at the city level:** As per CSCAF 2.0 data, there are 0 buses based on clean fuel like CNG, LPG, Hybrid, Biofuels, or electricity in the city. The PM 2.5 concentration in Satna is also 5 times above World Health Organization guidelines, indicating the need to shift towards cleaner fuels⁵⁵.
- **Description:** While augmenting its bus fleet, Satna can consider piloting bio-CNG or electric buses similar to cities like Indore, Bhopal, etc.
 - **Bio-CNG buses:** While working towards increasing its public transport bus system, the city can pilot some low-carbon buses (CNG or electric buses) in the fleet. A model like Indore can be implemented where the bio-CNG from waste is used to run city buses⁵⁶. Indore is also planning to run 400 CNG buses from the recently inaugurated bio-methanation plant in 2022. The plant can produce 19,000 kg of bio-CNG from 550 tonnes of wet waste⁵⁷. A similar pilot can be explored in Satna Mandi or other mandis.
 - **Electric buses:** The city has currently invited bids to install 10 electric charging stations¹³. It is recommended that the city can also work towards introducing some e-buses in its planned public transport system. Before rolling out the electric buses, Satna should consider the following factors in order to choose whether a route is feasible for electrification: average daily kilometers travelled on the route, time between shifts per bus, number of stops, average driving speed, maximum halting time and availability of space and electricity at the depot. SMC should plan for number of e-buses to be deployed in each route, estimate budget, plan for charging infrastructure at terminals or bus stops, consult with DISCOMS regarding sanctioned load at each charging station and conduct pre-feasibility checks⁵⁸.

Proper trial runs need to be conducted for these buses before they are formally inaugurated. The Ahmedabad BRTS also introduced 18 new e-buses in 2019 after trial runs for six months⁵⁹. This was also accompanied by a public battery swapping station for buses with a capacity to charge 12 batteries at a time. Once the pilots have been assessed, they can be scaled up after addressing the barriers, and the city can aim for long term conversion of the entire bus fleet into EVs.

- **Inclusivity analysis:**
 - Communication material on the EV buses, its advantages, routes, timings, etc. can also be provided in English and native languages to enable better reach.
 - Women's safety is another aspect that must be incorporated in the new electric buses, perhaps by training women drivers, separate seats for men and women, limiting overcrowding in buses or having women-only buses in some routes.
 - This can also help generate jobs for low-income workers for the bio-methanation plants or for setting up charging infrastructure. Government bus drivers, mostly from low-income communities need proper training on operating and maintaining EV or Bio-CNG buses.
- **Implementing stakeholders:** Satna City Transport Services Pvt. Ltd. (lead), Satna Smart City Development Limited (SSCDL), SMC, financial agencies, private operators, citizens, MPPKVVCL.
- **Timeframe:** Medium term (3-5 years), maintenance and route rationalization long term (>5 years).
- **Possible alignment with schemes:** FAME phase II, Madhya Pradesh EV policy.
- **Monitoring indicators:** Quantity of waste treated in the plant, Quantity of bio-CNG produced per day from the treated waste, number of bio-CNG buses in the city, reduction in AQI, number of EV buses in fleet, number of EV charging stations in a 3x3km grid, % reduction in emissions from transport sector.
- **Alignment with CSCAF indicators:**
 - Indicator 1: Clean technologies shared vehicles.
 - Indicator 2: Availability of public transport under the mobility and air quality sector.

Action 3: Policy measures for strengthening Non-Motorized Transport in the city

- **Challenges addressed at the city level:** Only 0.75% of total road network consisted of footpaths or cycle tracks as of 2020¹¹. Satna recently developed a 5km cycle track⁴.

- **Description:** The city is already promoting NMT infrastructure in the city and can implement the following policy actions to further strengthen their efforts:
 - 3.1 Implementing a special NMT cell within SMC: According to MoHUA's guidance document⁶⁰ for NMT strategies in cities, the first step is the establishment of a NMT Cell to enable policy-level and planning-level interventions, with representatives from various city agencies, local government departments, academic institutions, NGOs, and the private sector. Engagement techniques to ensure integration of NMT principles into the backbone of all policy processes may include visioning workshops, public outreach processes, identifying technical leadership along with brainstorming on a NMT roadmap with short-term, medium-term, and long-term interventions with a timeline. Examples in the Indian context include Chandigarh⁶¹, one of the best practices shared as part of CSCAF best practices book.
 - 3.2 Satna non-motorized transport policy: The city can introduce a policy that would strengthen and sustain its efforts to improve NMT planning and implementation. Examples of cities with innovative policies include Chennai's Non-motorized Transport Policy (2014) aiming to increase the modal share of walking and cycling in addition to creating pleasant footpaths, complete streets with street furniture and infrastructure for children, cycle tracks and greenways, 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)⁶².
 - 3.3 NMT focused urban street design guidelines: In order to mainstream NMT principles within urban planning, the city can implement NMT focused, inclusive design guidelines to create streets that support non-motorized. Cities like Pune⁶³, Delhi, Mumbai⁶⁴ and Ahmedabad have already such guidelines in place. These guidelines act as binding documents that mandate street designs and urban renovation to include people-friendly aspects and support non-motorized mobility. A central coordinating body like an urban design cell, as in the case of Pune can be developed to facilitate this action⁶³. All new road development should follow these guidelines.
 - 3.4 Creating pedestrian-friendly plazas in the city: The city can develop pedestrian-friendly plazas within the municipal area of the city that get congested – for example around public tourist spots like Lake Nectar, Satna Mandi or Chamadiya market. 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.
 - > 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.
- **Inclusivity analysis:**
 - This central, multi stakeholder coordination should enable inclusive development and planning for increased walking and cycling networks in the city. It should ensure NMT access to the disabled and other vulnerable groups. (e.g.: wheelchair access from road to pavement, supports like railings for the elderly, separate cycle tracks with clear signage, separate lane for the disabled in pavements and removal of encroachments).
 - A dedicated area for street vendors can also be planned in the pedestrianization pilots to ensure they do not lose their livelihoods. Alternatively, they can be relocated after sufficient discussions and consultations.
 - Many cities in India have painted separations which are often encroached upon by cars. The cycle tracks must be physically segregated from roads and there should be clear signages to ensure safety of children cyclists⁶⁵.
 - It is important to use a variety of engagement channels to communicate with different audiences who have different needs. Stakeholder engagement must also be regularly tracked, monitored, and improved⁶⁶. It should also be done in local languages to increase uptake and a sense of ownership.
- **Implementing stakeholders:** Satna Municipal Corporation (lead), SCTSL, private operators, public, Urban Development and Housing Department (GoMP), Public Works Department (GoMP), traffic police, vendors, citizens, RWAs, shop owners.
- **Timeframe:**
 - Short term (1-2 years)
 - 3.1 Implementing a special NMT cell within SMC.
 - 3.2 Satna Non-motorized Transport Policy
 - Medium term (3-5 years)
 - 3.3 NMT focused urban street design guidelines.
 - 3.4 Creating pedestrian-friendly plazas in the city.
- **Possible 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), Government of Madhya Pradesh Transit Oriented Development Policy.
- **Monitoring indicators:** Creation and active functioning of an urban-level NMT cell, increase in length of inclusive and safe cycle and walking paths

(percentage of total road length), % reduction in emissions from the transport sector, increase in the modal share of NMT modes (disaggregated by gender and income), % of commuters walking or cycling to and from transit stations, ward level access to footpaths (disaggregated by low- and high-income wards).

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

Action 4: Increase the share of clean technologies shared vehicles in Satna

- **Challenges addressed at the city level:** Only 1.69% of shared vehicles in Satna run on clean fuel technologies¹¹. The PM 2.5 concentration in Satna is also 5 times above World Health Organization guidelines, indicating the need to shift towards cleaner fuels⁵⁵.
- **Description:**
 - **Leveraging the private sector:** SMC can tie up with private players such as OLA to increase the fleet of electric cars, 2-wheelers, buses, and rickshaws. For example, Nagpur launched Maharashtra's first multimodal e-mobility project with OLA⁶⁷. OLA launched a fleet of 200 EVs, primarily buses, taxis, and e-rickshaws. The company catered to over 350,000 customers, covering more than 7.5 million clean kilometers. This must be accompanied by strengthened charging and battery swapping infrastructure⁶⁸. The city is already planning to install 10 EV charging stations and had invited bids in September 2022⁶⁹. The city can consider the best practice from Mumbai, where the EV charging stations are set up at strategic locations, including popular retail malls, business hubs, highways, and neighborhoods. The chargers can also monitor the car battery charging status and the units consumed while charging a car⁷⁰. Satna can consider installing chargers in commercial complexes, auto rickshaw stands, taxi stands, tourist places around talabs, Satna Municipal Corporation office, etc.
 - **Promoting e-scooters:** Two wheelers account for 30% of mode share and have a huge potential to reduce emissions if shifted towards alternative fuels. Satna can implement an electric 2-wheeler sharing system⁷¹, involving private players such as Ola, Bounce and Vogo. Indore has a similar scooter sharing system called i-ride⁷². The scooters can be used through a pay and park scheme. Alternatively, the government can also look at implementing a program for taking back old petrol or diesel scooters and selling subsidized e-scooters for college students and working professionals. For example, Gujarat has a subsidy scheme for e-scooters and e-rickshaws, in which the state

government will give a subsidy of Rs 12,000 each to students to buy e-scooters⁷³. Additional incentives like free permits, exemption/ reimbursement of road tax or vehicle registration fee for five years, 100% waiver on parking charges at any municipal corporation run parking facility for five years⁷⁴, etc. can also be used, similar to the provisions for e-rickshaws under the MP EV policy.

- **Creating a single window process for installation of slow and fast chargers in the city:** Satna can create a single window process for residents to install fast and slow chargers. Example: in Delhi, private and public consumers can submit a request for new electricity connection (if required) and EV charger installation on the DISCOM's portal. DISCOM will approve the request based on load availability at the site. Post payment, DISCOM will install EV connection and EV meter at consumer's premises and EV charger vendor will install the EV charger(s) within 7 days of request approval⁷⁵. This can be accompanied with awareness creation on EVs, available models, incentives, etc to resident welfare associations and corporates.

