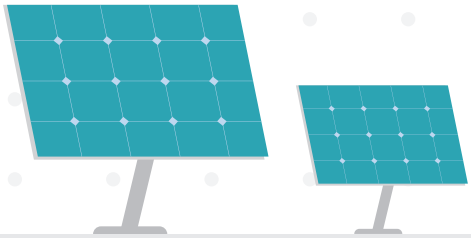
January, 2022

Climate Change and Environment Action Plan of

Nagpur District



Prepared By

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The Climate Change and Environment Action Plans (CCEAP) have been developed for multiple districts of India by Vasudha Foundation with support from Shakti Sustainable Energy Foundation.

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

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January, 2022
Nagpur, Maharashtra

Cover page images

Top left image:
Korari thermal power station, Nagpur

Bottom right:
Western coal field

Land use map of Nagpur district:
Created using data from Landsat 8, secondary data from NRSC/ISRO Bhuvan portal, Google Earth and ORNL-DAAC

- Built-up land
- Cropland
- Fallow land
- Coal mine
- Barren land
- Forest (Deciduous, broadleaf
- Mixed forest
- Plantations
- Shrubland
- Wasteland
- Water bodies

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R. Vimala I.A.S.
Collector & District Magistrate

आज़ादी का अमृत महोत्सव

.nagpur

Foreword

Climate change has emerged as a global threat, prompting nations to come together to tackle the challenge. India announced its intention to achieve net zero emissions by 2070 and other ambitious targets at COP26 at Glasgow in November, 2021.

To achieve these goals, it is imperative that all the states commence their climate actions immediately and contribute towards the national targets. Maharashtra is leading by example through its ambitious initiatives to combat climate change such as the Majhi Vasundhara Abhiyan, the Project on Climate Resilient Agriculture (PoCRA) and the latest Electric Vehicle Policy, among many others. Further, Maharashtra has joined the Race to Resilience, and 43 cities in the state, including Nagpur, have announced their commitment for Race to Zero, both international pledges aimed at sustainable and low carbondevelopment. In recognition of its efforts,the Maharashtra government received an award for 'Inspiring Regional Leadership' at the COP26 summit.

While state level policies and initiatives are being put in place, I am happy to share, a first of its kind, 'Climate Change and Environment Action Plan'(CCEAP) ofNagpur district prepared by Vasudha Foundation with support from Shakti Sustainable Energy Foundation. This Action Plan has been developed in consultation with the district administration and Nagpur Municipal Corporation with an aim to contribute towards state and national climate actions. The action plan is a comprehensive assessment of the climate variability and projections, sectoral greenhouse gas emissions, and climate change drivers in the district. Based on the assessment, the plan identifies various local level interventions, which are in line with state and national-level policies and programmes. It also incorporates a comprehensive set of recommendations, in alignment with Sustainable Development Goals (SDGs), for various climate-related sectors and environmental issues ofNagpur district, as well as estimates mitigation potential of each sector.

I appreciate the efforts made towards developing the CCEAP for Nagpur district. The recommendations given in this Action Plan may be used by the relevant departments for mainstreaming climate action in alignment with the district's development priorities.

With best wishes,

(R. Vimala)

13/1/2022

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Shri Radhakrishnan B., IAS
Municipal Commissioner
NMC
Government of Maharashtra

Preface

The recently concluded United Nations climate summit, COP26 at Glasgow, was a much-awaited conference specially for climate vulnerable countries seeking tangible action on anthropogenic GHG emissions. India has made ambitious commitments of generating 500 GW energy from non-fossil fuel sources and achieving net zero by 2070at COP26.

Owing to its sheer size and diversity, India is one of the most climate vulnerable countries in the world. In the past few decades, India has witnessed an alarming rise in the frequency and intensity of extreme events such as floods, droughts and heatwaves among others. To tackle these emerging threats, India formulated its National Action Plan for Climate Change more than a decade ago and has since then also taken many initiatives and participated in multiple international commitments to combat climate action.

In addition to this, formulation of State Action Plans for Climate Change has helped streamline action at the state level. The Government of Maharashtra has made several proactive commitments to ensure low carbon growth and sustainable development through various initiatives. Following the concept of bottom-up approach a "Climate Change and Environment Action Plan" for Nagpur district has been developed. This Action Plan captures the current profile and priorities of Nagpur and provides region specific recommendations for various climate relevant sectors.

I am certain that this Action Plan will serve as a roadmap for both district and municipal level planning efforts to integrate climate action and development. I appreciate that Vasudha Foundation with support from Shakti Sustainable Energy Foundation has undertaken this detailed study in consultation with Nagpur Municipal Corporation, district administration and other stakeholders.

(Radhakrishnan B.)

ACKNOWLEDGEMENTS

We would like to thank Ravindra H Thakare, IAS (Collector & DM, Nagpur) for his inputs and appreciation of the plan, which have been vital in the development of the Climate Change and Environment Action Plan for Nagpur district.

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

We extend our gratitude towards other departments and organizations – Shweta Banerjee (Superintending Engineer, Environment, NMC), Pradeep Dasarwar (Deputy Municipal Commissioner, NMC), M.K. Rao, IFS (PCCF (IT&P), Nagpur), A.P. Dharamadhikari (Joint Director of Industries, Nagpur), Kaushik Chakraborty (GM, Environment, WCL) and officials from Forest Department and MEDA for inputs and suggestions to refine the action plan.

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

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

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

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

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

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ACRONYMS

AFOLU	Agriculture, forestry and other land use
AMRUT	Atal Mission for Rejuvenation and Urban Transformations
ASP	Activated sludge process
ARR	Aggregate revenue requirement
AT&C	Aggregate technical and commercial losses
BAU	Business as usual
BEE	Bureau of Energy Efficiency
BMW	Bio-medical waste
BOD	Biological oxygen demand
BRT	Bus rapid transit
CAGR	Cumulative annual growth rate
CAPEX	Capital expenditure
CBWTF	Common bio-medical waste treatment facility
CETP	Common effluent treatment plant
CFA	Central finance assistance
CGWB	Central Ground Water Board
CHP	Combined heat and power
CPCB	Central Pollution Control Board
CPP	Captive power plant
C&D	Construction and demolition
CPEIR	Climate Public Expenditure and Institutional Review
DISCOM	Distribution company
DDUGJY	Deen Dayal Upadhyaya Gram Jyoti Yojana
EC	Electricity consumption
ECBC	Energy conservation building code
EEPS	Energy efficient pumping system
EESL	Energy Efficient Services Limited
EF	Emission factor
EV	Electric vehicle
FAME	Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles
FSI	Forest Survey of India
FY	Financial year
GDP	Gross domestic product
LMV	Light motor vehicle
MCF	Methane conversion factor
MERC	Maharashtra Electricity Regulatory Commission
MLD	Million litres per day
MGNREGA	Mahatma Gandhi National Rural Employment Guarantee Act
MPCB	Maharashtra Pollution Control Board
MRF	Material recycling facility
MSEDCL	Maharashtra State Electricity Distribution Company Ltd.
MSME	Micro, small & medium enterprises
$MtCO_2e$	Million tonnes of carbon dioxide equivalent
MU	Million units
MW	Megawatt
M&E	Monitoring and evaluation
NMRDA	Nagpur Metropolitan Region Development Authority
NPK	Nitrogen, phosphorus and potassium
NSSCDCL	Nagpur Smart and Sustainable City Development Corporation
PAT	Perform, achieve and trade
PLF	Plant load factor
PPP	Public private partnership
PT	Public transport
PUC	Pollution under control
PMKSY	Pradhan Mantri Krishi Sinchai Yojana
RE	Renewable energy
REC	Renewable Energy Certificate
RESCO	Renewable Energy Service Company
RPO	Renewable purchase obligation
RO	Reverse osmosis
RTS	Rooftop solar
RWA	Resident welfare association
RWHS	Rain water harvesting system
SBR	Sequencing batch reactors
SEZ	Special economic zone
STP	Sewage treatment plant
GHG	Greenhouse gas
GHGPI	GHG Platform India
GIM	Green India Mission
GW	Gigawatt
HW	Hazardous waste
ICE	Internal combustion engine
IISS	Indian Institute of Soil Science
IoT	Internet of things

IPCC	Intergovernmental Panel on Climate Change
IPT	Intermediate public transport
IPPU	Industrial Processes and Product Use
ISWM	Integrated Solid Waste Management
JNNURM	Jawaharlal Nehru National Urban Renewable Mission
KUSUM	Kisan Urja Suraksha evem Uttaan Mahabhiyan
kW	Kilowatt
kWh	Kilowatt hour
LED	Light emitting diode
SLNP	Streetlight National Programme
SMB	Solar municipal bonds
SW	Solid waste
SWM	Solid waste management
T&D	Transmission and distribution
TOE	Tonnes of oil equivalent
TOU	Time of use
TPD	Tonnes per day
TPP	Thermal power plant
TSDF	(Hazardous waste) Treatment, storage & disposal facility
ULB	Urban local body
UJALA	Unnat Jyoti by Affordable LED for All
UDAY	Ujwal DISCOM Assurance Yojna
WSP	Waste stabilisation pond
W2E	Waste to energy
W	Watt
WW	Wastewater
ZEV	Zero emission vehicle

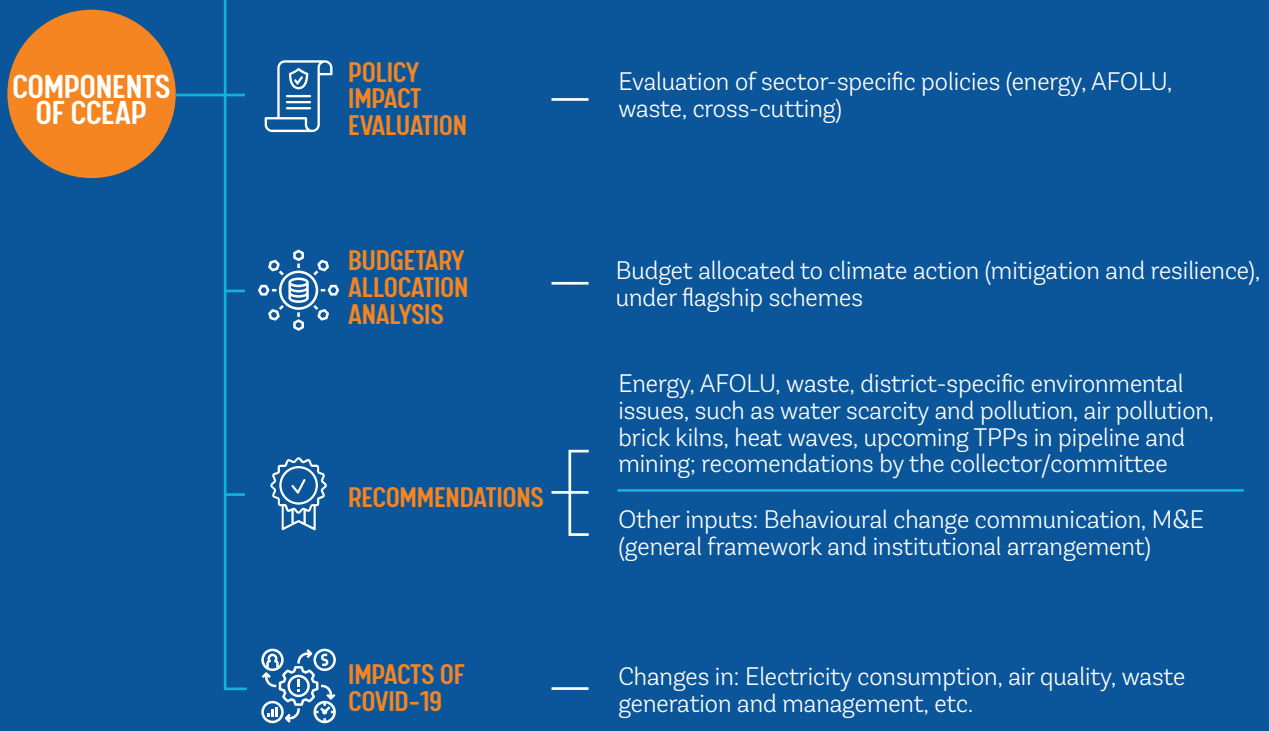
EXECUTIVE SUMMARY

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

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

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

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



CLIMATE PROFILE AND PROJECTIONS

This section analyses historical data and projects changes in rainfall and temperature for Nagpur district using IMD and NASA's NEX-GDDP datasets, following the multi-modal mean (MMM) approach. Here are some findings for the district:

- **Rainfall expected to increase:** The seasonal rainfall is projected to increase by 4 to 20 percent under RCP4.5 and 15 to 35 percent under RCP8.5 emission scenarios.[1] The number of rainy days is also projected to increase during monsoon, particularly in July and August.
- **Summers are getting hotter:** A significant trend of increase in the maximum temperatures during summer months is seen in the district, which is observed to be accelerated during the last decade. The mean percentage of warm days has increased by about nine percent. The minimum temperature is also projected to increase in the winter season.
- **Warms days to increase:** Maximum temperatures are projected to increase by about 1.2°C to 2.4°C under RCP4.5 and 1.5°C to 4.4°C under RCP8.5 emission scenarios. In future, the percentage of warm days are also projected to increase by over 55 percent of the present climate. The minimum temperatures also show an increasing trend – the percent of cold days may decrease in all epochs under changing climate conditions.

SECTORAL GREENHOUSE GAS EMISSIONS PROFILE: CLIMATE CHANGE DRIVERS

- **Greenhouse gases have increased ten-folds since 2005:** Between 2005 and 2019, the total greenhouse gas (GHG) emissions of Nagpur district increased by 1,046 percent (from 4.73 million tonnes CO_2e in 2005 to 54.20 million tonnes CO_2e in 2019) with a CAGR of 19.03 percent. These estimates represent GHG emissions from 14 categories covering three major sectors – energy; agriculture, forestry and other land use (AFOLU); and waste.
- **Energy sector is the highest contributor of emissions:** Energy sector (direct fuel combustion for public electricity generation, transport, industries, agriculture, residential categories etc. and fugitive emissions from mining) is the highest contributor of GHG emissions. The energy emissions increased 12-folds between 2005 and 2019 at a CAGR of 20.7 percent (mostly due to increase in public electricity generation). Under the BAU scenario, energy sector emissions are projected to increase by 357 percent by 2030.
- **AFOLU sector is now witnessing high GHG emissions:** Although the forest area of Nagpur district improved between 2004 and 2008, the overall stock of carbon reduced due to reduction in the carbon stock density. As a result, the 'forest removals' could not become a sink. The emissions from forest removals slightly dipped post 2011 (because the rate of loss in forest area was very low), but increased again from 2016 (due to significant reduction in forest area). The emissions under AFOLU sector increased by 49 percent between 2005 and 2019 at a CAGR of 3 percent. Under the BAU scenario, AFOLU sector emissions are projected to increase 144 percent by 2030.
- **Waste sector emissions have dropped:** Overall, waste sector emissions have increased by 38 percent between 2005 and 2019 (at a CAGR of 2.34 percent), but its contribution reduced from 4 percent to 1 percent in economy-wide emissions. Domestic liquid waste management practices have improved more than solid waste management practices. As a result, after 2011, the emissions from wastewater have increased at a marginal rate of 1.23 percent CAGR, whereas solid waste emissions increased by 2.58 percent CAGR (between 2011 and 2019). Under the BAU scenario, waste sector emissions are projected to increase 26 percent by 2030.

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

ASSESSMENT OF POLICIES THROUGH THE LENS OF CLIMATE CHANGE

A total of 39 major national/state-level policies and programmes of energy, AFOLU and waste sector were evaluated for their climate mitigation potential.

- **Power and energy:** Eleven policies/programmes were evaluated. UDAY and PAT schemes were found to be the biggest contributors to GHG mitigation.
  - Policies related to clean energy generation mitigated 9,46,137 tCO_2e. emissions.
  - Policies pertaining to energy-efficient buildings and processes helped avoid 48,47,063 tCO_2e. emissions.
- **AFOLU and cross-cutting:** Thirteen policies were assessed.
  - Forestry policies alone led to a mitigation of 70,77,360 tCO_2e. emissions.
  - Policies pertaining to livestock proved to be beneficial for climate action, avoiding 3,007 tCO_2e.
  - For the agricultural sub-sector, GHG impact of the policies could not be computed due to lack of availability of data.
  - Policies pertaining to cross-cutting sector helped mitigate 5,03,778.5 tCO_2e. emissions.
- **Waste:** Fifteen policies were assessed.
  - Policies pertaining to sanitation added 2,25,092 tCO_2e. emissions.
  - Composting as a part of solid waste management practices mitigated 36,096 tCO_2e. emissions.
  - Domestic wastewater treatment interventions have led to 30,204 tCO_2e. emissions.

BUDGETARY ANALYSIS TO ESTIMATE EXPENDITURE ON CLIMATE ACTION

This section analyses the district expenditure to estimate spending on climate action. District budgets from the Planning Department, Government of Maharashtra for the years 2016-17 to 2018-19 were analysed to understand expenditure on climate action in Nagpur district. The expenditure on climate relevant actions is estimated to be 9.34 percent, 19.79 percent, and 18.85 percent, respectively, of the total district budget for three years. The distribution of expenditure on climate action in the district between 2016-17 to 2018-19 is summarised in Figure 1a below. The distribution of schemes reveals that most climate relevant schemes over 2016-17 to 2018-19 fall under the marginal category, indicating the scope for increasing commitment to climate action at the district level (see Figure 1b). Further, Figure 1c gives the budgetary allocation attributed to climate action by level of climate relevance (direct, indirect, marginal, potential) of the schemes listed in the district budget .

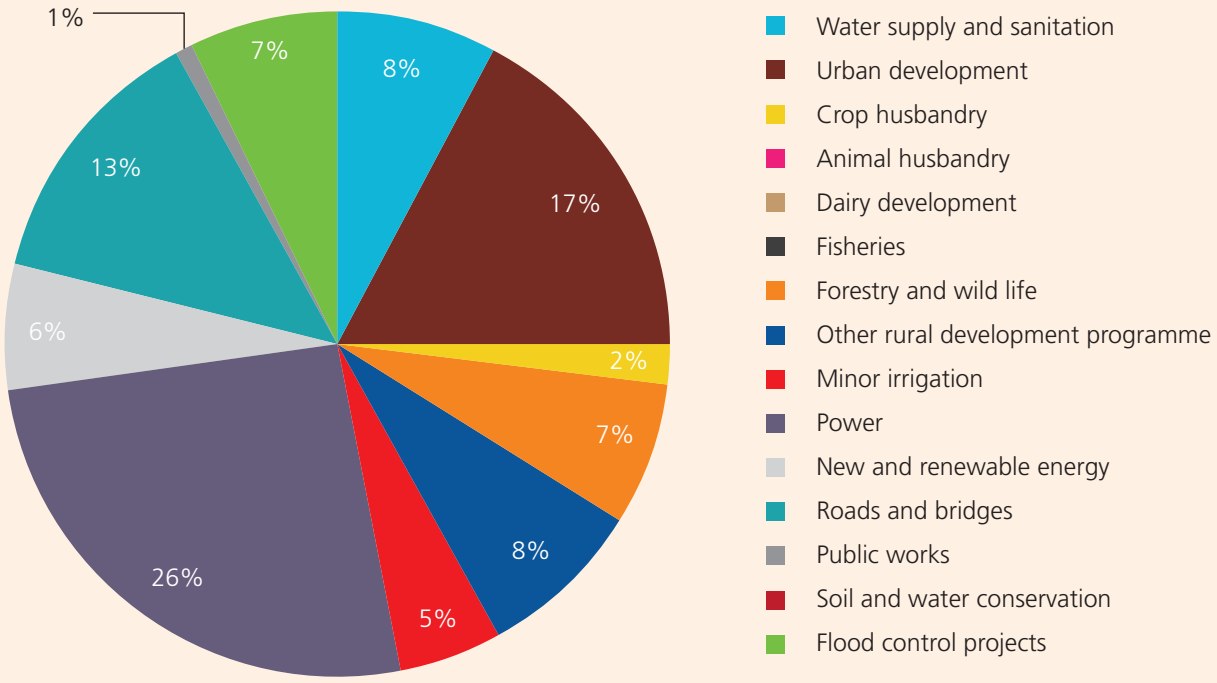


Figure 1a: Nagpur District: distribution of expenditure on climate action

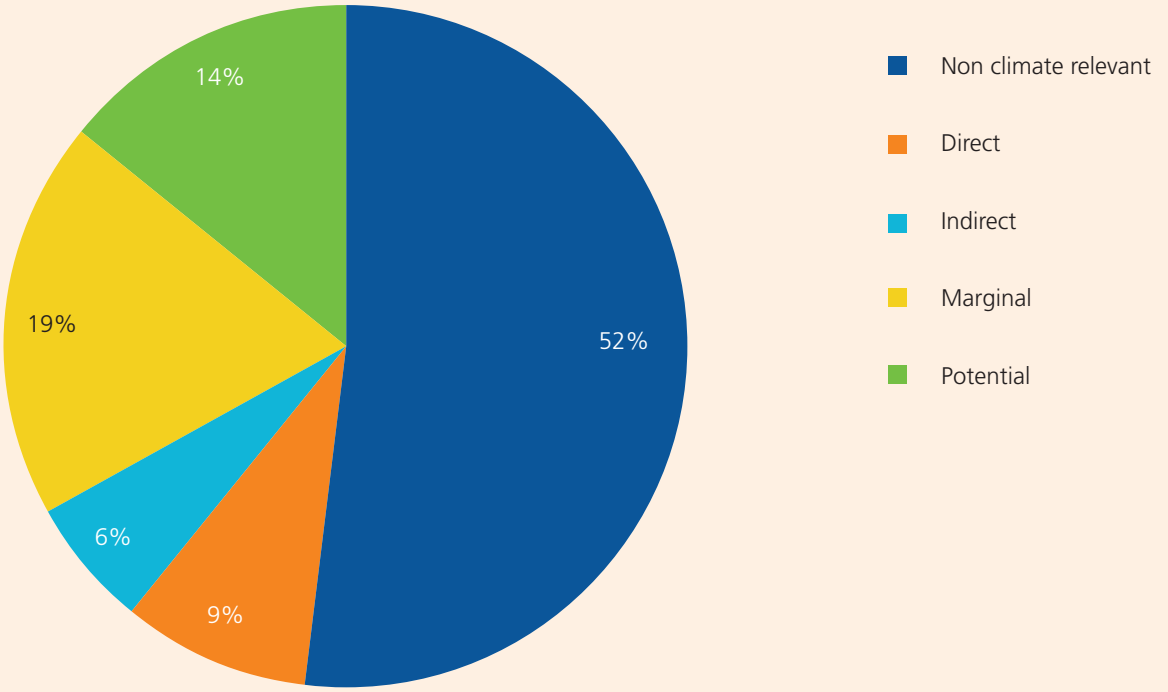


Figure 1b: Distribution of schemes by relevance to climate action in Nagpur district between 2016-17 and 2018-19

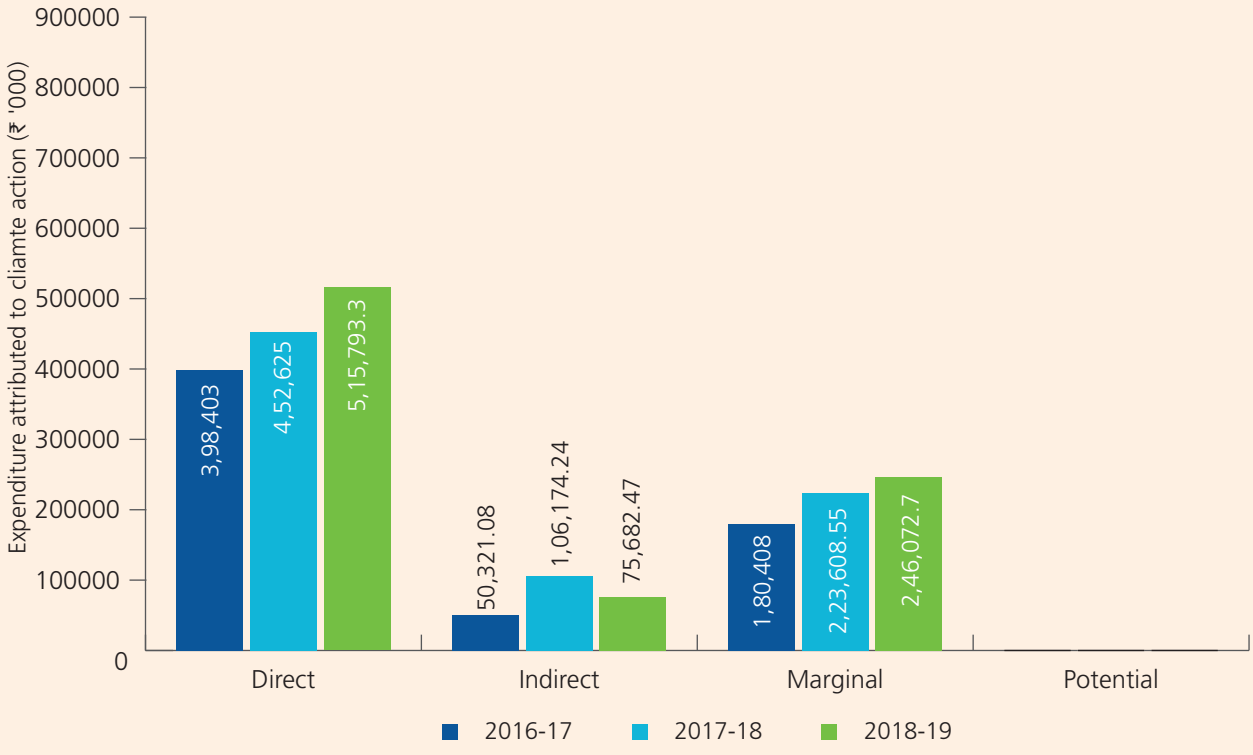


Figure 1c: Expenditure attributed to climate action by category of climate relevance in Nagpur district between 2016-17 and 2018-19

Further, a total of 39 flagship schemes were reviewed to identify those with climate resilience and mitigation relevance. Of these, based on availability of information across districts as well as relevance to climate actions, five schemes were selected for further analysis.

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

Scheme selected	Climate relevant activities	Year	Total allocation to district under scheme (₹ lakh)	Allocation to climate action (₹ lakh)	% of total scheme budget for climate action at district level*
MGNREGS	Eleven out of 17 activities were identified as climate relevant: Drought proofing, fisheries, flood control and protection, land development, micro-irrigation, renovation of traditional water bodies, rural connectivity, drinking water, sanitation, water conservation and water harvesting	2018-19	5,492	1,757	32
		2019-20	4,599	1,058	23
PMKSY	Micro-irrigation activities	2016-17	595	410	69
		2019-20	483	333	
AMRUT	Water supply, sewage and septage management, urban transport, drainage, green spaces	2015-16	27,297	713	2.6
		2016-17	150	31.5	21
DDUGJY + Saubhagya	New and upgradation of substations, LT lines, feeder segregation, consumer metering, DTR metering, etc	Up to April 2020	16,321	8,160	50

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

RECOMMENDATIONS

The action plan provides comprehensive, sector-wise recommendations from a climate perspective. The aim is to align the district with India's 2030 NDC commitments through this Climate Change and Environment Action Plan (CCEAP).

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

Further, the action plan is created in congruence with the Majhi Vasundhara programme of the government of Maharashtra. In fact, the themes of *Bhumi, Vayu, Jala, Agni,* and *Akash* find multiple cross linkages in the sectoral buckets of the CCEAP.

Overall, the mitigation actions suggested in the recommendations can help mitigate 8.6 Mt CO_2e per annum. The sectoral breakdown of the same is as following:

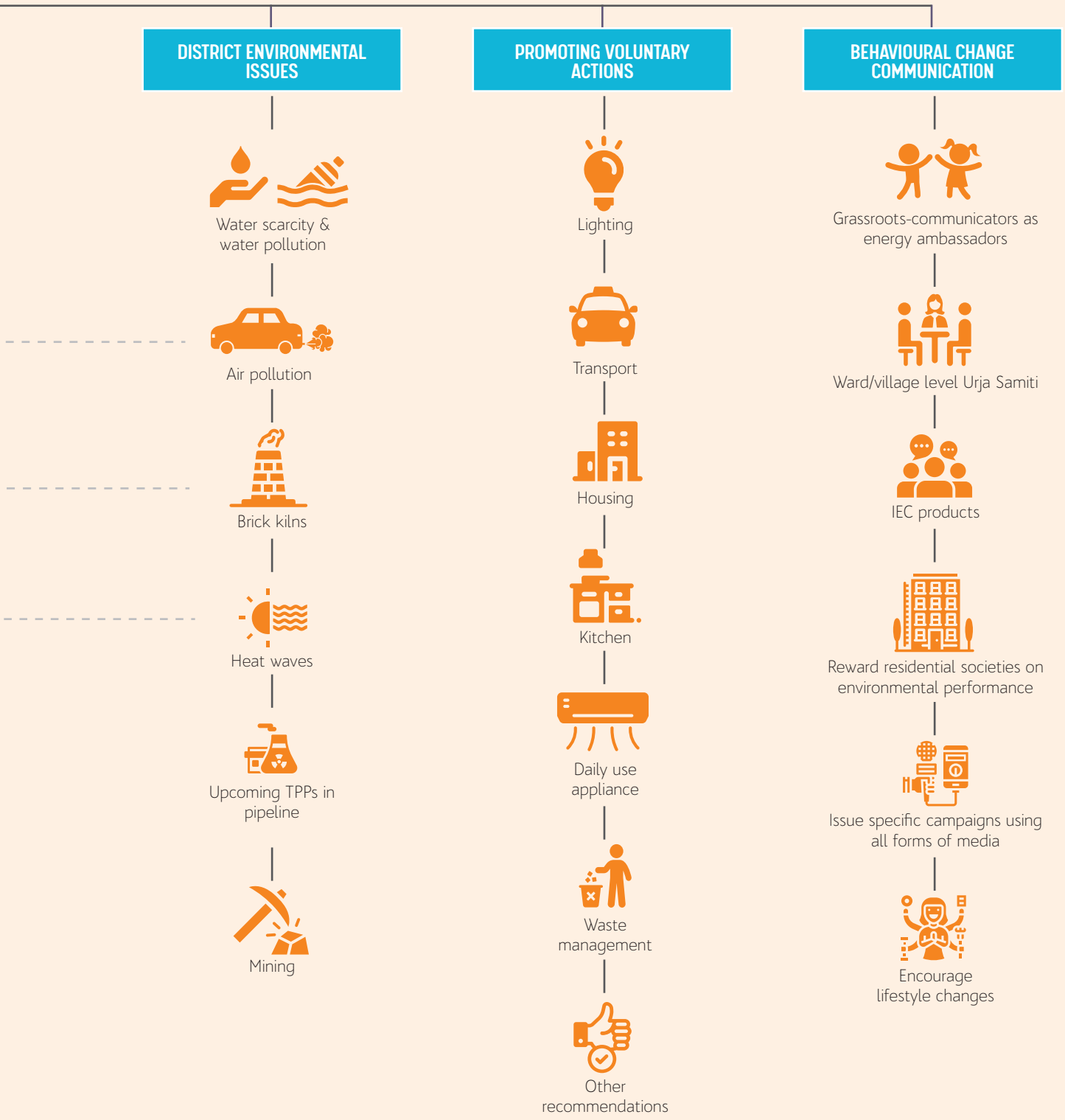
GHG mitigation potential of CCEAP recommendations (tCO_2e)

Energy
68,66,857

AFOLU
17,54,734

Waste
44,914.26

Figure 2 Recommendations for CCEAP Nagpur


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

Here are some in-brief, sector-wise recommendations

Power and energy

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

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

Transport

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

AFOLU

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

Waste

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

Given the unique environmental issues of the district, the action plan also recommends:

1. Adopting a holistic approach for water conservation and wastewater management, including conservation techniques such as rainwater harvesting, net zero water infrastructure, minimising losses in water supply, installing water-efficient fittings, water metering and adoption of inclusive and sustainable water governance.
2. Developing extensive infrastructure to monitor air pollution and suggestions on interventions for preventive measures.

3. Making brick kilns sustainable.
4. Minimising emissions and climate change impacts of the existing and upcoming Thermal Power Plant (TPPs).
5. Ensuring sustainable mining practices in the district.

COVID-19 IMPACT

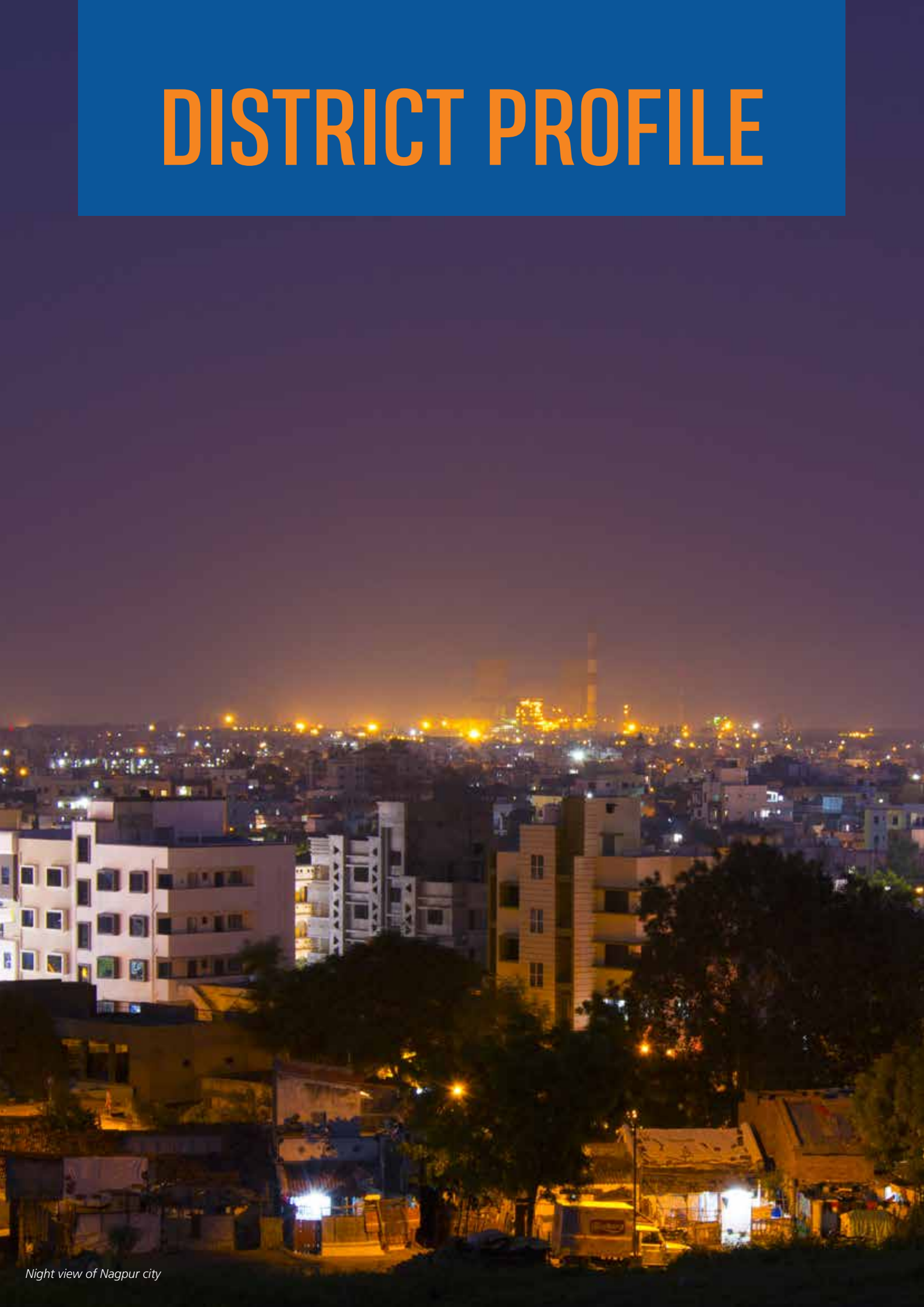
This section presents an assessment of how the COVID-19 pandemic has impacted various sectors and the developmental measures. During the national lockdown in 2020, the total energy demand in India went down considerably

The Maharashtra-Madhya Pradesh border in Nagpur district was a key crossing point for many migrants in both the states. Nagpur faced an outflux of migrant workers during the lockdown period. In the agriculture sector, harvesting activities were interrupted due to the lockdown. Supply chain problems were also witnessed. However, the reverse migration proved beneficial for kharif season.

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


Seoni
Betul
Chhindwara
Balaghat
Amravati
Nagpur
Bhandara
Wardha
Chandrapur
Yavatmal
Maharashtra

DISTRICT PROFILE



Night view of Nagpur city

1. DISTRICT PROFILE

Nagpur, the winter capital of Maharashtra and the geographical centre (zero-mile site) of India, is one of the Deccan Plateau districts of northern Maharashtrian Wardha-Penganga-Wainganga plain. Characterised by undulating plateau incised with rivers, the district has three distinct physical features: The hills of Satpura, the uplands of Kanhan and Umred, and the plains of Nagpur and Katol. In terms of area, Nagpur ranks fourteenth, while in terms of population, it is the fifth largest district of Maharashtra. The city of Nagpur, administered by Nagpur Municipal Corporation (NMC), is the district headquarter and an important administrative, commercial and industrial centre in the state. The city borrows its name from its major river – the Nag River. The city is endowed with two other rivers – Pill and Wainganga – and 11 lakes.

Nagpur district has some economically important minerals including manganese, limestones, etc. The industrial area of Butibori, spread across 24 sq. km in Nagpur, is one of Asia's largest industrial areas. One of the most literate cities of India (with a literacy rate of 92 percent), Nagpur is known as an educational hub of central India.

1.1. Key statistics

Table 1: District profile of Nagpur

General characteristics of the district			
Location	West Maharashtra, western Indian state		
Latitude	20°35' and 21°46' north	Area	9,892 sq km
Longitude	78°15' and 79°40' east	Elevation	310 msl
Agro-climatic zone (ICAR, 2016)			
Agro-ecological sub region (ICAR)	Central Highlands (Malwa, Bundelkhand and Eastern Satpura Range), hot, sub-humid (dry/moist) eco-region		
Agro-climatic zone (Planning Commission)	Western plateau and hills region		
Agro-climatic Zone (NARP)	Eastern Vidarbha zone (MH-9) and part of central Vidarbha zone (MH-8)		
Administrative units (Census of India, 2011)			
Block	14	ULBs	Municipal Corporation: 1 Municipal Council: 14 Nagar Panchayat: 6
Constituency	12	Towns Census villages	41 (Census: 29; Statutory: 12) 1,859
Demography (Census of India, 2011)			
Population (total)	46,53,570	Population density	470/sq km
Population (urban)	31,78,759	Household	10,41,544
Population (rural)	14,74,811	Urbanisation	Population: 68.31% Household: 67.35%
Population growth (2001-2011/ decadal)	14.4%	Women-headed household	
Land utilisation statistics 2018-19 (area: sq km) (Department of Agriculture, 2019), (FSI, 2019)			
Geographical area	9,892	Culturable waste land	340
Forest	2,000.38	Other fallows	214
Land under non-agricultural uses	991	Current fallow	206
Barren and uncultivable land	338	Net area sown	5,593
Permanent pastures	552	Area sown more than once	973
Miscellaneous trees and groves	78	Gross cropped area	6,565

Agriculture profile (ICAR, 2016; (Department of Agriculture, 2020)					
Major crop season	Kharif (rainfed) and rabi (rainfed/irrigated)				
Major field crops Horticulture crops	Food grain: Rice, maize, pulses, wheat, pigeon pea, gram, green gram, jowar, black gram Oilseeds: Soybean, linseed, safflower, rabi sesamum Important cash crop: Cotton lint, sugarcane, onion, orange				
Soil type	Deep black soil (43.4%), medium deep black soil (13.8%), shallow black soil (42.7%)				
Industrial profile (MSME, 2013)					
Existing MSME & artisan units	15,585 units (current 20,000+)	Large-scale industries/PSU	84 units	No. of industrial areas	11

Table 2: Nagpur vs. Maharashtra: A comparative profile

Particular	Nagpur district	Maharashtra	% contribution
Total population (2011)	46,53,570	11,23,74,333	4.14%
Urban population (2011)	31,78,759	5,08,18,259	6.26%
Percentage of urban population	68.31%	45%	Almost 1.5 times higher than the state
Geographical area (sq. km)	9,892	3,07,713	3.2%
Forest cover (sq km) (FSI, 2019)	2,000.38 (Very dense: 401.06; moderately dense: 902.56; Open forest: 696.76)	50,777.56 (Very dense: 8,720.53; Medium dense: 20,572.35; Open forest: 21,484.68)	3.21%
Per capita forest cover (ha/person)	0.043	0.045	Comparable to the state
Total registered vehicles	33,60,175	2,99,59,572	11.21%
Total rice production (in tonnes) (Department. of Agriculture, 2020).	2,048.23	31,826.017	Accounts for almost 60% of the state production
Installed capacity of electricity generation (conventional, MW)	7,796	29,851.87	26.11 %
Major types of industries (MSME, 2017)	Mining (coal, manganese), textile, steel, automobiles & ancillary, electricals, research & development, brick kilns	Hindustan Aeronautics, Shipping Corporation, Hindustan Petroleum, Bharat Petroleum, Bharat Electronics, chemical, pharmaceuticals, fertilisers, textile, agro & food processing, automobiles, etc.	--
Existing industrial area (Ha): Land acquired & developed (MSME, 2013)	3,887.83	--	--
Human development index (HDI 2011)	0.79	0.75	Higher than the state

1.2. Power and energy sector

Nagpur district is home to six coal-based thermal power plants with a total installed capacity of 7,176 MW (Vasudha Power Info Hub, 2021).[2] The district receives its electricity from the state-owned DISCOM – Maharashtra State Electricity Distribution Company Ltd (MSEDCL). Figure 3 shows that the industrial sector is the predominant electricity consuming sector in the district, followed by agricultural, domestic, and commercial sectors. The overall electricity consumption increased at 5.95 percent CAGR between 2008 and 2019, with the consumption mix remaining unchanged for that period (MERC).