- **Inclusivity analysis:**

- The city can provide some benefits for the private players for installation of EV chargers in government affordable housing complexes. Thus, making sure the infrastructure is accessible to all groups in the city. This will also increase the uptake of e-vehicles ownership by low-income residents⁷⁶.
- Access to loans for purchasing vehicles can be made easier 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 uptake⁷⁷.
- Information should be provided in English and Hindi and should be accessible to all through digital, print or radio platforms.

- **Implementing stakeholders:** Satna Municipal Corporation (lead), SCTSCL, MPPKVCL, MPUVN Satna smart city, private operators, charging infrastructure companies, community organizations and citizens

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

- **Possible alignment with schemes:** Madhya Pradesh Electric Vehicle Policy 2019, FAME phase II.

- **Monitoring indicators:** % increase in registration of electric vehicles across segments (RTO data), increase in the number of e-scooters sold, increase in the availability of reliable charging infrastructure in key areas of the city, percentage of use by low-income communities, % of low carbon shared vehicles in the city.

- **Alignment with CSCAF indicators:**
 - Indicator 1: Clean technologies shared vehicles under the mobility and air quality sector
 - Indicator 3: Fossil fuel consumption in the city within the energy and green buildings sector
 - Indicator 4: Level of air pollution under mobility and air quality.

Action 5: Implement and scale up an electric public bicycle sharing system

- **Challenges addressed at the city level:** Only 0.75% of road network has footpaths and cycle tracks¹¹.
- **Description:** Satna has already implemented a 5km cycle track and aims to increase it in the next phase. To promote cycling, the city should consider piloting a public bike sharing network at least in a small area.
 - Satna should first conduct a feasibility study to assess existing ridership for cycling, areas of high demand and infrastructure needed. They should also map existing informal cycling network and bike rental shops to integrate them into the new system.
 - Next, based on the above data, they should create a network design connecting areas with highest cycling and walking footfall. Cycle tracks can also connect tourist areas/ lakes and be rebranded in that manner. Separate cycle lanes should be created with physical barrier from road to avoid encroachment by private vehicles and improve cyclists' safety. As a next step, the city should ensure the cycle tracks are linked to bus stops and each bus stop or terminal has parking lots for cycles.

The city can aim to pilot some electric bicycles in Phase 1 itself. The example of Bhopal can be looked into, where they plan to electrify the public bicycle sharing system⁷⁸. Private sector players such as Yulu, a popular electric bike rental start-up in India already active in Mumbai⁷⁹, can be leveraged. The PBS system could have GPS enables e-bikes and designated automatic docking stations. The case of Belagavi⁸⁰ can be looked into where the Belagavi Smart City Limited (BSCL) together with Yaana bikes through a PPP model, has procured 100 e-bicycles, 100 e-bikes and 100 regular bicycles for its 20 smart docking stations. As the city is also reviving and redevelopment the major lakes in the city, Satna should focus on rebranding and effective marketing of cycle lanes and linking these to the talabs (lakes), green areas and other recreational spots.

- **Inclusivity analysis:**
 - Satna needs to ensure that the cycle tracks are inclusive and accessible to low-income groups and are physically segregated from the main road to ensure safety. The bikes should be tracked with

GPS to prevent theft. They should be affordable for all income groups. SMC should also ensure accessible modes for usage including digital and non-digital methods to cater to those without cellphone access. The PBS marketing should also be done in local language. Stands should be placed in low-income areas as well.

- The city can set nominal fees for the rent of the electric bicycles, so that it is affordable by all groups including low-income households and students. The city can look into similar examples like Chandigarh⁸¹, where the residents can hire the vehicles at a nominal Rs 10 for half an hour.

- **Implementing stakeholders:** SCTSL (lead), Satna Municipal Corporation, Satna smart city, private operators, research organizations, Transport Department (GoMP), traffic police, citizens.
- **Timeframe:** Short term (1-2 years) for introduction, medium term (3-5 years) for implementation.
- **Possible 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), Government of Madhya Pradesh Transit Oriented Development Policy, Madhya Pradesh Electric Vehicle Policy 2019.
- **Monitoring indicators:** Mode share for cycling, length of cycle paths in the city, % of low-income wards with cycle stands, # of cycles in the public bicycle sharing network.
- **Alignment with CSCAF indicators:** Indicator 3: Percentage coverage of NMT network (pedestrian and bicycle) in the city under mobility and air quality.

Action 6: Parking management policy for Satna

- **Challenges addressed at the city level:** Satna has a high mode share of private vehicles (76% currently¹²) and needs to reduce congestion and optimize parking demand.
- **Description:** The city needs to implement strict travel demand measures to disincentivize private transport. An example of this can be to introduce a parking levy and a subsequent parking management policy. As per the Smart City proposal², a smart parking system had been proposed for the city to provide accurate information on available parking spaces along with a parking guidance system aimed at saving time and fuel. This can be included within a larger parking policy.

The parking management policy can have measures that minimize on-street parking and plan for off-street

parking to reduce congestion and increase road space for NMT users, optimize existing parking facilities (for example through multilevel parking, app-based parking management, etc.) before creating new facilities, monitor illegal parking, and introduce paid parking⁸². Many Indian cities have existing or planned parking management policies in place including Indore⁸³, which is preparing a policy in partnership with the UK government, Jabalpur's smart parking system⁸⁴ and Pune's parking management policy⁸⁵. Shimla has a mandate for residents to provide proof of sufficient parking in their building before buying a car and no parking is allowed in main roads⁸⁶. The parking policy can also encourage electric or CNG vehicles by providing dedicated parking places or reduced parking fees for electric or CNG private vehicles and electric freight.

- **Inclusivity analysis:**
 - The policy can prioritize parking in the following order: physically disadvantaged, residents, short-term visitors for commercial activities and long-term parkers such as work commuters⁸⁷.
 - Plans for utilization of the parking fee revenue must be transparently communicated and used to improve overall urban welfare, e.g.: public transport or NMT infrastructure improvements⁸⁸.
 - Multi stakeholder consultations must be conducted in the planning and implementation stages.
- **Implementing stakeholders:** Satna Municipal Corporation (lead), SCTSL, Satna smart city, private operators, research organizations, Transport Department (GoMP), traffic police, citizens.
- **Timeframe:** Short term (1-2 years) for introduction, medium term (3-5 years) for implementation.
- **Possible 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), Government of Madhya Pradesh Transit Oriented Development Policy.
- **Monitoring indicators:** Reduction in private vehicle modal share, revenue from parking fines, parking policy implemented, ratio of maximum to minimum parking fee (as per the MOHUA transport SLB).
- **Alignment with CSCAF indicators:**
 - Indicator 3: Percentage coverage of NMT network (pedestrian and bicycle) in the city under mobility and air quality
 - Indicator 3: Fossil fuel consumption in the city within the energy and green buildings sector
 - Indicator 4: Level of air pollution under mobility and air quality.

Action 7: Prepare a clean air action plan

- **Challenges addressed at the city level:** Satna faces problems related to air pollution due to atmospheric wastes of cement factories². The SPM & RSPM are observed to be 387.6 & 263.5 microgram/ cum respectively, which are more than double the CPCB's permissible limits². As per CSCAF 2.0, Satna should develop a clean air action plan.
- **Description:** Satna recognizes air pollution and its associated hazards and monitors PM₁₀, PM_{2.5}, NO_x, and SO_x as per CPCB guidelines and CO, NH₃, Pb and O₃ as per NAAQS. The city also displays the available pollutant data in the public domain. However, based on the Ministry of Environment, Forest, and Climate Change's National Clean Air Program (NCAP), the city, with MPPCB, should develop a Clean Air Action Plan.

As a first step, Satna should conduct an emissions inventory and source apportionment study for the baseline (2023) and should collect sectoral data from transport, industries especially cement, brick kilns (if any), bakeries and waste sector (including waste burning, construction and demolition waste, etc). This should highlight the key sources of air pollution (PM 10 and PM 2.5) for the city from point sources and area sources. The major issues in each sector should be examined and bottlenecks identified to propose air pollution mitigation actions with clear targets and timeline. All the other MP smart cities have prepared such plans, which can be referred to.

In Surat's clean air action plan prepared by WRI India, key sectors considered were household cooking, construction, open burning of waste, industries, eateries, hotels and restaurants, transportation and non-exhaust emissions. Examples of actions and targets for Surat include transitioning to 10% electric bus fleet, 10% electric 3 wheelers and 5% electric 2 wheelers by 2026, discounts on road tax and municipal tax for those replacing pre BSVI vehicles to BS-VI vehicles, increasing the availability of Continuous Ambient Air Quality Monitoring Stations (CAAQMS), usage of fogging machines to reduce construction dust, to name a few⁸⁹.

- **Inclusivity analysis:**
 - The clean air action plan should include stakeholder consultations in every stage right from formulation to implementation, with representation from NGOs, low-income communities, regional transport office, autorickshaw union, industry associations, municipal departments, and other relevant organizations.
 - The plan should include some measures to mitigate air pollution amongst vulnerable communities. For example, Surat's clean air action plan assessed

the percentage of households using fuels like kerosene, firewood, and cow dung for cooking, which contributes to increased indoor air pollution. It was highlighted that the main reason for using these fuels was limited affordability of LPG for low-income households, who spend 6-8% of their monthly expenditure on cooking fuels as opposed to high income households (1-2%). Initiatives to promote LPG use in low-income communities included increased community awareness, promoting mini-LPG cylinders, and providing electric induction stoves especially for migrant workers living together with 50-50 funding from government and industries⁹⁹.

- **Implementing stakeholders:** MPPCB (lead), Satna Municipal Corporation, SCTSL, MPPKVCL, NGOs, auto rickshaw unions, research organizations, Transport Department (GoMP), traffic police, citizens.

- **Timeframe:** Medium term (3-5 years) with continuous monitoring and implementation.
- **Possible alignment with schemes:** National clean air action plan, Madhya Pradesh Electric Vehicle Policy 2019.
- **Monitoring indicators:** Preparation of a clean air action plan, % reduction in air pollution parameters (PM 10, PM 2.5), reduced incidences of diseases or mortality due to air pollution.
- **Alignment with CSCAF indicators:**
 - Indicator 3: Fossil fuel consumption in the city within the energy and green buildings sector.
 - Indicator 4: Level of air pollution under mobility and air pollution sector.



Goal 3: Water-Resilient Satna

River Tons, Son, and Paisuni are three important rivers of Satna District. Amongst these, the Tons River (also known as Tamsa River, a tributary of River Ganga) is the biggest and most prominent source of fresh water for Satna city. It is located about 43 kms away from Satna city¹⁶. The city had augmented its water supply system with an installed capacity of 59 MLD, which is estimated to be sufficient to cater to the water demand till 2031². However, Satna is likely to face higher impacts of climate change for different sectors. In terms of water resources, Satna faces high vulnerability, showing a high risk of decreasing availability of water, increasing crop water stresses, and increasing frequency of extreme events like floods and droughts. This necessitates Satna to ensure adequate water supply to new developments.

As per the Central Groundwater Board (CGWB) assessment⁹⁰, excessive sulphate content is found in deeper groundwater systems across the district, as observed in CGWB exploratory wells at various locations. Excessive sulphate in water acts as a laxative and a concentration of more than 200 mg/ liter causes stomach disorders in humans. Excessive nitrate content was also reported in Satna district. High nitrate content in ground water is perhaps from seepage of sewerage into groundwater, causing local pollution and contamination. Satna needs to consider actions around this. Moreover, given that Satna is a critical block with respect to groundwater availability as per Central Ground Water Board⁹, there is a need to increase recycling and reuse of wastewater.

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.
- **Description:** The city aims to have 24x7 water supply with 100% metering as per its Smart city proposal and has a water connection application and bill payment module under e-Nagarpalika initiative². As per CSCAF 2.0, the city should carry out the following measures:
 - Set up a water resources management team within the water utility department in SMC, 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. This should include collecting current and historical hydrological data. More guidelines on this are available in the NIUA guidance toolkit⁹¹.
 - 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. A demand management plan should comprise of a water supply status outlining current water supply sources, distribution losses and sectoral usage along with a water audit to establish where losses are happening in the network.
 - The city should then develop water management strategies. Satna can use treated wastewater for city services such as gardening, and cleaning. 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 2023⁹². These meters helped residents reduce their water consumption and allowed corporation to charge according to usage rather than a uniform rate. Housing societies can use this information to further come up with water conservation strategies.
- **Inclusivity analysis:** 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. Further, space to construct water management infrastructure (e.g., rain barrels, storage) may be unavailable in dense informal settlements. The implementation of demand side management interventions by Satna 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. Optimal demand management and monitoring of water loss can ensure more equitable access to water especially for slums and low-income households.

- **Implementing stakeholders:** Satna Municipal Corporation (lead), private agencies, MPPHED, resident welfare associations, water meter suppliers, NIUA, CGWB, NGOs working in this space.
- **Timeframe:** Medium term (3-5 years).
- **Possible alignment with schemes:** Smart Cities Mission, Smart Meter National Programme (SMNP), Madhya Pradesh Urban Services Improvement Project.
- **Monitoring indicators:** % reduction in water usage and tariffs for consumers, reduced non-revenue water (%), % of households with water supply.
- **Alignment with CSCAF indicators:**
 - Indicator 1: Water resources management within the water management sector.

Action 2: Capacity building for smart water governance

- **Challenges addressed at the city level:** As per the CSCAF 2.0 data, the city does not have a water resources assessment and demand management plan in place.
- **Description:** As per the proposed demand management plan in action 1, Satna can install water meters in all households and commercial buildings. In May 2022, SSCDL signed a 5-year contract with Itron and Yokogawa⁵ to monitor and reduce water loss in the city's water transmission network. The city will use SCADA data with Itron's hydraulic modelling to optimize the water distribution network, identify leaks, and help with water demand fluctuations. The solutions are to be deployed across Satna's water treatment plants, tanks, underground reservoirs, water pump houses and bulk water supply networks. However, AI-based systems will not be able to carry out the necessary data processing and data analyses completely autonomously⁹³. So additional personnel will be necessary for the handling of these AI-based systems. It is important to train and build capacities of the municipal staff, so that they are equipped to operate, maintain and trouble shoot the smart systems. As part of the capacity building initiative, Pune Municipal Corporation (PMC) has developed a digital literacy center⁹⁴ at Ghole road ward office, where employees can be trained on the implementation

and monitoring of digitization systems for smart governance. SSCDL and SMC can develop a similar center and conduct capacity building programs to train all the municipal officers and employees in the water and sanitation department.

- **Inclusivity analysis:**
 - Digitization in smart urban water governance can bring down the water lost due to physical leakages which could then be utilized to provide adequate quantity of water to the low-income sections of the society.
 - There also needs to be posters or media bulletins distributed in the low-income housing areas, preferably in the local language, to make them aware of this initiative and their access to clean water.
 - People from low-income communities can be trained in managing these water meters.
- **Implementing stakeholders:** Satna Municipal Corporation (lead), Satna Smart City Development Limited (SSCDL), Madhya Pradesh Public Health Engineering Department (GoMP), resident welfare associations, private agencies for providing smart meters and citizen forums.
- **Timeframe:** Medium term (3-5 years).
- **Possible alignment with schemes:** AMRUT: Funding for projects that strengthen water supply; Smart Cities Mission; MP Urban Services Improvement Project, Jal Jeevan Mission.
- **Monitoring indicators:** Reduced NRW (%), % increase in wards with access to drinking water, # trained officers, % houses covered with smart meters, # new jobs created (disaggregated by income type).
- **Alignment with CSCAF indicators:**
 - Indicator 1: Water resources management
 - Indicator 2: Extent of non-revenue water within the water management sector

Action 3: Implement an integrated flood and storm water management plan incorporating nature-based solutions

- **Challenges addressed at the city level:** As per CSCAF 2.0, the city has not conducted a flood/water stagnation risk assessment. Satna is also expected to face increasing risk of higher intensity of rainfall and urban flooding in the future.
- **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 plan⁹⁵ must include structural and non-structural strategies and is essential to:

- Reduce flood risks to roads and buildings.
- Incorporate storm water drains into new developments.
- Improve water reuse and water security.
- Reduce infiltration of untreated sewage into water bodies.
- Improve ground water table.
- Improve coordination and planning for flood risk management.

Strategies can include early warning systems, setting up rain recording stations, stock of drinking water in case of contamination during floods, creation of flood relief shelters, etc., similar to those suggested in Tripura's flood management plan which can be looked into⁹⁶.

The city can also incorporate sustainable urban drainage systems⁹⁷, 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, etc⁹⁸. Satna 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. They not only typically lack basic infrastructures that mitigate flooding or heat (e.g., trees for shade, proper storm-water drainage channels), but they also typically lack political representation. Satna city needs to regularly collect census data on informal, migrant, and low-income communities in order to capture the magnitude of risk for these communities. This disintegrated data should be utilized for a data-driven informed decision making²¹.
- Green infrastructure on public property, such as more street trees, green lawns, and roofs and bioswales may also raise nearby real estate prices that outprice low-income residents and unintentionally usher in "green gentrification⁹⁹." 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. These partnerships and holistic consultations with the different players push revitalization to be productive, rather than destructive, to low-income communities.

- **Implementing stakeholders:** Satna Municipal Corporation (lead), Satna Smart City Development Limited (SSCDL), Satna Development Authority, Water Resources Department (GoMP), Public Health Engineering Department (GoMP), gardens department, NGOs, RWAs.
- **Timeframe:** Medium term (3-5 years).
- **Possible alignment with schemes:** AMRUT- Thrust areas like sewerage facilities, septage management and storm water drainage management; Madhya Pradesh Urban Services Improvement Project by ADB.
- **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 under the water management sector. In accordance with level 5 under the climate action plan indicator, water sensitive urban design¹⁰⁰ considerations can also be incorporated in the city's master plan.

Action 4: Initiatives to promote wastewater recycle and reuse in Satna

- **Challenges addressed at the city level:** Less than 5% of treated water is reused in Satna¹¹. As per the DEP Satna 2021⁶, it has been identified that there are no industries which have a common effluent treatment facility for usage of treated wastewater for non-potable industrial uses.
- **Description:** As per the data from smart city, the city is currently undertaking the construction of 3 STPs. In August 2022, the city invited bids for construction of three sewage treatment plants (STPs) of 4 MLD, 4 MLD and 3 MLD capacity each, for wastewater flowing through Umri, Gahera and Khermai Nallahs. So, plants of 11 MLD total capacity are under construction and are expected to be completed as per the tender timelines over the next 11-12 months by 2024¹⁹. The treated water can be used in the following ways in the public, domestic and industrial sectors:
 - Reuse of treated wastewater for the management of parks and urban gardens: This will encourage decentralized wastewater treatment and reuse at the community level. Further, it would reduce pumping and supply of freshwater for gardening purposes, which in turn would reduce pressure on water supply system, especially during water stress season. Central Pollution Control Board¹⁰¹ also encourages this as this would also help the

- city increase and manage its green cover. This is being practiced in Delhi where decentralized STPs are being constructed in four main locations to treat water and supply it for parks and gardens, to reduce conveyance costs and energy as the current STPs are installed in distant locations¹⁰².
- **Promote use of treated water by industries:** Satna housing a major cement cluster, can collaborate with industries to reuse treated water. For example, cement production requires water for cooling heavy equipment and exhaust gases, in emission control systems like wet scrubbers and for preparing slurry in wet process kilns¹⁰³. Satna can issue a mandate to the industries within the city, to use treated wastewater. The best practice case of Nagpur can be examined. In Nagpur¹⁰⁴, the Nagpur Municipal Corporation (NMC) entered into a 30-year contract with a privately owned thermal power plant - wherein NMC provided wastewater and the company invested in the treatment plant and utilized the water, thus reducing their costs. The thermal plant in this case paid Rs 3.4 instead of Rs 9.6 per cubic meter of water, while NMC used the revenue generated to finance the operations and maintenance (O&M) of other water treatment plants in the city. Satna can also develop such models for implementation particularly for cement industries like MP Birla cement and Prism cement plant.
- **Inclusivity analysis:**
 - Existing city programs providing information on how to install and use wastewater management systems may be inaccessible to these groups and ineffective if they do not target women, who typically manage household water use. Thus, women should be placed at the center of the action while doing such city programs. SMC can host gender-sensitive trainings on installation and maintenance of decentralized water recycling systems. The trainings must be accessible to low-income and informal communities and can be done in local languages.
 - To generate practical awareness, involvement, and participation from local users for the decentralized approach, an online web-based tool — MOUNT (Menu on Un-Networked Technologies for Sewage and Septage Management) created by the Centre for Science & Environment, India¹⁰⁵ which comprises successfully implemented decentralized wastewater treatment technologies can also be used by the city during the training modules.
 - **Implementing stakeholders:** Satna Municipal Corporation (lead), Satna Smart City Limited, MPPHED (GoMP), MP Pollution Control Board, resident welfare associations, citizen forums, builders' associations, industry associations, NGOs.
- **Timeframe:**
 - Short term (1-2 years): 4.1 Reuse of treated wastewater for the management of parks and urban gardens
 - Medium term (3-5 years): 4.2 Promote use of treated water by industries
 - **Possible alignment with schemes:** Government of Madhya Pradesh State Level Policy (2017) for Wastewater Recycle & Reuse, AMRUT- Funding for water reuse projects, Smart Cities Mission, Ministry of Power's Power Tariff Policy of 2006 - mandating thermal power plants within 50 km of STPs to use treated sewage water¹⁰⁶.
 - **Monitoring indicators:** Increased water availability (MLD), Increased % of wastewater treated and reused, % of treated water used for gardening purposes in the city, reduced cost for freshwater use in industries, # of decentralized STPs installed in the city, # of industries reusing treated water, revenue generation for SMC.
 - **Alignment with CSCAF indicators:**
 - Indicator 3: Recycling and reuse of wastewater under the water management sector.