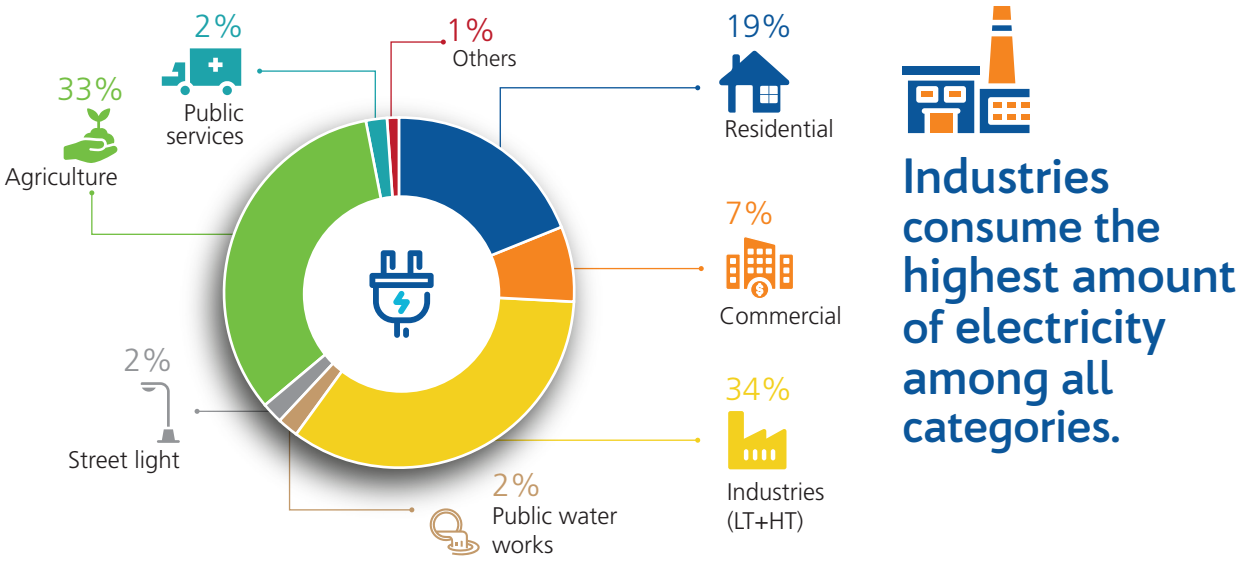


Figure 3: Consumer-wise electricity consumption in Nagpur (2019)

For FY 2019-20, MSEDCL purchased 1,27,729 MUs of electricity, of which 75.6 percent came from coal, followed by renewable sources, hydro, and nuclear-based generation, illustrated in Figure 4 (MERC, 2021) (Vasudha Power Info Hub, 2021). In the RE basket, solar power contributed to around 24.5 percent of the electricity purchase (MERC, 2021) (Vasudha Power Info Hub, 2021).

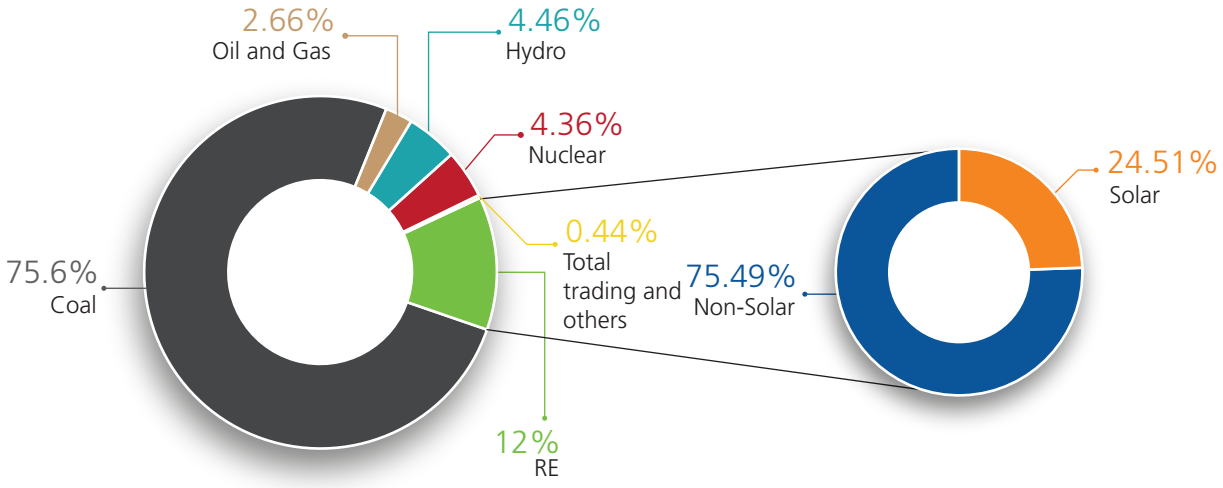


Figure 4: Electricity procurement mix of MSEDCL (2019-20)

2 Mauda TPP, Butibori TPP, Koradi TPP, Khaparkheda TPP, Mihan TPP and Bela TPP

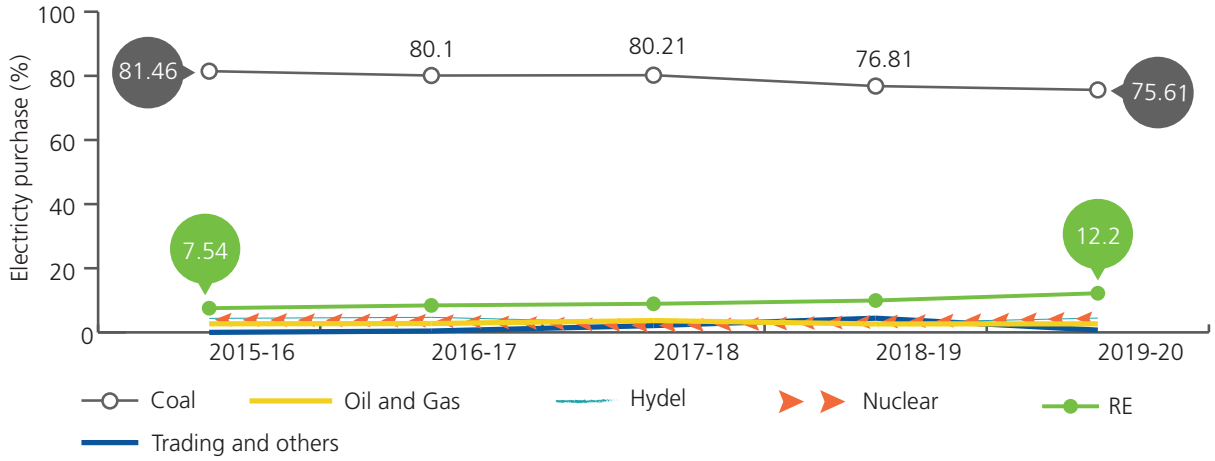
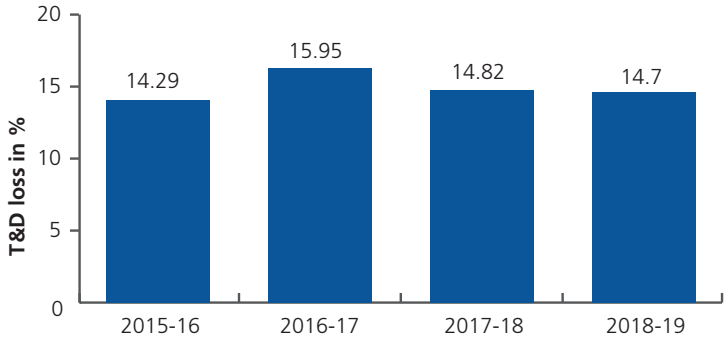


Figure 5: Electricity purchase mix (%) of MSEDCL over the years

The transmission and distribution losses for MSEDCL were 15.95 percent during FY 2016-17 (MERC, 2018), lesser than the national average of 21.42 percent (CEA, 2020). For FY 2018-19, the T&D losses of MSEDCL stood at 14.70 percent (MERC, 2021)



T&D losses in MSEDCL remained below the national average but have the scope to improve.

Figure 6: T&D losses (in %) for MSEDCL over the years.

Information on category-wise electricity consumption (EC) for Nagpur district and the projections of electricity consumption are depicted in Figure 7 and 8.[3] Despite having six thermal power plants with a cumulative installed capacity of 7,176 MW, the district consumed only 4,931 MUs of electricity in 2019. The Government of Maharashtra and Nagpur district websites, as well as a mapping exercise done by Vasudha Foundation indicate that five new units of these coal-based thermal power plants, with a proposed cumulative capacity of 2,920 MW, are in the pipeline.

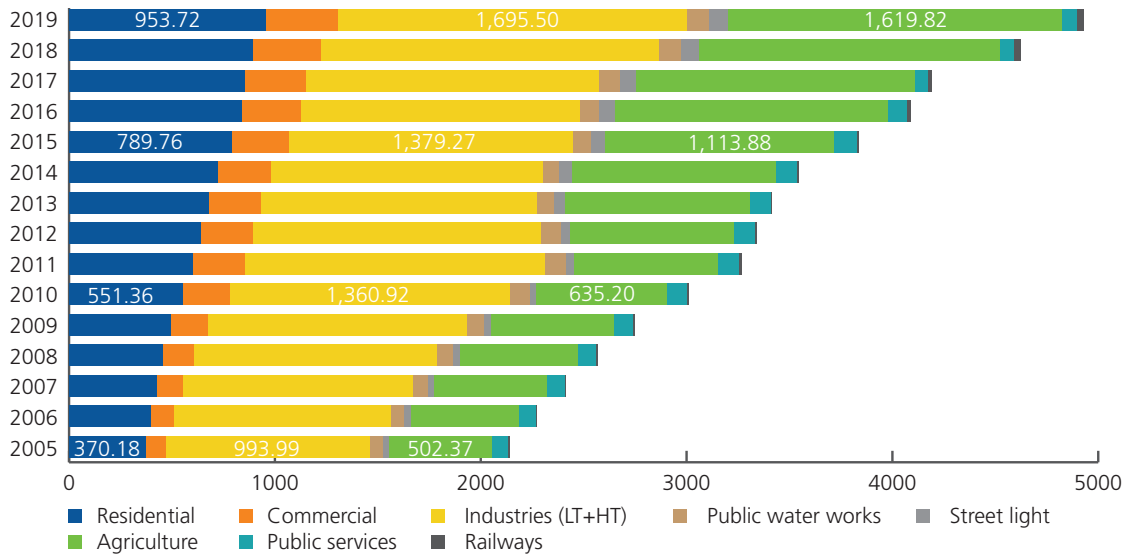


Figure 7: Category-wise electricity consumption in Nagpur over the years (MUs)

3 Electricity is supplied in the district by MSEDCL DISCOM.

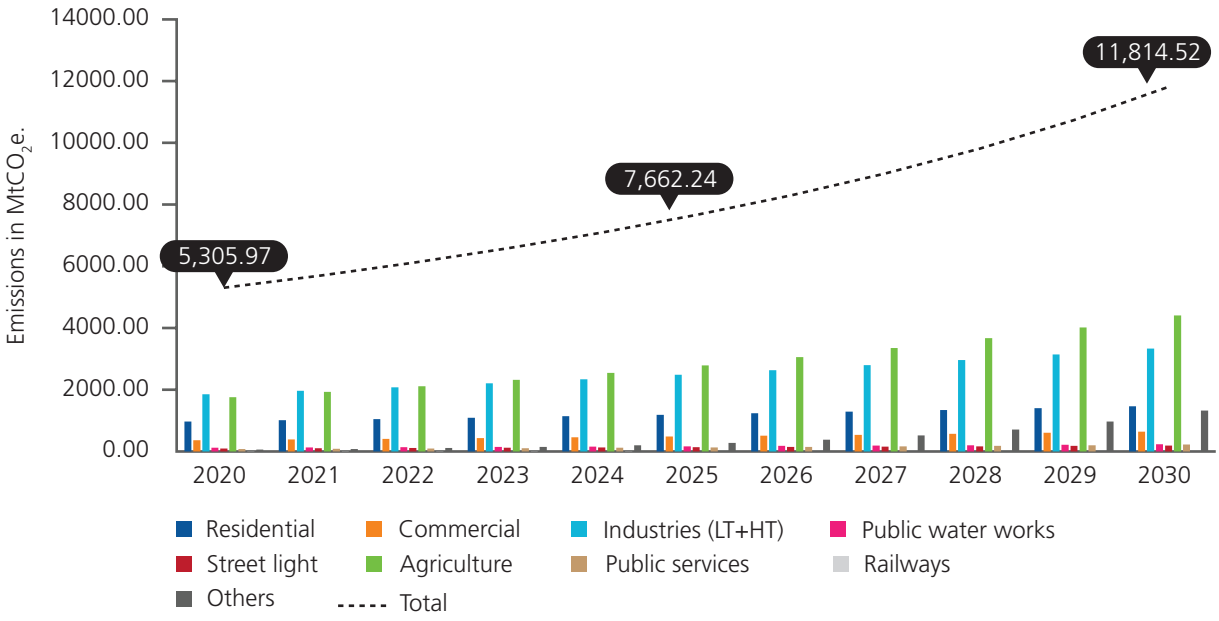


Figure 8: Projections of Electricity Consumption (in $MtCO_2e$.)

1.3. Transport and related infrastructure

Nagpur is a major junction for roadways as India's two major national highways – NH 7 (from Kanyakumari to Varanasi) and NH 6 – (from Mumbai to Kolkata via Sambalpur) pass through the district. Nagpur city has a distinct radial pattern, with two ring roads. The total length of the roads in the district is about 1,907 km, of which 1,150 km of roads is within the jurisdiction of Nagpur Municipal Corporation (NMC). 65 percent of the roads in Nagpur are paved while 33 percent are unpaved. Further, only 18.7 percent of the city has footpaths.

The city bus service, called Aapli Bus in Nagpur city, is operated by the Nagpur Mahanagar Parivahan Limited (NMPL), a special purpose vehicle (SPV) of Nagpur Municipal Corporation (NMC). At present, NMC operates a fleet of 438 buses, including 237 standard buses, 150 midi, 45 mini and six electric buses. Further, NMC is also in the process of procuring 40 electric buses under FAME II.

Maha Metro, the metro service in Nagpur was inaugurated in March 2019. Currently, Phase II of the metro project is underway in Nagpur. There are two routes, covering an operational system length of 24.5 km and 22 stations.

Figure 9 represents the mode share of Nagpur city. It can be observed that two-wheelers have the highest share, followed by auto rickshaws and buses (UMTC, 2018). Share of non-motorised transport (NMT) is quite low in the district.

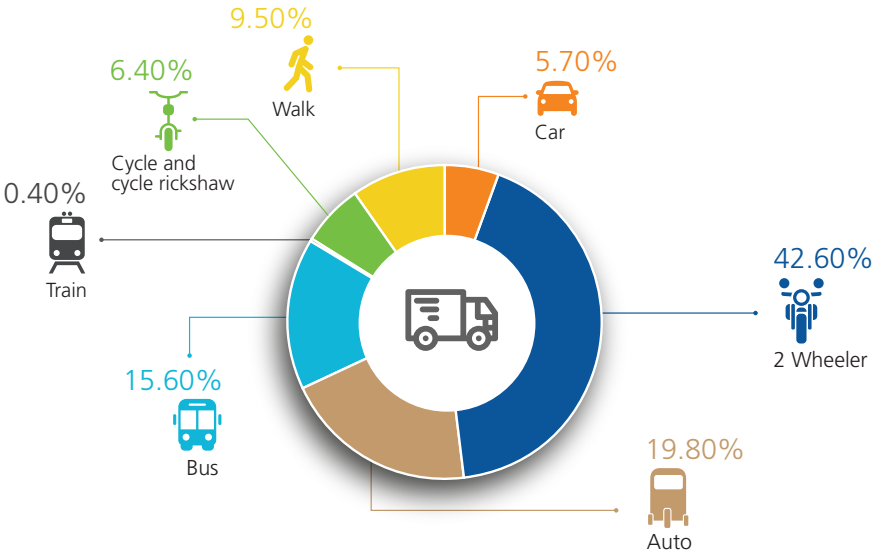


Figure 9: Modal share in Nagpur city (2017-18)

1.4. Habitat (urban and rural)

Since Nagpur has a small geographical area (9,892 sq. km comprising only 3.2 percent of the state) and a high percentage of urbanisation (at 68.31 percent), the population density of the district is relatively high (around 470/sq. km), and slightly higher than the state and national average (Census, 2011). This indicates that there is a huge pressure on its resources and infrastructures. Overall, there are 20 urban local bodies in the district, one municipal corporation, 14 municipal councils and six nagar panchayats. The developed area of Nagpur city is summarised in Figure 10.

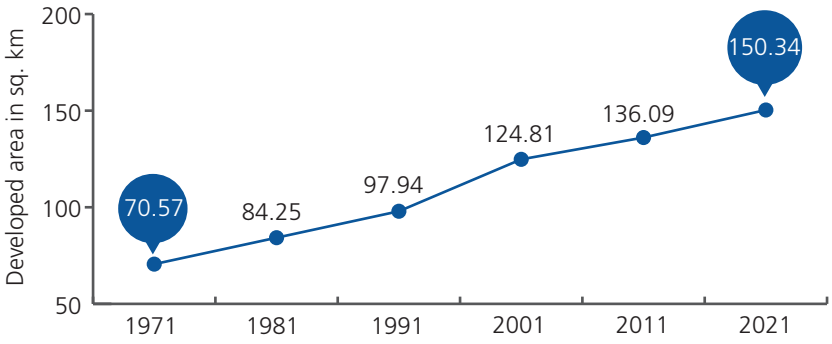


Figure 10: Trajectory of developed area in Nagpur city (1971-2021)

Nagpur city is the third most populous and fifth largest in Maharashtra.

1.5. Industrial profile

There are 11 industrial areas in Nagpur with 2,195 units in production, covering an area of 3,887.83 hectares. The district has a total of 10,356 registered industrial units, of which 213 are in the medium and large categories.

There are 84 large-scale industries/ public sector undertakings in the district. Emissions from some of them fall under the industrial processes and product use (IPPU) category, including activities such as metal and non-metal industries.

By 2012, a total of 10,228 units had been set up with a total investment of ₹ 1,48,349, employing 1,06,119 workers (MSME Development Institute, 2013). Further details about industrial units in the district are available in Annexures 1.1 and 1.2.

1.6. Natural resources

Nagpur district lies in the central highlands ecological sub region. It lies in the eastern and central Vidarbha agro-climatic zones. The district has a net sown area of 4,99,000 hectares with a cropping intensity of 123.2 percent. Major produce is soybean, cotton, sorghum, wheat, chickpea, oranges, tomatoes mangoes, guavas, potatoes, onions among others. The net irrigated area is 1,34,000 hectares while 4,99,000 hectares of agricultural land is rainfed (AGRICOOP, 2012). Figure 11 shows the distribution of irrigation sources utilised in the district.

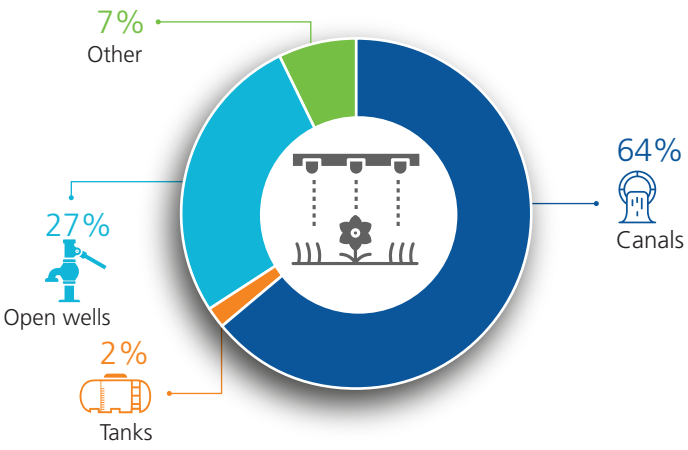


Figure 11: Percentage share of irrigation type in total irrigated area

Total livestock population of Nagpur is 23,74,702 (Livestock Census, 2012), comprising approximately 15 percent of Maharashtra's livestock population.[4] In the fisheries segment, there are a total of 7,761 reservoirs and lakes in the district varying from 10 to over 1,000 hectares. There are 430 farmer owned ponds, 70 reservoirs and 502 village tanks being used for fishing activities with a yield of 0.73 tonnes/hectare (AGRICOOP, 2012).

In Nagpur, the forest cover comprises of 20.22 percent of its geographical area and is higher than the state average of 16.5 percent (Forest Survey of India, 2019). With respect to the 2017 assessment (FSI), Nagpur has witnessed a decline in its forest cover from 2,01,900 hectares to 2,00,038 hectares in 2019, indicating an 18.62 percent decrease.

4 category wise livestock population details, provided in Annexure 1.4

Nagpur has 1,053 wetlands, covering an area of 41,791 hectares, comprising 4.23 percent of the district's geographical area. The district is dominated by man-made wetlands (ISRO, 2011).

The district is rich in minerals and, has deposits of coal, manganese ore, dolomite, clay, copper ore, chromites, tungsten ore, zinc ore, quartz, etc. Coal reserves are found in the north-western belt of the district. Coal-fields are spread across an area of 1,344.78 sq. km and hold a premier position in India for providing a considerable share of reserve of thermal grades of non-coking coal. The coalfield has 16 coal blocks, six of which are allocated to Coal India Limited (CIL), one is allocated as a captive block to Maharashtra State Electricity Generation Company (MahaGenco) and the remaining are unallocated (CMRDI,2021). Manganese, limestone, mica and tungsten are also mined in the district.

Besides major mineral mines, Nagpur district also has minor mineral mines. Out of the total 35 mines in the district, three are allocated for sand mining. With development activities gaining pace in the district, sand mining has been witnessing an upward trend since FY 2016-17. Kanhan river bed is the source of sand mining in the district. Every year certain number of sand ghats are auctioned. In 2020, 26 sand ghats spread across four talukas were put out for auction.

Ground water status in the district is an issue of concern. The water quality is suitable for drinking and irrigation purposes. However, there is presence of localised magnesium, nitrate and fluoride and high salinity hazards in some areas of the district. The stage of groundwater development in Nagpur district is 38.54 percent (CGWB, 2013). The net annual groundwater availability in the district is 1,058 MCM, while annual draft (irrigation and domestic) is 407.8 MCM. In general, rise in water level is in the range of 2 to 54 cm/year whereas decline is in the range of 0.6 to 86 cm/year in the pre-monsoon time.

As per analysis of IWRIS data between 2005 and 2019, pre-monsoon groundwater levels of 42 stations located in the 14 blocks of Nagpur indicate that the water level below the ground improved significantly, especially in the Narkhed and Katol tehsil. However, it reduced in Umred tehsil and few small pockets of Nagpur tehsil (Figure 12) and remained same in other parts of the district. The post-monsoon analysis for the same period indicates that the ground water level is declining in the post monsoon season in the entire district, with the exception of Umred tehsil (Figure 13).

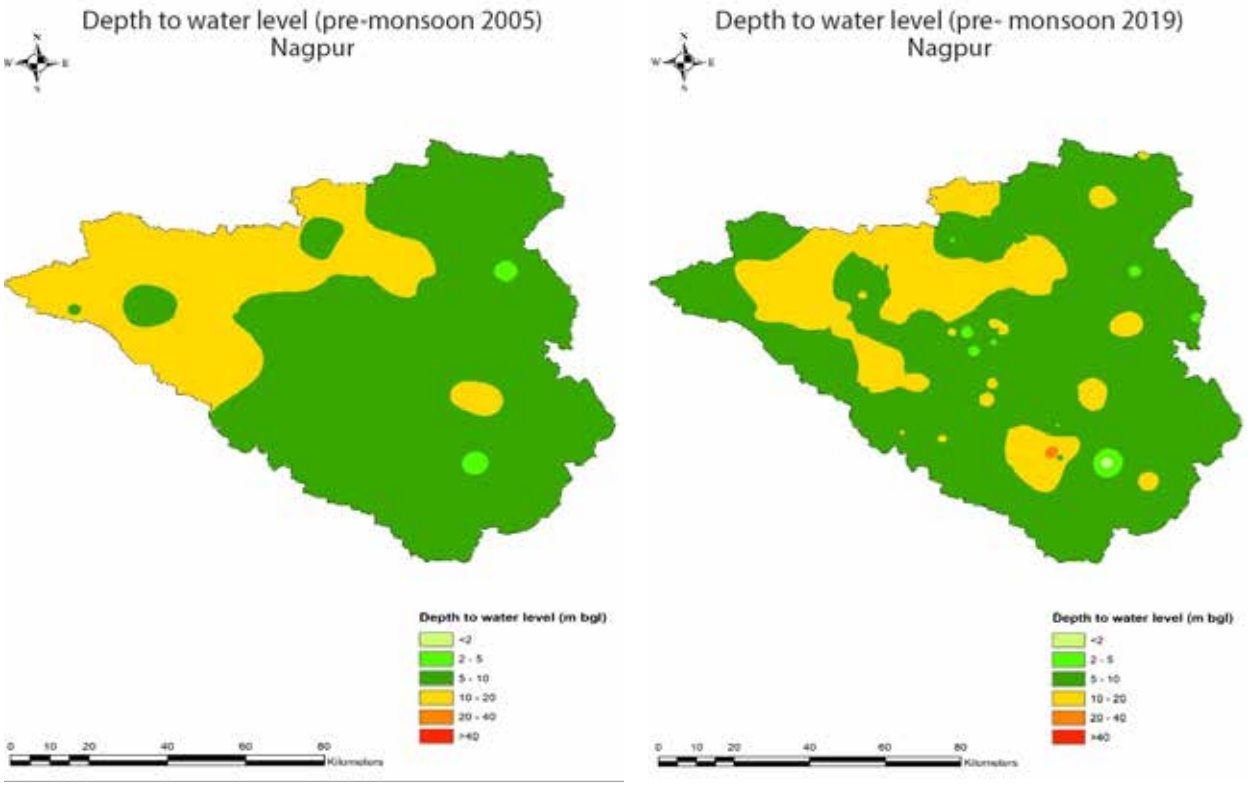


Figure 12: Pre-monsoon groundwater levels in Nagpur: a) 2005 and b) 2019

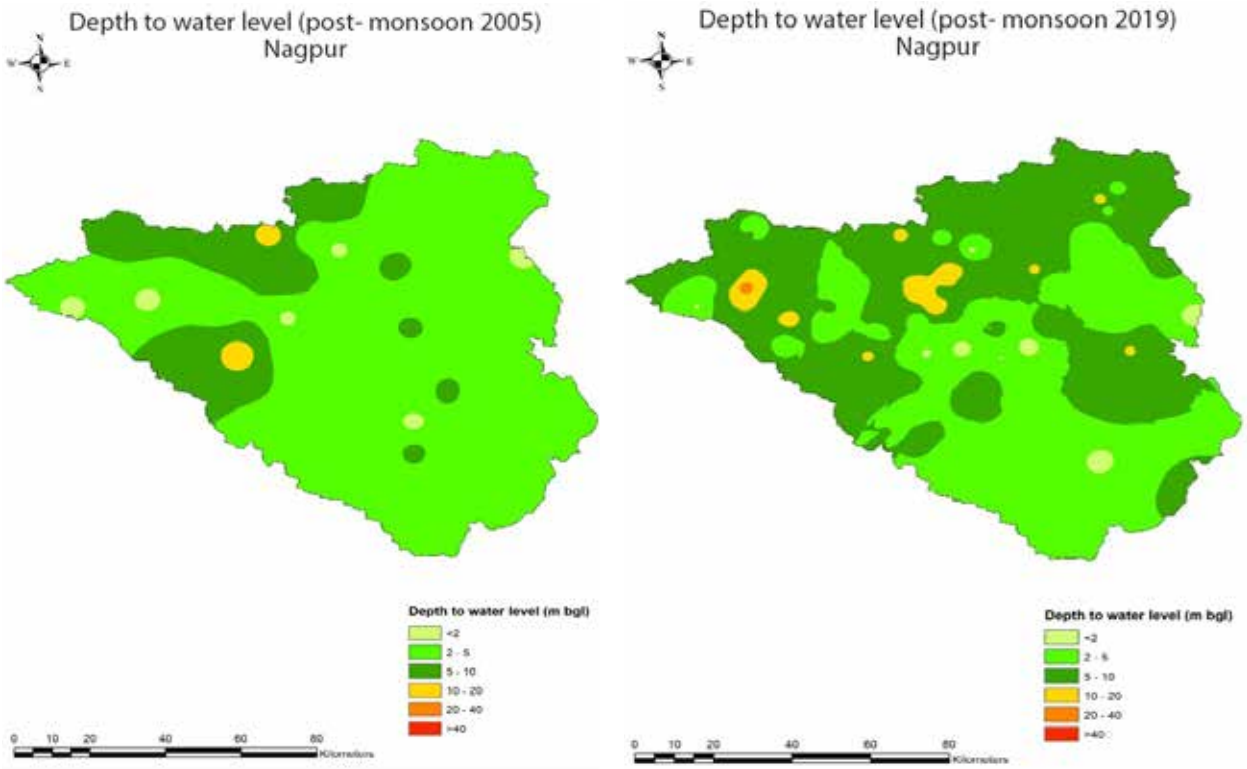


Figure 13: Post-monsoon groundwater levels in Nagpur: a) 2005 and b) 2019

1.7. Waste sector

Nagpur (city) ranked 18th among 47 cities with a population above 10 lakh in India in the 2020 sanitation survey – 'Swachh Survekshan' (cleanliness, hygiene and sanitation survey) (MoHUA, 2020). The city has upgraded its rank from 58th in 2019, indicating an improvement in the waste management sector. As per MPCB, 79 percent of the total solid waste generated in Nagpur goes straight to the landfill without any treatment. About 41 percent of the solid waste generated in the district is biodegradable, though currently only 21 percent is composted (MPCB, 2019). Bhandewadi is the landfill site for Nagpur, located at a distance of 15 km from the city and operating beyond its lifespan. The city generates 345 MLD of sewage that is collected through a 96 percent sewer network connection coverage of 1,670 km length. However, only 100 MLD is treated at the Bhandewadi aerobic STP. The remaining untreated sewage is disposed of in the Gosikud Dam (CPCB, 2015). Though there are several industrial clusters in the district, data on industrial wastewater generation or treatment is not in the public domain.

WASTE MANAGEMENT IN NAGPUR

Solid waste

Bio-medical waste

E-waste

Hazardous waste

GENERATION

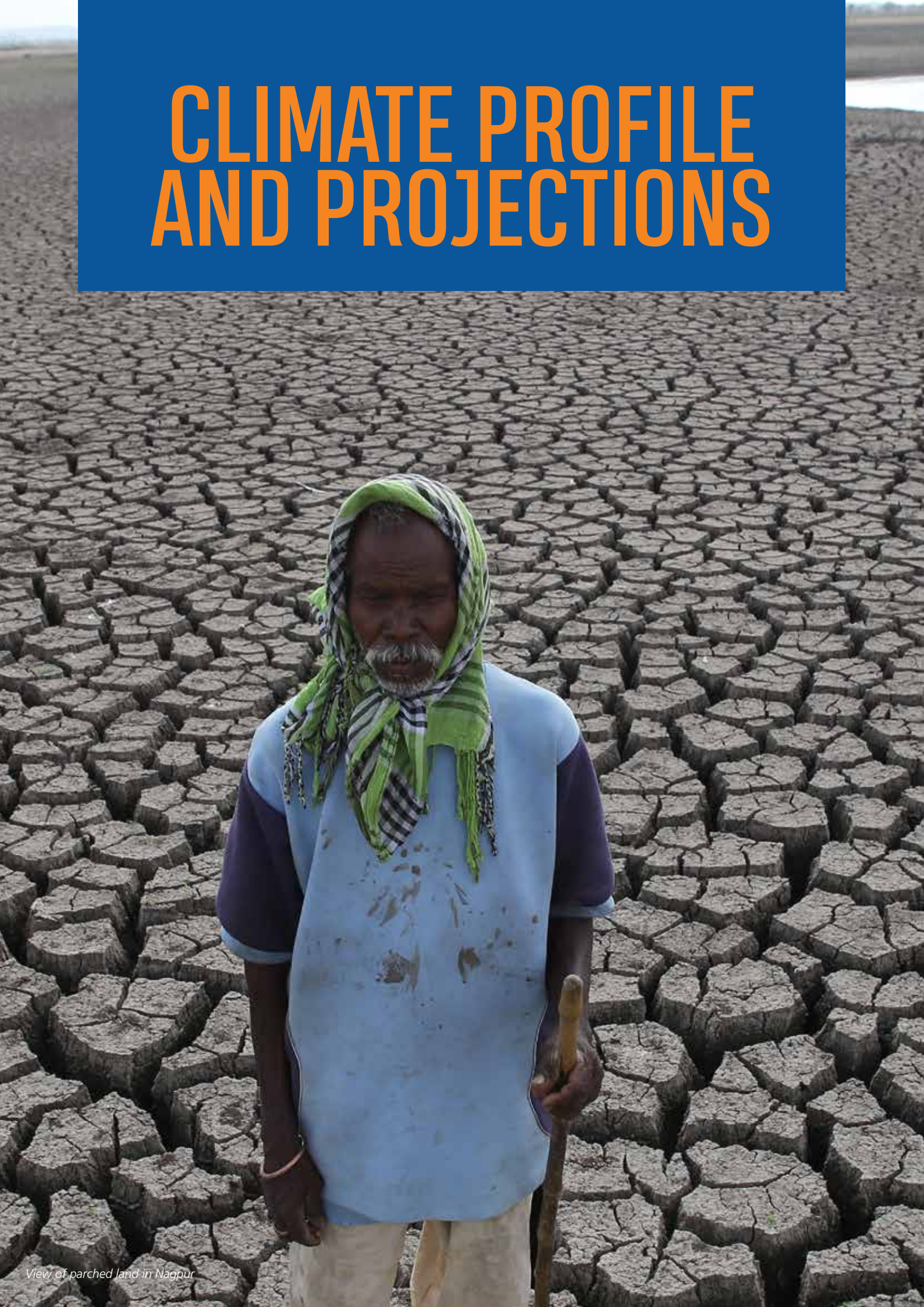
Solid waste	Bio-medical waste	E-waste	Hazardous waste
1,347 TPD	3,660 kg/day	No recent e-waste inventory	Nagpur region generation: 4,078.71 (MT/A) Total disposal at Nagpur TSDF: 28,071.94 MT/A

DISPOSAL

Solid waste	Bio-medical waste	E-waste	Hazardous waste
Vermi-composting, recycling plant, resource derived fuel, scientific landfill for inert waste	Treated at CBWTF (incineration, autoclave, etc.) & captive facilities	Mostly routed informally	Treated at TSDF (secured landfill, reclaimed landfill, incineration)

* C&D: Construction & Demolition; CBWTF: Common Bio-medical Waste Treatment Facility; TSDF: Treatment, Storage & Disposal Facility;

CLIMATE PROFILE AND PROJECTIONS



View of parched land in Nagpur

2. CLIMATE PROFILE AND PROJECTIONS

2.1. Observed climate variability over Nagpur district

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

This section focuses on the current mean climate variability in Nagpur district, analysing the observed data of the past 68 years. Precipitation and temperature are used as the key climate variables in this analysis.[5]

2.1.1 Precipitation variability

The climate of Nagpur district can be broadly described as tropical with generally dry conditions prevailing for most of the year. The mean monsoon rainfall in the district is around 940 mm, with July and August being the main monsoon months. The number of rainy days (days with rainfall of ≥ 2.5 mm) in the district vary from 10 to 17 in a month during monsoon. The district receives more than 50 days of good rainfall during the monsoon season.

Year-to-year rainfall variability during monsoons and seasonal mean for 1951 to 2018 over Nagpur district (area averaged) is depicted in Figure 14. Though there is no significant trend in the monsoon rainfall, a slight increase is observed in the recent decades in both individual months and throughout the season. It has been observed that the variability in rainy days is higher in July and August, and these two monsoon months show a slightly decreasing trend during the period 1951 to 2018 (Figure 15).

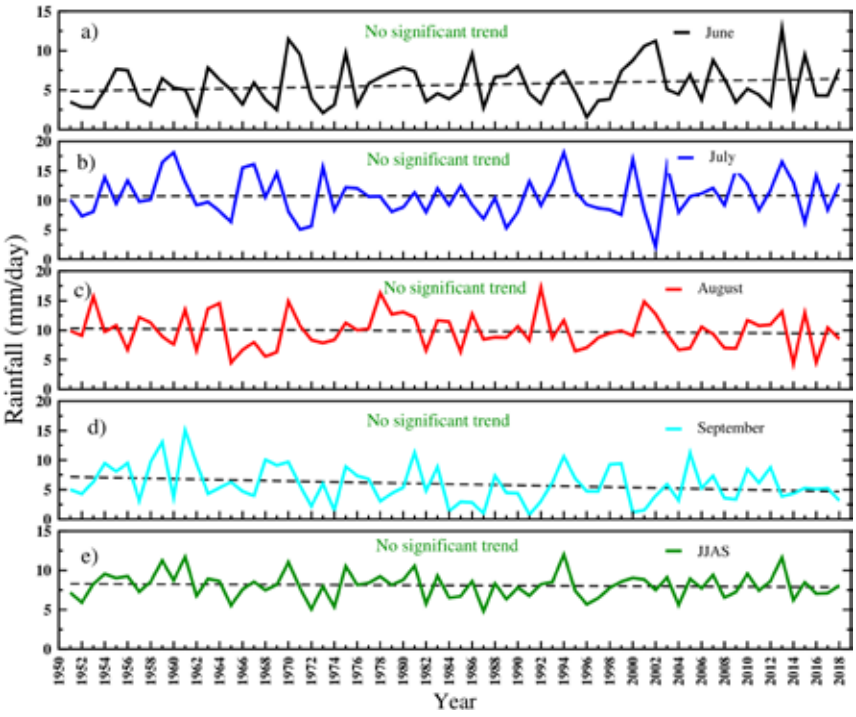


Figure 14: Inter-annual variability of rainfall (mm/day) for Nagpur for 1951-2018

With more than 50 days of good rainfall during monsoon, Nagpur district receives a mean monsoon rainfall of 940 mm.