Goal 4: Satna as the Sustainable Cement Capital

According to India's third biennial update report, cement production was responsible for about 4% of the country's total emissions¹⁰⁷. These emissions arise from electricity usage (13%), combustion of fossil fuel (coal, gas etc. for energy use) (31%), and the conversion process of limestone into lime (process emissions), which accounts for 56%¹⁰⁸. Satna being the cement capital of India, contributes to 9% of India's cement production. However, the 10 cement factories in the city are also major sources of air pollution². Moreover, a major portion of GHG emissions from stationary energy (49%) comes from manufacturing industries including cement. Satna attracts unskilled workforce from regional hinterland due to opportunities in its industries. At the same time, skilled and semi-skilled work force in Satna is compelled to migrate to larger cities such as Jabalpur, Bhopal, and Indore due to limited employment opportunities in Satna. Since, industrial activity primarily from exporting cement is the primary economic driver for Satna, it becomes imperative to address climate resilience and emissions reduction in the cement industry.

Identified Actions

Action 1: Develop a low-carbon roadmap for Satna's cement industries

- **Challenges addressed at the city level:** There are only three Perform Achieve and Trade (PAT) designated cement industries in Satna including Maihar cements, Prism Cements and Birla cements¹⁰⁹.
- **Description:** With its 2.2 million tonnes per annum clinker capacity, Satna has some major cement production plants including Satna Cement Works¹¹⁰ (Birla Cement Plant), Satna Cement Mines, Jaypee Cement Plant, and the Prism Cement Plant¹¹¹. Each ton of cement produced generates around 0.7-0.93 tCO₂e depending on the kiln technology used¹¹². The city must develop a focused approach and a low-carbon roadmap for the cement industries to identify different strategies for GHG emissions mitigation in the sector. MPPCB's regional office and Satna Municipal Corporation in collaboration with research organizations/ NGOs can develop an emissions inventory for the sector and conduct an updated air quality assessment specifically pertaining to the cement clusters in consultation with cement manufacturers. This assessment can help build the foundation of a holistic low-carbon roadmap for the cement industry with set short, medium, and long-term strategies such as¹¹³:
 - Promoting alternative fuel use: Satna can introduce tenders to set up co-processing plants for using waste as fuel for cement industries. For example, the foundry sand which is a waste of the foundry industry can easily replace the Silicates required in the cement industry¹¹⁴. Plastic can also be used as a source of fuel. Other alternative fuels include rubber waste, residue oil, wood waste, used tires, thermal fraction from domestic waste, sewage sludge or animal meal¹¹⁵.
 - Promote usage of best available technologies (BAT) for new and retrofitted kilns: The city can provide one-time payments or subsidies to cement industries for deploying BATs. Satna can also collaborate with international and national agencies, research institutions and finance institutions working in this space to support awareness creation and capacity building for implementing low carbon BATs.
 - Promote and providing training for setting science-based targets: The Cement Science Based Target Setting Guidance is the world's first framework for companies in the cement sector and other users of cement like construction businesses, to set short term and long-term science-based targets in line with 1.5°C¹¹⁶. SMC can collaborate with experts to provide trainings on the same.
 - Increase energy efficient retrofitting of plants: SMC in partnership with a few NGOs or research organizations can conduct pilot assessments to understand the current uptake of energy efficient equipment and processes in the big cement plants in Satna. Studies indicate that modern cement plants consume 68-93 units to produce a ton of cement while plants with older equipment's use up 110-120 units of electrical energy¹¹⁷. The city can conduct awareness programs for industry associations and promote technologies such as waste heat recovery system (WHRS), that have the potential to generate 20 to 30% of a plant's power requirements¹¹⁸. At Birla Vikas Cement Works¹¹⁹, India, the older and inefficient raw mill vent fans were replaced by more-efficient fans, and variable speed drives were installed to control the air volume. This action helped reduce the energy consumption by 0.36 kWh per ton of clinker.
- **Inclusivity analysis:** While developing this transition roadmap, it is essential to assess the impact of new technologies and interventions on the workers employed in the cement industry. The cement industry often relies on migrant workers; thus, any big

intervention would have an effect on their livelihood. Thus, the roadmap must consider the equity aspects in terms of new jobs created and upskilling programs conducted for all the workers whose livelihood is dependent on the cement manufacturing and processing industries in Satna.

- **Implementing stakeholders:** MP Pollution Control Board (lead), Satna Municipal Corporation, cement manufacturing companies, CPCB, citizens, international organizations, experts, workers unions.
- **Timeframe:** Short term (1-2 years) for developing roadmap with short-, medium- and long-term actions.
- **Possible alignment with schemes:** Perform Achieve and Trade (PAT) scheme of Ministry of Power, Government of India, National Clean Air Action Plan.
- **Monitoring indicators:** Development of a plan, reduced emissions from cement industry, % reduction in air pollution due to cement industry, % reduction in GHG emissions from manufacturing sector.
- **Alignment with CSCAF indicators:**
 - Indicator 3: Fossil fuel consumption in the city under the energy and green buildings sector
 - Indicator 4: Level of air pollution under the mobility and air quality sector.

Action 2: Business models to use alternative fuels and raw materials (AFR) in cement production

- **Challenges addressed at the city level:** 49% of stationary energy sector's GHG emissions comes from the manufacturing sector, including cement industries.
- **Description:** Co-processing is the use of waste as an alternate source of energy or raw material or both to fossil fuels such as coal, petroleum coke etc. in the manufacturing process for cement production. Owing to its economic, environmental and social benefits, it has been recognized as one of the five important levers for large scale reduction of CO₂ emissions from Indian cement industry. Satna can explore pilots for promoting co-processing of waste and usage of alternative fuels and raw material in its cement plants¹²⁰. Examples include:
 - **Co-processing of plastic waste:** Satna can encourage cement industries to use plastic waste and enter into collaboration models to sell plastic waste at a nominal rate to industries. Satna can also set up a waste to refuse derived fuel (RDF) plant. A first of its kind plant has been set up in Meghalaya by a Korean company¹²¹. Kumbakonam municipal corporation converts its non-recyclable plastic waste into refuse-derived fuel and sends it to the Dalmia and Ultratech cement plants for

co-processing. The municipality bears the transportation charges. The Dhenkanal Municipal Corporation, where non-recyclables are sent to a cement plant through a formal agreement facilitated by a private agency. Indore also uses non-recyclable plastic waste in cement plants¹²². Ultratech Cement's Reddipalayam plant has achieved a 25% alternative fuel substitution rate using waste from 11 municipalities in Tamil Nadu and Kerala¹²³. Satna can also explore models to import waste from other cities and selling it to the cement factories.

- **Collaboration with cement industries:** Satna can enter into memorandum of understanding with cement plants like Birla and Prism for using RDF. For example, Municipal Corporation of Delhi (MCD) entered into an agreement with JK Cement to lift RDF from landfills. JK Cement will pay Rs. 100 per Mt to MCD for the RDF and will get Rs. 300 per Mt transport subsidy if it lifts less than 5000 Mt per month, Rs. 400 per Mt if it uses between 5000-7000 Mt per month and Rs. 500 transport subsidy per Mt if it uses more than 10,000 Mt per month. MCD is expected to save Rs. 6.7 Crores through this initiative¹²⁴.
- **Co-processing other non-recyclable waste:** Surat converts cloth waste and non-recyclable plastic into refuse derived fuel for cement factories and makes Rs. 6.9 lakh per annum. Chandrapur in Maharashtra sends non-recyclables like rubber, leather and thermocol to cement kilns for RDF¹²².

- **Inclusivity analysis:**
 - Satna can ensure employing more youth especially from low-income groups as well as informal waste pickers in the managing and operation of the RDF plant or in the collection and transportation of waste.
 - Training and expert workshops can be provided to cement industry associations and workers in collaboration with MPPCB to increase their awareness and address their concerns around the use of RDF in cement production.
- **Implementing stakeholders:** MP Pollution Control Board (lead), Satna Municipal Corporation (waste department), cement manufacturing companies, CPCB, citizens, experts, informal waste workers.
- **Timeframe:** Short term (1-2 years)
- **Possible alignment with schemes:** CPCB Guidelines for Co-processing of Plastic Waste in Cement Kilns 2017, Swachh Bharat Mission Urban 2.0.
- **Monitoring indicators:** % of non-recyclables used as RDF, % of cement industries using municipal waste for RDF, increase in revenue generation for Satna Municipal Corporation, reduced emissions from cement manufacturing.