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

Higher variability in rainy days is observed during July and August.

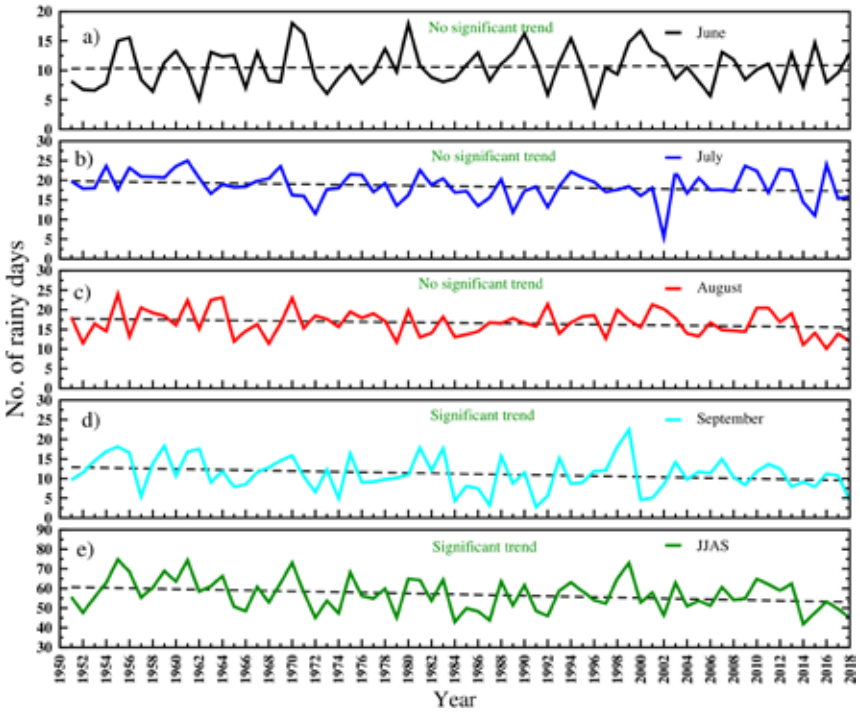
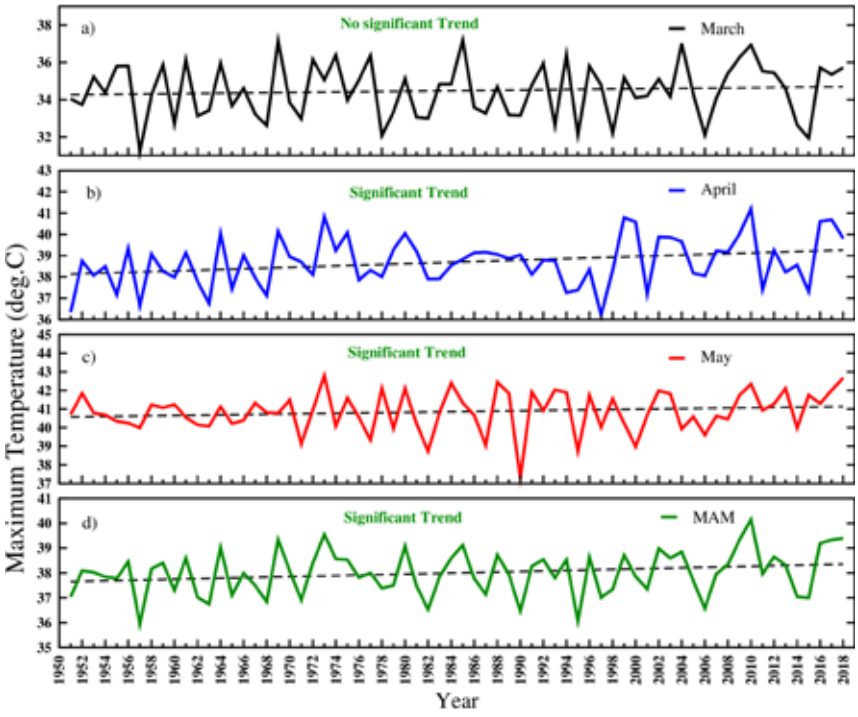


Figure 15: Inter-annual variability of rainy days (number of days) over Nagpur for 1951-2018

2.1.2. Temperature variability

The mean temperature in the district ranges between 34°C and 45°C during summer-time (March, April and May) with May being the hottest month. Summer is the driest period of the year and the maximum temperature in the summer months shows an increasing trend, which got accelerated during the last decade (Figure 16). The mean percentage of warm days has also increased in the district (Figure 17) by about 9 percent during the period of 1986 to 2005.[6]



Maximum temperatures during summer months show an increasing trend.

Figure 16: Inter-annual variability of maximum temperature (°C) over Nagpur for 1951-2018

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

Warm days have increased by 9% between 1986 and 2005

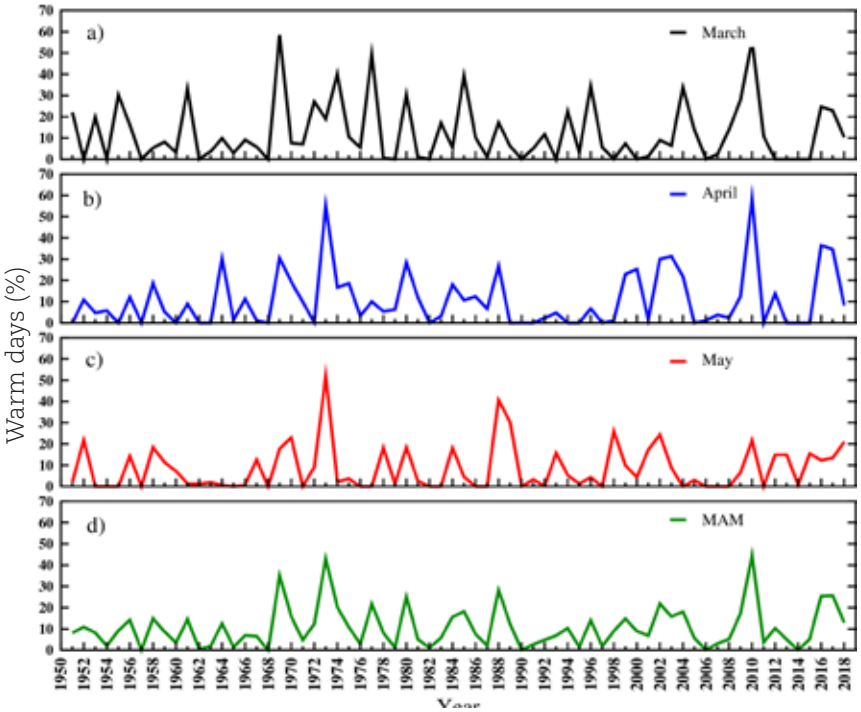


Figure 17: Inter-annual variability of warm days (%) over Nagpur for 1951-2018

In winter (December, January, and February) temperatures range between 9°C and 10°C, with January being the coldest month in the district. Year-to-year variability of minimum temperature (Figure 18) indicates an increasing trend throughout the winter months, but the mean percentage of cold days shows a large variability. (Figure 19)[7]

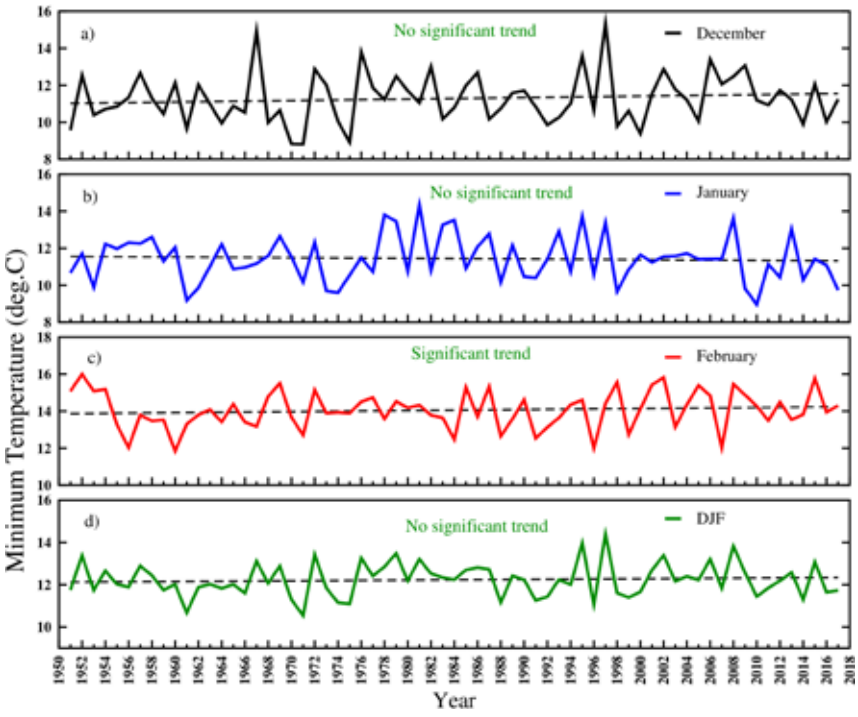


Figure 18: Inter-annual variability of minimum temperature (°C) over Nagpur for 1951-2018

Mean minimum temperature shows increasing trend, especially in February

7 Cold days - correspond to cases when the minimum temperature falls below the 10th percentile of the temperature distribution of the season,

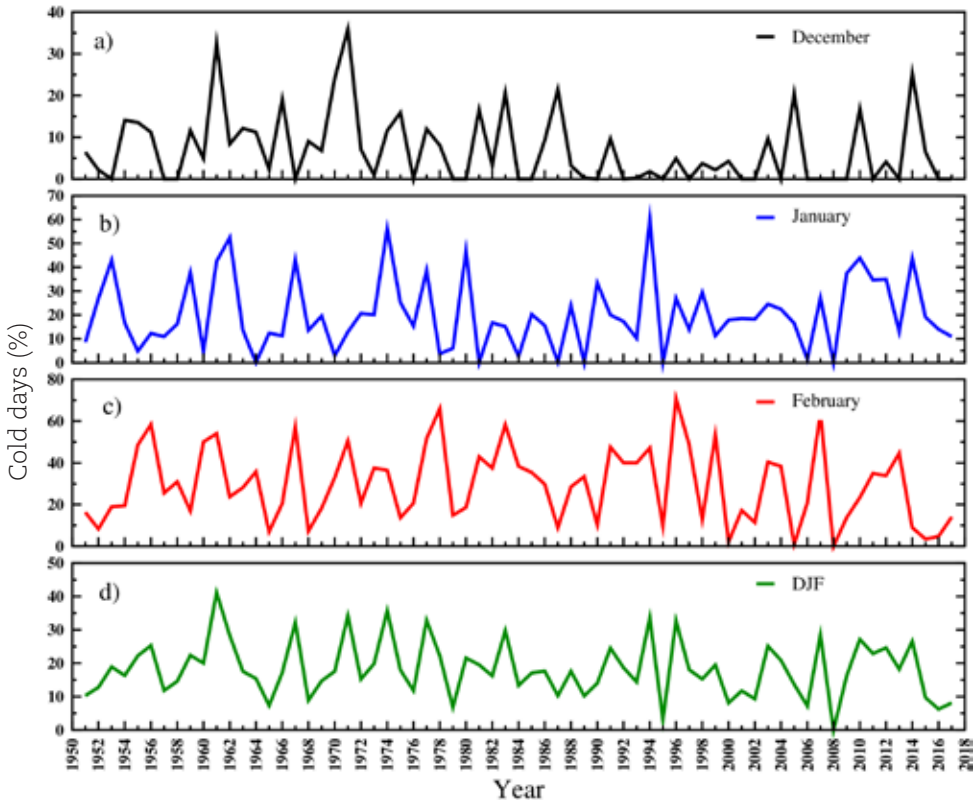


Figure 19: Inter-annual variability of cold days (%) over Nagpur for 1951-2018

2.2. Future climate projections for Nagpur district

Precipitation and temperature for the period of 1986 to 2005 have been simulated using the multi model mean (MMM) ensemble. The district may experience an increase in the quantum of rainfall in the monsoon months and the season as a whole in different epochs (2021-2040, 2041-2060, 2061-2080 and 2081-2100) under medium (RCP4.5) and high (RCP8.5) emission scenarios. There may be an increase in seasonal precipitation by 4 to 20 percent under RCP4.5 and 15 to 35 percent under RCP8.5 emission scenarios, respectively (Table 4). The number of rainy days is also projected to increase during the monsoon season, though marginally, particularly in July and August (Table 5).

Table 4: Observed (1986-2005), simulated (1986-2005) and projected mean monthly and seasonal rainfall (mm) for Nagpur district

Rainfall (mm)	June	July	August	September	JJAS (total of Jun, Jul, Aug and Sept)
Observed	185	300	295	154	938
Simulated	154	313	302	176	950
RCP4.5					
2030s (2021-2040)	154	304	316	212	991
2050s (2041-2060)	157	330	340	224	1056
2070s (2061-2080)	161	322	367	251	1106
2090s (2081-2100)	170	352	367	250	1144
RCP8.5					
2030s	155	358	368	209	1096
2050s	154	369	400	266	1196
2070s	149	394	396	276	1221
2090s	169	379	440	291	1285

Table 5 Observed (1986-2005), simulated (1986-2005) and projected mean monthly and seasonal number of rainy days (days with rainfall ≥ 2.5mm) for Nagpur district

Rainy days (day with rainfall of 2.5 mm or more rainfall)	June	July	August	September	JJAS (Total of Jun, Jul, Aug and Sept)
Observed	11	17	17	10	55
Simulated	10	18	18	11	57
RCP4.5					
2030s (2021-2040)	10	17	17	12	57
2050s (2041-2060)	9	18	18	13	58
2070s (2061-2080)	10	17	18	13	58
2090s (2081-2100)	10	19	18	13	60
RCP8.5					
2030s	9	18	18	12	57
2050s	9	17	18	13	58
2070s	9	18	17	13	57
2090s	9	17	18	13	57

The projected changes in maximum and minimum temperatures were analysed on a monthly scale during the summer/ winter season. The projections in different time epochs indicate that the maximum temperatures may increase by 1.2°C to 2.4°C under RCP4.5 and 1.5°C to 4.4°C under RCP8.5 over the district, particularly during the month of May (Table 6). The percentage of warm days is also projected to increase by the end of the century (Table 7). In winter season, the minimum temperatures are projected to increase by 1°C to 2.5°C under RCP4.5 and 1.3°C to 4.8°C under RCP8.5 with the percentage of cold days decreasing in all epochs under changing climate conditions (Table 8). A clear increase in temperature towards the end of the century can also be seen (Table 9). Due to these temperature changes, the district is likely to lose the night time breezes.

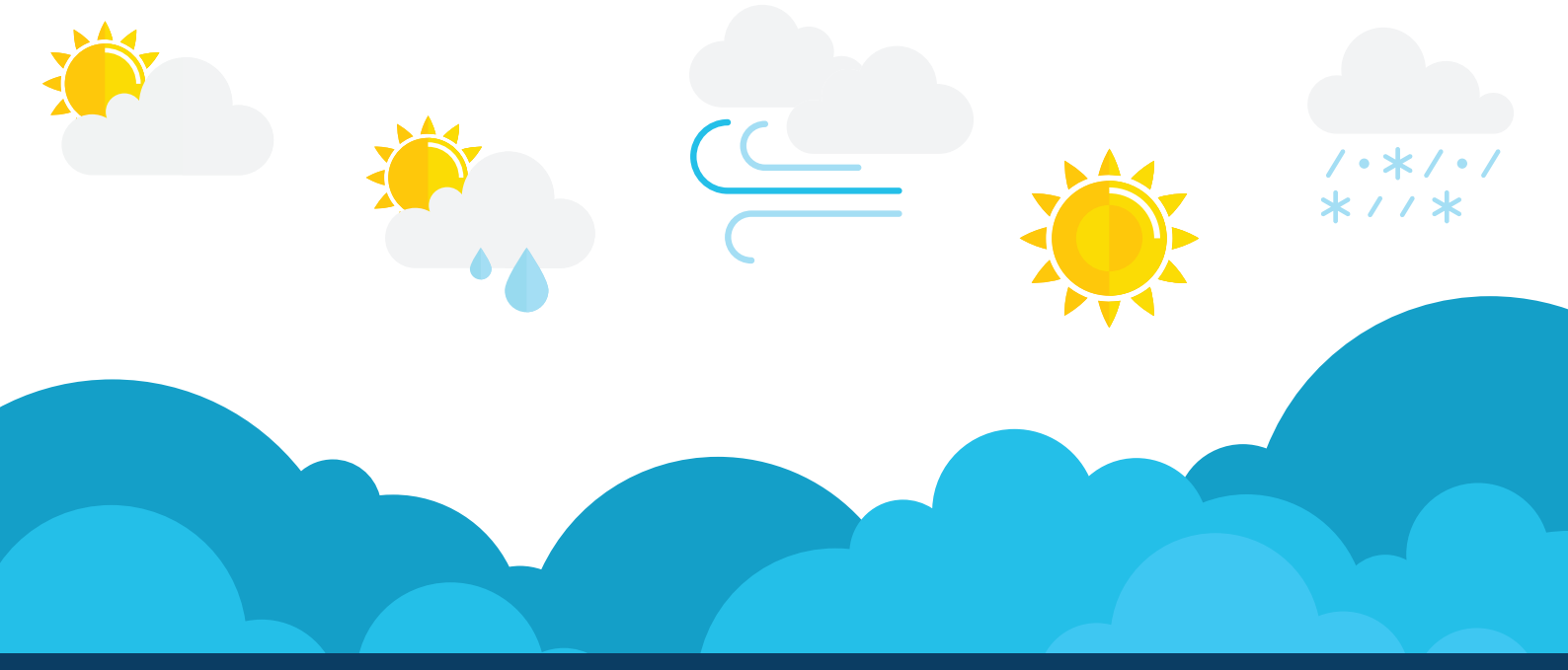


Table 6: Observed (1986-2005), simulated (1986-2005) and projected mean monthly and seasonal maximum temperature (°C) for Nagpur district.

Temp. max (°C)	March	April	May	MAM (average of March, April and May)
Observed	34.3	38.7	40.7	37.9
Simulated	35.8	39.8	42.1	39.2
RCP4.5				
2030s	37.2	41.2	43.4	40.4
2050s	37.7	41.6	43.9	41.0
2070s	38.2	42.1	44.2	41.5
2090s	38.2	42.2	44.4	41.6
RCP8.5				
2030s	37.2	41.8	43.5	40.7
2050s	38.1	42.1	44.4	41.7
2070s	39.5	43.4	45.5	42.8
2090s	40.3	44.2	46.3	43.6

Table 7 Observed (1986-2005), simulated (1986-2005) monthly and projected mean monthly and seasonal warm days (%) for Nagpur district

Warm days (%)	March	April	May	MAM (average of March, April and May)
Observed	9	10	10	9
Simulated	10	10	9	9
RCP4.5				
2030s	35	40	44	40
2050s	47	55	58	55
2070s	56	65	68	64
2090s	59	67	73	67
RCP8.5				
2030s	38	43	50	44
2050s	58	67	73	67
2070s	80	85	89	85
2090s	88	91	94	90

Table 8: Observed (1986-2005), simulated (1986-2005) and projected mean monthly and seasonal minimum temperature (°C) for Nagpur district.

Temp. min (°C)	DEC	JAN	FEB	DJF (average of Dec, Jan and Feb)
Observed	11.3	11.5	11.3	11.3
Simulated	12.7	12.9	15.5	13.6
RCP4.5				
2030s	13.7	14.3	16.3	14.6
2050s	14.5	14.9	17.4	15.5
2070s	15.1	15.5	17.9	16.1
2090s	15.2	15.5	18.0	16.1
RCP8.5				
2030s	14.0	14.3	16.8	14.9
2050s	14.9	15.4	18.0	16.0
2070s	16.4	16.9	19.5	17.5
2090s	17.3	17.9	20.4	18.4

Table 9: Observed (1986-2005), simulated (1986-2005) and projected mean monthly and seasonal cold days (%) for Nagpur district.

Cold days (%)	Dec	Jan	Feb	DJF (average of Dec, Jan and Feb)
Observed	5	19	29	17
Simulated	8	21	37	22
RCP4.5				
2030s	3	7	15	8
2050s	1	4	10	5
2070s	0	2	6	3
2090s	0	2	5	3
RCP8.5				
2030s	3	9	17	9
2050s	1	3	6	3
2070s	0	1	1	1
2090s	0	0	1	0

2.3. Sectoral impacts of climate change

Heat stress in Nagpur

Nagpur is one of India's hottest cities that experiences heat stress every year, particularly during the months of pre-monsoon summer (March to May), when maximum temperatures reach 45°C. The effects of heat stress observed in the city are: a) health impacts including dehydration, heat exhaustion and stroke, exacerbations of chronic cardiovascular and respiratory diseases; b) worsening of environmental factors like water stress and deteriorating water quality; c) outbreaks of vector-borne diseases, such as malaria, chikungunya and dengue; and d) incidences of diarrheal diseases. Poorer communities with low prevalence of protective measures and workers in outdoors or in high-risk industries like glass and metal works are the vulnerable groups with higher risk of heat-related illnesses (Knowlton, et al., 2014).

Nagpur is is one of India's hottest cities

Climate change linked extreme heat events are globally widespread. Mean annual temperatures across India have also increased relative to historical averages. The climate variability study conducted under the current district action plan, observes a 4.9°C and 2.8°C rise in maximum average summer temperatures (March to May) by the end of the century as per the high emission pathway (RCP8.5) and medium emission pathway (RCP4.5), respectively. This also suggests that more frequent and intense heat waves are likely to occur in the district, making it a critical issue to be addressed in climate action plans and adaptation execution measures for the district. The same is reflected in the one of the highest temperatures of the decade at 47°C, even during lockdown (in the month of May, 2020).

Maharashtra State Public Health Department and NMC developed a Nagpur Regional Heat Action Plan (HAP) in 2019. The action plan has been coordinated between Nagpur and four neighbouring cities (Vidarbha region), and is the first regional approach to heat wave planning in the country.

The HAP has colour-coded signals for heat alert according to different temperature thresholds based on an analysis of the mortality rates. The plan has identified vulnerable populations and awareness activities have also been undertaken under it. The HAP consists of heat mitigation measures in accordance with the guidelines issued by National Disaster Management Agency (NDMA). Under the HAP, efforts to mitigate impact of heat waves include providing drinking water at public transit locations, closing markets in the afternoon, cooling jackets and helmets for traffic police, among others. Long-term measures include town planning to reduce heat vulnerability with afforestation, plantation drives, rainwater harvesting, shelters for traffic police, green nets for shade and strengthening inter-sectoral coordination.

Even though the HAP effectively addresses immediate concerns to minimise the impacts and considers a long-term cool roof planning, several other critical aspects remain untouched. These aspects are important to holistically evaluate heat stress impacts and to implement robust mitigation measures. Chapter 6 has detailed recommendations on these aspects.

Agriculture

Rising temperatures, erratic rainfall, and extreme weather events are having adverse effects on Maharashtra's agricultural output year after year. The yields of rainfed food crops as well as irrigated cash crops are both being impacted. Major crops affected include sugarcane, pearl, millet, wheat, rice, cotton, soybean, sorghum and jowar among other crops. Nagpur district has been experiencing serious repercussions due to climate change. In the past decades, the monsoon onset is delayed by more than 15 days in Nagpur region. In 2018, Nagpur recorded the highest ever rainfall with 300 mm in 24-hours as well as the lowest minimum temperature at 3.5°C. In 2019, Nagpur recorded the highest maximum temperature with 47.5°C.

In 2018, Nagpur recorded the highest ever 24 hour rainfall of 300 mm, as well as the lowest minimum temperature at 3.5°C.

The predicted rise in temperature in the region is very likely to reduce the productivity of traditional rainfed crops like jowar, bajra and pulses, as well as irrigated cash crops like sugarcane, onion and maize. The rise in annual minimum temperature, particularly during the winter season, can also adversely affect wheat yield. The reduction in the number of rainy days and untimely hailstorms can have a detrimental impact on the harvesting of important horticulture crops in the region.

Over the last six years, Maharashtra has faced four droughts. In addition to the decrease in yield as mentioned above, frequent droughts have had significant negative impacts on horticulture and animal agriculture across the state.

Higher temperatures along with increase in rainfall can threaten agricultural productivity by catalysing an increase in fungal diseases and bacterial leaf-blight, among other plant diseases. Furthermore, the warming climate also makes the region susceptible to pest invasions such as locusts, as witnessed in the summer of 2020, which can have a detrimental effect on all standing crops in the region.

Water resources

The Nagpur district is endowed with Kanhan, Pench, Wardha and Wainganga rivers. Majority of the region's water demand is met through reservoirs on these rivers. Groundwater utilisation in the district is marginal and the water demand is primarily met through three surface water resources – Gorewada lake, Kanhan river and the Pench Dam.

In 2019, Gorewada lake, a reservoir on Pili river 8 km from Nagpur city, dried up for the first time in more than 100 years. Raw water availability in Kanhan River has also declined in recent years due to upstream development activities. Further, Pench dam, which serves majority of the district (approximately 70 percent), is also experiencing a decline in water availability.

Traditionally, the rainfall in the district has been well distributed. The region receives almost 90 percent of its rainfall during the south-west monsoon, with the maximum in July. However, the shift in monsoon onset and reduced number of rainy days during the season have made Nagpur susceptible to both droughts and floods. These disasters have had a major impact on agriculture and daily life in the district. It would also result in fluctuating water storage levels in natural and man-made reservoirs, thus widening the water demand and supply gap due to decreased water availability, particularly during the dry months. As of March 2021, 15 of the 16 dams in the region had 58.4 percent water stock as compared to 60.7 percent at the same time during the previous year.

Major flooding events in recent years have had devastating impacts on agriculture, infrastructure and human lives in the district. Climate change induced shifting rainfall pattern in the district could further exacerbate these issues in the long run, unless prompt action is undertaken.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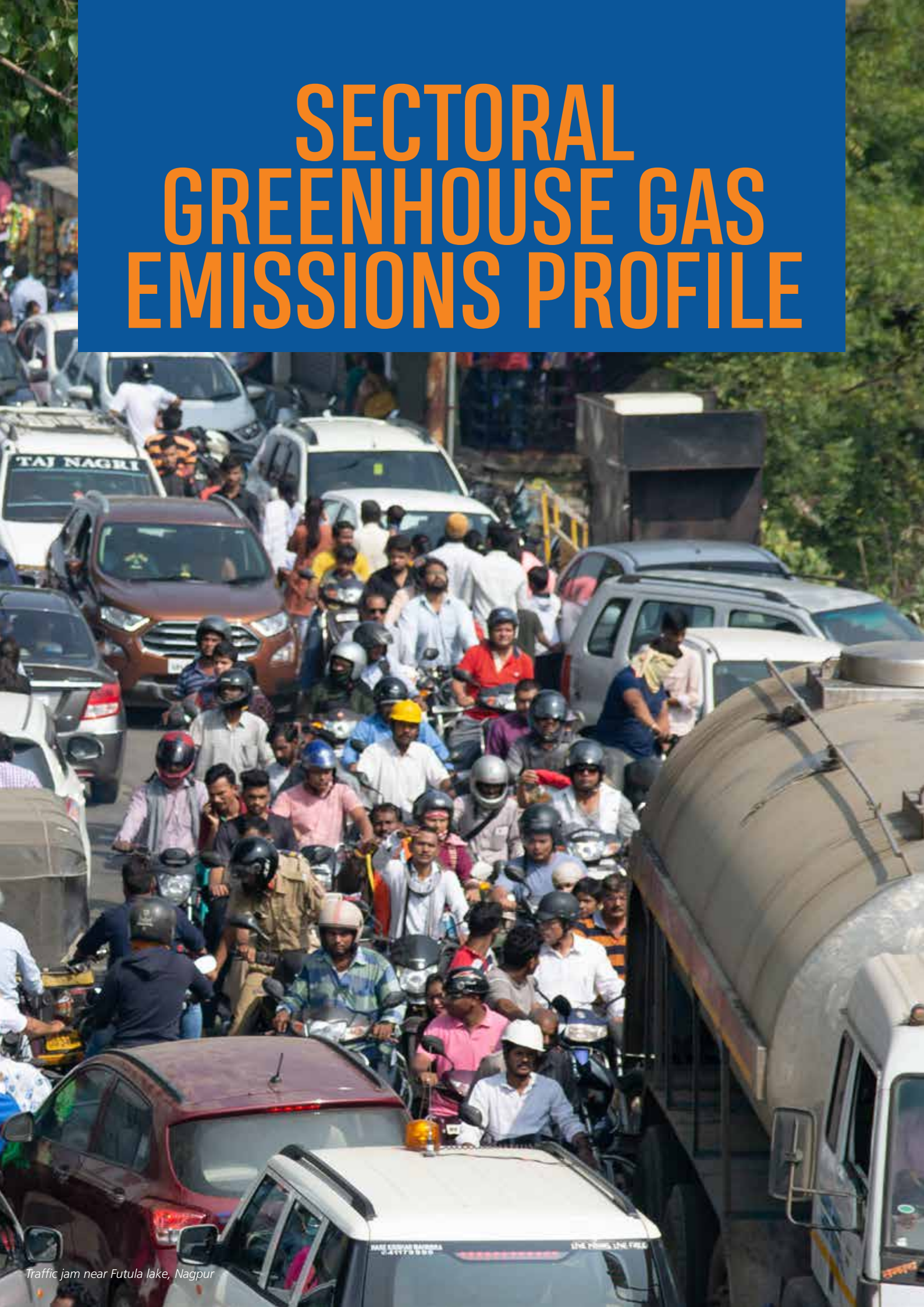
SECTORAL GREENHOUSE GAS EMISSIONS PROFILE



Traffic jam near Futula lake, Nagpur

3. SECTORAL GREENHOUSE GAS EMISSIONS PROFILE: CLIMATE CHANGE DRIVERS

This section estimates greenhouse gas (GHG) emissions for Nagpur district using the guidelines laid down by the Intergovernmental Panel on Climate Change (IPCC).[8] Estimates have been provided for 14 categories, covering three major sectors – energy, agriculture, forestry and other land use (AFOLU), and waste – for the years 2005 to 2019.[9] Nagpur district has a few industrial units (especially cement and chemical manufacturing units) that lead to emissions from the industrial processes and product use (IPPU) sector as per the IPCC guidelines. However, emissions from the IPPU sector could not be taken into account due to unavailability of activity data (industry-wise production details). Energy used in industries and the corresponding emissions are reported in the energy sector.

The activity data was sourced from government-approved datasets for all the sectors and wherever possible, country-specific emission factors were used in place of default-emission factors.[10]

3.1. Direct emission estimates

3.1.1 Economy-wide emissions

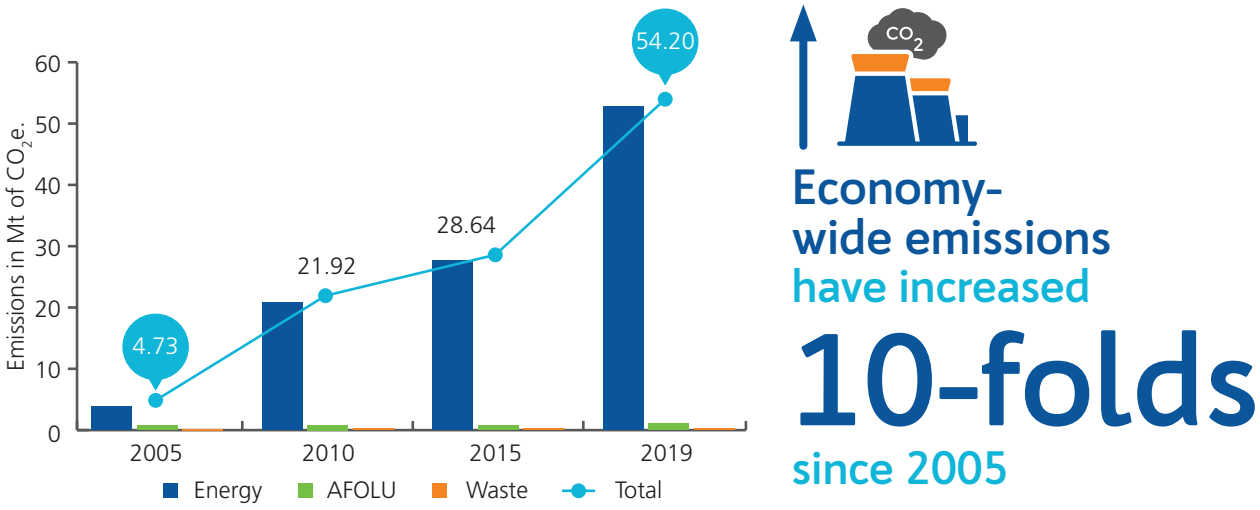


Figure 20: Economy-wide emissions of Nagpur district (Mt of CO_2e.)

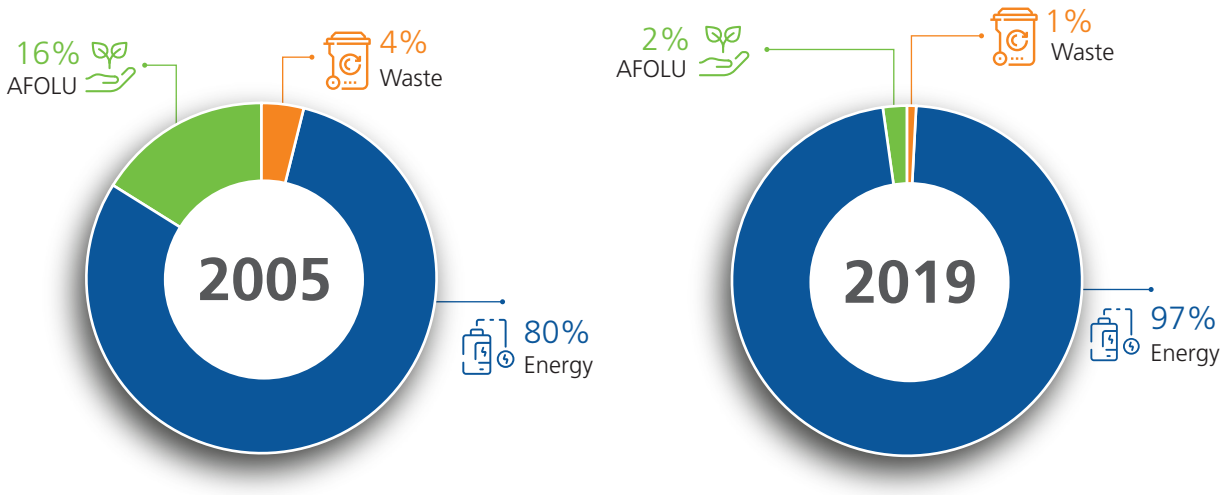


Figure 21: Percentage share of sectors in total emissions

8 To the extent possible, 2006 IPCC guidelines were followed; and for a very few categories, the 1996 IPCC guidelines were referred to. Background note on GHG inventorisation and its significance is given in Annexure 3.1

9 For some categories, estimates for 2017, 2018 and 2019 have been obtained by applying CAGR on the latest possible GHG calculations (based on availability of activity data)

10 Emission category-wise activity data sources provided in Annexure 3.2

- Between 2005 and 2019, the total emissions of Nagpur district have seen a 10-fold increase (from 4.73 Mt CO_2e in 2005 to 54.20 Mt CO_2e in 2019). The CAGR for the economy-wide emissions during this time frame was 19.26 percent.
- With massive increase in electricity generation (from the six thermal power plants of Nagpur), also termed as public electricity generation category, the energy sector emissions have grown at a CAGR of 24.68 percent (between 2005 and 2018).
- As a result, the share of energy sector emissions in total emissions has increased from 80 percent in 2005 to 97 percent in 2019.
- AFOLU sector emissions reduced after 2011, but increased significantly after 2016 due to loss of forest area. Despite this, the share of AFOLU sector dropped from 16 percent (2005) to two percent (2019).
- Waste sector has grown at a slow rate (CAGR of 2.34 percent) and its contribution dropped from four percent (in 2005) to one percent in 2019.
- Sectoral details and analyses are given in the following sections

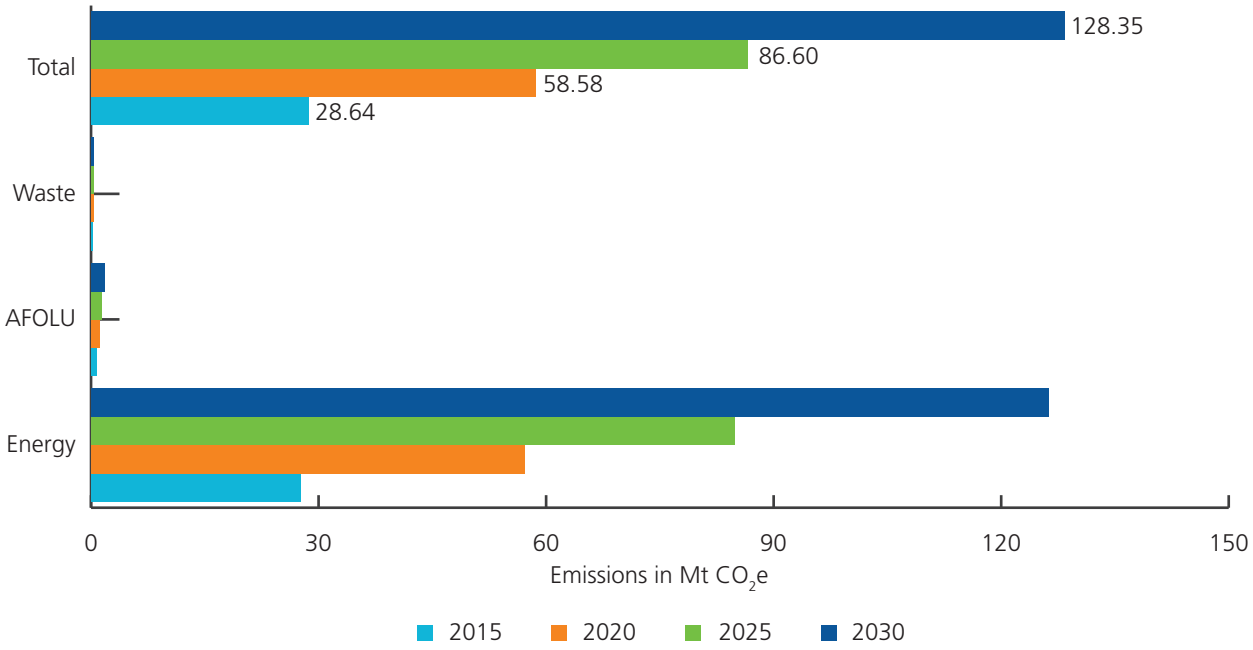
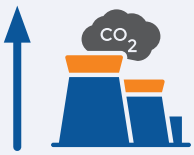


Figure 22: Projections of economy-wide emissions (BAU) for Nagpur district (Mt of CO_2e.)

If emissions from the thermal power plants continue to rise at the same rate, then Nagpur district will witness a



348 %

rise in economy wide emissions by 2030

- In the business-as-usual (BAU) scenario (i.e., no actions/policies are put in place to mitigate the emissions), the total emissions of Nagpur in 2030 are likely to be 3.4 times (i.e., 348.20 percent) higher than the 2015 levels.
- Projections for sectoral emissions have been presented in the following table:

Projected emissions (BAU) in million tonnes (Mt) of CO_2e				
Sector	2015	2020	2025	2030
Energy	27.65	57.17	84.89	126.24
AFOLU	0.72	1.14	1.40	1.77
Waste	0.26	0.28	0.31	0.35
Total	28.64	58.58	86.60	128.35

- During the same period (2015 to 2030), total emissions of Maharashtra are likely to increase by 58.79 percent (given a CAGR of 3.12 percent between 2005 and 2015) (GHGPI, 2019).
- Overall emissions of the district can be reduced significantly if emissions from public electricity generation are curtailed.

3.1.2 Per Capita Emissions

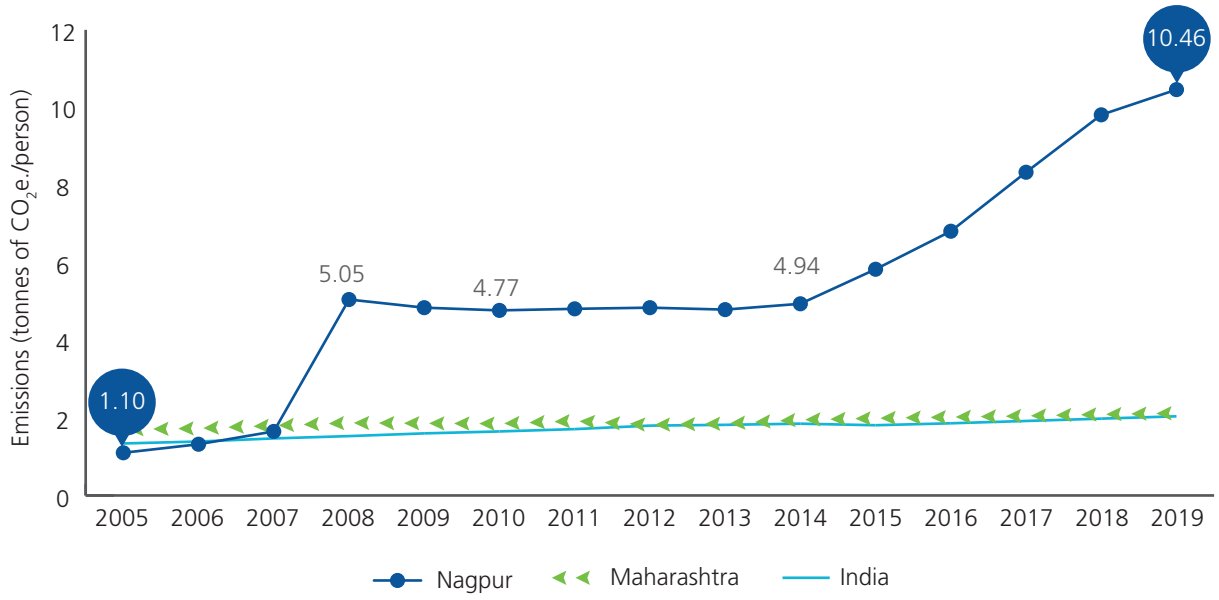


Figure 23: Per capita emissions (tCO_2e./person)-comparison

- The per capita emissions of Nagpur district were computed using the district's total emissions that were estimated in this analysis (therefore, it does not include emissions from IPPU).
- Nagpur district's per capita emissions are much higher than Maharashtra and national average.
- Although, Nagpur has only 4.14 percent of state population, its contribution to state emissions was 12.07 percent in 2015 and 20.20 percent in 2019.[11]
- Presence of six coal-fired thermal power plants is the major reason behind the higher emissions in Nagpur, with respect to state emissions.

11 State emissions estimates are taken from GHGPI-Phase III

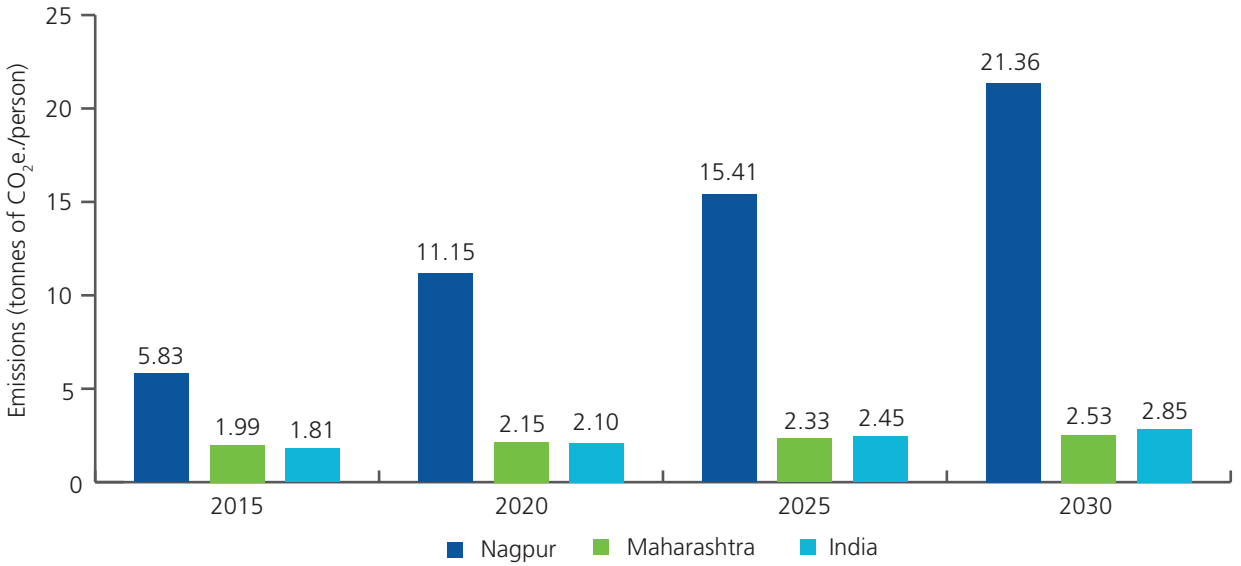


Figure 24: Projected per capita emissions (BAU) (tCO_2e/person)

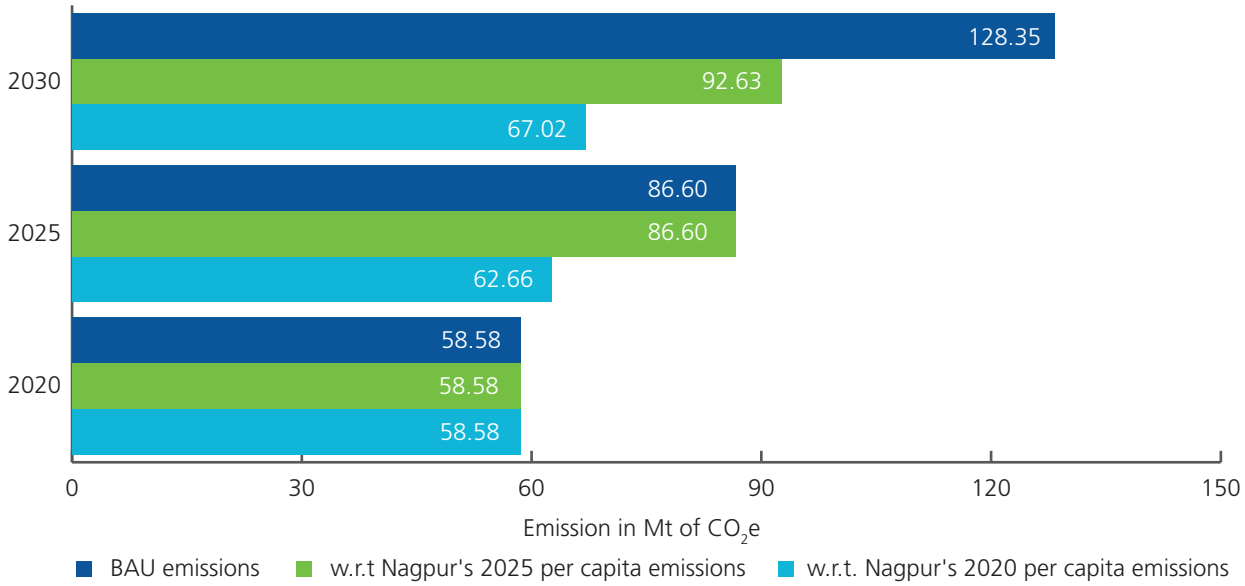


Figure 25: Projected total emissions (Mt of CO_2e) with different per capita emissions scenarios

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

91% less if 2020 per capita emission levels are maintained

39% less if 2025 per capita emission levels are maintained

- The decadal population growth (2001-2011) of Nagpur district has been 14.40 percent. The rate of growth of population is much lower than the rate of increase in emissions. As a result, the BAU projections indicate that the per capita emissions of Nagpur will be quite high in 2030 (approx. 21.39 tonnes of CO_2 e./ person/annum)
- The BAU projections of per capita emissions indicate that total emissions will increase by 119 percent between 2020 and 2030 (as shown in economy-wide projections as well).
- However, if the per capita emissions of 2020 or 2025 are maintained, the overall growth in emissions would only be around 14 percent or 58 percent respectively (between 2020 and 2030).

3.1.3 Sectoral analysis and projections

Energy sector

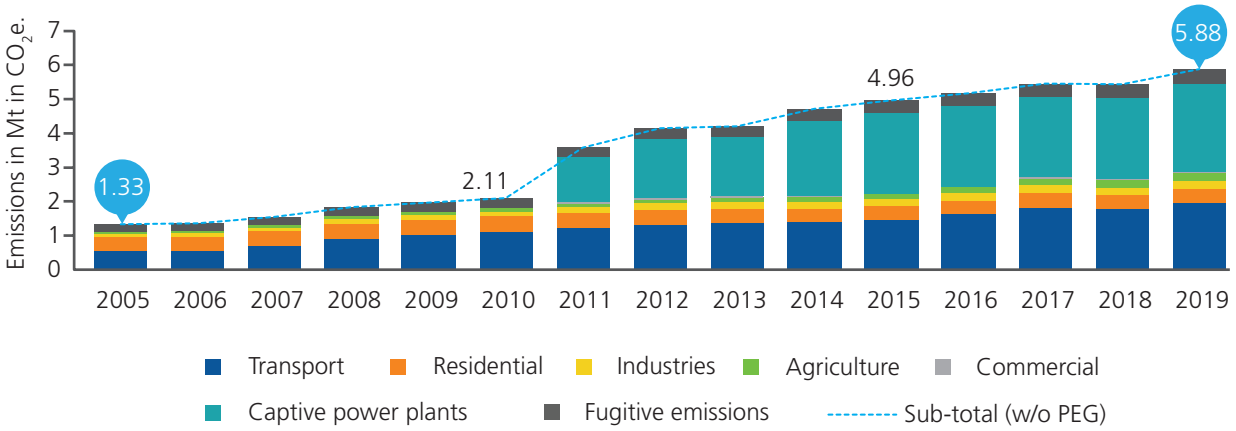


Figure 26: Energy sector emissions of Nagpur district (excluding public electricity generation category) (Mt CO_2e.)

Energy sector emissions have increased

12 folds

since 2005

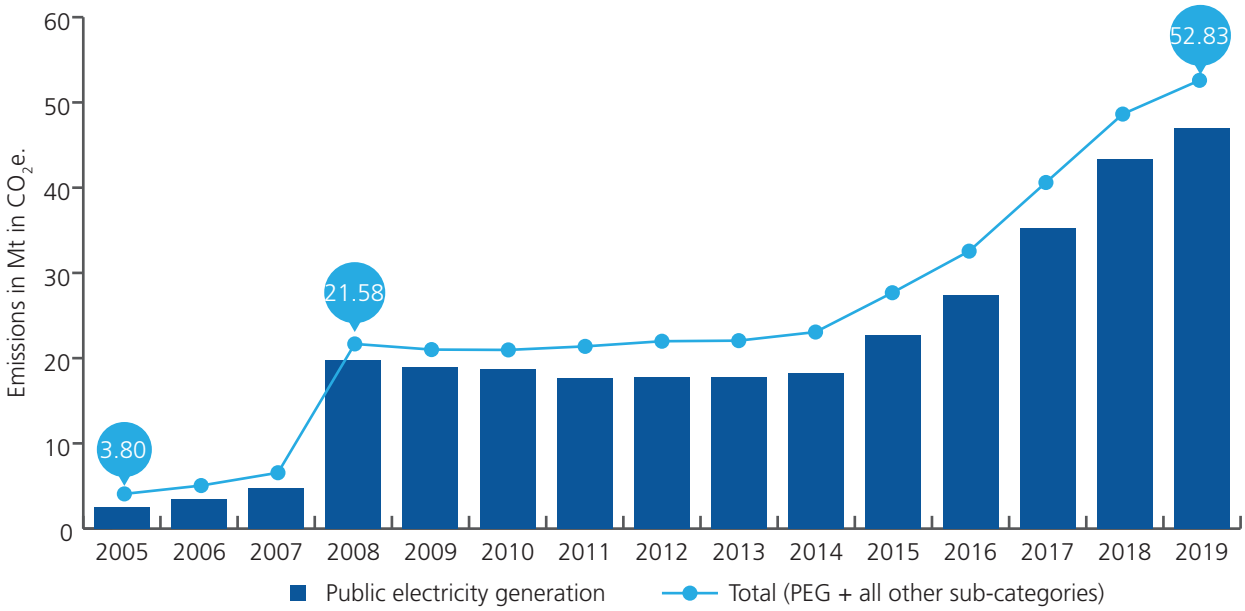


Figure 27: Total energy sector emissions of Nagpur district (MtCO_2e.)

- This section estimates emissions due to fossil-fuel consumption by various sub-sectors.
- Between 2005 and 2019, emissions from energy sector have seen a 12-fold increase (from 3.80 Mt of CO_2e. in 2005 to 52.83 Mt of CO_2e. in 2019).
- Power plants are categorised into two – public electricity generation (PEG) or plants that generate electricity primarily to supply power to the grid and captive power plants (CPP) or plants that generate electricity for consumption at the site (CPPs can be independent or parallel to the grid).
- Nagpur has six PEG plants. Before 2008, the total generation of electricity through PEGs in Nagpur was quite low. For making future demand projections, the CAGR for PEG category is calculated between 2008 and 2018.
- Data on CPPs is available from 2011. Emissions from CPPs increased at a CAGR of 8.85 percent between 2011 and 2018.
- In 2019, transport category was the third highest contributor to energy emissions (after PEG and CPP). Its share dropped from 14 percent (in 2005) to 4 percent (in 2019).
- Emissions from residential category and fugitive emissions from coal mining in Nagpur contributed to 11 percent and 8 percent respectively (in 2005). But in 2019, the share of both these categories dropped to around 1 percent each.

Table 11: Growth in energy sector emissions

Category	Sub-category	CAGR	Percent share in energy emissions (2019)
PEG (CAGR 2008-18)		8.19 %	88.86 %
Captive power plants (CAGR 2011-18)		8.85 %	5 %
Transport CAGR: 9.66%	Road	9.59 %	3.74%
	Aviation	10.00 %	
	Railway	10.92 %	
Fugitive emissions		4.67 %	0.79 %
Residential		-0.51 %	0.75 %
Industrial		7.55 %	0.46 %
Agriculture		10.92 %	0.43 %
Commercial		17.76 %	0.09 %

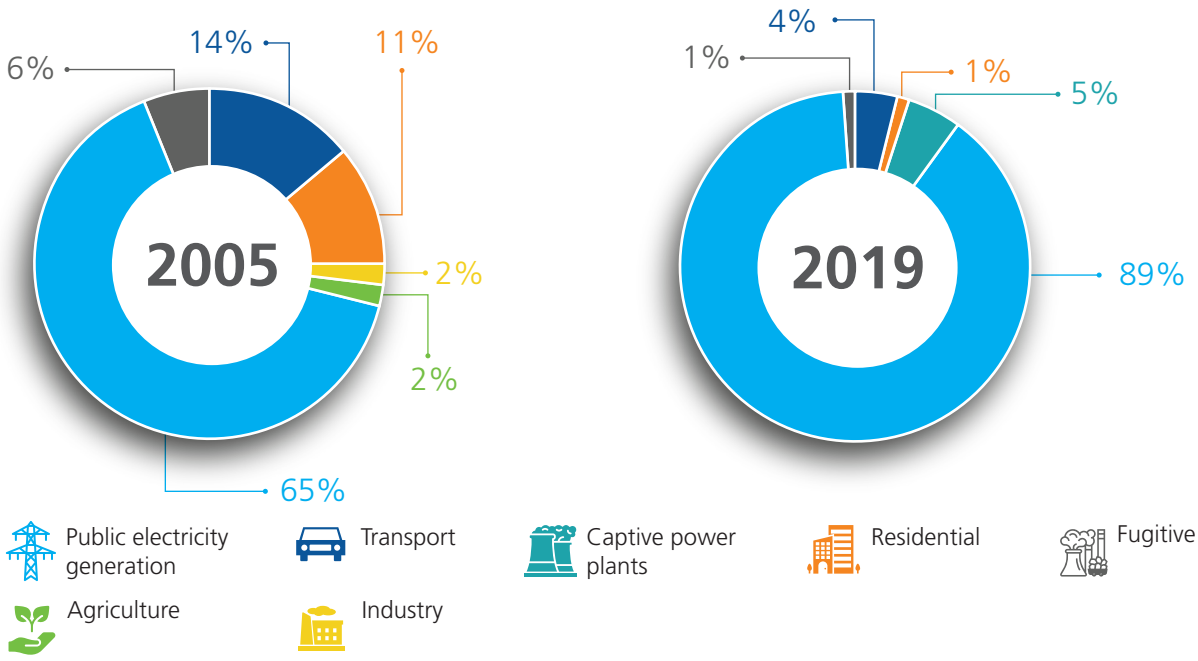


Figure 28: Category wise contribution to total energy emissions in 2005 and 2019

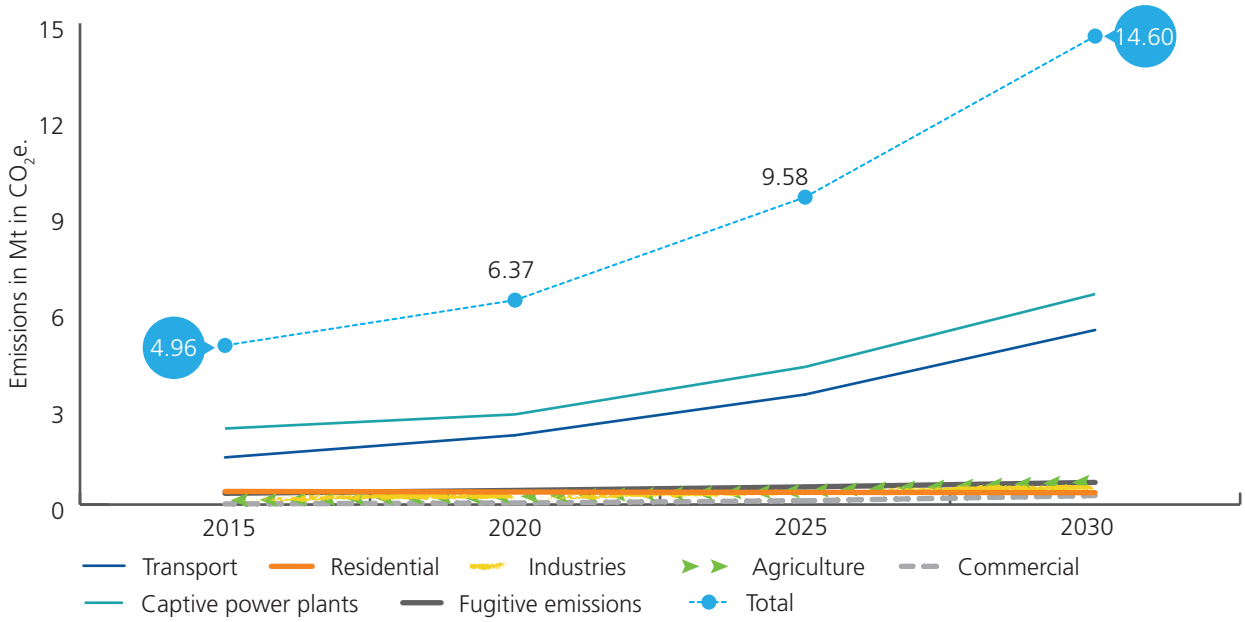


Figure 29: Projected energy sector emission (excluding public electricity generation category) (BAU)

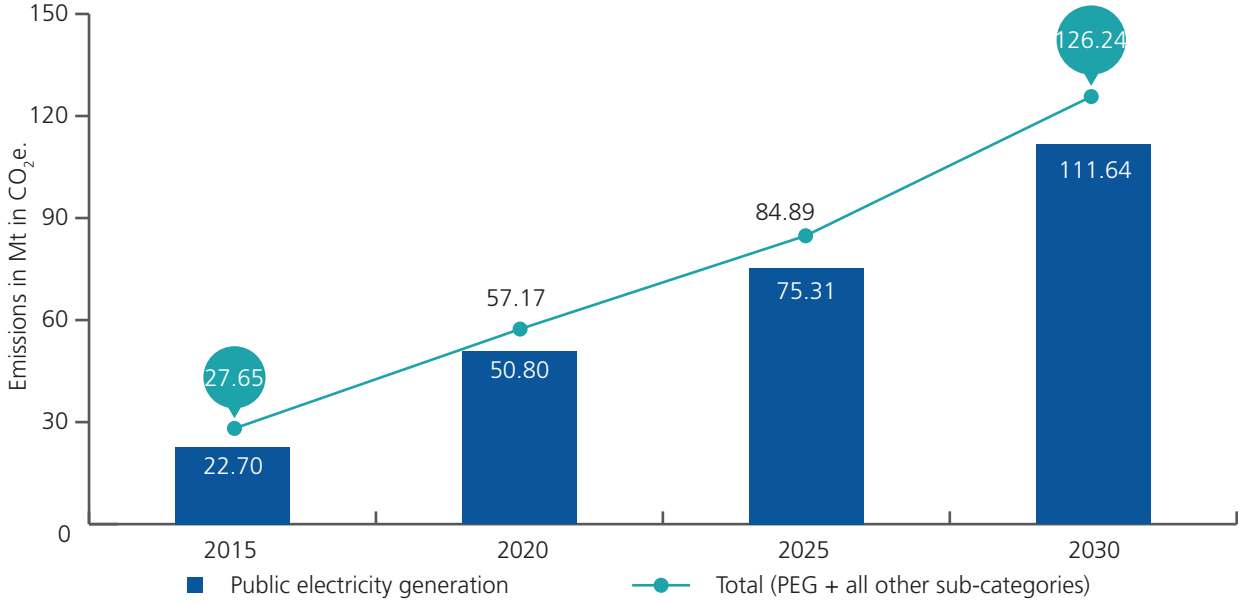


Figure 30: Total projected energy sector emissions (PEG + all other categories) (BAU)

- In business-as-usual scenario, the total energy emissions of Nagpur district are likely to increase by 356.49 percent by 2030 (w.r.t. 2015 levels).
- Improving the overall efficiency of the existing PEG units and CPPs and enhancing the share of RE in electricity generation can help curtail this growth in emissions.

Agriculture, forestry and other land use (AFOLU) sector

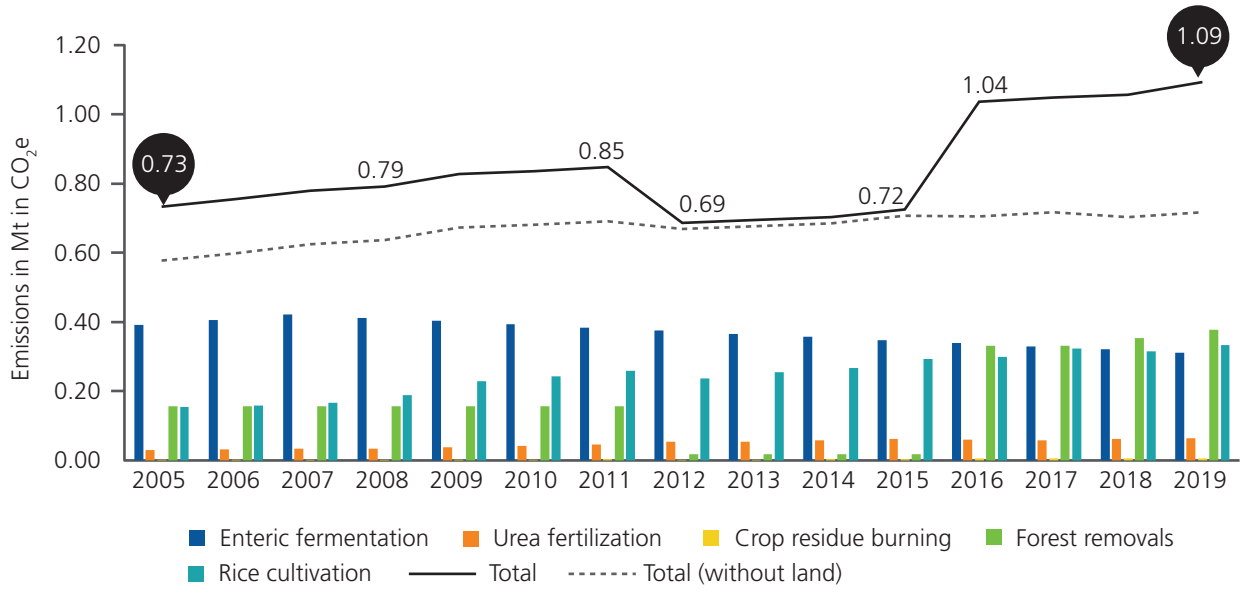


Figure 31: AFOLU sector emissions of Nagpur district (Mt of CO_2e).

AFOLU sector emissions have increased by **49%** since 2005.

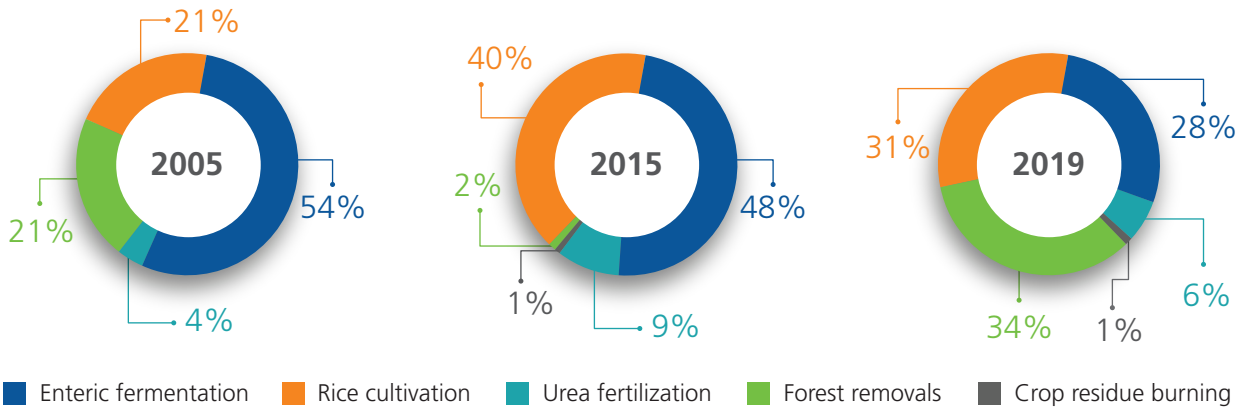


Figure 32: Category-wise contribution to total AFOLU emissions in 2005, 2015 and 2019

Table 12: Growth in AFOLU emissions (2005-15) and percentage share

Category	CAGR (2005-18)	% share in AFOLU emissions (2005)	% share in AFOLU emissions (2015)	% share in AFOLU emissions (2019)
Enteric fermentation	- 1.42 %	54 %	48 %	28 %
Forest removals	6.49 %	21 %	2 %	34 %
Urea fertilization	-0.74 %	4 %	9 %	6 %
Rice cultivation	5.70 %	21 %	40 %	31 %
Crop residue burning	9.49 %	1 %	1 %	1 %
Total emissions	6.88 %	NA	NA	NA

AFOLU sector emissions to rise by **143%** by 2030 in BAU scenario

- Although the forest area of Nagpur district improved between 2004 and 2008, due to reduction in the carbon stock density, the overall stock of carbon reduced and as a result the 'forest removals' could not become a sink.
- The emissions from forest removals slightly dipped post 2011 (because the rate of loss in forest area was very low), but increased again from 2016 (due to significant reduction in forest area).
- As per the 20th Livestock Census (2019), the population of bovine animals (specifically indigenous cattle) has reduced in comparison to 19th Livestock Census (2012). As a result, the emissions from enteric fermentation of livestock have witnessed a negative trend.
- Emissions from rice cultivation have doubled between 2005 and 2018 due to increase in area under rice production.
- Use of urea in agriculture has reduced; although the crop production for Nagpur has increased over the years.

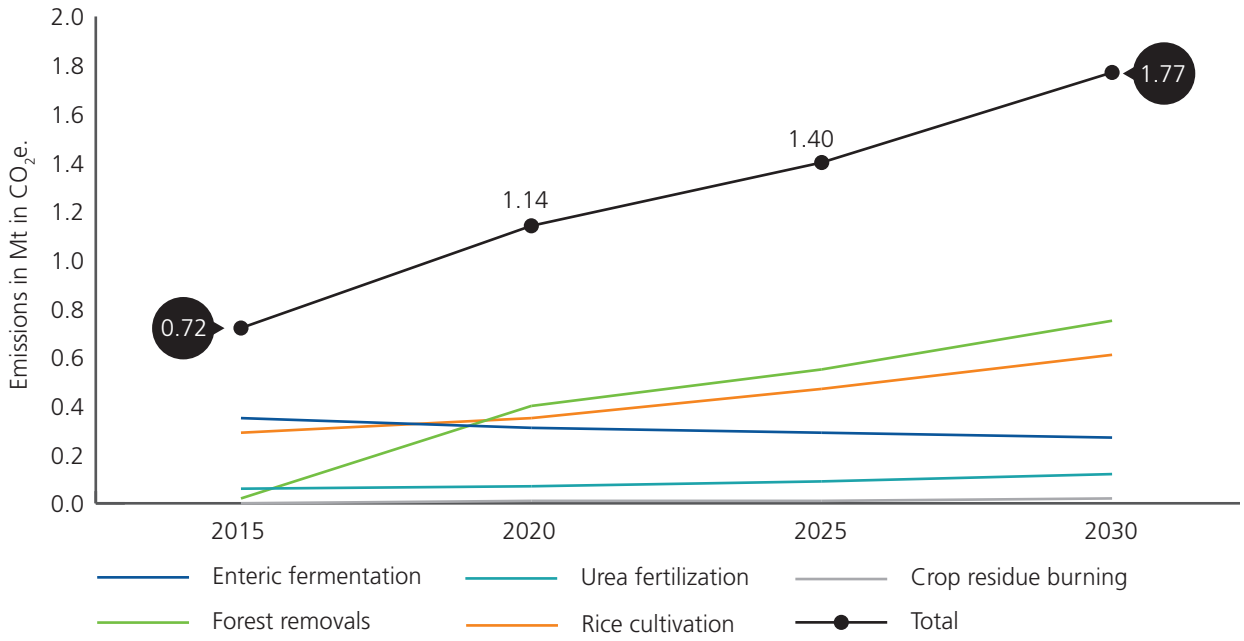


Figure 33: Projected emissions of AFOLU sector (BAU)

- In the business-as-usual scenario, the total AFOLU emissions will increase by 143 percent in 2030, w.r.t 2015 levels.
- Emission from enteric fermentation in Nagpur is likely to continue the declining trend, in the future.
- However, the rate of forest removals remains a cause of major concern.

Waste sector

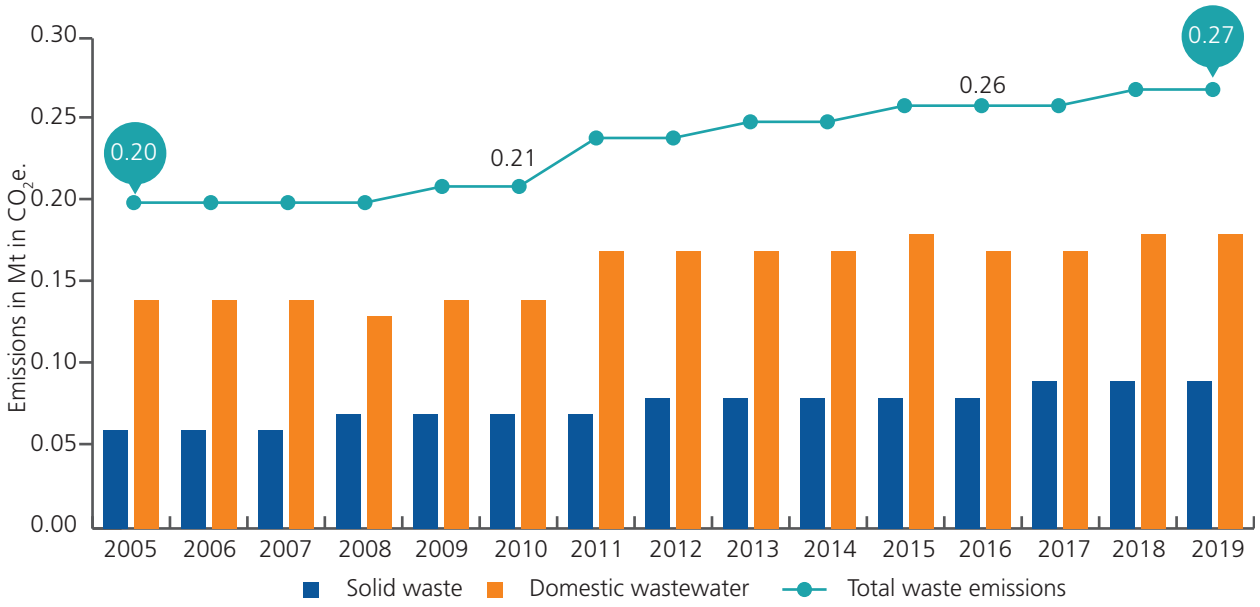


Figure 34: Waste sector emissions of Nagpur district (Mt CO_2e.)

- Overall, waste sector emissions have increased by 38 percent between 2005 and 2019 (at a CAGR of 2.34 percent).
- In comparison to solid waste management, the domestic liquid waste management practices have seen more improvement.
- As a result, after 2011, the emissions from wastewater have increased at a CAGR of only 1.23 percent whereas, solid waste emissions increased at a CAGR of 2.58 percent (2011-19).
- In BAU scenario, the emissions from waste sector will increase by 26 percent by 2030 (w.r.t 2015 levels).

Waste emissions have increased by

38%

since 2005

Growth in emissions		
Category	CAGR (2005-19)	% share in waste emissions
Solid waste	2.71 %	33 %
Domestic wastewater	2.16 %	67 %

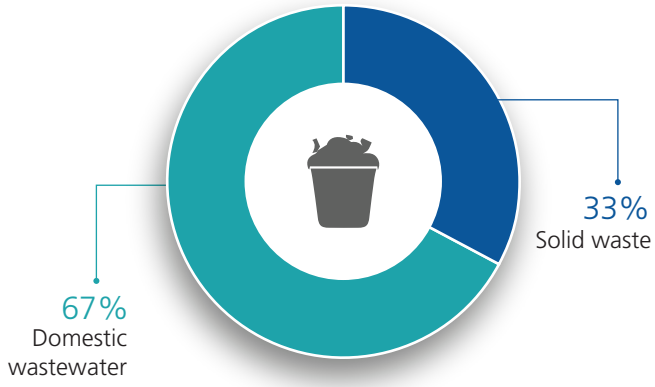


Figure 35: Percentage share of categories in total waste (2019)

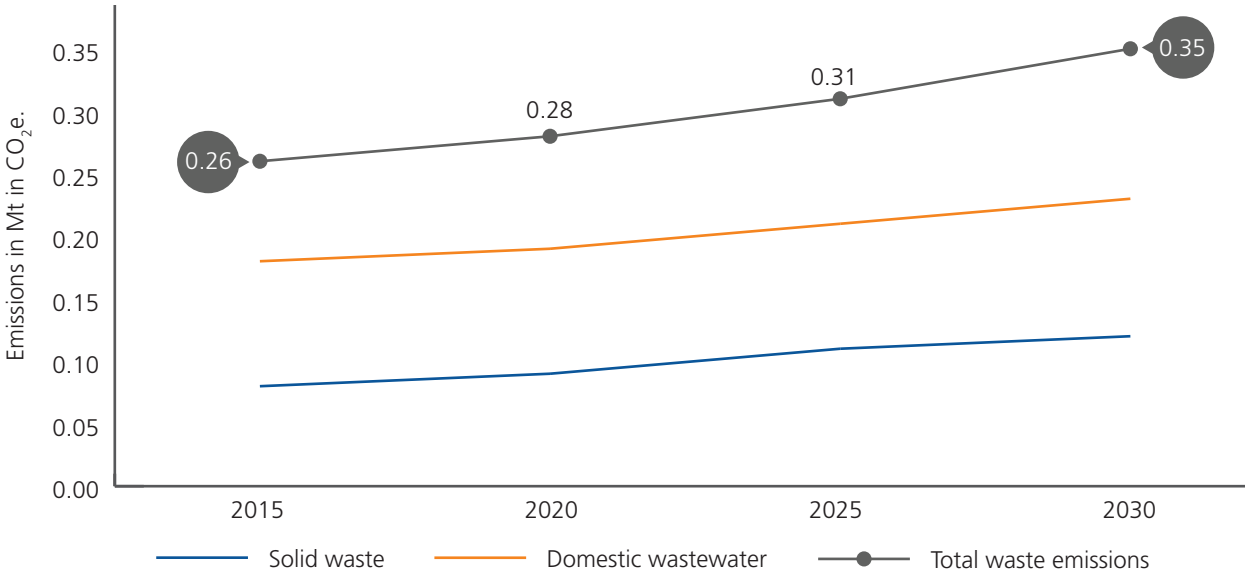


Figure 36: Projections for waste sector emissions (BAU)

3.2. Carbon footprint due to electricity consumption

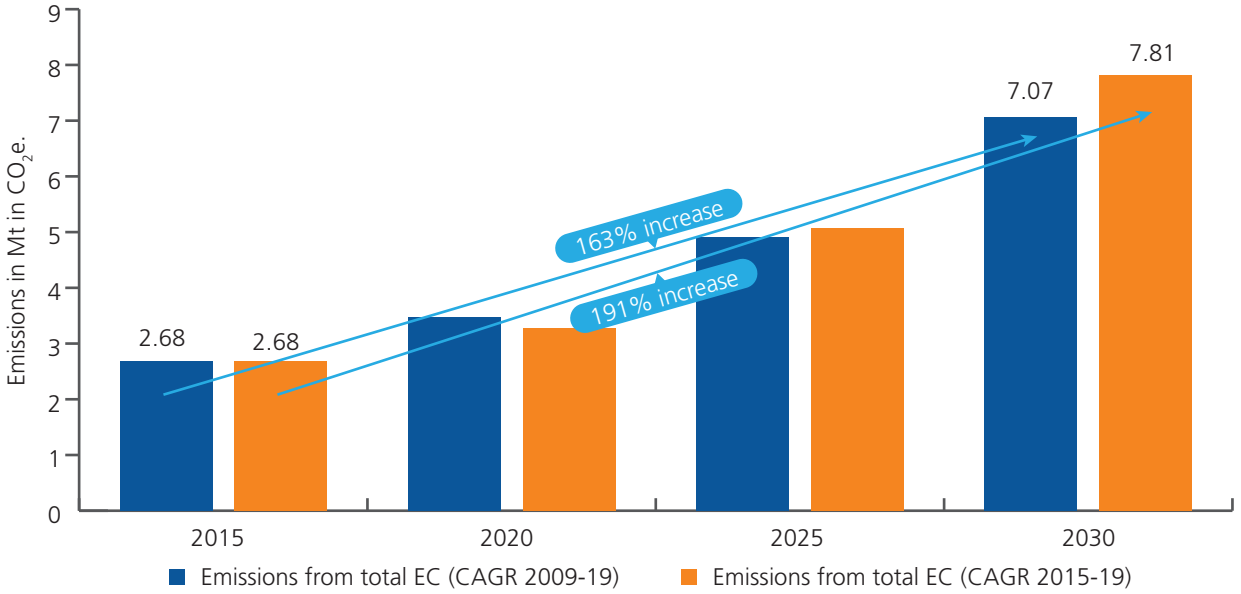


Figure 37: Carbon footprint due to electricity consumption of Nagpur district (Mt CO_2e.)