- **Alignment with CSCAF indicators:**
 - Indicator 3: Fossil fuel consumption in the city under the energy and green buildings sector
 - Indicator 4: Level of air pollution under the mobility and air quality sector

Action 3: Promote use of fly ash in all new constructions, cement roads and flyover embankments

- **Challenges addressed at the city level:** Satna faces air pollution problems due to the atmospheric wastes from cement factories, with the pollution levels double the CPCB thresholds².
- **Description:** Clinker is the main component in most types of cement. Mixing alternative materials like fly ash, which is the residue from coal fired plants can reduce the fuel and power related emissions from clinker production¹¹¹. Fly ash, if not managed properly pollutes water, air and soil. The Satna Municipal Corporation can mandate the use of alternative building materials— like bricks made from fly ash (residue from coal-fired cement plants) in all new construction of buildings and cement roads. The city can also provide guidelines on the minimum blending ratio. Nagpur¹²⁵ has mandated the use of fly ash bricks for all new constructions, making it a pre-condition for building plan approvals. As per the Maharashtra fly ash utilization policy 2016, use of fly ash is also mandatory in cement roads. The Nagpur Municipal Corporation (NMC) had signed an MOU with the MahaGENCO Ash Management Services Limited, a subsidiary of the state power generation company for utilization of fly ash. The Brihanmumbai Municipal Corporation (BMC) also proposed the use of fly ash to make concrete and bricks for constructing buildings, in its Development Control and Promotional Rules (DCPR) in 2016¹²⁶. An article stated that the MP power stations are struggling to dispose of the polluting fly ash¹²⁷. This action would address the existing issues that the city and power stations are facing, thus resulting in a win-win situation.
- **Inclusivity analysis:**
 - The traditional coal-fired brick kilns do not provide a stable source of income for workers. The kilns close during the monsoon, thus giving unstable income for the workforce and pushing them to look for other work. Conducting skill development programs in partnership with councils like Building Materials and Technology Promotion Council (BMTPC)¹²⁸, for skilling the existing workforce with capacities to manufacture bricks out of fly ash, might give more employment opportunities for the workers during that time.
 - Mandating use of fly ash bricks in the new construction of buildings, cement roads and flyover embankments could open value pools around

green building materials and promote business for small start-ups manufacturing green/alternative building materials like the fly ash bricks and those in their supply chain.

- **Implementing stakeholders:** Satna Municipal Corporation (lead), MPPCB, cement plants, Satna Smart City Development Limited, Confederation of Real Estate Developers' Associations of India (CREDAI), Building Materials and Technology Promotion Council (BMTPC), material manufacturers.
- **Timeframe:** Short term (1-2 years), long term (>5 years) for continued implementation and monitoring.
- **Possible alignment with schemes:** The Fly Ash notification (1999) amended in 2003, 2009 and 2016, Swachh Bharat Mission Urban 2.0.
- **Monitoring indicators:** % reduction in air pollution from cement industries, % recycling and reuse of fly ash in construction of new buildings, roads and flyover embankments, housing products, % reduction in GHG emissions from cement industries.
- **Alignment with CSCAF indicators:**
 - Indicator 4: Level of air pollution under the mobility and air quality sector
 - Indicator 1: Waste management initiatives in the city under the waste management sector

Goal 5: Rejuvenate Green & Blue Spaces in Satna

The city of Satna aims to increase its percentage of green cover and open spaces. As per CSCAF 2.0, the city has only 1.39% of green cover out of the total municipal area. As per the data from the smart city, Satna has completed the redevelopment of Lake Nectar and Lake Bhima. It has also nearly completed constructing and developing the Amodha Talab (lake), Jagat dev Talab and is working on the construction and redevelopment of Narayani talab (lake), Dhawari Talab (lake) and Santoshi mata Talab (lake)⁷. Along the urban biodiversity lens, the city does not have an established city-level biodiversity management committee and has not conducted a baseline assessment for urban biodiversity management. The city has also not identified measures to increase urban biodiversity by allocating sufficient resources for implementation. Though Satna is already undertaking considerable measures to increase the green cover by the redevelopment of talabs, it is also important to maintain and manage these spaces in an inclusive manner by engaging citizens in the management.

Identified Actions

Action 1: Engage citizens in the conservation and management of the green and blue spaces in the city

- **Challenges addressed at the city level:** As per the CSCAF 2.0 data, the city had only 1.39% of green cover out of the total municipal area in 2020.
- **Description:**
 - **Citizen championship initiatives:** Satna has already set an example by involving its residents in the upkeep of urban greenery, where they adopt parks and take care of their maintenance¹²⁹. They have also been implementing the save the seeds campaign where they collect seeds from citizens and plant them across the city³. Involvement of citizens, local institutions like resident welfare associations, self-help groups, urban forestry experts and NGOs is crucial for conservation and management of these spaces. Satna can introduce “citizen greening championship programs” and even do outreach of this initiative on their website, where the interested citizens can enroll to be part of the initiative. The city can then form groups depending on the location and nearest accessible open space of the representative, and then each representative can be assigned to maintain these developed open spaces. The representatives can be incentivized with food coupons as a token of appreciation. This program can also provide funding for individuals, companies or NGOs who want to engage in greening projects. The city can create an app for effective monitoring of this initiative, where citizens can upload the photos of their conservation journey. By this way, the city can ensure that the green spaces are also well maintained in an inclusive manner.
 - **Mapathons to identify new green spaces:** Satna can organize events like collective citizen-driven mapathon to map out potential areas for new urban forests, gardens, or parks. This will engage citizens and tourists in the mapping and conservation of urban green spaces and will also instill a sense of responsibility and ownership amongst citizens. Kochi did something similar within the Cities4forest project implemented by WRI India¹³⁰. Mapathons were regarded as a good idea to understand new areas for plantations, as per the consultations.
 - **Digital methods to spread awareness:** Bengaluru also has an open-source platform providing guidance and tools for mapping trees in the city¹³¹. Satna can also introduce apps to help citizens map trees and also identify the best type of trees to plant, based on the conduciveness of the location. Examples include Kerala¹³², where an app was launched to help citizens identify the types of trees to plant based on their location and Goa¹³³, which helps citizens geotag trees and monitor their health. Technical organizations can also be involved in helping SMC prepare GIS based maps of urban green cover on a yearly basis to understand decrease or increase of green cover with time. Satna can examine the case of Nagpur, which has prepared a methodology to map urban green spaces using GIS¹³⁴.
- **Inclusivity analysis:**
 - Satna should first conduct a GIS based mapping of green spaces and ward level access to understand the distribution of green and open spaces amongst low- and high-income wards. This will help the city develop actions for an equitable increase in green spaces. Slums usually are exposed to high heat stress due to poor vegetation, like in Mumbai where slums were 5-6 degrees hotter than their neighboring localities⁴¹.
 - Satna can involve more school and college students in the geo-tagging and mapping exercises to increase awareness from a young age. They can in-turn spread the knowledge to their families, many of whom may come from low-income communities.
 - The new green spaces must have safety and accessibility features like seating, adequate lighting, etc. to provide comfort for all age groups, elderly and disabled.

- **Implementing stakeholders:** Satna Smart City Development Limited and Satna Municipal Corporation (lead), councilors, local experts, citizens, Directorate of Town, and Country Planning, GoMP, NGOs, schools and colleges, digital solutions providers.
- **Timeframe:** Short term (1-2 years), long term (>5 years) for continued implementation and monitoring.
- **Possible alignment with schemes:** AMRUT: 2.5% of project cost is funded for development of parks with children- and elderly-friendly features, Nagar Van Scheme, Green Highways Mission, Van Mahotsav, National Clean Air Programme.
- **Monitoring indicators:** Number of communities represented in the citizen engagement initiatives, increase in urban forests, increase in percentage of urban green cover and biodiversity, # of mapathons conducted.
- **Alignment with CSCAF indicators:**
 - Indicator 1: Rejuvenation and conservation of water bodies and open areas.
 - Indicator 2: Proportion of green cover under urban planning, green cover and biodiversity.

Action 2: Set up a biodiversity committee and develop Local Biodiversity Strategies and Action Plans (LBSAP)

- **Challenges addressed at the city level:** As per CSCAF 2.0, the city does not have an established city-level biodiversity management committee and has not conducted a baseline assessment for urban biodiversity management. The city has also not identified measures to increase urban biodiversity by allocating sufficient resources for implementation.
- **Description:** As a first step, Satna should institute a city level biodiversity committee which can include representatives from Horticulture Department, Forest Department, TCPO, ULB, and Development Authority, as per the Biological Diversity Act, 2002. The committee can then engage in community-driven small-scale pilot exercises to develop local biodiversity strategies and action plans (LBSAPs)¹³⁵ for Satna in order to prioritize urban biodiversity management and integrate biodiversity issues with local planning. The steps involved in preparing local biodiversity strategies and action plan as provided in the learning document¹³⁶ under CSCAF are:
 - Collecting and assessing existing data and information: National, regional, and local ecological databases along with existing surveys, records, photos, maps, projects, and studies related to the city's ecosystems can be valuable sources. For example, a study¹³⁷ was conducted to assess the

biodiversity of Mukundpur region in the Satna Forest district and the area was identified as a rich source for medicinal and herbal plants, mainly used by the indigenous rural communities. Another example is the biodiversity register developed by the Pithorabad Biodiversity Committee in the Pithorabad gram panchayat in Satna District¹³⁸.

- 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 Index¹³⁹ 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 indexes¹⁴⁰ 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 plans¹⁴¹. 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. Satna can adopt a similar approach.
 - **Implementing stakeholders:** Satna Municipal Corporation and MP State Biodiversity Board (lead),

EPCO, city biodiversity committee, councilors, local experts, citizens, School of Planning and Architecture Bhopal, NGOs, local activists.

- **Timeframe:** Medium term (3-5 years) for development and long term (>5 years) for implementation.
- **Possible alignment with schemes:** National Biodiversity Action Plan 2014¹⁴², Integrated Development of Wildlife Habitats (IDWH) scheme.
- **Monitoring indicators:** Development of biodiversity strategies and action plan, calculation, and improvement of the City Biodiversity Index, increase in species diversity (as per species list and area map).
- **Alignment with CSCAF indicators:**
 - Indicator 2: Proportion of green cover.
 - Indicator 3: Urban biodiversity under urban planning, green cover and biodiversity.

Action 3: Implement green walls and terrace gardens

- **Challenges addressed at the city level:** As per CSCAF 2.0, only 1.39% of municipal area comprises of green cover.
- **Description:** Vegetated vertical gardens can serve as a biofiltration system to treat grey water from buildings and provide cooling effect. Cities have already started implementing these mainly in flyover pillars and buildings. Ludhiana Municipal Corporation¹⁴³ is planning for green walls to cover pillars on Southern bypass while Delhi has also implemented the same in metros and flyover pillars. Walls with green vegetation showed a temperature drop up to 2°C¹⁴⁴. Satna can implement the same under flyovers and municipal buildings. They can also incentivize vegetated walls in new residential and commercial buildings through property tax rebates, reduced utility bills or coupons with discounts.