- An exercise has been done to determine the electricity consumption of Nagpur district (by analysing Maharashtra's DISCOM data, details given in Chapter 1: District profile).
- After finding the total million units consumed in Nagpur district (over the years), the emissions emitted from generation of that electricity were estimated (by applying the percentage of electricity that comes from coal and natural gas; and then applying the respective national grid emission factors).
- This analysis helps identify that although Nagpur district emitted 43.4 Mt of CO_2e emissions in 2018 due to public electricity generation, its own total electricity consumption (from all consumer categories) is responsible for only 3.36 Mt of CO_2e emissions (i.e., 7.4 percent of the PEG emissions). It may be noted that emission from electricity consumption is not added in the emission profile to avoid double counting.
- Electricity consumption and its corresponding emissions have been projected until 2030, based on CAGR of electricity consumption. Two CAGRs have been considered, one from 2009 to 2019 (longer timeframe) and another from 2015-19 (shorter timeframe).
- Emissions from electricity consumption in Nagpur district are likely to grow by 163 percent (if the CAGR of longer timeframe i.e., between 2009 and 2019 is applied) and by 191 percent (if the CAGR of shorter timeframe i.e., between 2015 and 2019) is applied.

3.3. Vehicular growth trends

Nagpur district has three RTOs- Nagpur Urban, Nagpur Rural, and Nagpur East. The data trend below conforms to vehicular registrations at all the RTOs, from 2012 to 2020 (Parivahan Sewa, 2021) (see Table 18 and Figure 36).

Table 18: Trend of vehicular registrations over the years in Nagpur (2012 to 2020)

Vehicle category	2012	2013	2014	2015	2016	2017	2018	2019	2020
Heavy goods vehicle	1,744	1,177	1,184	1,551	1,640	2,423	3,776	2,816	1,311
Heavy motor vehicle	0	6	7	6	8	19	8	9	7
Heavy passenger vehicle	410	427	105	392	205	46	56	98	51
Light goods vehicle	2,453	2,459	2,104	1,877	2,687	2,631	3,380	3,929	2,464
Light motor vehicle	18,757	15,053	15,476	17,170	18,448	20,097	18,933	18,327	16,203
Light passenger vehicle	362	795	725	979	1,814	1,931	1,985	1140	323
Medium goods vehicle	345	270	177	226	284	278	356	281	156
Medium motor vehicle	15	11	4	8	19	28	38	39	25
Medium passenger vehicle	102	151	122	115	129	280	133	140	31
Other	142	126	113	133	164	234	466	553	439
Three-wheeler	645	1,482	2,964	1167	2,570	2,964	6,404	3,757	1,564
Two-wheeler	1,01,272	99,371	1,10,176	112472	1,17,385	1,15,913	1,22,410	1,01,912	71952
Total	**1,26,247**	**1,21,328**	**1,33,157**	**1,36,096**	**1,45,353**	**1,46,844**	**1,57,945**	**1,33,001**	**94,526**

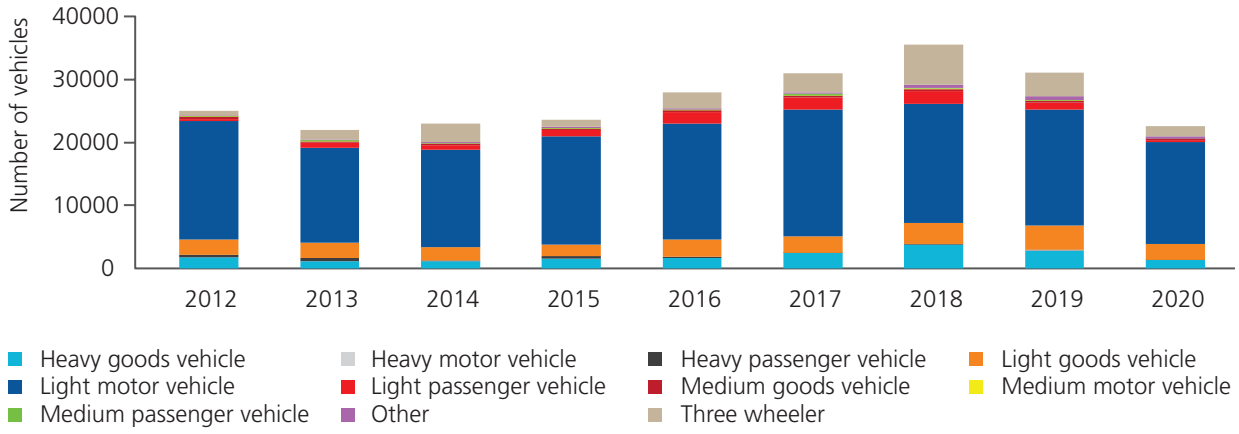


Figure 38: Trend for vehicular registrations in Nagpur over the years without two-wheelers

Table 19: Projections for vehicle numbers (vehicle category-wise) for Nagpur (CAGR 2013-18)[12]

Vehicle category	2013	2015	2018	2020	2025	2030
Heavy goods vehicle	1,177	1,551	3,776	1,311	4,206	13,493
Heavy motor vehicle	6	6	8	7	9	12
Heavy passenger vehicle	427	392	56	51	7	1
Light goods vehicle	2,459	1,877	3,380	2,464	3,387	4,655
Light motor vehicle	15,053	17,170	18,933	16,203	20,379	25,632
Light passenger vehicle	795	979	1,985	323	806	2,014
Medium goods vehicle	270	226	356	156	206	271
Medium motor vehicle	11	8	38	25	86	298
Medium passenger vehicle	151	115	133	31	27	24
Three-wheeler	126	133	466	439	1,624	6,005
Other	1,482	1,167	6,404	1,564	6,758	29,204
Two-wheeler	99,371	1,12,472	1,22,410	71,952	88,634	1,09,184
Total	**1,21,328**	**1,36,096**	**1,57,945**	**94,526**	**1,26,130**	**1,90,794**

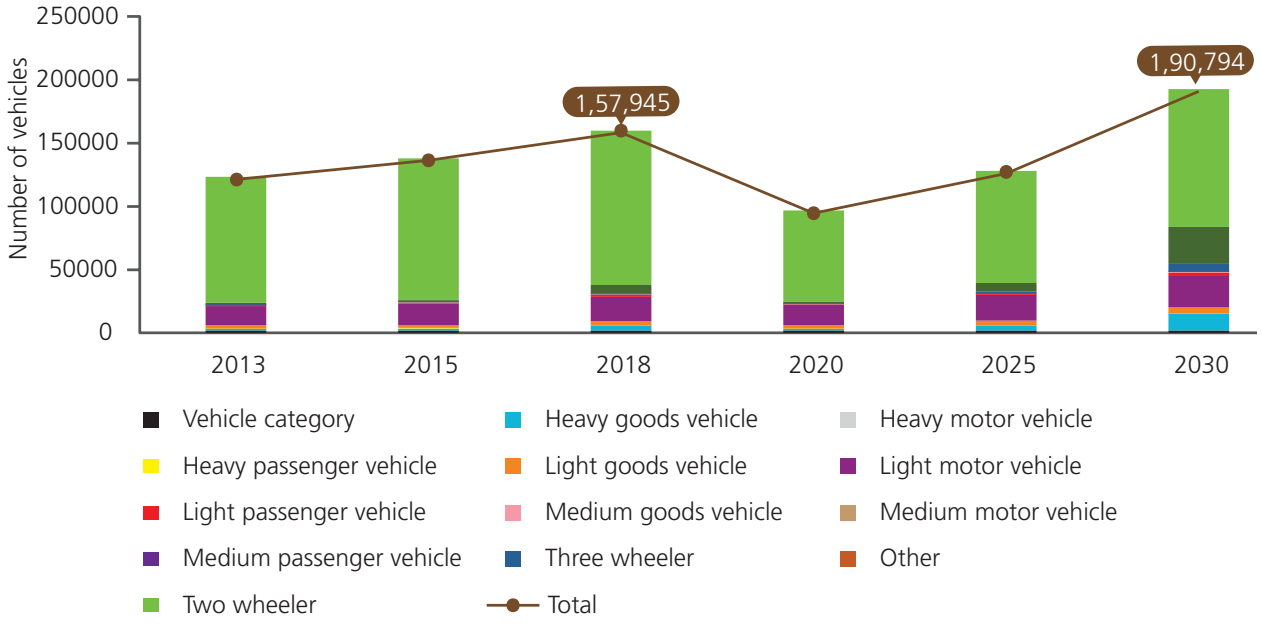
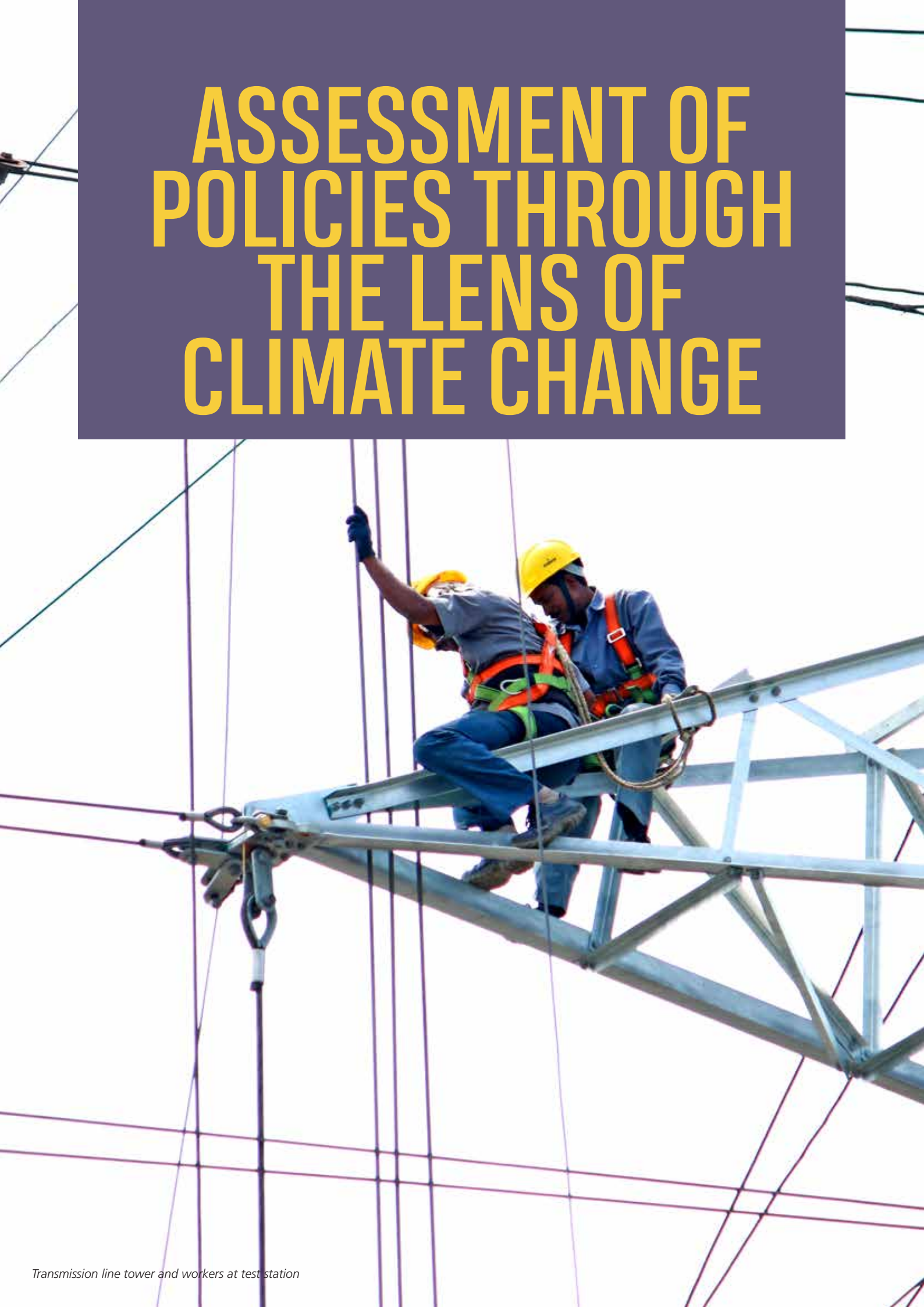


Figure 39: Projections for vehicle numbers (vehicle category wise) for Nagpur (CAGR 2013-2030)

12 From 2013 to 2018, the vehicular registrations for all the three RTOs in Nagpur combined displayed a normal increasing trend. Dips in registrations can also be observed in 2019 and 2020, due to recession in automobile sector and COVID-19 pandemic, respectively. Hence, CAGR has been observed from 2013 to 2018 to depict a fair trend of projections.

ASSESSMENT OF POLICIES THROUGH THE LENS OF CLIMATE CHANGE



Transmission line tower and workers at test station

4. ASSESSMENT OF POLICIES THROUGH LENS OF CLIMATE CHANGE

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

Emission calculation methodology for evaluating the policies has been derived from the 2006 IPCC Guidelines, peer reviewed papers on policy impact evaluation, briefing papers and Phase III work of GHGPI. Relevant methodological assumptions were made after consulting the sectoral experts.

4.1. Sector-wise policy impact analysis

4.1.1. Power and energy sector

This section includes policies on clean energy, power, energy efficiency, residential and industrial energy, and transport. A total of 11 policies/ programmes have been evaluated for analysing the climate impact by computing the GHG emissions added or avoided by these policies.[13]

List of policies evaluated

Clean Energy

1) State Renewable Energy Policy, 2020, 2) Policy for grid-connected solar projects, 3) Off-grid Policy, 2020, 4) Biomass Gasifier Programme, 5) Biogas Power Programme

Energy Efficiency in buildings, public infrastructure and industrial processes

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

Transport

BRTS, Nagpur

Emissions evaluation

Amongst the policies evaluated,

- Clean energy related policies and programmes resulted in avoidance of 9,46,137 tonnes of CO_2e emissions (policies on solar energy: 2,52,633 tCO_2e; and biomass: 6,93,504 tCO_2e)
- Policies and programmes related to enhancing energy efficiency in buildings and processes have avoided 48,47,063 tonnes of CO_2e emissions (UJALA Scheme: 1,42,281 tCO_2e; SLNP: 71,246 tCO_2e; IPDS, R-APDRP, UDAY: 36,55,121 tCO_2e; PAT Scheme: 9,78,415 tCO_2e.)

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

Information gaps

1) Policies pertaining to renewable energy: a) Year-on-year data is not available for Nagpur, since inception (for the policies considered here); b) Generation data of the solar and biomass plants is not available.
2) Energy efficiency: Year-on-year data on number of UJALA LEDs distributed and number of LED streetlamps installed in the district is not available.
3) Transport: Modal share of transport for the time-period under consideration is not available, and therefore, impact of the policies pertaining to transport could not be calculated.

4.1.2 Agriculture, forestry and other land use (AFOLU)[14]

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

List of policies evaluated

For Nagpur district, a total of 9 policies and programmes under AFOLU sector and two programmes under cross-cutting (nexus of agriculture, water and energy) have been considered for this evaluation.

Agriculture

(1) Soil Health Card Scheme, (2) National Food Security Mission, and (3) Soil & Moisture Conservation (SMC)

Livestock

(1) Cattle and Buffalo Development Programme, and (2) Feed and Fodder Development Programme

Forestry

(1) Wildlife Protection Act, 1972, (2) Diversion of forests for non-forest purpose under the Forest Conservation Act, 1980, (3) Social Forestry Scheme, and (4) National Agroforest Policy, 2014

Cross-cutting (agriculture and energy)

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

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

Emissions evaluation

An attempt has been made to quantify GHG emissions avoided/added by each initiative. However, for a few policies and programmes it could not be computed due to lack of required data/ information. This exercise helped identify the following:

- Forestry policies helped in avoiding 70,77,360 tonnes of CO_2e emissions.
- Policies pertaining to livestock proved to be beneficial for climate action by avoiding 3,007 tonnes of CO_2e.
- For the agricultural sub-sector, GHG impact of the policies could not be computed due to lack of data.
- Under the cross-cutting sector, the National Mission on Micro Irrigation resulted in avoidance of 152 tonnes of CO_2e emissions (from reduction in use of fertiliser). Additionally, the Pradhan Mantri Ujjwala Yojana has helped mitigate 5,03,626.50 tonnes of CO_2e/year.

Information gaps

In order to accurately quantify the impact of these policies on GHG emissions, the following data/ information is needed:

1) Specific number of livestock in Nagpur that can be attributed to Cattle & Buffalo Development Programme.
2) Information pertaining to Feed & Fodder Development Scheme, such as quantity of feed additives added to the fodder, number of target population etc.
3) Percentage of wheat and pulses production in Nagpur that can be attributed to National Food Security Mission.
4) Area covered under Soil Health Card Scheme.
5) Reduction in chemical fertilizer use due to recommendations (followed by farmers) given in the soil health cards.

4.1.3 Waste management

Waste sector policies implemented in the district of Nagpur were categorised into sanitation, waste management (solid, BMW and HW) and wastewater management (domestic and industrial).[15]

List of policies evaluated

A total of 14 national and state-level policies/programmes were analysed to evaluate their contribution as emission mitigation strategies.

Sanitation

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

Waste management

1) Solid Waste Management Rules, 2016 and Amendment 2018, 2) Bio-medical Waste Management Rules, 2016 and Amendment 2018, 3) Hazardous & Other Wastes (Management and Transboundary Movement) Rules 2016

Domestic and industrial wastewater

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

15 The detailed impact analysis of policies and programmes (giving information on input indicators, calculation methodology etc.) for Waste is given in Annexure 4.4

Emissions evaluation

Along with methane emission concerns from the sanitary measures and sewerage treatment plants, the current evaluation has also considered emissions from incineration of bio-medical waste and hazardous waste. The policies have had the following impacts on annual average emissions:

- Emission of 35,633 tCO_2e from individual household latrines (also known as IHHL or two pit latrines) and 1,89,459 tCO_2e from community latrines (septic tank) constructed under sanitation programmes/policies.
- Emission mitigation of 36,096 tCO_2e from biological treatment (composting) of MSW, emission of 470 tCO_2e from incineration of bio-medical waste, and 2,462 tCO_2e for hazardous waste incineration.
- Emission of 30,204 tCO_2e for STPs constructed under sewerage connection programmes. The implementation of these activities has avoided an annual average emission (w.r.t baseline[16]) of 42,541 tCO_2e and 3,943 tCO_2e by sanitation and liquid waste management developmental/policy initiatives respectively in the district.

Information gaps

1) Sanitation: For old and completed policies, there is a gap in availability of data on the number of sanitation infrastructure constructed. In most cases, the district level data was not available.
2) Waste: Yearly district-level BMW generation and incineration data and hazardous waste incineration data was not available from MPCB.
3) Domestic wastewater: No policy-wise data is available.
4) Industrial wastewater: Industry category-wise wastewater treatment and discharge data was not available.

Gaps in policy and implementation

Power and energy sector

- Maharashtra ranks #2 in solar rooftop installed capacity at the national level. The current total solar installed capacity of Maharashtra stands at 2.43 GW (as on July 31, 2021), out of which 67.8 percent is ground-mounted, 30.8 percent is solar rooftop, and 1.4 percent is distributed/off-grid (MNRE). It is noteworthy that GoM provides a subsidy of 30 percent on installation of rooftop solar for domestic consumers and achievement-linked incentives for government buildings, in addition to the 30 percent provided by the Central Government (to both domestic and non-domestic consumers). Despite these efforts, the state is deficient by 5.9 GW of the state target of 7.6 GW solar installed capacity by 2022. This indicates that the state needs to enhance its endeavours in implementing the solar projects in the state in order to cover this lag in due time. Nagpur, being a highly industrialised and moderately urbanised district, has a huge potential for solar rooftop installations, as well.

Current total solar installed capacity of Maharashtra stands at 2.46 GW

67.8% of which is ground-mounted and **30.8%** is solar rooftop

- CM Solar Pump Yojana, in tandem with PM Kusum Yojana, was launched to provide solar pumps to farmers in order to reduce their dependence on the grid for irrigation. The policy needs an aggressive promotion and implementation strategy to capture mass attention.

16 Quantification of impact of policies (considered in this study) on GHG emissions takes the baseline emissions into account.

- ECBC compliance: The draft Energy Conservation Building Code (ECBC) was published in 2017. However, the code is yet to be notified and implemented in the building by-laws for Maharashtra.
- Transport sector policies: Policy-level intervention is needed to improve BRTS and other public transport modes in terms of robustness, reliability, frequency and better reach in the district.

AFOLU sector

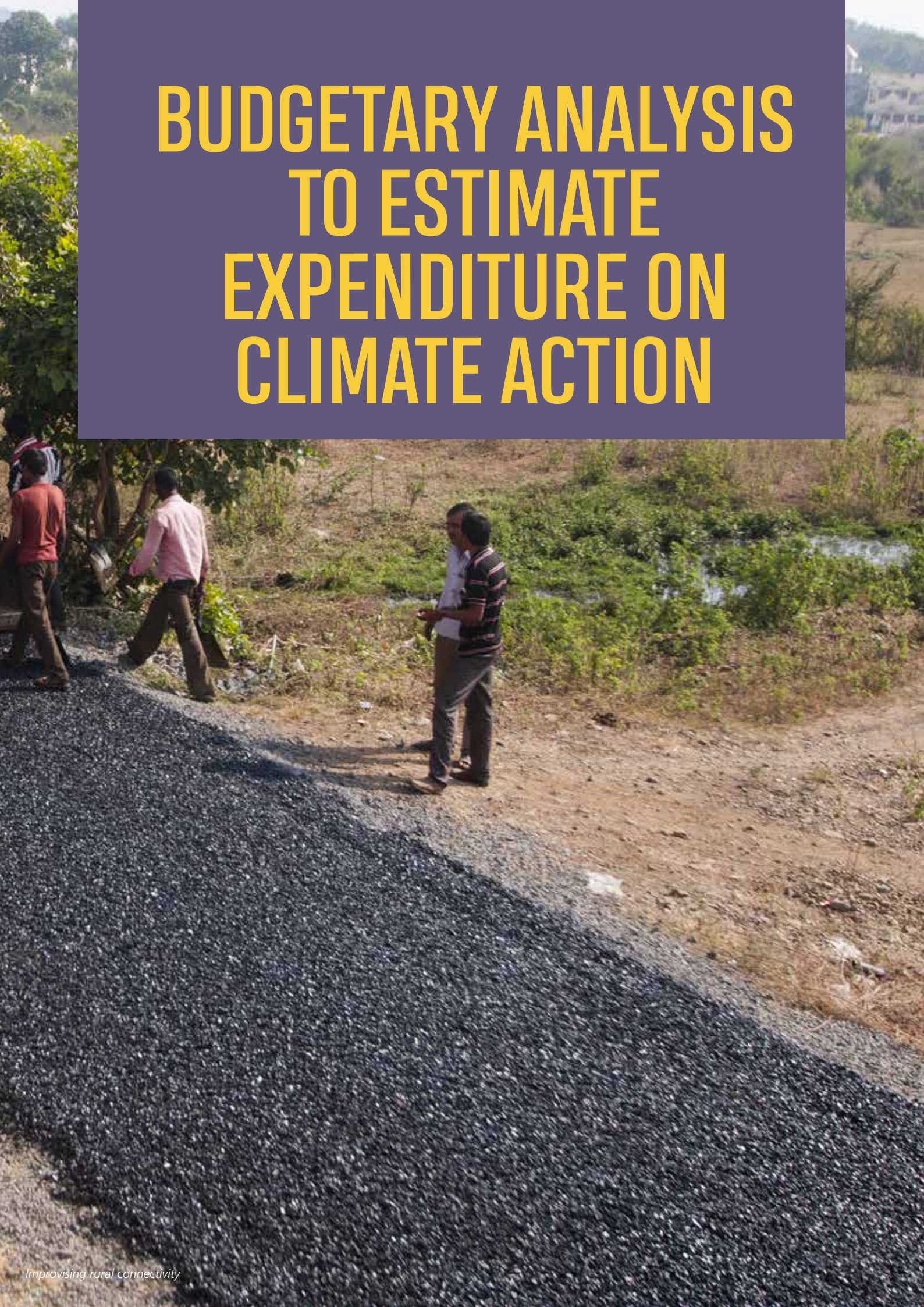
- Maharashtra State Forest Policy came into force in 2008. However, Nagpur's forest area has been declining since 2008 and there was a substantial loss in forest area in 2017 (as per the latest FSI Report, 2019). This indicates a lacuna in implementation of the policy. To ensure that the district's forest cover is not impacted any further by rapid urbanisation or mining activities, district-level initiatives are needed to not only curb the loss of forest cover but also to enhance it. These interventions, in the form of rigorous implementation of existing schemes and policies as well as through creation of more focussed programmes and campaigns would help in the following ways:
  - The green cover will act as a sink for the district's GHG emissions
  - Reduce the urban heat island effect
  - Help India achieve the NDC target of creating additional carbon sink of 2.5 to 3 billion tonnes CO_2e by 2030.
  - Strengthen the dwindling ground water resources etc.
- Rice is a major crop for Nagpur district and the area under rice cultivation more than doubled between 2005 and 2018. Increased productivity of rice is needed to meet the growing demand, but cultivation of rice also leads to methane emissions (due to anaerobic decomposition of organic matter in flooded paddy fields). And methane is 21 times more potent than CO_2. Since reducing rice production is not an option, policy-level interventions are needed to make rice cultivation less GHG intensive. For example, farmers can be given subsidies to install single or multiple aerators in their rice fields; high yield rice variety that does not require water inundation for longer periods can be promoted etc.
- Although the contribution of emissions from crop residue burning is low in total AFOLU emissions, it may be noted that these emissions have significantly increased between 2005-18 within the district, as well as in comparison to national/state average. To address this, policy instruments should be put in place, wherein crop residue/stubble is used for other purposes (thatching) or in other industries (paper/cardboard, furniture, pellets etc.)
- The nexus of power and agriculture sector has a gap at the policy-level. Agricultural activities, like non-judicious irrigation practices, lead to high electricity consumption patterns. Policies pertaining to electricity pricing, subsidies, and collection of tariffs must be revised.

Waste management

- Though waste generation and treatment reporting are mandated at the state-level, district-wise and waste treatment type-wise data maintenance and reporting is not a policy requirement for any categories of waste except for bio-medical waste. Even for BMW, this data is not being recorded and maintained in public domain at the district level.
- There are no policies for data maintenance and availability of domestic and industrial wastewater (industry category-wise) generation, treatment and discharge pathways.
- Waste policies do not suggest gas management/capture facilities for composting and incineration units to dispose waste.
- Waste transportation emission reduction is never addressed in any of the waste policies.
- Though mentioned in the Solid Waste Management Rules, 2016, the producer take-back mechanism for disposables in municipal solid waste is never implemented as the policy does not suggest any monitoring or reporting framework for the same.
- E-Waste (Management) Rules, 2016 recommends states to have an e-waste inventory. Though Maharashtra has an e-waste assessment report for Mumbai and Pune, it is outdated, and does not cover all districts, thereby not representing the current situation. An e-waste inventory with district-level information as per the 2016 rules need to be developed.

Inventories of different waste streams are critical for estimating waste sector emissions

BUDGETARY ANALYSIS TO ESTIMATE EXPENDITURE ON CLIMATE ACTION



Improvising rural connectivity

5. BUDGETARY ANALYSIS TO ESTIMATE EXPENDITURE ON CLIMATE ACTION

5.1. Introduction to budgetary analysis

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

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

Annexures 5.1 and 5.2 detail the rationale and the methodology adopted to conduct district level analysis.

5.2. Analysis of district budget

District budgets from the Planning Department, Government of Maharashtra for the years 2016-17 to 2018-19 were analysed to understand expenditure trends. Over the three years, expenditures under 40, 35, and 38 schemes were identified to be climate relevant under 18 different sub-heads in the budget document. The sub-heads were selected on the basis of their relevance to climate action heads, corresponding to sectors of water, sanitation, rural and urban development, forestry, energy, and agriculture. Figure 40 gives the year-on-year distribution of the budgetary allocation to climate action with power and urban development sub-heads being the major contributors.

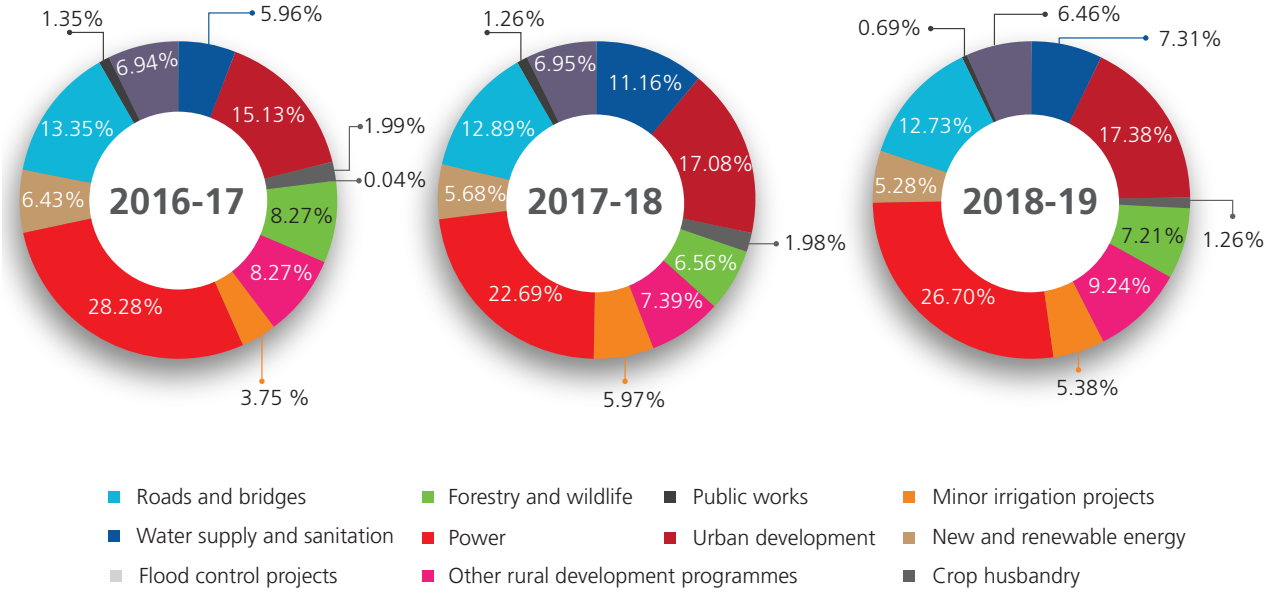


Figure 40: Distribution of expenditure attributed to climate action in Nagpur district (2016-17, 2017-18, 2018-19)

The objectives and activities undertaken in the shortlisted schemes and programmes were reviewed to understand their outcomes, impacts and potential vis-à-vis climate action. Based on the extent of climate action, the activities were categorised as *direct, indirect, marginal,* and *potential* (see Annexure 5.2 for further details). Figure 41 details the number of schemes under each category of expenditure. As observed for all the three years, the number of schemes under each category has proportionally remained the same. A larger number of schemes have been categorised as either marginal or potential, indicating that a majority of the schemes identified have scope for development, inclusion and prioritisation of climate-oriented actions and strategies.

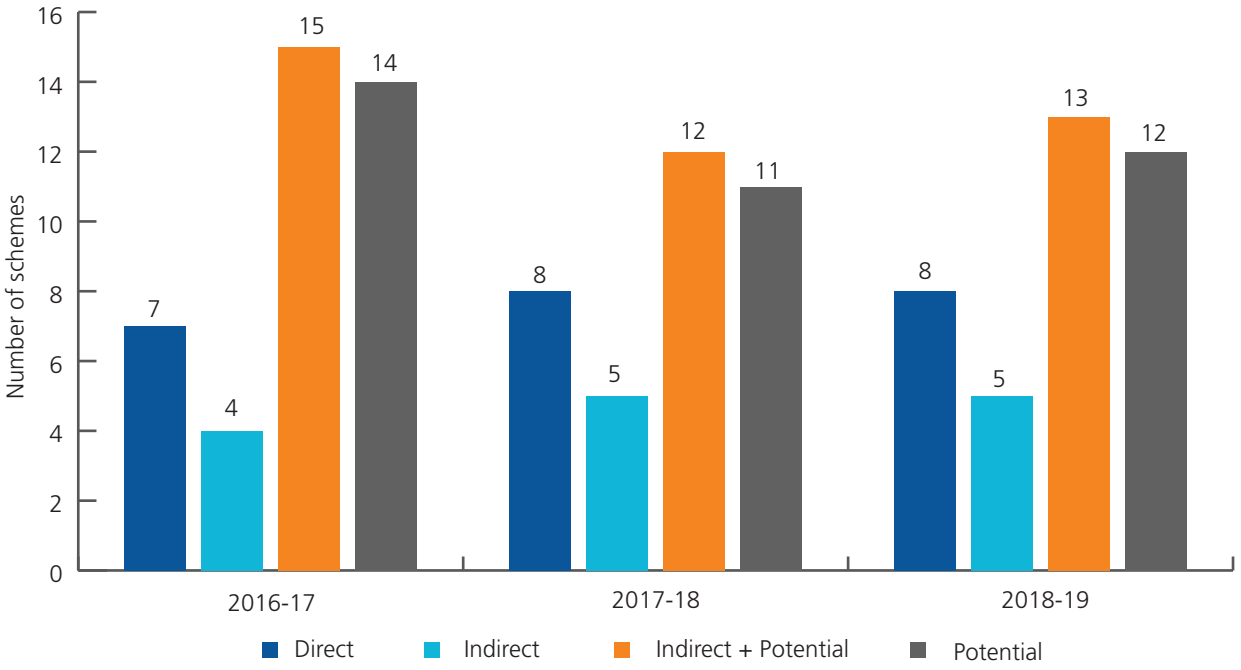


Figure 41: Climate relevant schemes by category in Nagpur district budget

The total expenditure on climate relevant actions is 9.34 percent, 19.79 percent, and 18.85 percent, respectively for the three years between 2016-17 to 2018-19. Figure 42 details these expenditures by the type of impact achieved (mitigation (M), resilience (R) or both (M+R)) by the schemes being implemented.

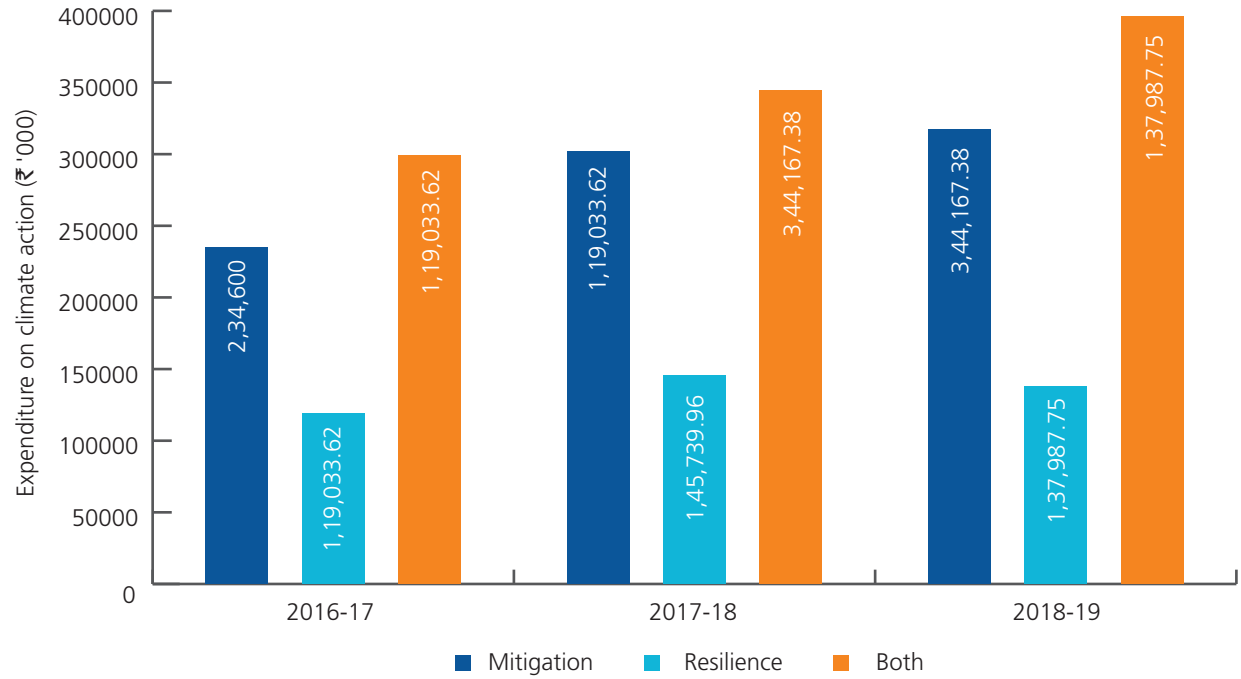


Figure 42: Nagpur district budget expenditure by impact of climate action (mitigation (M), resilience (R), both (M+R))

5.3. Analysis and findings of flagship schemes

5.3.1 Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS)[17]

2018-19

- Annual budgetary expenditure: ₹ 5,492.16 lakh
- Allocation to climate action: 32%
- Majority of climate action works: drought proofing, water conservation and water harvesting, and rural sanitation.

2019-20

- Annual budgetary expenditure: ₹ 4,599.47 lakh
- Allocation to climate action: 23%
- Majority of climate action works: drought proofing, water conservation and water harvesting, and rural sanitation.

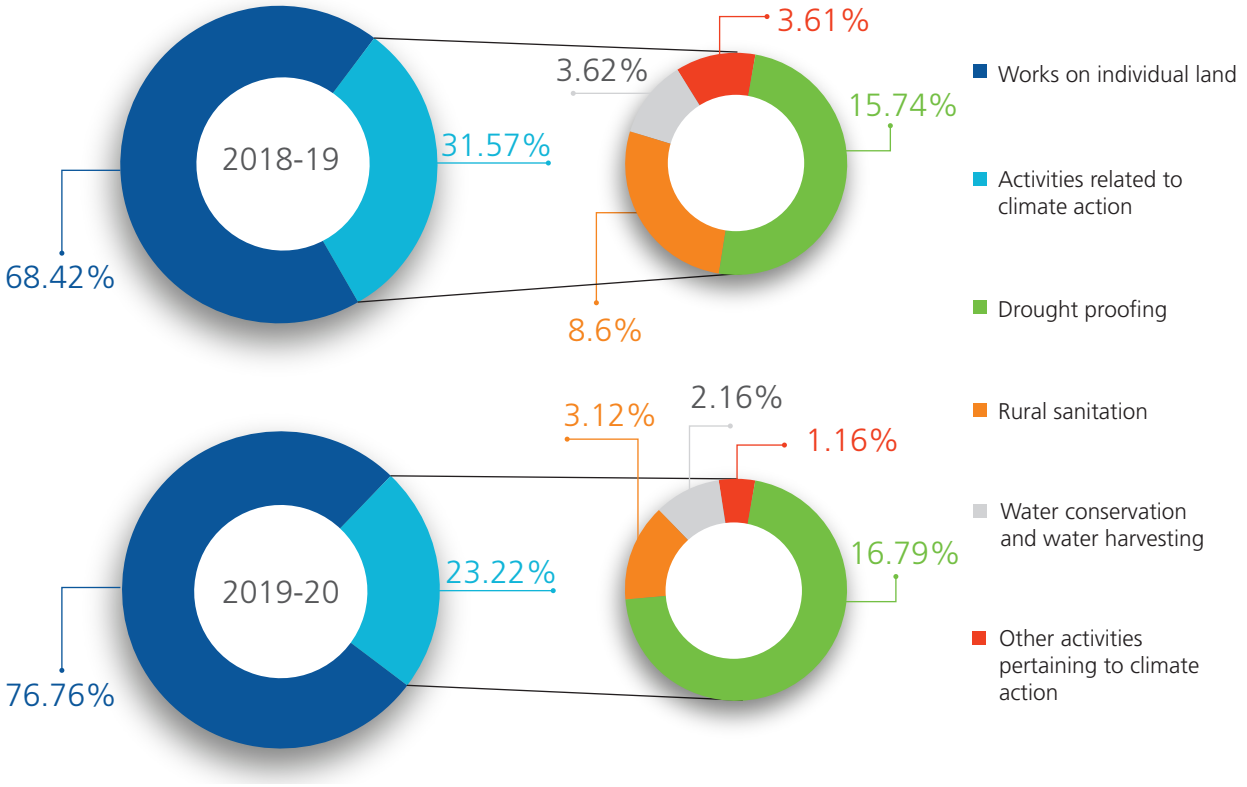


Figure 43: MGNREGS expenditure in Nagpur district for 2018-19 and 2019-20

Annual expenditure (₹ lakh)

	Drought proofing	Rural Sanitation	Water conservation and water harvesting	Other works related to climate action
2018-19	864.56	472.08	199.02	198.46
2019-20	772.08	143.73	99.27	53.13

Figure 44: Comparing annual expenditure under MGNREGS in Nagpur between 2018-19 and 2019-20

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

5.3.2 Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)

The micro-irrigation techniques employed in the district under this scheme are: 1) Drip irrigation technique; and 2) sprinkler irrigation technique. Other works include building of community ponds, tanks, check dams, and earth dams.

Budget allocation	2016-17	2019-20
Budgetary spending on micro-irrigation activities (₹ lakh)	595.00	483.00
Budget attributed to climate action (69%) (₹ lakh)	410.55	333.27
State budget for PMKSY micro-irrigation (₹ lakh)	33,000	23,200
% attributed to climate action (micro-irrigation budget under PMKSY) given to district w.r.t state budget	1.24	1.44

5.3.3 Atal Mission for Rejuvenation and Urban Transformation (AMRUT)

Based on the methodology and assumptions mentioned in Annexure 5.2, amounts of ₹ 713.3 lakh and ₹ 31.5 lakh can be attributed to climate action, for Nagpur district in FY 2015-16, and FY 2016-17, respectively (See Figure 45 for budget distribution) under AMRUT.

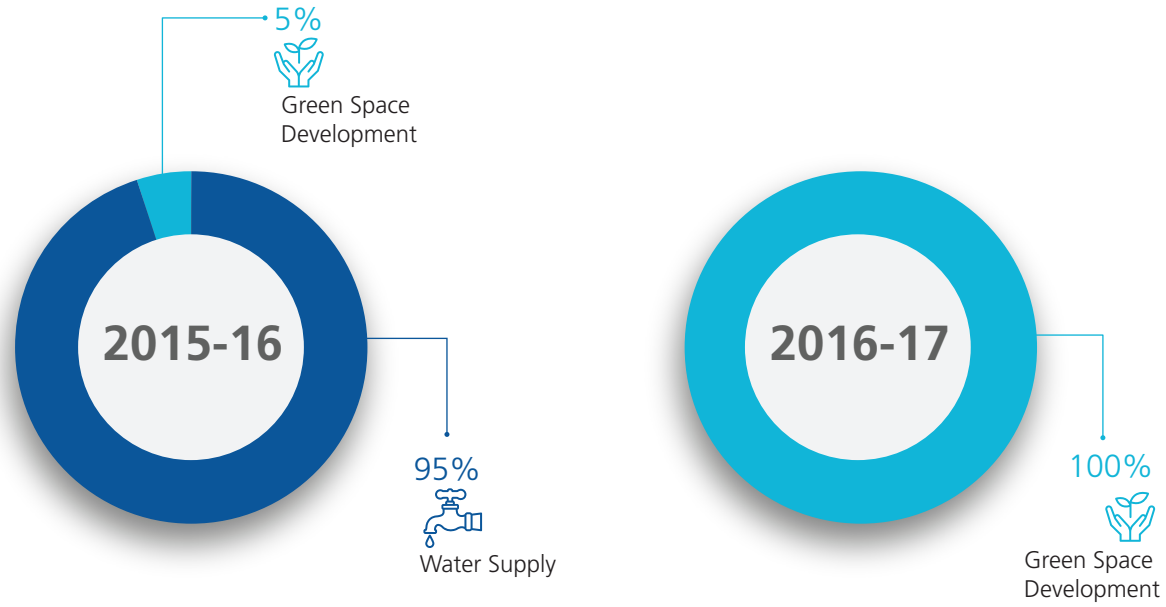


Figure 45: Comparison of budget distribution on climate related activities under AMRUT scheme in Nagpur for 2015-16 and 2016-17.

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

Until April 30, 2020, an amount of ₹ 163.21 crore has been released to carry out the activities[18] under DDUGJY and Saubhagya Scheme. An amount of ₹ 81.60 crore can be attributed towards climate action for Nagpur district (see Annexure 5.2 for methodology and assumptions).

18 New substations, augmentation substations, LT lines, feeder segregation, consumer metering etc.


नागपुर
NAGPUR

RECOMMENDATIONS

Existing parking spaces can be equipped with e-vehicle charging infrastructure

6. RECOMMENDATIONS

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

- Recommendations are grouped under four broad categories: Energy; agriculture, forestry and other land use (AFOLU); waste; and district-specific environmental issues.
- The recommendations, if implemented, have the potential to mitigate 68,66,857 tCO_2e in the energy sector, 17,54,734 tCO_2e in AFOLU and 44,914.26 tCO_2e in waste sector.
- Actions under each category on which recommendations can be made by the district collector/committee to the relevant state departments as well as inputs on innovative financing have been identified.
- These recommendations are based on district-specific ground realities and situations.
- The state and district vision documents were factored in while developing the recommendations. Additionally, the recommendations are developed in synergy with actions in Maharashtra government's Majhi Vasundhara mission.
- Information provided on timeframe and framework for implementation would help the district authorities and concerned departments prioritise actions.
- List of existing policies, programmes and schemes that can help streamline actions is provided along with the concerned primary and supporting departments in a separate table following each sectoral recommendation matrix.
- Additionally, this section provides information on SDGs and other co-benefits that can be addressed through the mentioned recommendations in this action plan.
- Further, the cross sectoral benefits of each recommendation have been identified and indicated using the icons as listed in the following table:

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

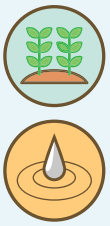
6.1. Sector-specific recommendations

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

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Increasing RE share in the electricity generation basket				
Increase the share of renewable energy (RE) generation by advancing rooftop and ground-mounted installations and other RE installations.		Short to medium-term (government buildings) Medium-term (commercial buildings) Medium to long-term (residential and others)	Policy framework and RE targets exist (section 6.1.1.1) Need to create awareness in residential sector	India has a target of 40 GW for solar rooftop (2022). As of February 28, 2021, only 4.32GW has been achieved. Maharashtra has only 647.73MW (as of February 2021) of solar rooftop capacity. In Maharashtra, in 2020, off-grid solar rooftops were installed by MEDA in 26 out of targeted 31 government buildings, with an upper cap of 20kW. *Case example calculation:* a) If eqipped with solar rooftops, the government schools in Nagpur district alone can generate 55.34 MUs of electricity, thereby avoiding 47,600 tCO_2e emissions, annually. b) If 50% households are equipped with solar rooftops, total potential installed capacity would be 4,800 MW, which can help avoid 6.29 Mt CO_2e emissions, annually. Meeting the solar rooftop targets can be expedited by making it mandatory for the hospitality industry / new construction (having a built-up area greater than 20,000 sq. ft) / private healthcare infrastructure (above certain bed-capacity). Ground mounted solar: The current installed capacity of ground mounted solar in Maharashtra stands at 1.64 GW (as of February, 2021). Nagpur district has a huge potential for solar power generation (rooftop and ground mounted). In the highly industrialised and urbanised Nagpur city, solar rooftop installation can be promoted. For the remaining part of the district, ground mounted solar installations can be more viable.
Battery storage for RE to be aggressively promoted.		Short to medium-term	Additional financial support can be created	MEDA has installed 650 Ah (Ampere hour) batteries for a few solar projects in Maharashtra. MEDA has also proposed, and installed a few hybrid inverters for RE projects across Maharashtra. Hybrid inverters take power from RE/battery installation up to a particular load, and on increased load demand, switch to the grid supply.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Encourage captive use of renewable energy, particularly in rural areas for small industries and creation of local entrepreneurs.		Short to medium-term	Policy framework exists (section 6.1.1.1) Need to create awareness	By 2030, the electricity demand for Nagpur district is expected to be around 11,000 MUs annually. If all of this electricity demand were to be met from coal, it would lead to 9.5 $MtCO_2e$ emissions, annually. Decentralised Renewable Energy (DRE) setups can power small/cottage industries, which in turn can play an important role in providing livelihoods in rural areas as well as support reverse-migration (that was recently witnessed during the COVID-19 pandemic). Such setups would also create new jobs, and empower rural entrepreneurs. Cold storage and other rural non farm productive use appliances across the district can be powered by DRE. Such set-ups could also be used for reliable storage of vaccines besides farm produce.
Energy demand side management (DSM) and energy efficiency				
Encourage faster penetration of Street Lighting National Programme (SLNP). This would ensure that all street and public lighting fixtures are replaced with energy efficient LED bulbs, prioritising premises and recreational areas of all government / public institutions.		Short-term	Policy framework and schemes exist (section 6.1.1.1)	Smart streetlighting can reduce electricity use by up to 80%. Around 320 million streetlighting poles are in use globally, but fewer than 3% of these are smart enabled (International Energy Agency, 2021). SLNP had a national target of replacing 1.34 crore conventional street lamps with LED lamps by March 2020, but as of September 16, 2021, only 1.22 crore LED lamps have been installed. Replacement of the existing 79,548 conventional lamps in Nagpur district with LED lamps under SLNP can potentially avoid 41,898 tCO_2e emissions, annually.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Expedite installation of smart meters in collaboration with MSEDCL in an effort to develop Advanced Metering Infrastructure (AMI). Installing smart meters, along with its associated IT infrastructure would allow the DISCOM to obtain real time energy consumption data of each consumer for subsequent analysis and will pave the way for initiating various smart measures such as: (a) Time of day (TOD)/ time of use (TOU) billing (b) Prediction and management of peak demand (c) Providing real time energy consumption data to the consumer (d) Prepaid billing facility (e) Remote connection and disconnection of load (f) Development and adoption of a differential pricing model to demotivate energy consumption during peak hour, etc.		Short to medium-term	Policy framework and targets exist (section 6.1.1.1) Create awareness for consumer segment	Implemented by EESL (BEE), Smart Meter National Programme aims to replace 25 crore conventional meters across the country with smart meters. *Case example:* Adani Electricity Mumbai Limited has announced plans to install over 7,00,000 smart meters in Mumbai. The Maharashtra Electricity Regulatory Commission (MERC) has approved capital expenditure schemes for the installation of smart meters. In Delhi, Tata Power Delhi Distribution Limited has installed 2,00,000 smart meters in partnership with Landis+Gyr and Siemens across its domestic, industrial and commercial consumer segments under its AMI project. These smart meters have proved to be extremely beneficial for the DISCOM in raising bills based on actual readings instead of provisional ones during the lockdown in April-May 2020. The company managed to raise over 3,50,000 bills during this period, and avoided over 1,50,000 visits to consumer premises per month. Under National Smart Grid Mission, smart grid pilot project was planned for MSEDCL to be implemented at Congress Nagar, Nagpur in 2016. The approved project cost is ₹ 139.15 crore and the project aimed to cover 1.25 lakh consumers. So far, there is no progress reported for this in the monthly update documents on the NSGM. Commencement of the project can help MSEDCL, and subsequently Nagpur district would reap the benefits.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Replace/upgrade existing inefficient pumping infrastructure with energy efficient pumps/ solar pumps (where possible) for supply of piped drinking water in both rural and urban pockets of Nagpur district.		Short to medium-term	Relevant schemes and programmes can help achieve this (section 6.1.1.1) Inter-departmental collaboration required	One of the objectives of the Maharashtra State Energy Conservation Policy, 2017 is to promote energy conservation measures in the street lighting systems and water pumping systems, both of which show significant energy conservation potential. Around 4% of the energy consumed in the state is through the state water supply and around 2% is through street lighting systems. MEDA provides financial assistance of up to ₹ 50 lakh through Energy Service Company (ESCO) to ULBs for implementing energy savings projects of street lighting and water pumping schemes. All the ULBs in Nagpur, in co-ordination with the relevant departments can avail the financial assistance/ benefits of the scheme to make their systems energy efficient.
In agriculture, promote energy-efficient water pumps (provided by EESL) and solar pumps, wherever possible (through PM-KUSUM Yojana).		Short to medium-term	Policy framework exists (section 6.1.1.1)	According to BEE, 30% to 40% energy savings are possible in agriculture by adoption of energy-efficient star labelled pump sets. Conversion of the existing electricity/ diesel-operated tube-wells (those with permissions of operation under the Groundwater Development and Management Rules, 2018) to solar in Nagpur district can potentially reduce substantial GHG emissions.
Increase community awareness on and access to energy-efficient appliances and fixtures. Provide additional incentives over and above existing schemes/ programmes on energy-efficient appliances. *(Other recommendations pertaining to energy efficiency are listed under sections on habitat industry and other recommendations that can be made by the collector's office to the state departments)*		Medium-term	Additional financial support can be created Create awareness through dedicated IEC and long running campaigns	*Case example:* BSES Yamuna Power Ltd. (BYPL) launched an AC replacement scheme in Delhi NCR, with the objective to promote energy efficiency and green initiatives among households and bring down the power consumption in the National Capital Region. Under the programme, upfront rebate per air conditioner (BEE 5 star rated/ inverter) has been offered by BYPL to the consumer in exchange of their old non-star rated air conditioner. MSEDCL can implement a similar scheme in its area of supply, with a pilot in Nagpur district.

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

Sub-sectors	Policies and programmes[19] that can push forward the recommendation	Primary departments/ agencies	Supporting departments/ agencies
Increase RE share in the electricity generation basket	1. Maharashtra State Renewable Energy Policy, 2020 2. Policy for Grid-connected Solar Projects 3. Off-Grid Policy, 2020 4. Grid connected Wind power projects 5. National Solar Mission 6. i-SMART Project 7. PM KUSUM	1. MEDA, GoM 2. Industries, Energy and Labour Department, GoM	1. ALL ULBs 2. Maharashtra Electricity Regulatory Commission (MERC). 3. Urban Development Department, GoM 4. Department of Rural Development and Panchayat Raj, GoM 5. Department of Housing, GoM 6. Department of Environment and Climate Change, GoM 7. MSEDCL 8. Department of Agriculture, GoM 9. Proposed District level Committee on Climate Change and Environment
Energy demand side management (DSM) and energy efficiency	1. Maharashtra State Energy Conservation Policy, 2017 2. Smart Meter National Programme (SMNP) 3. National Smart Grid Mission 4. Integrated Power Development Scheme, 2014 5. Streetlight National Programme (SLNP), 2015 6. UJALA Scheme, 2015 7. Standards and Labelling Programme 8. Sustainable Habitat Mission 9. Smart Cities Mission 10. National Mission for Enhanced Energy Efficiency 11. Municipal Energy Efficiency Programme (MEEP) 12. PM KUSUM 13. Maharashtra State Renewable Energy Policy, 2020	1. MSEDCL 2. MEDA, GoM 3. BEE (EESL) 4. All ULBs 5. Panchayati Raj Institutions (PRIs) 6. Industries, Energy and Labour Department, GoM	1. Department of Environment and Climate Change, GoM 2. Department of Agriculture, GoM 3. Urban Development Department, GoM 4. Nagpur Smart and Sustainable City Development Corporation Limited (NSSCDCL) 5. Proposed District level Committee on Climate Change and Environment

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

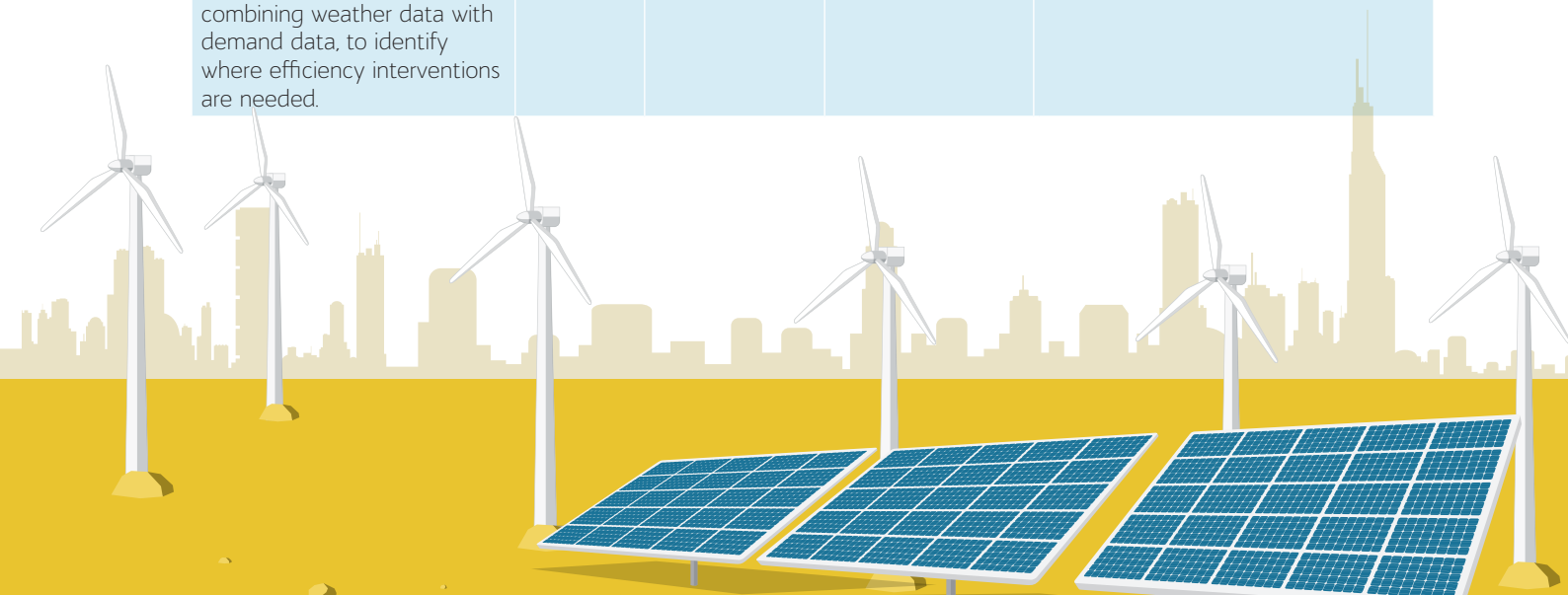
6.1.2 Habitat (urban and rural development): Recommendations, cross-cutting sectors, qualifying priority and district scenario

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for implementation	
Energy efficiency in buildings				
Incorporate Energy Conservation Building Code (ECBC) in the building bye-laws and encourage green building rating programs by incentivising ULBs, as a pathway to buildings having net zero energy consumption.		Medium to long-term	Policy framework exists (section 6.1.2.1) Inter-departmental collaboration required Need capital incentives/relevant exemptions over and above the existing provisions from the district administration	The residential and commercial sectors in Nagpur contribute to around 27% of the total electricity consumed in the district. MEDA is working to incorporate ECBC into building compliance systems in Maharashtra. In 2019, Indian Green Building Council (IGBC), agreed to sign an MoU with Nagpur Smart and Sustainable City Development Corporation Limited (NSSCDCL) for a period of three years to construct all new buildings as per the green building norms to use less water, optimise energy use, conserve natural resources, and generate less waste as compared to conventional buildings.
District administration, in collaboration with the ULBs can implement the India Cooling Action Plan (ICAP) and achieve its objectives. District administration can also explore the possibilities of piloting solar-passive architecture/other renewable energy technologies in a few of its iconic buildings. Implementing this at the district level could help avoid significant GHG emissions.		Medium-term	Policy framework exists (section 6.1.2.1) Needs inter-departmental collaboration Need capital incentives/relevant exemptions from the district administration	In September 2018, India became the first country in the world to have a Cooling Action Plan which seeks to: (i) Reduce cooling demand across sectors by 20% to 25% by 2037-38, (ii) Reduce refrigerant demand by 25% to 30% by 2037-38, (iii) Reduce cooling energy requirements by 25% to 40% by 2037-38, (iv) Recognise "cooling and related areas" as a thrust area of research under national S&T Programme, (v) Training and certification of 1,00,000 servicing sector technicians by 2022-23, synergising with Skill India Mission. The plan aims to provide the following benefits: (i) thermal comfort for all – provision for cooling for EWS and LIG housing, (ii) sustainable cooling – low GHG emissions related to cooling, (iii) doubling farmers income – better cold chain infrastructure (iv) skilled workforce for better livelihoods and environmental protection, (v) Make in India – domestic manufacturing of air-conditioning and related cooling equipment and other benefits.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for implementation	
Replace diesel powered backup with solar-powered or other RE powered backup in a phased manner. This can essentially be promoted in government / commercial / institutional buildings with built-up area above certain sq. ft.		Short to medium-term (government buildings) Medium to long-term (privately owned, commercial, institutional, and others)	Policy intervention is required Proper policy backup can mitigate GHG emissions and align India with Paris targets Needs inter-departmental collaboration	A DG set of 200kW, (used in industries/huge commercial buildings) operating at full-load consumes approximately 45 litres diesel/hour. This results to an emission of around 117 $kgCO_2e$/hour. Replacing DG sets with solar powered backup could help in avoiding these emissions. If 50% of the DG sets in the district are replaced with solar powered backup then 67,359 tCO_2e emissions could be averted annually.
Upgrade public transport infrastructure to include RE and ECBC compliance. Roadside hoardings near such infrastructure can also be powered through RE.		Short to medium-term	Can be pushed forward by aligning with existing policy framework for solar rooftop (section 6.1.2.1) ECBC compliance of public transport infrastructure to be mandated by building bye-laws	Nagpur district can adopt and implement initiatives, similar to the one in Lucknow, where the municipal corporation has planned to set up 200 solar-powered bus stops.
Promoting formulation of energy communities in existing RWAs/other residential committees where residents have ownership over their energy supply. Energy communities can host wind and solar generation installations, or a self-sufficient system functioning as a microgrid/undergrid-minigrid. These committees can make agreements between the community, the private developer and the utility company. Digitalisation can create innovative billing mechanisms and generate data that will provide important investment information for the energy market.		Medium-term	Deploying public funding schemes like feed-in tariffs, leverage national and international funds, and providing digital upskilling opportunities to citizens can help promote the initiative.	

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for implementation	
Encourage fast penetration of UJALA scheme in every household of Nagpur district.		Short to medium-term	Schemes and programmes are available (section 6.1.2.1)	The UJALA scheme provides an LED bulb at a nominal price for replacement of incandescent lamps / conventional bulbs. A projected estimated number of LED bulbs to be used in the households of Nagpur district through implementation of UJALA scheme by 2025 can potentially avoid emission of 0.42 $MtCO_2e$ annually. Under the recently launched Gram Ujala programme by CESL (Convergence Energy Services Ltd.), 7 watt and 12-watt LED bulbs with three years of warranty will be given to rural consumers on submission of working incandescent bulbs, at a price of ₹ 10/LED bulb. Consumers can exchange a maximum of five incandescent bulbs with LED bulbs. In the first phase of this programme, 15 million LED bulbs will be distributed across villages of Aarah (Bihar), Varanasi (Uttar Pradesh), Vijaywada (Andhra Pradesh), Nagpur (Maharashtra), and villages in western Gujarat. The programme will be financed entirely through carbon credits and will be the first such programme in India.
Enhance public awareness for switching to energy efficient BEE star-labelled home appliances.	 	Short-term and continuous	Needs collaboration and awareness	
Demand-side management for Habitat				
Promote and subsidise good practices for all ULBs, such as installing rainwater harvesting setups in buildings, to considerably reduce energy dependence (submersible motors) for groundwater pumping.	  	Short-term	Schemes and programmes exist (section 6.1.2.1) Need to generate awareness	Since 2005, rainwater harvesting is mandatory in all buildings, layouts of open spaces, amenity spaces of housing societies and new constructions of area equal to or more than 300 sq. m in Nagpur. They shall have one or more rainwater harvesting structures such as an open well or bore well, or underground storage tank or percolation pits. The bye-law envisages that no building permission will be granted unless provision is made for rainwater harvesting. The owner/society also has to ensure the maintenance of these structures. In the case of non-compliance with the aforementioned rules, NMC would levy a fine of up to ₹ 1000/annum/100 sq. m of built-up area.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for implementation	
Implement individual water metering in residential sector to reduce water wastage and introduce other energy efficient measures for drinking water and wastewater plants, thereby, bringing down the energy consumption.		Medium-term	Policy intervention required Need to create awareness	Water metering can help save 25 to 30% water every year. In November 2011, NMC launched its uninterrupted water supply scheme, called 24x7 Water Supply Scheme. One of the objectives of the scheme was to install water meters in 3.09 lakh households in Nagpur by 2018, against which only 1.60 lakh were installed. The project is being implemented by private operator – Orange City Water Private Limited.
Encourage residential societies to install solar-thermal water heaters.		Short-term and continuous	Schemes and programmes exist (section 6.1.2.1) Inter-departmental collaboration required Scheme to be implemented as part of green buildings	Multi-storey (up to 12 storeys) residential buildings can meet around 70% of the annual electricity requirement for water heating (BEE) through community solar water heating systems on the roof (assuming utilisation of 60% of roof area).
Promote installation of automatic / smart water pumps to control overflowing of tanks.		Short-term	Need to create awareness	
Water cess / pricing by municipal corporation to be revised and gradually increased.		Medium-term	Policy framework to be revised	
Digital tools, such as GIS, remote sensing can be used to identify opportunities to reduce energy demand and implement energy efficiency interventions where it holds most value, and identify where and how to set up mixed-use zones to flatten demand curves. Energy demands (for cooling) of the district can be mapped, combining weather data with demand data, to identify where efficiency interventions are needed.		Medium to long-term	Needs policy intervention and infrastructural development	By identifying optimal locations for water features or vegetation, Nagpur can counteract on heat islands through tree plantations that provide shade and reduce the power demand for cooling in buildings.



6.1.2.1 Habitat: Policy framework and concerned departments/agencies

Sub-sectors	Policies and programmes that can push forward the recommendation	Primary departments/ agencies	Supporting departments/agencies
Energy efficiency in buildings	1) Maharashtra State Energy Conservation Policy, 2017 2) ECBC 2017 / IGBC rating system 3) India Cooling Action Plan, 2018 4) UJALA Scheme,2015 5) Maharashtra State Renewable Energy Policy,2020 6) Policy for Grid-connected Solar projects 7) Off-Grid Policy, 2020 8) Smart Cities Mission 9) Sustainable Habitat Mission	1) Department of Housing, GoM 2) MEDA 3) All ULBs 4) Nagpur Smart and Sustainable City Development Corporation (NSSCDCL) 5) Panchayati Raj Institutions (PRIs)	1) MSEDCL 2) Department of Environment and Climate Change, GoM 3) Urban Development Department, GoM 4) Department of Rural Development and Panchayat Raj BEE (EESL) 5) Maharashtra State Road Development Corporation Limited (MSRDCL) 6) Maharashtra Transport Department 7) Proposed District level Committee on Climate Change and Environment
Demand-side management for Habitat	1) Maharashtra State Energy Conservation Policy, 2017 2) Maharashtra State Water Policy, 2019 3) ECBC 4) Building bye-laws	1) Department of Housing, GoM 2) All ULBs 3) Panchayati Raj Institutions (PRIs)	1) Urban Development Department, GoM 2) Department of Rural Development and Panchayat Raj, GoM 3) Water Supply and Sanitation Department, Maharashtra, GoM 4) Nagpur Smart and Sustainable City Development Corporation (NSSCDCL) 5) Proposed District level Committee on Climate Change and Environment 6) Department of Environment and Climate Change, GoM

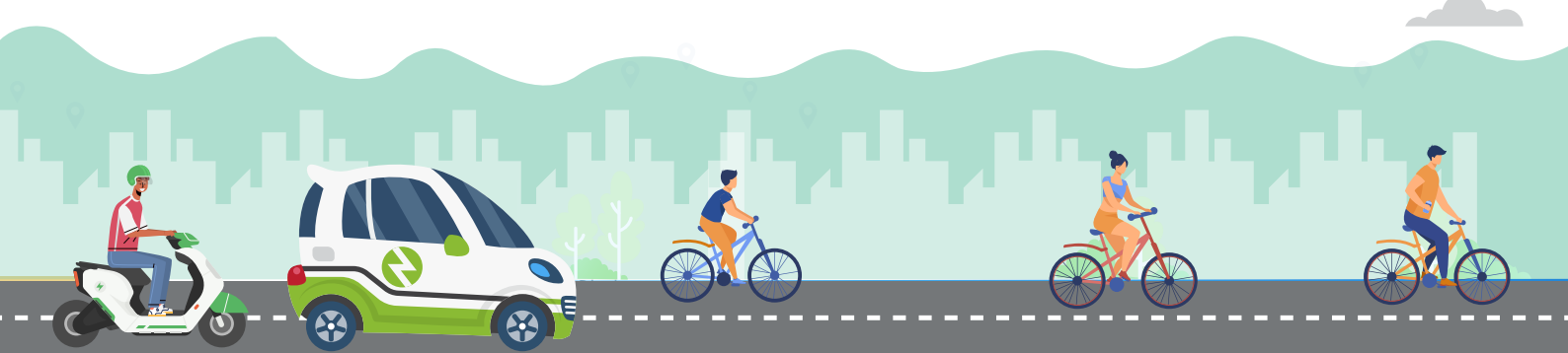
6.1.3 Transport: Recommendations, cross-cutting sectors, qualifying priority and district scenario

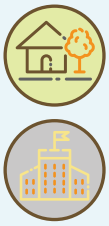
Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for implementation	
Promote e-mobility				
Generate awareness and disseminate information to encourage adoption of electric vehicles.		Short-term and continuous	Inter-departmental collaboration and dedicated long-running campaigns required	Maharashtra EV Policy, 2021 aims to promote a sustainable transport system through EV infrastructure development in major urban centres in the state, including Nagpur. The policy states that awareness programs will be designed and implemented by the state government in partnership with industry players and civil society organisations. The programme will aim to create awareness on EVs, their benefits and incentive support available under state and central government policies.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for implementation	
Increase modal share of e-vehicles to achieve the target of National Electric Mobility Mission Plan (NEMMP) and FAME II.		Short-term and continuous	Policy framework exists (section 6.1.3.1) and budgetary provisions can be made available through various schemes	The Maharashtra Electric Vehicle Policy, 2021 aims to increase the modal share of electric vehicles in major cities of Maharashtra, including Nagpur, through introduction of electric buses, two wheelers, three-wheelers, and cars in cities. The policy has set a target that by 2025, 10% of all new vehicle registrations in the state should be of electric vehicles. Further, to promote EV adoption, the policy offers subsidy of ₹ 5000/kWh on purchase of electric two, three and four-wheelers (capped at ₹ 10,000, ₹ 30,000 and ₹ 1,50,000, respectively), with further benefits to promote purchase of EV vehicles within the year.
Make all public transport (PT) modes low carbon intensive, such as shifting of current fossil fuel-based vehicles to electric powered or hybrid vehicles.		Medium to long-term	Policy framework (section 6.1.3.1) and budgetary provisions exist	In 2019, Nagpur Municipal Corporation launched India's first electric bus fleet for women in public transportation service under its 'Tejaswini' initiative. Six electric buses with CCTV security were launched in the city. Further, in 2020, NMC announced plans to procure 40 electric buses under FAME II. The Maharashtra EV Policy 2021 aims to electrify 25% of all public transport in major cities of the state including Nagpur. Furthermore, 15% of all MSRTC buses will be electrified by 2025. The policy provides incentives of up to ₹ 20,00,000 on purchase of electric buses to state transport undertakings.
Similarly, initiate transition of intermediate public transport (IPT) vehicles to electric by incentivising IPT operators through: a) subsidies, b) separate lanes, c) dedicated parking spaces, d) replacement of lead acid battery-powered electric IPT vehicles with more sustainable Li-ion battery e-vehicles in a phased manner.		Medium-term	Policy framework exists (section 6.1.3.1)	The Maharashtra EV Policy 2021 aims to promote transition of IPT to electric in the state through a number of incentives and non-fiscal benefits. Some major provisions regarding subsidies and parking spaces are as follows: a) An incentive of ₹ 5,000/kWh to three-wheelers up to ₹ 30,000 is offered. Additional incentives for assured buyback and battery warranty of at least five years. b) ULBs are encouraged to provide lane and parking preferences to EVs. c) At least 25% of the total capacity of all dedicated off-road public parking spaces and the parking spaces of all institutional and commercial complexes to be made EV ready by 2023.[20] d) Free parking provisions for EVs in all future public parking spaces. e) The state government shall engage and encourage financial institutions and banks to offer preferential interest rates for EV customer segments such as e-autos, goods carriers, and taxis.

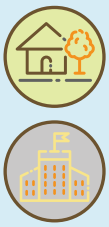
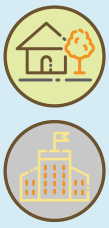
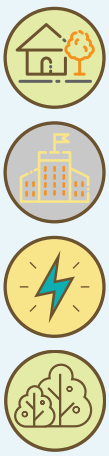
20 A parking spot is defined as EV ready when it is provided with charging infrastructure and a separate meter connection

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for implementation	
District administration, ULBs (for office use and solid waste transport activities) and all district level government offices can adopt e-vehicle fleets. Additionally, all these offices need to install charging infrastructure at the earliest.		Short to medium-term	Policy framework exists (section 6.1.3.1)	The Maharashtra EV Policy, 2021 has announced that new vehicles inducted into the government fleet starting April 2022 will be electric-only. Further, it pushes for 100% conversion of the parking spaces of all government office complexes to be EV ready by 2025.
Develop robust and widespread charging infrastructure: a) Charging infrastructure to be at strategic locations – commercial hubs, public parking, airports and railway stations etc., preferably RE powered, b) Adopt relevant policies, c) Prioritise land acquisition for setting up charging infrastructure, d) Introduce dedicated parking spaces for EVs with charging facilities, e) Incentivise restaurants and restaurant owners, fuel stops and other commercial spaces along the highways to install charging infrastructure for e-vehicles in order to make long journeys with e-vehicles hassle-free, f) Install integrated EV charging points within lamposts as a cost effective solution to reduce street clutter and to open access to charging facilities, particularly for those without garages. This can be initiated as a trial solution and scaled up further in the future.		Medium-term	Policy framework exists (section 6.1.3.1) Inter-departmental collaboration required	Nagpur was the first city in the country to have an electric charging station in 2017 (Business Standard, 2019). In 2020, first fast charging station for all types of electric vehicles in Nagpur was set (Hindustan Times Auto, 2020) Maharashtra State Electricity Distribution Company Ltd. (MSEDCL) has sanctioned installation of 500 electric vehicle charging stations across the state. In the first phase, it allocated funds for the installation of 10 electric charging stations across Nagpur. The Maharashtra EV Policy, 2021 aims to establish 150 charging stations in Nagpur by 2025. The policy provides incentives for setting up public and semi-public charging stations, both slow and fast across the city as well as offers rebates in property tax to residential owners setting up private charging stations. These incentives will only be provided after the charging station is functional. The policy mandates new residential buildings as well as institutional and commercial complexes to make at least 20% and 25% respectively of total parking spaces EV ready. The policy has also targeted creation of low-emission zones that shall be served primarily by zero tailpipe emission vehicles.