Another option is implementing terrace gardens. Urban green terraces are an efficient way to integrate greening into existing urban infrastructure. Urban green terraces are an efficient way to integrate greening into existing urban infrastructure while also helping residents reduce food costs by cultivating their own produce. The government can take steps to increase awareness and interest in green terraces. An example is the case of Madurai, where the government is selling subsidized terrace garden kits¹⁴⁵. The kits contain 10 seed varieties, bags, and manure. The government of Tamil Nadu also provides 50% subsidy for procuring materials to start a green terrace under the “do it yourself” kit program. Each buyer can avail the subsidy five times¹⁴⁶. Bihar has also started a

similar program along with training workshops for farmers and residents¹⁴⁷. Further incentives to reduce costs can be tax rebates for residential communities with terrace gardens. Satna can collaborate with the state government to promote terrace gardens in schools and houses.

- **Inclusivity analysis:** Low-income areas may lack adequate rooftop infrastructure for such initiatives. In these cases, common community terrace gardens or kitchen gardens can be explored in community spaces like schools, public gardens, Anganwadis, etc. Children can also be involved in managing these gardens, thereby increasing awareness from a young age.
- **Implementing stakeholders:** Satna Municipal Corporation (lead), EPCO, councilors, local experts, citizens, Horticulture and food processing department, Government of Madhya Pradesh, Satna Development Authority.
- **Timeframe:** Medium term (3-5 years) for development and long term (>5 years) for implementation.
- **Possible alignment with schemes:** Nagar van scheme.
- **Monitoring indicators:** % of vertical vegetated gardens installed in the city, % of buildings with vertical vegetated gardens and terrace gardens, % increase in green cover in the city.
- **Alignment with CSCAF indicators:**
 - Indicator 2: Proportion of green cover.
 - Indicator 3: Urban biodiversity under urban planning, green cover and biodiversity.

Goal 6: Towards a Climate-Smart & Circular Waste Economy in Satna

As per the district environment plan 2021 for Satna⁶, the city generates about 90 TPD of MSW. The city also has 100% door-to-door collection of MSW. About 9 TPD is the estimated quantity of plastic waste generated. The city has no infrastructure in place for collection/processing of C&D waste recycling facility. Though the city has been recognized for its sanitation practices, the waste management sector needs to be strengthened further to reduce emissions and improve livelihoods in an inclusive manner.

Identified Actions

Action 1: Increase collection of e-waste in the city by including the marginalized/informal sector

- **Challenges addressed at the city level:** As per the DEP Satna 2021, the city has a partial gap as there are only 2 e-waste collection centers in the city, however it has been identified that the city has no collection centers established by producers. There are also no authorized e-waste recyclers or dismantlers.
- **Description:** To improve the collection and recycling of e-waste, Satna can consider public-private partnership models, similar to the case of Jamshedpur¹²². Jamshedpur had hired a single recycling company (Hulladek Recycling Private Limited) dedicated for e-waste management and working as a producer responsibility organization (PRO), an organization authorized or financed collectively or individually by producers to collect and recycle e-waste from end-of-life products. The following are some key aspects that worked in this system:
 - **Collection and segregation:** Monthly collection was done by two Hulladek e-rickshaws with 2 staff members for collection and awareness creation. 80 municipal vehicles also collected e-waste in a segregated compartment along with regular dry and wet waste. 200-250 households were covered by door-to-door e-waste collection. Satna can increase the e-waste collection centers in the city through collaborations with platforms such as Sanshodhan¹⁴⁸ and Karo Sambhav¹⁴⁹.
 - **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.
 - **Storage, transportation, processing, and disposal:** The e-waste management center by Hulladek has a capacity of 35 Mt from where it is transport to a

warehouse in Kolkata with a capacity of 160 Mt. From there, it is sent to six authorized recyclers. SMC 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, reimbursement of municipal taxes for three years and capital investment subsidies of Rs 1 crore for a minimal investment of Rs. 5 crores for first 5 recyclers and refurbishers¹⁵⁰. This would boost recycling and refurbishing of e-waste in Satna and reduce the carbon emissions released by this sector.

- **Inclusivity analysis:** The city should conduct a baseline assessment of all the informal waste pickers and formalize them with IDs, health benefits, regular pay, etc. The city should provide the workforce with more accessible equipment, knowledge, and skills. This will form an opportunity to bridge the informal and formal sectors to build more inclusive and sustainable e-waste chains.
- **Implementing stakeholders:** Satna Municipal Corporation (lead), MPPCB, research organizations, informal waste pickers, electronic companies, citizen groups, private organization.
- **Timeframe:** Medium term (3-5 years).
- **Possible alignment with schemes:** E-waste Management Rules, 2016, Swachh Bharat Mission Urban 2.0.
- **Monitoring indicator:** % reduction in GHG emissions from waste, # of e-waste collection centers in the city, % of electronic waste recycled, # of new jobs created.
- **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: Upgrade waste collection and transportation infrastructure to electric vehicles

- **Challenges addressed at the city level:** The city lacks shared vehicles running on clean fuels, including municipal fleets. Moreover, 23% of total GHG emissions were 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 Pradesh¹⁵¹ and in Chennai, Tamil Nadu¹⁵² on a PPP basis. Indore Municipal Corporation (IMC) has also deployed a fleet of 25 electric vehicles for waste collection, as part of the clean air initiative¹⁵³. The city can also collaborate with a few EV operators and pilot test the use of EV tricycles in the city for municipal garbage collection. The Greater Chennai Corporation has collaborated with a private company to introduce 14 electric tricycles for garbage collection¹⁵⁴ under the Corporate Social Responsibility project (CSR) of State Bank of India to fund these e-tricycles. Satna can also tap a few CSR funds to procure EV tricycles in the city. Based on the findings during the trial run in Chennai, it is claimed that these vehicles will operate at 50% higher capacity and at half the price compared to the existing electric vehicles available for the Greater Chennai Corporation.

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

- **Inclusivity analysis:** SMC should ensure that the drivers of these new electric waste pick-up trucks, who are usually from low-income communities are provided training and capacity building on operating and managing the fleet. New jobs for low-income groups and women can also be created through the setting up and management of charging infrastructure through sufficient training.
- **Implementing stakeholders:** Satna Municipal Corporation (lead), SSCDL, private operators, public, research organizations, RWAs, MPPKVVCL, MPUVN, Charging manufacturers.
- **Timeframe:** Medium term (3-5 years).
- **Possible alignment with schemes:** Solid Waste Management Rules 2016, National Clean Air Action Program, FAME Phase II scheme.
- **Monitoring indicators:** % of EV vehicles in total waste collection fleet, % of women EV vehicle drivers for waste collection, % reduction in emissions from transport sector.

- **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.

Action 3: Plan for efficient recycling of construction and demolition waste

- **Challenges addressed at the city level:** City does not have a C&D recycling plant and does not measure the quantity of C&D waste generated.
- **Description:** C&D waste assessment: Satna's C&D waste generation is not provided in the District Environmental Plan. As a first step, the city should assess the total construction and demolition waste generated ward wise, map out organizations and create a database of bulk generators. SMC should also assess the current methods of disposing waste (how much is recycled by bulk generators and how much is dumped in low lying areas or landfill). Based on the quantity of waste generated and current processing methods, a recycling facility and collection center can be established, and a public private partnership model can be explored similar to Delhi and Gurugram.

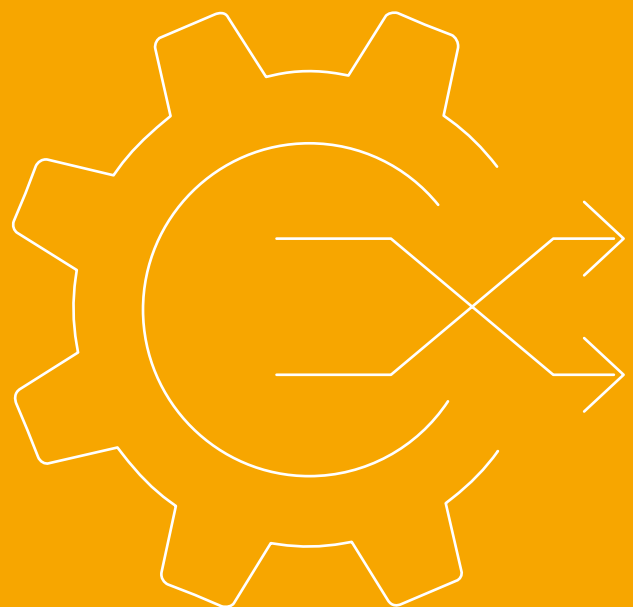
C&D waste management: The city can also have separate C&D waste collection vehicles. Delhi introduced 92 vehicles and 23 machines for exclusive collection of C&D waste and also geotagged and color coded them for easy identification. One municipal officer was appointed in each ward to oversee the collection and transport of waste and fine generators for non-disclosure. The city of Satna can procure electric vehicles for the collection of this waste to transport to the recycling center. The treated C&D waste can be used to make ready-mix concrete, cement bricks, hollow bricks, pavement blocks, curb stones, concrete bricks, and manufactured sand, for use in new construction. Over 16 lakh C&D waste recycled blocks have been used in the construction of new Supreme Court annex building in Delhi¹²².

- **Inclusivity analysis:** This action would incorporate effective coordination between public and private agencies and stakeholder engagement for collection and disposal of C&D waste. Jobs can be provided for informal workers from low-income groups to manage the recycling facility, monitor the waste, etc. For example, Municipal Corporation of Gurugram had provided ID cards and uniforms for the employees in these centers along with authorization letters for collection and enforcement¹²². Effective public engagement would also increase awareness and accountability for managing the waste.

- **Implementing stakeholders:** Satna Municipal Corporation (lead), Satna Smart City Development Limited, bulk generators, informal waste pickers, citizen forums, residential welfare associations, bulk waste generators for C&D waste.
- **Timeframe:** Medium term (3-5 years).
- **Possible alignment with schemes:** Swachh Bharat Mission Urban 2.0, FAME phase II.
- **Monitoring indicators:** % of C&D waste recycled, % reduction in air pollution from construction waste, % reduction in waste sector GHG emissions, # of vehicles for C&D collection, # of new jobs created.
- **Alignment with CSCAF indicators:** Indicator 3: Construction and demolition (C&D) waste management under waste management.