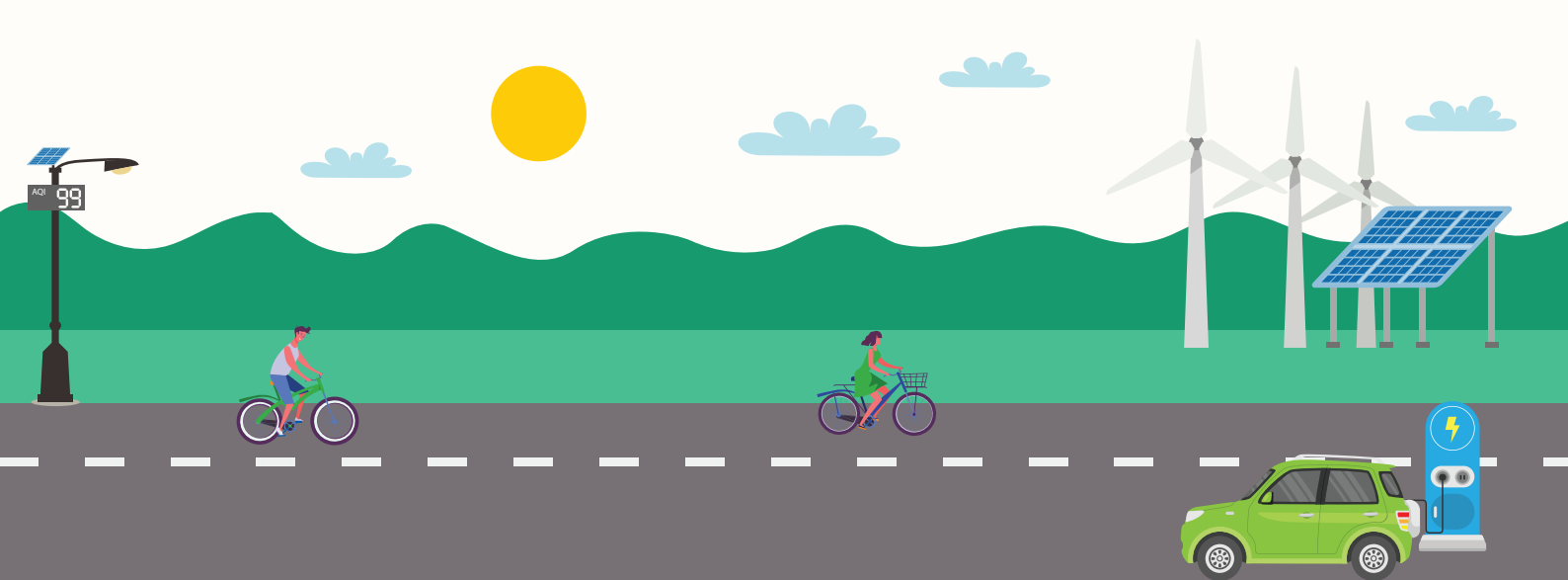


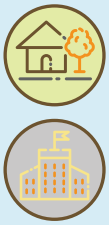
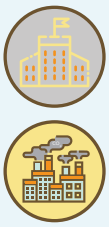
Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for implementation	
The district administration, in collaboration with the ULBs and state officials, may explore options to provide incentives to e-vehicle owners over and above existing programmes through: a) exemptions on road tax, b) exclusive parking for e-vehicles, c) additional subsidy scheme for women and students.		Short-term	Enhancing the existing policy frameworks towards holistic integration of e-vehicles	The Maharashtra EV Policy, 2021 has a target of increasing the modal share of EVs by adding at least 300,000 electric vehicles in the state by 2025 and has recommendations suggesting means to promote EVs (as listed in the point above). Nagpur can lead by example in the state and the country by easing transition to EV through additional incentives, as suggested.
Promote fast registration of EVs at RTO.		Short-term	Policy framework exists Create awareness to popularise EVs	Maharashtra EV Policy, 2021 has provisions to incentivise and fast-track adoption of EVs by exempting them from road tax and registration charges and renewal of registration.
Encourage development of local network of rental e-vehicles across the district, including cars and bikes, as well as a battery rental network for faster adoption of EVs. Further, this can be integrated with smart cards.		Medium-term	Needs policy backing and PPP models to be explored	Nagpur can initiate e-vehicle rental service, similar to many other cities in India, including Ahmedabad, Bengaluru, Pune, Delhi among others. The successful rental model of Yulu bikes in Bengaluru can be emulated to develop hour-based electric bike rentals for key routes. These bikes can be a part of an integrated ticketing system that utilise smart cards for payments.
Encourage and promote adoption of EVs for all delivery operations within the district.		Short to medium-term	Policy framework exists (section 6.1.3.1)	Currently, most delivery partners for food, courier and other kinds of services rely on self-owned fossil fuel-based two- or four-wheelers. In cities like Delhi, Mumbai and Bengaluru, e-commerce food delivery companies such as Zomato are working towards developing an EV fleet. The Maharashtra EV policy, 2021 also endeavours towards fast-tracking and ensuring time-bound registration of EV fleets owned by aggregators, last mile delivery providers, logistics players etc.
Range anxiety is a key barrier to EV adoption. Mobile applications (local app, google map, etc) with real-time data availability of charging points and the cost of charging at various locations will be critical in popularising EVs, as it would allow users to plan routes that have charging points.		Medium to long-term	Needs support for digitalisation	

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for implementation	
Smart lampposts can radically improve electrical efficiency and enable a number of new services, such as being equipped with PV modules to harvest and store solar energy during the day to power lighting at night. They can also come with sensors and communication technologies that can adjust their output according to ambient light levels, monitor traffic, noise and air pollution, seismic activity and increase coverage of cellular and Wi-Fi networks.		Medium to long-term	Needs technological, infrastructural and policy interventions	
Public transport (PT) and intermediate public transport (IPT)				
Increase reliability, accessibility and enhance last mile connectivity of public transport (PT) and intermediate public transport (IPT) through: a) integrated ticketing and smart cards that works across all transport modes (IPT, cycle hire, etc), b) integrating smart mobility applications with real-time service updates across modes, including car hire, public transit and shared micro-mobility schemes, c) increasing fleet strength, d) increasing frequency, e) adding more stops, f) enhanced reach to low or non-serviced areas, peri-urban and rural areas, g) developing dedicated parking spaces for IPT.		Medium to long-term	Existing policy framework can be enhanced Interdepartmental collaboration required	As per the Updated Comprehensive Mobility Report 2018, the share of public transport in Nagpur is 16% and is relatively low compared to India's most populous cities. Aapli bus, the public transport service in Nagpur, has a fleet of 438 buses, including 237 standard buses, 150 midi, 45 mini and six electric buses. Further, NMC is also in the process of procuring 40 electric buses. Nagpur Metro launched Maha Card in collaboration with NMC and SBI for pre-paid payments for travel via metro in 2019. It plans to expand the use of the card for payments for public transport, NMC parking areas, e-commerce transactions, shopping etc. Peri-urban areas are currently connected through MSRTC services. The frequency of services can be enhanced, and the number of stops can also be increased to cover these areas. As per the Updated Comprehensive Mobility Report for Nagpur, 2018, the share of IPT in Nagpur is 19.8%. RTO data from 2019 states that between 2016 and 2019, only 2,440 e-rickshaws were registered comprising only 13.32% of all autorickshaw registrations in Nagpur. Currently, the IPT sector is not formalised completely and the connectivity is limited to certain routes, majorly in and around popular commercial and residential areas. The informal IPT modes operating in the peri-urban areas of the district include mini buses, shared autos, and taxis. Residents in city outskirts/ peri-urban areas majorly rely on private vehicles or walking. Formalising this mode and transitioning it to a low-carbon regime is essential to reduce GHG emissions from the transport sector in Nagpur.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for implementation	
District administration can collaborate with ULBs to develop fiscal measures to discourage the use of personal vehicles like variable parking charges for peak hours.		Short-term and continuous	Requires policy intervention based on research and interdepartmental cooperation	Nagpur can adopt recommendations from Delhi Master Plan, 2021, which provides a Parking District Management Plan. The action plan suggests that the transport department, municipal corporations, traffic police and other agencies need to collaborate to develop and maintain parking areas. The plan also suggests that variable and time-based parking prices should be introduced.
Implement policy measures to discourage use of private vehicles: a) parking policy for vehicle ownership, b) no car days on certain roads, c) parking allowed only in dedicated areas.		Short to medium-term	Requires proper policy backing based on research and inter-departmental cooperation	To discourage use of private vehicles in the district, initiatives such as the ones stated below can be adopted: 1) Sikkim Parking Policy, 2010 mandates that only houses with parking slots can procure vehicles. 2) Gujarat University, in February 2016, announced that 1st and 15th of each month will be observed as no vehicle days, when only public transport and pedestrian movement will be allowed.
Improve enforcement of vehicular pollution control norms to minimise emissions from fossil fuel-based PT and IPT vehicles.		Short-term and continuous	Policy framework exists (section 6.1.3.1) Needs stricter implementation	
Awareness campaigns to popularise PT and IPT modes.		Short-term and continuous	Dedicated awareness campaigns required	
Augment non-motorised transport (NMT)				
Improve infrastructure to enhance modal share of NMT transport options in urban areas, by introducing measures such as segregated cycle lanes.		Medium-term	Proper policy based on research and inter-departmental cooperation is required	Current modal split in Nagpur indicates that the share of NMT is approximately 16% and has been decreasing over the years. NSSCDCL has planned an 18 km bicycle track in the city, mostly concentrated in lanes surrounding main roads. Further, efforts are needed to make NMT a preferred and viable option.
Regular O&M of NMT infrastructure by: a) developing and maintaining well-lit, clean and safe pathways for pedestrians and cyclists, b) consulting and engaging local experts and community for development and maintenance, c) removing encroachments.		Short-term and continuous	Policy framework exists Requires inter-departmental cooperation	

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for implementation	
Promote cycle hire service in key locations across the district.		Short-term	Policy framework needs to be enhanced Further, PPP models can be explored for successful implementation	Bicycle hire services have been initiated in many cities across the country, including, Pune, Bhopal, Indore, Delhi, Bangalore among others. However, very few of them have been successful, due to lack of awareness and non-strategic placement. Nagpur Smart and Sustainable City Development Corporation has planned development of an 18 km bicycle track in the city. Further, the Maharashtra State Urban Transport Policy, 2017 as well as the National Urban Transport Policy, 2006 promote development of cycling infrastructure in cities.
Improving traffic flow				
Promote staggered and flexible work timings to limit traffic movement at peak hours to and from key busy routes across the district.		Short-term	Requires research, multi-stakeholder engagement and inter-departmental collaboration	Nagpur district can adopt the following best practices to minimise congestion during peak hours: In 2019, the Delhi government decided to stagger working hours of its offices during the implementation of the 12-day odd-even scheme, a move aimed at reducing traffic congestion and pollution in the city. A similar, shift in work timing is also being planned in Bengaluru.
a) Create additional dedicated parking zones for vehicles in order to deter encroachment of road space and pavements. b) Promote business/ corporate centres to have mandatory private parking with sufficient parking slots to avoid parking on roads, service lanes and other public spaces.		a) Medium-term b) Short-term and continuous	Policy framework does not exist Multi-stakeholder and inter-departmental cooperation are required	Roadside parking in Nagpur reduces effective right of way on main streets in the city. Development of parking zones in a strategic manner and popularising the parking spaces through awareness initiatives can ensure better utilisation of the parking infrastructures developed by NMC.



Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for implementation	
Develop dedicated areas for street vendors in order to deter them from encroaching pavements. This will also avoid traffic congestion on the roadsides.		Short to medium-term	While the policy framework exists, implementation is irregular and for short timeframes Multi-stakeholder and inter-departmental cooperation are required	Providing dedicated areas for their business can ensure their livelihoods as well as help in decongestion.
Regular maintenance of roads to ensure smooth flow of traffic can help reduce GHG emissions, while extending the life of the road.		Short to medium-term and continuous	While the policy framework exists, implementation is lacking in some areas Multi-stakeholder and inter-departmental cooperation are required	

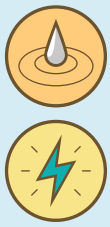
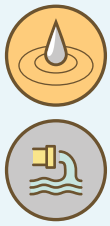
6.1.3.1 Transport: Policy framework and concerned departments/agencies

Sub-sectors	Policies and programmes that can push forward the recommendation	Primary departments/ agencies	Supporting departments/agencies
Promoting e-mobility	1) FAME II 2) Maharashtra EV Policy, 2021 3) JNNURM 4) National Electric Mobility Mission Plan 5) Smart Cities Mission 6) AMRUT 7) Proposed e-vehicle Policy (as per 2021-22 Union Budget) 8) National Urban Transport Policy, 2006	1) All ULBs 2) RTOs 3) MSEDCL 4) EESL	1) Housing and Urban Development Department, GoM 2) MEDA 3) Department of Motor Vehicle, GoM 4) Roads and Buildings Department, GoM 5) State Knowledge Management Centre on Climate Change (SKMCC) Department of Environment 6) Rural Development Department, GoM 7) Nagpur Metropolitan Region Development Authority (NMRDA) 8) Nagpur Smart and Sustainable City Development Corporation Limited (NSSCDCL) 9) PRIs 10) Airport Authority of India, 11) South East Central Railways - Nagpur Division 12) Proposed District level Committee on Climate Change and Environment
Public transport and intermediate public transport	1) BRTS 2) JNNURM 3) ECBC 4) Smart Cities Mission 5) AMRUT 6) National Urban Transport Policy, 2006	1) All ULBs 2) NSSCDCL 3) NMRDA 4) Nagpur Metro 5) MSRTC	1) Housing and Urban Development Department, GoM 2) Transport Department, GoM 3) RTOs 4) Roads and Buildings Department, GoM 5) State Knowledge Management Centre on Climate Change (SKMCC)- Environment Department 6) Rural Development Department, GoM 7) MEDA, MSEDCL 8) Proposed District level Committee on Climate Change and Environment

Sub-sectors	Policies and programmes that can push forward the recommendation	Primary departments/ agencies	Supporting departments/agencies
Augment non-motorised transport	1) Smart Cities Mission 2) AMRUT 3) National Urban Transport Policy, 2006 4) Maharashtra State Urban Transport Policy, 2017	1) All ULBs 2) NSSCDCL 3) NMRDA	1) Housing and Urban Development Department, GoM 2) Roads and Buildings Department, GoM 3) State Knowledge Management Centre on Climate Change (SKMCC)- Environment Department 4) Rural Development Department, GoM 5) PRIs 6) MEDA, MSEDCL 7) Maharashtra State Police 8) Proposed District level Committee on Climate Change and Environment
Improving traffic flow	1) BRTS 2) JNNURM 3) ECBC 4) Smart Cities Mission 5) AMRUT 6) National Urban Transport Policy, 2006	1) All ULBs 2) NSSCDCL 3) RTOs	1) Urban Development and Housing Department, GoM 2) Roads and Buildings Department, GoM 3) State Knowledge Management Centre on Climate Change (SKMCC)- Environment Department 4) Rural Development Department, GoM 5) Maharashtra State Police 6) Industries, Energy and Labour Department, GoM 7) PRIs 8) MIDC 9) NMRDA 10) Proposed District level Committee on Climate Change and Environment

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

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

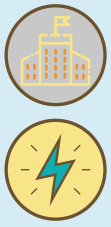
Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for implementation	
Optimise equipment efficiency. Equipment that are not usually turned off during down time, such as heating or cooling equipment, pumps, alarm systems, etc, need to be energy efficient and strategies must be developed to switch them off whenever possible.		Medium-term	Policy framework exists (section 6.1.4.1)	As per Maharashtra State Energy Conservation Policy, 2017: a) It will be binding on all commercial consumers like malls, multiplexes and industrial consumers in the state whose contract demand is 1000 kVA or more, to get energy audit conducted through companies registered with MEDA and to implement the audit report within two years. b) Industries will be encouraged for energy management system certification. Financial assistance of 50% of the cost of such certification and training program up to a maximum of ₹ 50,000/- will be provided to industries by MEDA. c) There are about five lakh MSMEs functioning in Maharashtra where enhancing energy efficiency is extremely essential. Cluster development programme will be implemented by MEDA, in collaboration with the Department of Industries, on a pilot basis. Information from successful programmes will be shared with other industries so that they too can implement similar energy conservation programme. A target is set to implement such pilot programmes in at least 100 clusters by 2022. d) A special training programme based on energy efficiency is planned for capacity building of technical staff in various industries for enhancing industrial energy efficiency.
Invest in green projects, such as plantation drives and afforestation activities within and around industrial areas.		Short-term	Policy framework exists. Improved monitoring and evaluation will give recommendation a further push	
Target better M&E of energy audits to improve accountability.		Short to medium-term	Policy framework exists Inter-departmental collaboration is required for successful implementation	
Encourage industries to use recycled water from their plants rather than freshwater.		Short-term	Policy framework exists. However, it needs to be upgraded in collaboration with the responsible agencies and departments.	

6.1.4.1 Industry: Policies frameworks and concerned departments/agencies

Sector	Policies and programmes that can push forward the recommendation	Primary departments/ agencies	Supporting departments/agencies
Industry	1) Maharashtra State Energy Conservation Policy, 2017 2) Maharashtra State Renewable Energy Policy, 2020 3) National Mission on Enhanced Energy Efficiency	1) Industries, Energy and Labour Department, GoM	1) Maharashtra Industrial Development Corporation (MIDC) 2) District Industries Centre 3) BEE 4) MSEDCL, GoM 5) Proposed District level Committee on Climate Change and Environment

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

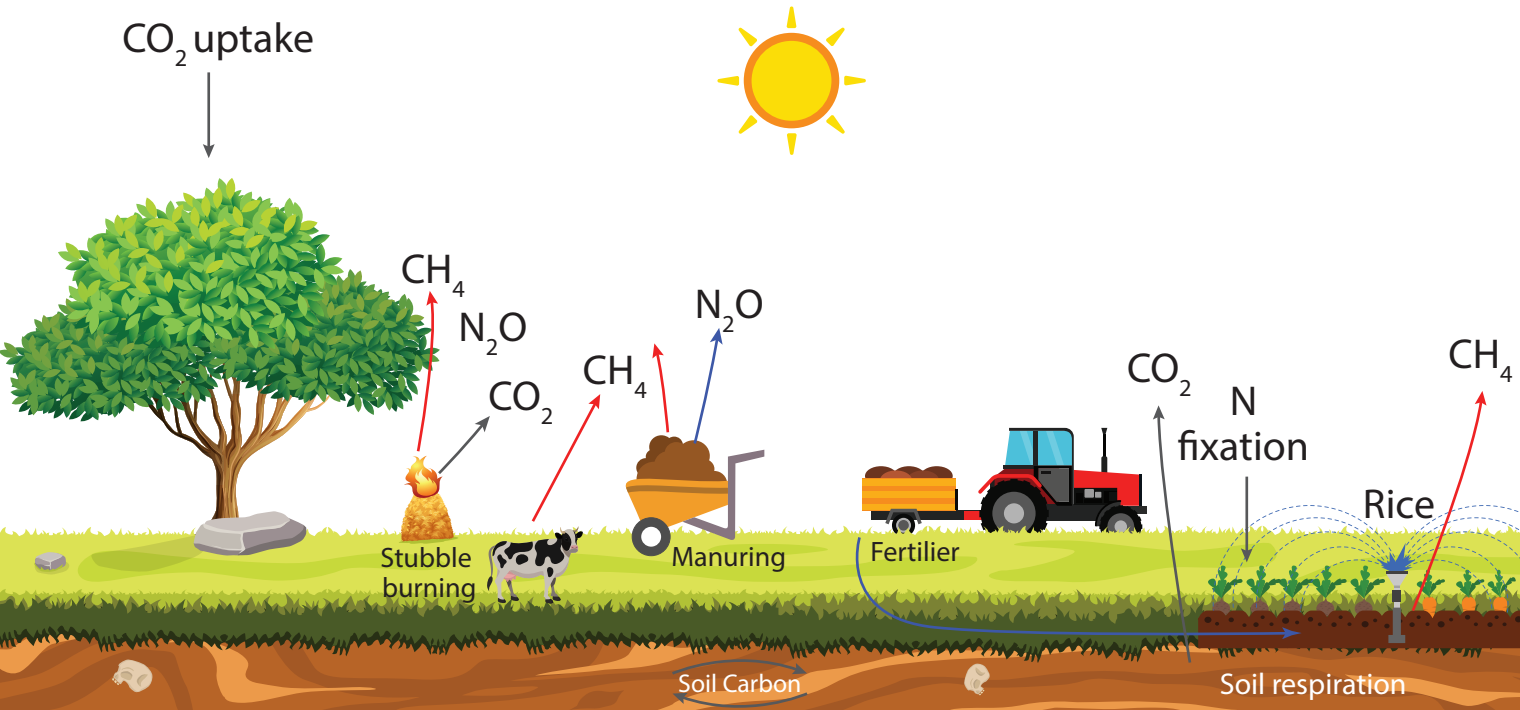
Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for implementation	
AFOLU: Agriculture				
Promote sustainable farming practices and programmes, such as the use of non-chemical fertilisers and zero budget natural farming in the district.		Short to medium-term	Policy framework exists (section 6.1.5.1) Budgetary provisions are available	In 2017-18, Nagpur used approximately 79,337 tonnes of urea for cultivation. Replacement of 10% of this with non-chemical fertilisers can help avoid 5,818 tonnes of CO_2e emissions/annum. This initiative would also contribute towards a) cutting down of compostable solid waste from landfilling/dumping and converting it to organic waste, which can be used to make organic fertilisers, thereby reducing emission from the waste sector; b) reducing harmful agricultural run-off (thereby, reducing water pollution and eutrophication).
Promote adoption of alternative ways for crop residue management other than burning. Promote adoption of improved harvesting practices, such as land leveller, direct seeding, nutrition management, etc. through agricultural extension programme and financial assistance/ formation of cooperatives, etc. Stubble can be used as feedstock for different industries to make products including paper, cardboard, furniture, organic fertiliser and animal feed. This will also act as an alternative source of income for the farmers.		Short to medium-term	Policy framework required Collaboration required Farmers to have easy access to markets/industries that would take crop residue/ stubble This also helps meet the following targets of SDG#8: 8.2; and SDG#12: 12.5, 12. a	Improved harvesting practices, such as the use of happy seeder, have the capacity to eliminate 78% of GHG emission (from crop residue burning). They can potentially add to farmers' profits by at least 10%. Feasibility studies for a cost-benefit analysis of such improved harvesting machines and practices need to be undertaken. Direct sowing of rice reduces soil disturbance, enabling it to retain more nutrients, moisture and organic content. It also, removes the need for stubble-burning, thereby reducing air pollution. Other feasibility studies or projects can be initiated, such as the development of biofuel pellets from crop residue.
Farmers should be encouraged to follow the recommendation given in soil health cards.		Short to medium-term	Can be implemented by generating awareness	According to the Soil Health Card Portal, so far 28,51,525 samples have been tested in cycle-II in Maharashtra. In Nagpur, 7% and 8% of all the soil samples tested, have reported very low nitrogen and phosphorus, respectively. Micronutrient (Zn, Fe, Cu, Mn, B, S) status is reported to be sufficient.

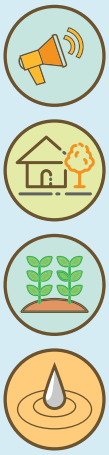
Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for implementation	
Promotion of micro-irrigation (MI) to improve water use efficiency. It saves water, energy and fertiliser consumption.		Short to medium-term	Policy framework is available (section 6.1.5.1) Enable swift procedures and subsidy disbursement for adoption of micro-irrigation The district may consider providing additional subsidies	According to PMKSY Achievement Report, 3,564.01 ha of land was covered under MI in Nagpur during 2019-20, which should have led to avoidance of approximately 3012.97 tonnes of CO_2 emissions /annum (w.r.t to conventional irrigation through groundwater).
Encourage adoption of latest technologies, such as: a) Solar pumps (under PM KUSUM Yojana and Mukhyamantri Saur Krushi Pump Yojana (MSKPY)) b) Star-rated energy efficient pump system (EEPS) c) Smart control panels and internet of things (IoT) based systems for optimum resource utilisation (water, energy).		Short to medium-term	Policy framework is available (section 6.1.5.1) Support in capital investment over and above the existing policy can be considered	In order to facilitate day time irrigation to the farmers and to promote use of renewable source of energy, GoM announced 'Mukhyamantri Saur Krushi Pump Yojana (MSKPY)' aiming to install 1,00,000 off-grid 3 HP and 5 HP solar photovoltaic water pumping systems in a phased manner. The solar power generated can be used to operate the agricultural pumps during the day as well as to meet the household electricity demands at night, particularly during times of power failure. Replacement of 1 lakh diesel pumps with solar pumps, over a period of 5 years, would result in diesel use mitigation of 900 million litres over the lifecycle of solar pumps, which translates into diesel subsidy saving of ₹ 840 crore and CO_2 emission abatement of 2.53 million tonnes. These initiatives will increase farmers' income, provide reliable sources for irrigation and reduce dependence on diesel in the farm sector.
Enhance the efficiency/ network of cold storage systems and initiate a gradual shift towards powering them with renewable energy.		Medium to long-term	Policy framework exists and can be enhanced (section 6.1.5.1.) Capital Investment required Align with solar rooftop policies and ECBC	According to a PIB press release, dated September 23, 2020, Maharashtra has 619 cold storages with a storage capacity of 10,09,693 MT.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for implementation	
AFOLU: Livestock				
Promote grasslands and cultivation of cattle feedstock for good quality forage and to manage fodder scarcity.		Short to medium-term	Policy framework exists (section 6.1.5.1) Research inputs required Collaboration between different communities (farming and pastoral) is needed	Encouraging intensive cultivation of *Sesbania grandiflora*, which produces about 7.8 kg/tree/year or 93.6 MT/year/ha, and feeding them to lactating crossbred cows can increase milk yield by 11.97%.[21] Straws from millets, corn and maize have better feeding quality than straws from rice, barley and wheat. This change in quality of forage specie leads to better productivity and an estimated 30% reduction in emission.
Promote cattle breeds with higher productivity. Moreover, productivity of indigenous cattle should also be improved (for instance, through the provision of Nand Ghars). However, it is essential to maintain the balance between resilience and productivity. Currently, in most areas flock sizes are negatively impacting climate and ecology.		Medium to long-term	Policy framework exists (section 6.1.5.1) Research collaboration required (to ensure biodiversity of the region is not impacted) Awareness generation Monetary support to the pastoral community is required	These initiatives will help meet the growing demand of milk, while keeping the livestock headcount low. In Nagpur, a 10% decrease in the number of indigenous cattle over a period of five years, will lead to loss in milk production of 29,923.8 litres, while emission of around 17,595.2 tCO_2e will be avoided. To compensate for this loss in milk production, a total of 17,767.25 new crossbreed cattle is required, resulting in 16,043.8 tCO_2e emissions. The net emissions avoided per year will be 1,553.62 tCO_2e.
Promote the use of waste from livestock and poultry as an important source of organic manure for crops. Poultry manure, which is rich in nitrogen, can be used for various crops, such as, sugarcane, potato etc. for enhancing crop production.		Short to medium-term	Collaboration between different communities (farming and pastoral) is needed Policy framework is available (section 6.1.5.1)	Poultry manure fertiliser is rich in nitrogen and contains all 13 essentials nutrients required for crop production. In comparison to cow manure, it is two to three times richer in inorganic fertiliser content.
AFOLU: Forestry and green spaces				
Ensure minimum diversion of forest land for any activity or project and promote compensatory afforestation (of the same species) from the funds given by the user agency. Funds for continuous tree improvement and tree breeding programmes can be ensured through the Compensatory Afforestation Fund Management and Planning Authority (CAMPA).		Short to medium-term	Policy framework and budget provisions exist (section 6.1.5.1) Policy implementation required Stringent monitoring and evaluation	According to the Environmental Clearance Report, 2017, 4,271.67 ha of total forest area in Nagpur has been diverted since 1980. In 2019, Maharashtra received ₹ 5,770 crore from CAMPA, which aims to promote afforestation and regeneration activities as a way of compensating for forest land diverted to non-forest uses.

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

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for implementation	
Measures to increase trees outside forest (TOF) area and green spaces in Nagpur: a) Setting up of urban parks, b) Adopting Miyawaki Urban Forestry method, c) Transplanting trees with the help of tree transplanter machines, d) Setting up of floating gardens, butterfly gardens etc, e) Initiating afforestation activities on wastelands and fallow lands, f) Plantation along village roads can be taken up under MGNREGS, g) Tree census should be conducted periodically, h) Development of green belt along the major terrain roads, and surrounding the industrial areas.		Medium to long-term	Policy framework is available (section 6.1.5.1) Capital investment, research collaboration and inter-departmental cooperation is required	As per the FSI report 2019, Maharashtra has 26,945 sq. km extent of TOF, which is the largest in the country. In 2018, NMC has adopted self-watering tree guard's technology for plantation, which has a higher survival rate than the traditional technique of planting saplings. Over 90% of the 447 saplings planted by the civic body's Garden Department in 2018 are now at least 25-30 feet tall. Common species planted were Ashoka, Neem, Bakul, Bougainvillea, etc. There is no recent tree census study available for Nagpur, which could have provided the CO_2 sequestration potential of the urban and sub-urban forest in the district. Green belts help mitigate air pollution and increase urban green cover, thereby leading to carbon sequestration.



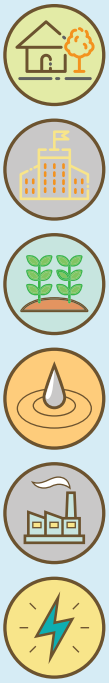
Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for implementation	
Enhance forest cover by promoting agro-forestry and social forestry to increase forest biomass and soil moisture along with adoption of the following measures: a) Control illegal timber trade b) Carry out mapping of agroforestry area to monitor the coverage c) Create provisions of financial instruments/ relaxation in other taxes (over and above the existing schemes) to encourage farming community to adopt agroforestry d) Encourage plantation of most found local, fast-growing species, particularly key stone species, fodder trees, fruit bearing trees, like, peepal (*Ficus religiosa*), neem (*Azadirachta indica*), etc. through various techniques/ strategies (Miyawaki) to aid increase of tree density.		Medium to long-term	Policy framework and budget is available, implementation required Stringent monitoring and evaluation are necessary	Currently, the forest cover of Nagpur district is 20.22% of the total geographical area. In an assumed scenario of increased forest cover to 25% over a period of 10 years, 11.89 $MtCO_2e$ emissions would be sequestered. Miyawaki urban forestry method has reported 15% faster growth rate per year compared to other reforestation methods. Social Forestry Department of Nagpur has turned a barren land in Patansawangi into an Oxygen Park through Miyawaki Forest Method. Since then, it has become a haven for birds. Tree species such as neem, bahava (*Cassia fistula*), shishu (*Dalbergia sissoo*), mahua (*Madhuca longifolia*), mango (*Mangifera indica*), etc were planted. The survival rate is proven to be 100%.
Ensure ULBs regularly monitor survival of the trees, post plantation. a) Undertake thorough study on the suitability of the site and survival ratio of species (majorly native species) before initiating any plantation drive. b) Prepare an audit every year on the number of saplings that survive after plantation drives. c) Ensure geo-tagging of trees (along with site and species) for proper monitoring.		Short to medium-term	Monitoring and evaluation required Collaboration among different stakeholders required	According to the minister for state forest, between 2017 and 2019, a target of 28.50 crore trees was set and approximately 28.34 crore trees were planted in the district, out of which 81.63% survived.

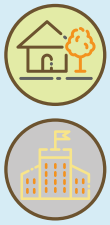
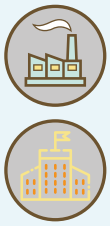
Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for implementation	
Promote regeneration of degraded and open forest areas by developing awareness among locals regarding the importance of green spaces.		Long-term	Strengthen the existing policy framework Collaboration among different stakeholders is required	According to 2019 Forest Survey of India report, there is a decrease in forest cover by 18.62 sq. km in Nagpur from 2017 assessment.
Various aspects of joint forest management need to be promoted: a) Capacity building and skill development of joint forest management committees in tribal and non-tribal areas by conducting workshops and training, b) Initiate participatory forest management programmes at the micro scale.		Short to medium-term	Exclusive communication strategy and information, education and communication (IEC) material to be developed and used Provisions of monetary support	As per ENVIS-Committees and Forest Area Under JFM till 2015, total area covered under JFM in Maharashtra is 24,03,344 ha with about 12,665 joint forest management committees.
Prevent invasion of non-indigenous species by adopting the following measures: a) Develop a database and update information on invasive species and their management b) Raise awareness at regional levels c) Strengthen and maintain institutions to coordinate invasive species programmes.		Medium to long-term	Undertake research studies of flora specific to the region Exclusive communication strategy and IEC material to be developed and used Requires funding, monitoring and evaluation and stakeholder collaboration	*Prosopis juliflora, Lantana camara, Parthenium hysterophorus, Gliricidia Sepium* are some major invasive species in Maharashtra. Preventing seed production helps manage the spread of invasive species. Removing flower heads prior to seed set will reduce the number of seeds available for spread by birds or other animals.
Develop participatory forest fire management strategies such as: a) Collecting baseline forest fire data w.r.t perceptions, beliefs, expectations and behaviour of local people pertaining to forest fires. b) Training local communities to tackle forest fires c) Organising awareness programmes in local schools d) Capacity building to develop an early warning system		Medium to long-term	Provisions of monetary support Exclusive communication strategy and IEC material to be developed and used Monitoring and evaluation required Need collaboration among different stakeholders	According to the Technical Information Series Volume-I FSI Report 2019, 3.4% of the total forest cover area in Maharashtra lies under extreme fire prone area, 16.65% under moderately fire prone area and 60.34% under least fire prone area.

6.1.5.1 AFOLU: Policies framework and concerned departments/agencies

Sectors	Policies and programmes that can push forward the recommendation	Primary departments/ agencies	Supporting departments/agencies
Agriculture	1) Rashtriya Krishi Vikas Yojana: Remunerative Approaches for Agriculture and Allied Sector Rejuvenation (RAFTAAR) 2) National Mission for Sustainable Agriculture 3) Pradhan Mantri Krishi Sinchayee Yojana 4) PM KUSUM Yojana 5) Soil Health Card 6) National Mission on Food Security 7) National Mission on Micro-irrigation 8) Saur Krishi Vahini Yojana 9) National Policy for Crop Residue Management 10) Maharashtra Agriculture Pump Electricity Policy, 2020 11) Integrated Cold Chain, Value Addition and Preservation Infrastructure Scheme	1) Department of Agriculture, Government of Maharashtra	1) Department of Environment and Climate Change, GoM 2) Rural Development and Panchayat Raj Department, GoM 3) Water Resources Department, GoM 4) State Energy Department, GoM 5) Industries, Energy and Labour Department, GoM 6) Forests and Environment Department, GoM 7) Directorate of Industries, GoM 8) Department of *Animal Husbandry*, GoM 9) APMCs 10) MIDC 11) Proposed District level Committee on Climate Change and Environment
Livestock	1) National Livestock Mission 2) Rastriya Gokul Mission 3) Kisan Credit Cards to Livestock farmers 4) National Programme for Dairy Development 5) Livestock Health and Disease Control 6) National Programme for Dairy Development 7) Intensive Cattle Development Programme 8) Navinya Purna Yojana 9) National Mission on Food Security 10) Rashtriya Krishi Vikash Yojana	1) Department of Animal Husbandry, Government of Maharashtra	1) Maharashtra Forest Department, GoM 2) Department of Agriculture, GoM 3) Department of Environment and Climate Change, GoM 4) Proposed District level Committee on Climate Change and Environment
Forestry and green spaces	1) National Afforestation Programme (NAP) 2) Project Tiger 3) Compensatory Afforestation Fund Management and Planning Authority (CAMPA) 4) Green India Mission (GIM) 5) Integrated Development of Wildlife Habitat (IDWH) 6) Intensification of Forest Management Scheme (IFMS) 7) Pradhan Mantri Ujjwala Yojana 8) Atal Bamboo Samrudhi Yojana	1) Maharashtra Forest Department, GoM	1) Department of Agriculture, GoM 2) Department of Environment and Climate Change, GoM 3) All ULBs 4) Directorate of Geology and Mining, GoM 5) Department of Housing, GoM 6) UDD & RDD, GoM 7) Proposed District level Committee on Climate Change and Environment 8) All PRIs

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

Recommendations	Cross-cutting with	Qualifying priority		District scenario/ case examples
		Time frame for the action to be accomplished	Framework for implementation	
Solid waste				
Waste prevention: Reducing landfilling				
Minimising landfill waste disposal by: a) Promoting reduction of waste at source through product reuse, extending lifetime (maximum use of resources) and right to repair, b) Ensuring efficient and 100% segregated waste collection from across the district (both urban and rural) by distributing colour-coded bins; monitoring waste collected from households and penalising households not practicing segregation, c) Ensuring and maximising recycling, recovery, optimum resource utilisation throughout product lifecycle and treatment, d) Promoting resource efficiency and circular economy practices across sectors.		a) Medium to long-term b) Short to medium-term c) Medium-term d) Long-term	a) Needs policy intervention, awareness generation and incentivisation b) Policy framework exists (section 6.1.6.1) c) and d) Needs policy intervention and execution (Resource Efficiency Policy has been drafted by NITI Aayog but has not been implemented)	Landfills are considered to be one of the largest anthropogenic sources of methane emissions contributing to 11% of all global CH_4 emissions. Hence, reducing landfill load and emission is critical in achieving India's NDCs. Following are some initiatives adopted in Nagpur (mostly the city area) that will reduce landfill emissions in the city and can be adopted in the district as well: (a) According to the latest MPCB report (2018-19), Nagpur district generates 1,347.09 TPD solid waste of which 289.37, i.e., about 21.5% gets treated. Nagpur Municipal Corporation (NMC) generates 1,200 TPD solid waste and has 100% waste collection efficiency. (b) Nagpur city has introduced door-to-door collection, eliminating more than 80% of the waste-bins of the city. (c) Treatment facilities include composting, vermi-composting, recycling plant, RDF palette making facility, waste bioremediation at the dumpsite. (d) Bhandewadi is the open dumpsite for NMC, operating since 1966. A part of the waste from the dumpsite was shifted and capping was provided over an area of 40,630 sq. m in 2011. NMC has already reclaimed 25 acres of land in the Bhandewadi through bio-mining.

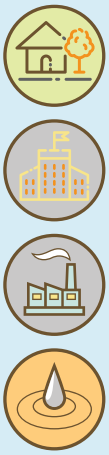
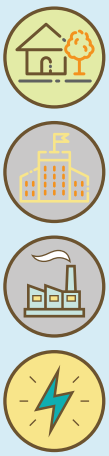
Recommendations	Cross-cutting with	Qualifying priority		District scenario/ case examples
		Time frame for the action to be accomplished	Framework for implementation	
Minimising single use plastic (SUP): Detailed information and recommendations on SUP are given in section 6.1.6.2.		Short to medium-term	Already a national priority Policy framework exists (section 6.1.6.2), but can be accelerated with district level interventions/ implementation	Disposable SW take-back has not been implemented in Maharashtra as of now. City plastic waste management plan is in preparation to implement EPR. About 25.7% of the total waste generated in Nagpur is inert waste and 19% is paper waste, much of which can be treated/recycled, thereby potentially leading to a huge reduction in landfill waste.
Implement producers' (manufacturer/brand owners, etc) take-back mechanism (SWM Rules, 2016) – either through financial assistance by the producers or a defined collection system facilitated by the producers for disposables, such as tin, glass, plastics packaging, sanitary napkins and diapers, etc. – for efficient management of these waste materials, thereby, reducing landfill inert waste load.		Short to medium-term	Mandated by the SWM Rules (2016) Needs regional policy formulation and interventions	
Ensure 100% recycling of recyclables at landfill through material recycling facilities (MRF), refuse derived fuel (RDF), waste to energy (W2E), etc. Encourage use of LDPE and HDPE plastic waste in road construction.[22]		Short to medium-term	Capacity enhancement of existing facilities required	
Management of construction and demolition (C&D) waste: a) Ensure segregation, collection, transport and proper management, b) Facilitate processing and recycling, c) Incentivise initiatives for C&D waste reuse in non-structural concrete, paving blocks, lower layers of road pavements, colony and rural roads, d) Make procurement of C&D materials (10% to 20%) in municipal and government contracts mandatory (subject to quality control).		Short to medium-term	Mandated by the rules, CPCB guidelines exist (section 6.1.6.1) Needs state-level policy formulation, implementation and enforcement Capital investment in infrastructure required	

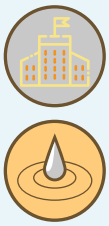
22 https://pib.gov.in/PressReleasePage.aspx?PRID=1736774

Recommendations	Cross-cutting with	Qualifying priority		District scenario/ case examples
		Time frame for the action to be accomplished	Framework for implementation	
Increasing consumer awareness and access to recycling facilities and repair options within the district.		Short to medium-term	Dedicated awareness campaign required	About 10% to 15% of global GHG emissions can be reduced through improved waste management that follows a lifecycle assessment approach[23]. Prevention and recovery of waste (as secondary material or energy) can significantly save GHG emissions from across the sectors of the economy, including energy, forestry, agriculture, mining, transport and manufacturing sectors.
Education and awareness drives for 100% at source segregation of biodegradable waste, non-biodegradable waste, domestic hazardous waste and household biomedical waste.		Short-term		
Introduce fiscal instruments to encourage waste reduction, such as mandatory carry bag charges, pay-per-bin schemes (charging residents for each community refuse bin).		Short-term	Needs district-level scheme/ notification and community participation	
Conduct behavioural change communication workshops targeting corporates, educational institutes, PSUs, government offices to influence behaviour at both individual and organisational level to better manage resource and reduce waste generated. For example, conducting weekly workshops at all public schools for waste reduction and recovery. These workshops can also address issues, like energy efficiency and water conservation.		Short-term and continuous	Needs sustained campaign for the target groups	
Consumer awareness for demand-side management of product choices with: a) sustainable packaging, b) displayed higher product lifespan, c) displayed recycling/ resource recovery efforts and information.		Short-term and continuous	Dedicated awareness campaign required	
Conduct waste audits at household level, corporate offices, institutes, etc. to identify scope of waste minimisation and promote the same as an evidence-based practice.		Short to medium-term	Needs research collaboration	

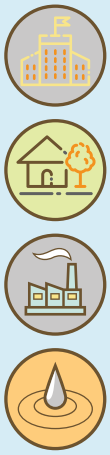
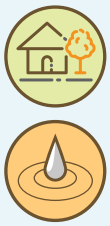
23 Global Waste Management Outlook - UNEP/ISWA, 2015

Recommendations	Cross-cutting with	Qualifying priority		District scenario/ case examples
		Time frame for the action to be accomplished	Framework for implementation	
Ensure segregation, collection and treatment of sanitary waste (sanitary napkins and diapers) to reduce landfill load.		Short to medium-term	Mandated by the SWM Rules, 2016 Capital investment in infrastructure development is required, which can be obtained from the producers	Sanitary waste segregation and treatment is currently not practiced in the district.
Transitioning the district to a green market approach by: a) Promoting local circular business models, b) mainstreaming of alternative sustainable business models for the consumers to have basket of choices.		Medium-term and continuous	Needs alternative business models, collaborations and awareness	
Reduce emissions from waste transportation: a) Encourage shifting to electric or zero emission vehicles for all kinds of waste transport, including municipal solid waste in all ULBs, bio-medical waste in all common bio-medical waste treatment facilities (CBWTFs) and hazardous waste in all treatment, storage and disposal facilities (TSDFs), b) Installation of waste bins with sensors to monitor volume and optimise the routes of collection vehicles to reduce consumption of fuels for waste transport and related emissions.		Medium to long-term	Needs capital investments	GIS based route map and vehicle tracking system for waste transport has been initiated within NMC to reduce transport emission and better monitoring. NMC has 153 smaller primary transport vehicles, 39 secondary transport vehicles (heavy) and 45 transport equipment for waste management. These vehicles take an average of 3-5 trips/day/vehicle. The Bhandewadi dumpsite is 10 km from the city centre. Hence, waste collection and transport are potentially leading to significant emission which can be avoided with a shift to ZEVs. Though, there are several specifications in place for CBWTF vehicles to ensure efficient management and monitoring of BMW, it does not consider the emission reduction part from transport.