IMPLEMENTATION AND GOVERNANCE OF SATNA CLIMATE ACTION PLAN



Creation of Satna Climate Change Cell

Satna Municipal Corporation is responsible for infrastructure development and citizen service. On the other hand, Satna 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 the development planning. Effective implementation of the plan requires mainstreaming climate actions within the scope of existing departmental priorities, project plans and future proposals by creating a dedicated cadre/working cell.

| Priority 1

Creating Satna climate change cell

- **Description:** To align with the State Action Plan on Climate Change and implement the Satna 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, Aurangabad etc. have developed such a cell which is tasked with the implementation and monitoring of the plans. The climate cell needs to coordinate with State Knowledge Management Centre on Climate Change, EPCO, Department of Environment, Government of MP, which is the state nodal agency for climate change to implement and report the progress of the actions proposed in the plan. 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, Satna 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, Satna Smart City, or nominated official (Member Secretary)
- **Implementation time:** Short term (1-2 years).

Creating a Satna 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 for every \$1 spent on flood protection infrastructure¹⁵⁵ 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 FY2021-22¹⁵⁶, the state has allocated Rs 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 by a green transition. Rs 2,581 crore which has been allocated to Atal Grah Jyoti Yojana, has also been aligned with some of the actions proposed in the plan. Rs 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.

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'¹⁵⁹ which earmarks funds for specific climate change programs. Odisha has a climate budget framework¹⁶⁰ institutionalized for its cities. Chhattisgarh, Assam, and Maharashtra are tracking the climate change relevance of their developmental projects through budget coding¹⁶¹. 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 4: State vulnerability score and financial expenditures

State	State Vulnerability Score ¹⁵⁷	Overall Average CSCAF 2.0 scores of MP's Smart cities	SDG Progress ¹⁵⁸ (Benchmark Score 66)	Status of Climate Budget in Public Expenditure Budget FY-21- 22	Scope of Urbanization and Climate Vulnerability
Madhya Pradesh	Medium Vulnerability	High Vulnerability ★ ★ ★	Performer-62	No climate budget framework institutionalized	7 smart cities

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

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

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

References

- ¹ Ministry of Housing & Urban Affairs PIB, Swachh Survekshan 2019 to focus on sustainability and public participation, Aug 2018
- ² Ministry of Housing & Urban Affairs, GoI, Smart City Proposal Satna, 2017
- ³ Punjab Kesari, save the seeds campaign started to increase greenery, June 2021
- ⁴ News18, Satna's cycle track becomes resting place for cows and buffaloes, waste of crores, December 2022
- ⁵ Itron website, Itron and Yokogawa electric corporation reduce water loss in India, May 2022
- ⁶ Office of the District Collector, Satna, Dist. Satna (M.P.), District Environmental Plan, Satna, September 2021
- ⁷ Satna Smart City website, projects list
- ⁸ GoMP, Urban Development and Environment Department, Presentation on Detailed Project Report for Satna under Rajiv Awas Yojana, 2015
- ⁹ Ministry of Water Resources, Central Ground Water Board, District Ground Water Information Booklet, Satna District, 2013
- ¹⁰ World Resources Institute Ross centre, Washington, DC Beard, V.A., A. Mahendra, and M.I. Westphal, "Towards a More Equal City: Framing the Challenges and Opportunities." October 2016
- ¹¹ CSCAF 2.0
- ¹² Ministry of housing and urban affairs, Open data platform, Smart cities, Public Transport Mode Share Satna
- ¹³ Mercom, clean energy insights, Bids Invited for Setting up 10 EV Charging Stations in Madhya Pradesh, August 2022
- ¹⁴ Ministry of Housing and Urban Affairs, Service Level Benchmarks for Urban Transport at a Glance
- ¹⁵ International Journal in Physical and Applied Sciences, Tiwari, Chaurasia, Pratap Singh, Study on the source of water supply of Satna city (M.P.), November 2019
- ¹⁶ Indian School of Development Management, Realising India Series 2017-2018: Satna, November 2019
- ¹⁷ Ministry of Urban Development, Government of India, Handbook of Service Level Benchmarking
- ¹⁸ E-tender, Tender floated for laying sewerage network in Satna municipal area, June 2021
- ¹⁹ Office of the Satna municipal corporation, E-tender, Construction of three STPs in Satna, July 2022
- ²⁰ Ministry of Water Resources Central Ground Water Board, North Central Region, Government of India, District Ground Water information booklet, Satna district, 2013
- ²¹ C40 WRI Ross Centre, Inclusive planning executive guide - How to tackle climate change and inequality jointly, October 2019
- ²² Press Information Bureau, Ministry of Housing & Urban Poverty Alleviation, Diu Smart City becomes first to run on 100% renewable energy during daytime
- ²³ Times of India, policy backs rebate for solar water heaters, April 2022
- ²⁴ The Indian Express, For property tax rebate, vermiculture pips water harvesting, May 2015
- ²⁵ Bangalore Electricity Supply Company Limited, December 2007
- ²⁶ Jhatkaa, Solar Toolkit: Your one stop guides for installation of Solar Rooftop Photo Voltaic (SRTPV) system
- ²⁷ NIUA, Green buildings for composite climatic zone
- ²⁸ Infra Construction and Equipment Magazine, Indira Paryavaran Bhawan - First On-site Zero Net Energy Building of India
- ²⁹ World Resources Institute, Accelerating Building Decarbonization: Eight Attainable Policy Pathways to Net Zero Carbon Buildings for All, September 2019
- ³⁰ Times of India, New NMMC headquarters' eco-friendly design gets LEED gold rating, February 2015
- ³¹ Times of India, Visakhapatnam: 12,000 streetlights to go solar in 2021, December 2020
- ³² Times of India, Over 700 solar streetlights to illuminate 'dark lanes' of 32 UP villages for the 1st time in decades, November 2022
- ³³ Intelizon, Solar streetlights: Across India, October 2020
- ³⁴ MNRE, PIB, Government launches SLNP and AJAY to install smart, energy-efficient LED streetlights and solar streetlights across the country, March 2022
- ³⁵ Government of India, Ministry of Railways, Handbook on solar light system, November 2015
- ³⁶ MOHUA and NIUA, Promotion of green buildings training manual, 2022
- ³⁷ Times of India, Madhya Pradesh bakes in heat wave, Satna sizzles at 48 degrees, June 2014
- ³⁸ GHMC to push Energy Code for large residential buildings in Hyderabad, The Indian Express, Dec 2022
- ³⁹ The Architectural Gazette, cool roofs, November 2018
- ⁴⁰ The Print, Mana Capitol redefines sustainable construction with the green roof concept, November 2021
- ⁴¹ Hindustan Times, Mumbai slums are 6 degrees Celsius warmer than neighbouring housing societies in October: Study, November 2020
- ⁴² Times of India, Bus stops go green with solar energy, February 2016

- ⁴³ Times of India, Vakkil street gets solar bus stop, November 2019
- ⁴⁴ Times of India, Delhi plans to install solar panels at DTC bus stops, March 2016
- ⁴⁵ Hindustan times, 200 bus shelters to become solar powered in the city, March 2017
- ⁴⁶ Times of India, Varanasi gets its first smart bus station run by solar power, November 2022
- ⁴⁷ Times of India, Indore: Solar-powered sludge treatment plant, July 2022
- ⁴⁸ The Times of India, District's first-ever solar-powered sewage treatment plant to come up at Vellalore, Coimbatore, October 2019
- ⁴⁹ Saur Energy International, Inoperative Sewage Treatment Plants set to be Solar Powered in Gujarat, November 2019
- ⁵⁰ The Times of India, Floating solar plants to power Jalood pumping station soon, Indore, November 2019
- ⁵¹ EQMagpro, Manpower requirements for assistance in Solar PV Modules testing jobs in STP plant at Mumbai, October 2020
- ⁵² Times of India, Chennai: 10 more small buses as feeder services for metro commuters, August 2022
- ⁵³ Times of India, BMTC to operate feeder bus every 15 minutes for Kengeri metro users , August 2021
- ⁵⁴ WRI Ross Centre, Bus Karo 2.0 case studies from India
- ⁵⁵ IQ Air, Air quality in Satna as on 27th March 2023
- ⁵⁶ Business Standard, Bio-CNG to power public transport buses in Indore, Indore, Jun 2018
- ⁵⁷ The Economic times, 400 buses in Indore to run on Bio-CNG generated from waste; PM to virtually inaugurate plant on Feb 19, February 2022
- ⁵⁸ WRI India Ross Centre, Rolling out Electric Buses: A Guidebook on Route Prioritization and Implementation Planning, March 2022
- ⁵⁹ Medium, India's first battery swapping station-Ahmedabad launched 18 e-buses, electric vehicles, Oct 2019
- ⁶⁰ MoHUA, Gol, NMT guidance document, sustainable urban transport project, May 2016
- ⁶¹ NIUA, Strategy for pedestrianization & non-motorized network
- ⁶² MoHUA, Gol, Complete streets – Best practices, Smart City Mission
- ⁶³ Urban Street Design Guidelines Pune, 2016
- ⁶⁴ Street Design Guidelines for Greater Mumbai, January 2014
- ⁶⁵ City of Bristol, Segregated Cycle Lanes, Traffic Choices BS1
- ⁶⁶ C40 Cities playbook: Inclusive community engagement, ARUP
- ⁶⁷ OLA Mobility Institute, Beyond Nagpur: The promise of electric mobility - Lessons from India's first multimodal E-Mobility Project, 2019
- ⁶⁸ ElectronicsB2B.com, How ready are Indian Cities for electric vehicles, Jul 2020
- ⁶⁹ Saur Energy, Satna E- charging station tender, August 2022
- ⁷⁰ Financial Express, charging ahead: Getting Indian cities electric-vehicle ready, Jun 2018
- ⁷¹ ETAuto.com, Scooter rental apps in India own over 15,000 vehicles, Dec 2019
- ⁷² AICTSL Indore, urban mobility India, Smart mobility solutions in Indore
- ⁷³ The Logical Indian, Gujarat: CM Vijay Rupani announces subsidy schemes for e-scooters, rickshaws, Sept 2020
- ⁷⁴ NRDC, Review of state EV plans across India amidst COVID-19, Sept 2020
- ⁷⁵ India today, Delhi gets 100 EV charging points under single window facility, September 2022
- ⁷⁶ MDPI Section Air, Climate Change and Sustainability, Anne Christine Lusk, Xin Li, and Qiming Liu, If the Government Pays for Full Home-Charger Installation, Would Affordable-Housing and Middle-Income Residents Buy Electric Vehicles? March 2023
- ⁷⁷ A study by Volterra Partners, A summary of the socio-economic benefits of shared e-scooters, Oct 2022
- ⁷⁸ The Times of India, Bike sharing project to go electric in Bhopal, Bhopal 2019
- ⁷⁹ TechCrunch, India's electric bike rental startup Yulu inks strategic partnership with Bajaj Auto, raises \$8M, Nov 2019
- ⁸⁰ Times of India, Smart bicycle sharing system launched in Belagavi city, December 2022
- ⁸¹ Indian Express, Chandigarh: With fuel prices on the rise, ride a cycle for Rs 10 from today, August 2021
- ⁸² The Hindu, Smart paid parking in Chennai, Dec 2020
- ⁸³ Traffic infra-Tech, new parking protocol in Indore, March 2020
- ⁸⁴ Jabalpur Smart City Ltd, Smart parking system
- ⁸⁵ ITDP India, Pune parks it right
- ⁸⁶ The Times of India, In Shimla, buy a parking slot before a car, May 2015
- ⁸⁷ Faheem Ahmed Malik, International Journal of Engineering Development and Research, Paper on sustainable parking, 2017
- ⁸⁸ CSE report, PAMPering Cities: How to manage urban India's parking needs, 2018
- ⁸⁹ World Resources Institute India, New Delhi, Nagpure, A.S., Anadkat, V., Sharma, B., Shaikh, Z., Tyagi, V., Ali, S., Wankhade, K., Patidar, R., Ramprasad, V., Krithi, V., Daftardar, C., Kajol, Krishnan, D., Pai.,M, Surat Clean Air Action Plan: Comprehensive Report, December 2021
- ⁹⁰ CGWB, Aquifer mapping report, Satna district, 2017

- ⁹¹ NIUA and MOHUA, Water resources management training manual, December 2021
- ⁹² Sensus website, Pune chooses sensus iperl meters to deliver its pioneering 24x7 water project, February 2019
- ⁹³ Institute of Water and Energy Management (IWE), How does digitization succeed in the municipal water sector? Germany, November 2021
- ⁹⁴ Pune municipal corporation, Rebooting Pune digital strategy 2018-2020
- ⁹⁵ Outlook India, Why India Urgently Needs an Urban Stormwater Management Plan, Aug 2022
- ⁹⁶ Tripura disaster management authority, Flood management plan, 2018
- ⁹⁷ SusDrain, Sustainable drainage
- ⁹⁸ EcoNaur, Require planning for strong storm water management in India, September 2022
- ⁹⁹ WRI Ross Centre, How to Prevent City Climate Action from Becoming "Green Gentrification", December 2019
- ¹⁰⁰ Climate Adapt - Water sensitive urban & building design
- ¹⁰¹ CPCB, Status of STPs
- ¹⁰² Times of India, pilot project: Govt to provide treated water for city parks, February 2022
- ¹⁰³ World Business Council for Sustainable Development, Good Practice in Cement Production: Dry Process Kilns
- ¹⁰⁴ World Bank Group open knowledge, Wastewater: From waste to resource: The case of Nagpur, India, October 2019
- ¹⁰⁵ Center for Science and Environment, Menu on Un-Networked Technologies For sewage and septage management flyer
- ¹⁰⁶ DownToEarth, Why better policies are needed for sewage water use in thermal power plants, Jun 2020
- ¹⁰⁷ MoEFCC, Third biennial update report to the UNFCCC, 2021
- ¹⁰⁸ Alliance for an energy efficient economy, Emission Reduction Approaches for the Cement Industry, February 2021
- ¹⁰⁹ MP renewable energy conservation: List of names of designated consumers of Madhya Pradesh
- ¹¹⁰ Business Standard, Birla Corporation to expand cement production capacity to 30 MTPA by 2030, Sept 2022
- ¹¹¹ Prism Cements website
- ¹¹² Rahul Baidya & Sadhan Kumar Ghosh, Low carbon cement manufacturing in India by co-processing of alternative fuel and raw materials, Dec 2018
- ¹¹³ WBCSD and International Energy Agency, Technology Roadmap Low-Carbon Technology for the Indian Cement Industry, February 2013
- ¹¹⁴ Cementis consulting, Co-processing waste in the cement industry: A solution to natural resource preservation and total emission reduction, October 2015
- ¹¹⁵ Ibrahim and Wilfred, Handbook of Eco materials, Alternative Fuels from Waste Products in Cement Industry, February 2019
- ¹¹⁶ SBTi, Cement Science Based Target Setting Guidance, September 2022
- ¹¹⁷ Ornate Solar, How solar energy can support the cement industry energy demand
- ¹¹⁸ Cement Manufacturers Association, India, Enhancing energy efficiency through waste heat recovery system (WHRS), Sept 2021
- ¹¹⁹ Powerline article, Climate-smart: Efforts to make the cement industry more sustainable, May 5, 2018
- ¹²⁰ Palash Kumar and Kare Helge, Co-processing of Alternative Fuels & Resources in Indian Cement Industry: Baseline and Potential, 2017
- ¹²¹ The News Mill, India's first project for refuse derived fuel plant launched in Meghalaya, May 2022
- ¹²² Centre for Science and Environment and NITI Aayog, New Delhi, Waste-Wise Cities: Best practices in municipal solid waste management, 2021
- ¹²³ Global cemfuels, UltraTech Cement's Reddipalayam plant reaches 25% alternative fuels substitution rate, July 2021
- ¹²⁴ Times of India, Delhi: Tie-ups with industries to help civic body clear refuse-derived fuel waste at landfills, October 2022
- ¹²⁵ Nagpur Municipal Corporation: Mandate for use of fly ash
- ¹²⁶ Hindustan Times, Mumbai civic body proposes use of air pollutant fly ash for construction of buildings, May 2018
- ¹²⁷ Global Cement, Madhya Pradesh power stations struggling to dispose of fly ash, Dec 2018
- ¹²⁸ Building Materials and Technology Promotion Council website, Capacity building and skilling programmes
- ¹²⁹ Stakeholder consultations with city officials, 2021
- ¹³⁰ The Hindu, Mapathon begins today in Kochi, Jan 2020
- ¹³¹ Open Tree Map: Bengaluru
- ¹³² The Hindu, This app will help green the landscapes of your city, June 2019
- ¹³³ Times of India, Tree-mapping app helps citizens preserve data on Goa's green cover, Sept 2020
- ¹³⁴ Sustainability, Lahoti, S.; Kefi, M.; Lahoti, A.; Saito, O. Mapping Methodology of Public Urban Green Spaces Using GIS: An Example of Nagpur City, India, 2019
- ¹³⁵ Development of a local biodiversity strategy & action plan (LBSAP), Urban LEEDS, Nagpur city
- ¹³⁶ NIUA, Climate Smart Cities Assessment Framework, Urban Biodiversity, Training Manual
- ¹³⁷ International Journal of Scientific Research, Biodiversity of flora of Mukundpur & ethnobotanical importance, Aug 2019
- ¹³⁸ UNDP, Biodiversity, and food: Pithorabad gram panchayat
- ¹³⁹ Convention on Biological Diversity, City Biodiversity Index (or Singapore Index)

-
- ¹⁴⁰ ICLEI Local Governments for Sustainability, City Biodiversity Index Reports for Indore, Bhopal Released, February 2023
- ¹⁴¹ United Nations University, Institute for the Advanced Study of Sustainability policy Report, Integrating biodiversity with local action planning, 2014
- ¹⁴² MoEFCC, Government of India, National Biodiversity Action Plan (NBAP), Addendum 2014 to NBAP 2008
- ¹⁴³ Times of India, Ludhiana: Vertical garden to deck up pillars on Southern Bypass, July 2022
- ¹⁴⁴ Times of India, Why vertical gardens are such a “cool” idea for Delhi, April 2018
- ¹⁴⁵ Times of India, Lush green urban terrace gardens flourish here, thanks to government, July 2016
- ¹⁴⁶ Subsidies for terrace gardens, Live Chennai.Com, Chennai, December 2013
- ¹⁴⁷ Hindustan times, 70 people apply for roof-top farming project in Gaya, July 2019
- ¹⁴⁸ Sanshodhan India – A global environment-social-governance (ESG) company for enabling sustainable development
- ¹⁴⁹ Karo Sambhav: Let’s make circular economy possible
- ¹⁵⁰ Information Technology, Electronics & Communications Department, Government of Telangana, E-waste management policy 2017
- ¹⁵¹ Your Story, Andhra Pradesh becomes the first state to adopt electric waste disposal vehicles, Sept 2019
- ¹⁵² The Week, TN CM launches new solid waste management system for Chennai, Sept 2020
- ¹⁵³ Times of India, Indore: Electric waste collection vehicles, 2022
- ¹⁵⁴ Electric Vehicles. in, e-Tricycles in Chennai for garbage collection, December 2019
- ¹⁵⁵ WRI India, Aqueduct Floods Methodology, Technical Note, January 2020
- ¹⁵⁶ PRS Legislative Research, Madhya Pradesh Budget Analysis 2021-22
- ¹⁵⁷ DST, Gol, Climate Vulnerability Assessment for Adaptation Planning in India using a common framework, 2019-20
- ¹⁵⁸ NITI Aayog, SDG India, Index & Dashboard, 2020-21
- ¹⁵⁹ Gujarat Climate Department, Budget book, 2019-20
- ¹⁶⁰ Odisha Finance Department, Govt of Odisha, Climate Budget Framework, 2020-21
- ¹⁶¹ The Bastion, Mainstreaming Climate Change in India through Climate Budgeting, October 2020





State Knowledge Management Centre on Climate Change (SKMCCC)
Environmental Planning and Coordination Organisation (EPCO)
Department of Environment, Government of Madhya Pradesh

Paryavaran Parisar, E-5. Arera Colony, Bhopal – 462016, India
Ph: 0755-2970499, 2970299, 2460255