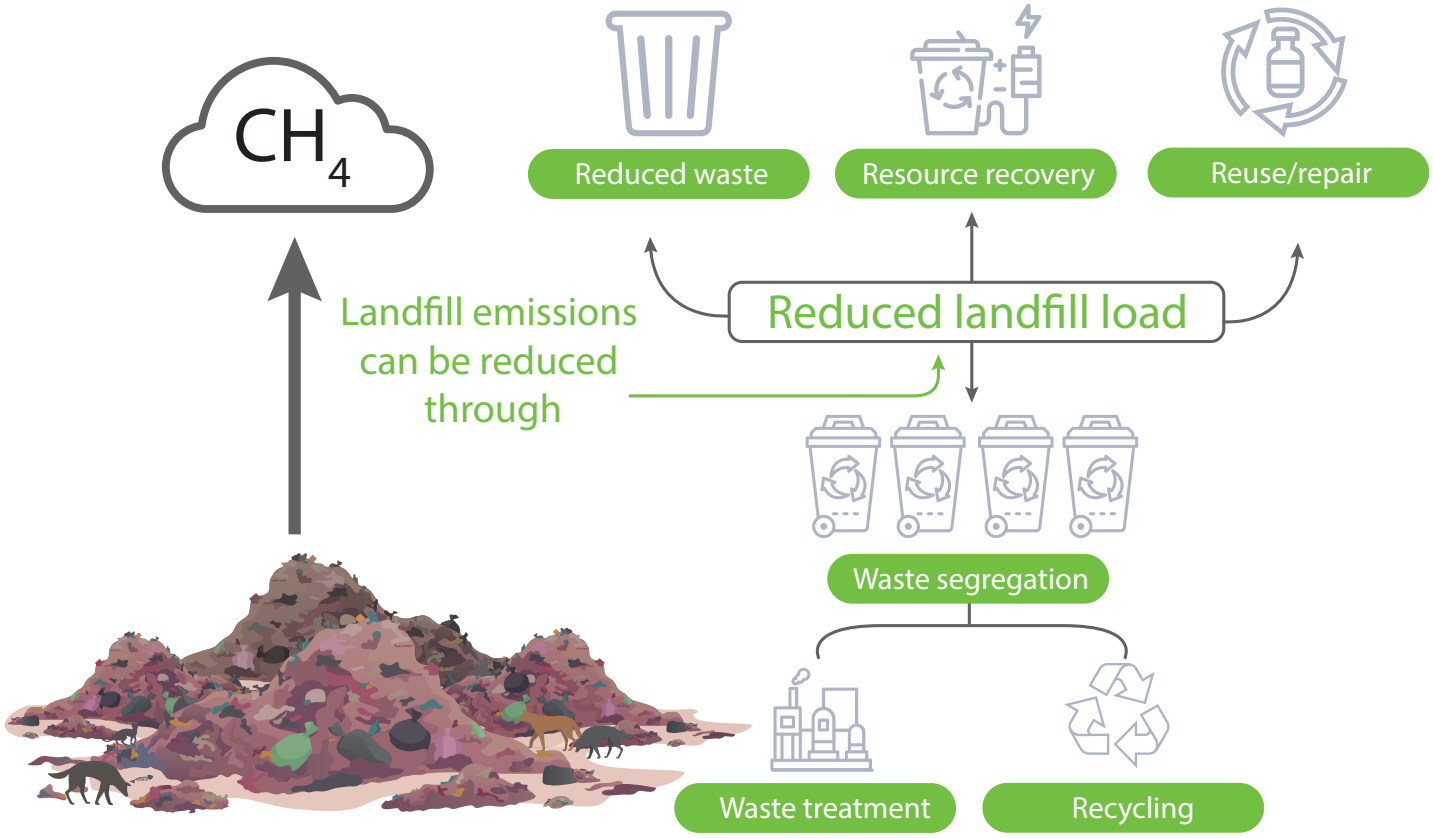
Recommendations	Cross-cutting with	Qualifying priority		District scenario/ case examples
		Time frame for the action to be accomplished	Framework for implementation	
Waste treatment: Composting				
Encourage 100% conversion of organic waste to biological waste processing (composting, bio-gas, etc.).		Short to medium-term	Policy framework exists (section 6.1.6.1) Needs awareness and infrastructure development	Organic treatment of compostable waste though initially leads to emission, but reduces GHG emissions drastically over the long run, as compared to landfill emissions. It takes at least three decades for landfill emissions to balance with those from aerobic composting. A number of best practices and technologies are available for reducing GHG emissions from composting. Even in the absence of gas management system, composting is considered a more environmentally sustainable practice as compared to methane capturing from landfilling of organic waste. Composting also avoids multi-layered pollution potentials and reduces landfill loads. About 41% of the solid waste generated in the district is biodegradable, out of which currently only about 21% is getting treated biologically. However, composting units do not have any gas management system to capture CH_4 emission. Composting emission potential of the district is 8,585 tCO_2e/year. Maharashtra is the only state to have registered its own brand of "Harit Maha City Compost" for promotion of marketing and sale of city compost, which fulfils the FCO standards and SWM Rules, 2016. Composting with gas management of the entire organic waste going to landfill can reduce emission by 14,710 tCO_2e/year in Nagpur district.
Develop composting facilities at ULB level in addition to cluster level to avoid: a) loss of carbon content in long route organic waste transport, b) reduce waste transport emission.		Medium-term	Needs land and infrastructural investment at ULB level.	
a) Equip new composting units and upgrade/convert existing composting units with gas management systems for gas capture after conducting feasibility studies. b) Biomethane produced from wastewater and solid waste processing can be used as a fuel for industrial production, to provide energy services in buildings or as a transport fuel. A benefit of biomethane is that the existing gas infrastructure can be utilised for transport and distribution. As a local, sustainable source of power and heat, biomethane offers communities and municipalities a flexible option that can contribute to lowering emissions.		Long-term	Needs policy intervention, district-level capital investment and research collaboration.	

Recommendations	Cross-cutting with	Qualifying priority		District scenario/ case examples
		Time frame for the action to be accomplished	Framework for implementation	
Emission profiling and reduction				
Facilitating research and documentation on characteristics and percentage share of waste, moisture content, localised BODs for domestic wastewater and industrial wastewater, etc. is important for accurate city or district-level emission estimations from the waste sector.		Short-term	Needs research collaboration	
Ensure better compliance to the waste management rules in terms of maintaining segregated waste collection and treatment data (solid waste, bio-medical waste, e-waste and hazardous waste) in the public domain (annual reports/websites), particularly at the district level.		Short-term and continuous	Policy framework exists in most cases (section 6.1.6.1)	
Bio-medical waste and hazardous waste				
a) Promote installation of modern incinerators with energy-recovery facilities (such as, the use of recovered heat for preheating of waste to be burnt or use of incinerator steam to generate electricity) for new CBWTFs and TSDFs and upgradation of the existing ones, b) Using smart controls, waste treatment plants equipped with energy recovery incineration facilities can be integrated as distributed energy sources into the electricity grid and as heat sources into the district energy network.		Long-term	Needs policy formulation and investment in infrastructure	Though not a recommended treatment due to its emission potential, incineration prevents manual scavenging and further contamination from certain kind of infectious waste, (particularly, the anatomical, contaminated waste, discarded medicines and chemical waste). Incineration is the best available and recommended practice currently in India. Current annual BMW incineration emission in the district is 469.76 tCO_2e/year. Energy recovery incineration is not practiced. Nagpur has one TSDF that received 28,071.94 MT/year hazardous waste during 2018-19, out of which 2,983.9 MT/year was incinerated leading to an annual emission of 2,461.73 tCO_2e. There is no district-wise hazardous waste generation data available to evaluate the incineration emission of just the district.
Strict monitoring of adherence to recommended incineration technologies, standards and practices through regular monitoring by the District Bio-medical waste Management Monitoring Committee.		Short-term and continuous	Mandated by the BMWM Rules, 2016 Needs monitoring by district level BMWM committee	
Ensure 100% segregation, collection and treatment of bio-medical waste through coverage and registration of all healthcare facilities to CBWTFs.		Short-term and continuous	Mandated by the BMWM Rules, 2016	

Recommendations	Cross-cutting with	Qualifying priority		District scenario/ case examples
		Time frame for the action to be accomplished	Framework for implementation	
Waste electrical and electronic equipment (WEEE)				
As per the provisions of E-Waste (Management) Rules, 2016, a state level e-waste inventory with district-level, category-wise e-waste generation information needs to be developed. The inventory must include all sources of generation and consider all WEEE categories as per the rules.		Short to medium-term	Preparation of e-waste inventory is mandated by the rules (section 6.1.6.1) Needs research collaborations	About 95% of the e-waste in India is processed informally (including rudimentary operations, like open burning, acid wash, open smelting, etc). City-based studies show that efficient management and recycling of electrical and electronic waste (WEEE) can significantly contribute to emission reduction targets. There is no authentic database available either at district (Nagpur) or at state level of the amount of e-waste generated annually and their routes to recycling or disposal. According to MPCB (2018-19), only 9,475 tonnes of WEEE was collected formally in the entire state, while a dated (2007) e-waste assessment of Mumbai-Pune area considering only four categories (cell phone, TV, PC, refrigerator) projected 50,000 tonnes and 3,500 tonnes of e-waste generation in Mumbai and Pune respectively in 2015 (MPCB, 2007). It should be noted that the E-waste Management Rules, 2016 mentions 17 major WEEE categories. Hence, it is evident that most of the e-waste generated in the state is routed informally. Nagpur – a popular choice as the upcoming IT hub after saturation of Mumbai and Pune – might outgrow its current e-waste generation at large margin soon.
Ensure stringent policy implementation: trace informal routing, ensure proper collection, restrict informal processing of e-waste (open burning, metal smelting, etc.), ensure proper disposal of electrical waste (lighting infrastructure including mercury containing lamps) and strict monitoring to stop landfilling of the same.		Short-term and continuous	Mandated by the rules (section 6.1.6.1) Needs monitoring, manufacturer collaboration and consumer awareness	
Tapping into the informal e-waste collection network and formalisation of the same to channelise e-waste disposal to the formal sector.		Short to medium-term	Can be achieved through the recyclers/producer responsibility organisations (PROs)	
Improve consumer awareness on responsible e-waste disposal and make information readily available about e-waste collection points, recyclers, producers (manufacturer), producer responsibility organisations (PROs) or local e-waste collection drives at the district level.		Short-term and continuous	Mandated by the rules for the producers (section 6.1.6.1) Dedicated campaign required Can be achieved by collaborating with producers	
Formulation of district level e-waste management programme.		Short to medium-term	Needs inter-departmental collaboration	

Recommendations	Cross-cutting with	Qualifying priority		District scenario/ case examples
		Time frame for the action to be accomplished	Framework for implementation	
Wastewater: Domestic and industrial				
Achieve 100% domestic wastewater treatment through: a) In both urban and rural areas of the district set up 100% closed and underground sewer collection network. b) Shift 100% domestic wastewater treatment to aerobic set ups by having only aerobic STPs for new constructions and transition of old anaerobic STPs to aerobic set up. c) Regular maintenance of sludge removal facilities of all STPs. The sludge can be used again for the bio-methanation of compost.		Medium to long-term	Policy intervention and capital investment required	Wastewater, if treated anaerobically, can be a huge source of methane and even nitrous oxide emissions. Being stagnant and subject to heating (anaerobic conditions), open sewers emit CH_4. Closed underground sewers, on the other hand, are considered to be an insignificant source of CH_4. Nagpur city had a sewerage generation of 345 MLD in 2015, of which only 29% was getting treated by the city's only STP of 100 MLD capacity at Bhandewadi. Projected sewerage generation is 472 MLD in 2021 and 752 MLD in 2041. About 96% of the city properties are connected with sewerage network (1,670 km length of sewer line) of which 70% is underground sewer network. The remaining sewer collected in the network is disposed untreated in Gosikhud Dam. Sewerage in some areas of the city outfalls into open drains and rivers. NMC has prepared a sewerage master plan and is planning to augment its sewer network under JNNURM from 100 MLD to 200 MLD sewerage treatment capacity (Ministry of Urban Development, GoI & World Bank, 2015). 100% closed and underground sewer connection and centralised aerobic well managed STPs can potentially reduce 30,204.26 tCO_2e emission from STPs to negligible or almost non-existent in Nagpur. Maharashtra government has mandated the reuse of treated wastewater for cooling thermal power plants and introduced 'Maharashtra Water Resources Regulatory Authority Water Entitlement Transfer (WET) and Wastewater Reuse Certificates (WRC) Platform Regulations, 2019'. *Case example:* Ahmedabad Municipal Corporation has set up the first sewage sludge hygienisation plant in the country at Pirana (operational from 2019), which can convert 100 tonnes of dry sludge into fertiliser per day. Similar plant can be developed for Nagpur.
Development of rural wastewater disposal and treatment plan for the district.		Medium to long-term	Requires capital investment and inter-departmental collaboration	
Create appropriate connecting infrastructure for the industries to utilise treated industrial and domestic wastewater. Provide subsidy/tax rebate to industries, healthcare, hospitality sectors for smart recycled water investments.		Medium to long-term	Policy implementation required Needs capital investment in infrastructure and technology upgradation	
Implement and operationalise the guidelines and regulations of National Policy on Faecal Sludge and Septage Management, 2017 to reduce emissions from faecal sludge. Regular collection and appropriate disposal of sludge should also be ensured.		Medium to long-term	Needs ULB level implementation and capital investment in infrastructure	

Recommendations	Cross-cutting with	Qualifying priority		District scenario/ case examples
		Time frame for the action to be accomplished	Framework for implementation	
Develop a policy mandate for data transparency and availability of waste and wastewater generation, treatment and discharge information for industrial sector.		Medium to long-term	Needs policy intervention and inter-departmental collaboration	Nagpur region has only one CETP of 5 MLD capacity and has treated 4.8 MLD industrial effluent during the year 2018-19. Data transparency on wastewater by industries is key to reducing water pollution. This can be achieved through rating of industries based on their emission and effluent discharge and treatment. For example, under its Star Rating Programme, the Odisha State Pollution Control Board gives star rating to industries and presents it through their website. This can help in environmental compliance and encourage public participation.
Encourage data transparency by the industries for wastewater generation, treatment and discharge information including those of CETPs.		Short to medium-term	Needs collaborative efforts	



6.1.6.1 Waste management: Policy framework and concerned departments/agencies

Sub-sectors	Policies and programmes that can push forward the recommendation	Primary departments/ agencies	Supporting departments/ agencies
Solid waste	1) Solid Waste Management Rules, 2016 & Amendment, 2018 2) Plastic Waste Management Rules, 2016 & Amendment Rules, 2021 3) Construction & Demolition Waste Management Rules, 2016 4) Integrated Solid Waste Management Project 5) Swachh Bharat Mission - Urban & Rural 6) Nagpur Master Plan, 2032 and City Development Plan, 2041 7) Nagpur Smart Cities Mission 8) National Resource Efficiency Policy (draft) 9) Guidelines on Environmental Management of C&D Waste Management in India, CPCB 10) Maharashtra Water Resources Regulatory Authority Water Entitlement Transfer (WET) and Wastewater Reuse Certificates (WRC) Platform Regulations, 2019 11) MPCB Annual Report	1) Urban Development Department, GoM 2) All ULBs 3) Rural Development and Panchayat Raj Department, GoM 4) All Gram Panchayats 5) Maharashtra Pollution Control Board (MPCB)	1) Nagpur District Administration and the proposed District Level Climate Change and Environment Committee 2) Maharashtra Urban Infrastructure Development Company Limited (MUIDCL) 3) Nagpur Metropolitan Region Development Authority (NMRDA) 4) Department of Environment and Climate Change, GoM
Bio-medical waste and hazardous waste	1) Bio-medical Waste Management Rules, 2016 2) Hazardous and Other Waste (Management & Transboundary Movement) Rules, 2016 3) Batteries (Management & Handling) Rules, 2001 4) MPCB Annual Reports 5) Revised Guidelines for Common Bio-medical Waste Treatment and Disposal Facilities, 2016, CPCB	Research funding can be obtained from the Department of Environment and Climate Change, GoM, MPCB, etc.[24]	1) MPCB 2) Nagpur District Administration 3) Proposed District Level Climate Change & Environment Committee 4) Healthcare facilities 5) CBWTF
Waste-Electrical and Electronic equipment (WEEE)	1) E-Waste (Management) Rules, 2016 2) Implementation Guidelines for E-Waste (Management) Rules, 2016, CPCB	Only implementation monitoring and research needs resources which can be obtained from the Dept of Environment and Climate Change, GoM; MPCB, etc.[25]	1) MPCB 2) Nagpur District Administration 3) Proposed District Level Climate Change and Environment Committee 4) Electronic and Electrical Producer Manufacturers/ Producers/Brand owners, Producer Responsibility Organisations

24 Bio-medical and hazardous waste management is profitable and not funded by the government except for providing the land, which generally are the Industrial Development Corporation lands

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

Sub-sectors	Policies and programmes that can push forward the recommendation	Primary departments/ agencies	Supporting departments/ agencies
Wastewater: Domestic	1) Atal Mission for Rejuvenation and Urban Transformation (AMRUT) 2) Jawaharlal Nehru National Urban Renewal Mission on Urban Infrastructure and Governance (JNNURM) 3) National River Conservation Plan 4) Integrated Urban Sanitation Programme 5) Swachh Bharat Mission (Urban) – Maharashtra 6) Swachh Bharat Mission (Rural) – Maharashtra 7) Nagpur Smart City Mission 8) Nagpur City Development Plan, 2041 9) Nagpur Metropolitan Area Development Plan, 2032	1) Urban Development Department, GoM 2) All ULBs 3) Rural Development and Panchayat Raj Department, GoM 4) Maharashtra Jeevan Pradhikaran (Water Supply and Sanitation Department), GoM	1) NMRDA 2) MUIDCL 3) Nagpur Smart City Development Corporation 4) All Gram Panchayats 5) Nagpur District Administration and the proposed District Level Climate Change and Environment Committee
Wastewater: Industrial	1) Common effluent treatment plant system 2) Online continuous emission monitoring system 3) MPCB Annual Report	1) MPCB 2) MIDC	1) City and Industrial Development Corporation (CIDCO) 2) Department of Environment and Climate Change, GoM 3) Nagpur District Administration & the proposed District Level Climate Change & Environment Committee

6.1.6.2 Single use plastics (SUPs) – critical to replace

Definition

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

Concerns

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

Easily replaceable SUP, their alternatives and key user industries

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

Microplastics

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

Regulatory provisions in India for single-use plastics

- Plastic Waste Management (Amendment) Rules, 2021 (announced on March 11, 2021): a) The manufacture, import, stocking, distribution, sale and use of SUP commodities: Ear buds with plastic sticks, plastic sticks for balloons, plastic flags, candy sticks, ice-cream sticks, polystyrene (thermocol) for decoration shall be prohibited from January 1, 2022, b) The manufacture, import, stocking, distribution, sale and use of the SUPs (including polystyrene and expanded polystyrene) items – plates, cups, glasses, cutlery such as forks, spoons, knives, straw, trays, wrapping/packing films around sweet boxes, invitation cards, and cigarette packets, plastic/PVC banners less than 100 micron, and stirrers shall be prohibited from July 1, 2022.
- Plastic Waste Management Rules, 2016 and Amendment Rules, 2018: a) Puts the onus on the producers, through extended producer responsibility (EPR), to collect plastic waste either individually or through the concerned local body, b) The primary responsibility is on producers, importers and brand owners (who introduce the products in the market) to collect used multi-layered plastic sachet, pouches and other packaging, c) Manufacturing and use of multi-layered plastic, which is non-recyclable or non-energy recoverable or with no alternate use, should be phased out in two years.
- Solid Waste Management Rules, 2016: a) Introduces EPR for manufacturers or brand owners of disposable products (including plastic packaging, sanitary napkins and diapers) to provide financial assistance to local authorities for waste management system and to set up a collection/take back system for packaging waste.
- Different policy frameworks for SUP ban or restrictions (of different kind) exist in at least 23 states and five union territories of India. Government of Maharashtra published the 'Maharashtra Plastic and Thermocol Products (Manufacture, Usage, Sale, Transport, Handling and Storage) Notification, 2018' under 'Maharashtra Non-Biodegradable Garbage (Control) Act, 2006'. The notification bans manufacture, usage, transport, distribution, wholesale and retail sale and storage, import of plastic bags with handle and without handle, and the disposable products manufactured from plastic and thermocol (polystyrene) such as single use disposable dish, cups, plates, glasses, fork, bowl, container, disposable dish/ bowl used for packaging food in hotels, spoon, straw, non-woven polypropylene bags, cups/ pouches to store liquid, packaging with plastic to wrap or store the products, packaging of food items and food grain material in the state of Maharashtra. The ban also applies to plastic and thermocol for decoration (Environment Department, GoM, 2018).

Recommendations[26]

- Implement the ban (as specified by the Plastic Waste Management Amendment Rules, 2021) on manufacture, import, stocking, distribution, sale and use of the single use plastic.
- Formulate policies with provisions to: a) Mandate producer responsibility for awareness, labelling requirement on disposal, clean-up, collection and treatment of SUP products/packaging, b) mandate collection target (can be a differential target for different products) for SUP producers as part of EPR, c) penalise consumers for accepting banned SUP carrier bags or products, d) strict and random monitoring for implementation of bans in supermarkets, street vendors, shopping malls, large organised markets, etc, e) gradual phasing out of other selected categories of SUP products (by granting the producers some transition time). The phasing out can be achieved by sensitising key producers and sectors and encouraging them to take voluntary action.

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

- Promote eco-friendly alternatives to SUPs through: a) Identifying alternative sustainable products, b) identifying micro-enterprises and cottage industries for the products, c) integrating them into the mainstream business models through connecting/cross-cutting policies, d) providing financial incentives for the alternative industries and for integrating sustainable products into mainstream business models, such as in the hospitality industry, e) strict quality control and certification requirement for plastic-free alternatives (for instance, resin or plastic powder should not be mixed in the product as an alternative).
- Promote extended lifespan and reuse of products (including sustainable ones) through continued and lasting campaigns for 'No Single Use' to ensure public participation. Replacing the concept of 'single use' is critical as biodegradability or recyclability have 'time' and 'conditions' (such as energy and water footprint, transport requirement, etc) attached to them.
- Introduce economic incentives/support: a) Invest in R&D to develop alternatives to different SUP products, b) support technology incubation and stimulate creation of micro-enterprises to drive job creation, c) introduce livelihood support schemes and/or include special provisions in the existing schemes to accommodate the job loss from plastic industry, d) tax rebate to alternative models, public-private partnerships, etc, e) incentivise plastic industries for shifting to sustainable alternatives.

6.2. Innovative financing

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for Implementation	
Promote green municipal bonds to mobilise untapped investments towards green projects, such as RE infrastructure, waste management, etc.		Medium to long-term	Needs policy formulation Collaboration among various stakeholders Create specific financial instruments	Since 2017, NMC is working to launch municipal bonds to raise capital for execution of developmental projects. Case example: In June 2017, Pune Municipal Corporation had raised ₹ 200 crore through municipal bonds (listed on BSE) at an interest of 7.59% to finance its 24x7 water supply project, under AMRUT. NMC can follow the Pune model.
Voluntary carbon market mechanism can be developed for the district to motivate industries, ULBs and other sectors to lower their emission levels through monetary incentives.	All sectors	Medium-term	Needs feasibility studies, research and inter-departmental and multi-stakeholder collaboration Institutional structure needs to be established	Case example: In 2020, Smart City Indore collected carbon credit of around ₹ 50 lakh through the smart city's two bio-methanisation plants. The gas generated from these plants is used by the city buses - City Bus and iBus. Through these projects, Indore has avoided emissions of 1,70,000 tCO_2 since 2019 and generated carbon credits.

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

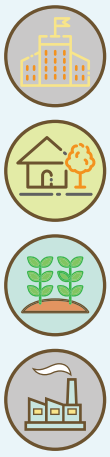
Recommendations	Cross-cutting with	Qualifying priority		District scenario / case examples
		Time frame for the action to be accomplished	Framework for Implementation	
Managing air pollution				
Increase the number of continuous air quality monitoring stations (CAQMS) to statistically, spatially, and temporally, represent the mix of sources and range of pollution. Increase the number of air quality display facilities in public places.		Short to medium-term	Policy framework and budgetary provisions exist	Nagpur is one of the 18 non-attainment cities in Maharashtra and amongst the 124 cities in India where particulate matter concentration (PM_{10} and $PM_{2.5}$) exceeds the prescribed norms set by the CPCB under the National Clean Air Programme (NCAP). The Action Plan to control air pollution in Nagpur city was developed by MPCB and has been revised recently to include inputs for FY 2020-21. The action plan identifies vehicular emissions, dust re-suspension, landfilling/open waste and biomass burning, industrial operations, construction and demolition activities and domestic fuel combustion as the major sources of local air pollution in the city. A source apportionment study of $PM_{2.5}$ in Nagpur shows vehicular emissions (62%) followed by inorganic aerosol (15%), re-suspended dust (8%) as the major sources of air pollution (Pipalatkar, Khaparde, Gajghate, & Bawase, 2014). While the sources were relatively similar across all of the sites studied, their percent contributions changed depending on the intensity of ongoing operations, emphasizing the need for a detailed source apportionment to address the issue. Nagpur currently has five ambient air quality monitoring stations (AAQMS), out of which two are located in residential areas, one in industrial area, one in commercial area and one in rural area (Civil Lines, Nagpur; IOE, North Ambazari Road, MIDC Office, Hingna Road, Govt. Polytechnic College, Sadar and Nagpur CAAQMS). Civil Lines is the only automated station out of the five; rest are manual AAQMS (MPCB, 2020).
a) Enforce environmental standards on exhaust fumes/ emissions from industries. b) Promote installation of air pollution control devices at point source of emissions.		a) Short-term and continuous b) Medium-term	Requires robust M&E	
Sprinkling of water (preferably, recycled grey water) to settle suspended road dust during peak pollution episodes.		Short-term and continuous	Needs inter-departmental co-operation	
Open waste burning (of solid waste, biomass, plastic, horticulture waste, etc) should be regulated by the municipal corporation/nagar panchayats.		Short to medium-term	Needs implementation of existing rules/ regulations	
Implementation of action plan for construction and demolition waste (C&D) (as per the CPCB guidelines).		Short to medium-term	Needs implementation of existing rules/ regulations	
Facilitate source apportionment studies to identify the sources, and take specific containment measures.		Short to medium-term	Needs support for research	
Ensure installation and operation of air pollution control devices in industries and adhere to emission standards.		Medium to long-term	Implementation of existing rules/ regulations is required Robust M&E required	

Recommendations	Cross-cutting with	Qualifying priority		District scenario / case examples
		Time frame for the action to be accomplished	Framework for Implementation	
Increase the modal share of public and non-motorised transportation. Further, promote e-vehicles (detailed recommendations under Transport, section 6.1.3). Ban on registration of diesel and petrol-driven auto-rickshaw and complete conversion to CNG/gas engine.		Medium to long-term	Policy framework available Awareness generation required Capital investment required Needs inter-departmental coordination	Maharashtra State Urban Transport Policy aims to decongest traffic by discouraging private vehicle ownership; promoting public transport, walking and cycling to enhance air quality; and making transport infrastructure focused on people as opposed to vehicles. Only a partial conversion of polluting auto-rickshaws to CNG/gas engines is recommended in Nagpur City's Action Plan to Control Air Pollution. Auto-rickshaws that run on diesel, petrol, and LPG dual combination are still operational in the district. India's first multi-modal e-mobility project was also implemented in Nagpur with electric fleet by Ola (combination of e-rickshaws and e-cabs) and charging stations at fuel pumps. Several provisions in the latest Maharashtra state E-vehicle Policy, 2021 can aid these recommendations (see Transport, section 6.1.3). Nagpur city has intelligent CCTV surveillance and automated traffic management systems installed at traffic intersections. In addition to existing NMC parking facility, parking lots in Dhantoli and along Ramdaspeth to Kachipura square and some other congested areas are proposed in the MPCB action plan.
Better traffic management, re-direction of traffic movement, development of multi-layered parking and ban on-street parking within specific perimeters of the multi-layered parking to ensure parking inside the facility.		Short to medium-term	Feasibility studies needed Needs implementation of existing rules/ policies Capital investment required	

Recommendations	Cross-cutting with	Qualifying priority		District scenario / case examples
		Time frame for the action to be accomplished	Framework for Implementation	
Increase/create green cover or green buffers along the major traffic corridors, roundabouts and industrial areas.		Medium to long-term	Inter-departmental coordination required Needs efficient maintenance and monitoring of plantation sites	About 16,759 sq. m green buffers at road dividers, channeliser, traffic islands and on both sides of the roads have been developed in Nagpur. But these do not cover all major polluting roads. Till date, 95 gardens have been constructed over a total area of 126.46 acres in the city. 22 new gardens have been proposed, with 8 (62.46 acres) falling under the AMRUT mission and 14 falling under the Chief Minister's special fund. As per the MPCB action plan, there is a proposed plan of ₹ 1.90 crore for creation of green buffers along the traffic corridors in Nagpur city under NCAP.
a) Shifting of industries from non-conforming zones (refer Development Control and Promotion Regulations for Nagpur Metropolitan Regional Development Authority). b) Switching over to clean technologies, clean fuels and pollution control devices. c) Development of green belt around the industrial zones.		a) Medium to long-term b & c) Short to medium-term	Policy framework exists Needs compliance	Major industries leading to air pollution in Nagpur are: Brick kilns, mining, coal-fired thermal power plant, oil-fired furnace/boiler, stone crusher, lime kilns, foundry, etc. Industrial development exists along fringe areas like Kamptee, Hingna, Wadi, Khapri, Butibori and Kalmeshwar. The New Industrial Policy, 2019 offers financial assistance for pollution control systems and captive RE power plants.

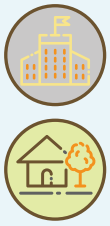
Recommendations	Cross-cutting with	Qualifying priority		District scenario / case examples
		Time frame for the action to be accomplished	Framework for Implementation	
Making brick kilns sustainable				
Adopt cleaner kiln technologies like zig-zag kilns and vertical shaft brick kiln (VSBK) to replace fixed chimney bull trench kilns (FCBTKs) and down draught kiln (DDKs).	   	Medium to long-term	Needs to be aligned with the existing standards Mandate required to ensure compliance Capital investment required	Zig-zag kilns appear to be the logical replacement for FCBTKs because of low-capital investment, easy integration with the existing production process and the possibility of retrofitting FCBTKs into zig-zag firing.
Promote mechanised coal stoking systems in brick manufacturing.		Medium-term		High particulate matter and black carbon emissions in FCBTKs occur during the period of fuel feeding. Continuous feeding of properly sized fuel, using a coal stoker in an FCBTK or a zig-zag kiln, can reduce the emissions significantly.
Promote sustainable brick types (e.g., clay-fly ash bricks and fly ash bricks).		Long-term	Needs awareness generation Needs to be aligned with existing policies Market/ demand needs to be generated	Preparing clay-fly ash bricks with around 30% fly ash content (when using black soil) can: a) Prevent consumption of around 30-40 tonnes of alluvial soil or 100-125 tonnes of black soil per lakh bricks, thereby reducing land-degradation and retaining the carbon content in soil. b) Save 3-7 tonnes of coal per lakh bricks produced. c) Increase the strength of the brick by 30% to 40%.
Promote modern RE technologies in brick making. Also, enhance communication through media engagement and outreach, mass awareness, engaging public, health and academic institutions, stakeholder discussions, etc.		Long-term	Research collaboration needed Capital investment required	
Thermal Power Plants in Nagpur: Operational and in pipeline				
Ensure new TPPs are 'designated consumers' (DCs) under the PAT scheme.	 	Short to medium-term	Policy framework exists	Of the six existing TPPs in Nagpur, four are PAT compliant – Koradi TPP, Khaparkheda TPP, Mouda TPP and Butibori TPP. These PAT compliant TPPs have saved approximately 7.7 lakh tCO_2e emissions till date.

Recommendations	Cross-cutting with	Qualifying priority		District scenario / case examples
		Time frame for the action to be accomplished	Framework for Implementation	
Thermal power plants can reduce their specific water consumption (m^3/MWh) and achieve zero liquid discharge through: (a) air-cooling of the cooling tower, (b) brine recovery systems, and (c) using recycled water.		Medium to long-term	Policy framework exists Capital investment required Awareness generation among the stakeholders is required	Data from the Government of Maharashtra and Nagpur district, as well as a power sector mapping exercise done by Vasudha Foundation indicate that five coal-based TPPs, with a proposed cumulative capacity of 2,910 MW are in pipeline. As per the Environment (Protection) Amendment Rules, 2015 issued by MoEFCC, all the power plants being setup after 2017 are required to use a maximum of 2.5 m^3/MWh water as specific water consumption and achieve zero liquid discharge, as compared to earlier standard of specific water consumption limit (3.5m^3/MWh). In 2013, MahaGenco and NMC agreed to build and operate a 130 MLD STP at Bhandewadi to deliver recycled water to three Koradi TPP units. Since then, Koradi TPP has been using recycled water.
Promote installation of technologies to curtail NO_x emissions from the plants. NO_x emissions can be reduced through: (a) Primary strategies: implementing NO_x reduction technology at the primary source-installing low NOx burners (LNBs). (b) Secondary strategies: installing selective catalytic reduction (SCR) / selective non-catalytic reduction (SNCR).		Medium to long-term	Policy framework to be enhanced Capital investment required Awareness generation among the stakeholders	A plan submitted by the Ministry of Power in December 2017, suggested pre-combustion modification such as in-situ modification in boiler, installation of low NO_x burners and over-fired air (OFA) to be adopted besides installation of selective catalytic reduction (SCR) / selective non-catalytic reduction (SNCR) systems by 2022. An affidavit dated August 20, 2018 (SCI 2019), was filed by the CEA with respect to NO_x, requesting for change of norm from 300 mg/Nm^3 and 100 mg/Nm^3 for thermal units installed after December 31, 2003 to 450 mg/Nm^3, which is practically achievable with the combustion modification. With the help of a separate over fired air (SOFA) provided in the boiler, NO_x level can be maintained at 450 mg/Nm^3. However, one of the most advanced primary NO_x reduction techniques consists of advanced burner technology in conjunction with carefully designed air supply system for combustion. This method can fulfill 300mg/Nm^3 NO_x emission requirement.

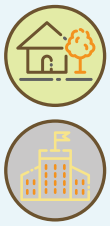
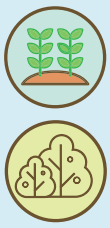
Recommendations	Cross-cutting with	Qualifying priority		District scenario / case examples
		Time frame for the action to be accomplished	Framework for Implementation	
Promote installation of flue gas de-sulphurisers (FGD) before the inlet of power plant stack/flue gas stack to curtail SO_x emission from power plants.[27]		Medium to long-term	Policy framework exists Capital investment required Awareness generation needed	The status of FGD implementation of TPPs in Nagpur district is as below: a) Koradi TPP Unit 6 and Unit 7: Feasibility study carried out, b) Koradi TPP Unit 8, 9 and 10: Bid opened, c) Butibori TPP Unit 1 and 2: notice inviting tender, d) Mauda TPP Unit 1,2,3 and 4: Bid awarded, e) Khaparkheda TPP Unit 1,2,3 and 4: Feasibility study carried out, f) Khaparkheda TPP Unit 5: Bid opened.
Water scarcity and water pollution				
Conduct assessment and mapping of zone-wise water challenges in the district.		Short-term	Stakeholder and research collaboration required	Just as the central administration has undertaken the groundwater recharge priority mapping, the state government/district administration can do a more holistic mapping of the water challenges of the district.
Prepare a comprehensive district action plan for integrated water resource management with a bottom-up approach. Establish sustainable and inclusive water governance in the district to develop, implement, evaluate as well as share information on programmes for water resource management in a transparent and inclusive manner with mandatory stakeholder engagement and public participation.		Short to medium-term	Policy intervention required Stakeholder and research collaboration required	Maharashtra Government had launched the Jalyukt Shivar Abhiyaan in 2015-16 to make the state drought-free by 2019. This inter-departmental collaborative scheme also covered Nagpur district with activities like, groundwater survey and development engineering, drainage deepening and widening, dam repairing and construction of minor irrigation ponds, water reservoir and drain dams, etc., in different blocks of the district (Water Resource Department, GoM, 2019). The programme introduced water budgeting as one of the key concepts and took initiatives which led to an increase in groundwater levels of 1.5 to 2 metres. Additionally, 11,000 villages have been declared drought-free and agricultural productivity has increased by 30% to 50% in the areas of implementation in Maharashtra (Niti Aayog, 2019).

27 FGD removes SO_x content from flue gas using chemical processes. For a typical coal-fired power station, FGD may remove more than 90% of the SO_x from flue gases. Various types of FGD technologies such as wet type FGD (using limestone, ammonia and sea water as raw material), semi-dry type FGD and dry sorbent injection FGD can be used. However, wet type FGD with limestone is the most popular, on account of lower capital and operational expenditure.

Recommendations	Cross-cutting with	Qualifying priority		District scenario / case examples
		Time frame for the action to be accomplished	Framework for Implementation	
Ensure proper implementation of Maharashtra Groundwater Development and Management Rules, 2018 (enacted as per the Model Bill for the Conservation, Protection, Regulation, Management of Ground Water, 2017) at the district level.		Short-term and continuous	Policy framework exists Needs strict implementation at the district level	Maharashtra Government has introduced the Maharashtra Groundwater Development and Management Rules (MGDMR), 2018 with provisions such as mandatory registration of wells and permission requirement for digging new wells, which is contingent on building a groundwater recharge structure alongside. Additionally, MGDMRs also have provisions to regulate, and in some cases even prohibit, extraction of groundwater through wells, to limit unsustainable groundwater use practices undertaken by farmers in the state.
Promote rainwater conservation through: a) renovation of existing rainwater harvesting structures, b) ensuring inclusion of rainwater harvesting structures in new construction of residential buildings, institutional, commercial centres, and industries in the district, as per building bye-laws, c) Mandatory rainwater harvesting at the upstream to halt run-off and recharge groundwater.		Short to medium-term	Policy framework exists Align with existing regulations Needs infrastructural investment	The pre-monsoon decadal ground water level trend (2010-2019) shows a rise in several parts of Maharashtra, including the Nagpur region. However, the post-monsoon decadal water level trend shows a declining trend of more than 0.1 m/year in isolated parts of Nagpur (CGWB, 2021). Under the Revised Development Control Regulation of Maharashtra, 2009, rainwater harvesting is mandatory in all buildings, layouts of open spaces, amenity spaces of housing societies and new constructions of area ≥ 300 sq. m in Maharashtra. They shall have one or more rainwater harvesting structures such as an open well or a borewell, or underground storage tank or percolation pits. The bye-law envisages that no building permission will be granted unless provision is made for rainwater harvesting. The owner/society also has to ensure the maintenance of these structures. In case of non-compliance with the aforementioned rules, the municipal corporation/council would levy a fine of up to ₹ 1,000/annum/100 sq. m of built-up area.

Recommendations	Cross-cutting with	Qualifying priority		District scenario / case examples
		Time frame for the action to be accomplished	Framework for Implementation	
		Medium-term	Research collaboration required	According to the Water Works Department of NMC, the average non-revenue water (NRW) within Nagpur city is 45.26% (against the national average of 15%) owing to pilferage, including leakage in pipes, theft, illegal diversion or non-metering (The Times of India, 2020).
Ensure minimum 'non-revenue water' (NRW), i.e., technical loss due to leakage, seepage or unauthorised use (theft). Promote 'net zero water' construction and infrastructure upgradation in urban areas, in alignment with ECBC norms.		Medium-term	Policy level interventions required	In November 2011, NMC launched its uninterrupted water supply scheme, called 24x7 Water Supply Scheme in PPP model. The project has helped the city improve water access, enhance efficiency, as well as reduce losses attributable to non-revenue water. Under this scheme, 85,000 of the 3,21,000 conventional connections were replaced with metered connections along 450 km of the pipeline coverage. Close to 1,00,000 unauthorised connections have been identified during the rehabilitation phase, and commercial losses have reduced and NMC revenues have increased. Service delivery issues are being tackled through infrastructure augmentation and increase in capacity of elevated service reservoirs (NITI Aayog, 2019).
Water billing based on water metering rather than fixed charges.		Medium to long-term	Policy framework exists	Under NMC's, '24x7 Water Supply Scheme' 1.60 lakh water meters were installed within the city. The scheme target was 3.09 lakh households in Nagpur by 2018. The project is being implemented by a private operator – Orange City Water Private Limited (PPP model) (NITI Aayog, 2019).
Promote dual-flush systems to reduce water consumption, energy consumption, and wastewater generation.		Short to medium-term	Align with the existing policies Could be implemented as a part of green buildings	

Recommendations	Cross-cutting with	Qualifying priority		District scenario / case examples
		Time frame for the action to be accomplished	Framework for Implementation	
Identification of non-point sources of pollutants, including chemicals from agriculture runoff, city sewerage from commercial and residential sector and untreated industrial effluent into the rivers and any other surface or groundwater sources. Improved inter-departmental exchanges and proactive measures by respective ULBs and MPCB to halt effluent discharge and waste dumping at water courses. Immediate investment into wastewater management infrastructure, ensure the functionality of the existing ones along the river courses, improve treatment status of wastewater before disposal and reuse of treated wastewater for industrial purposes.		Short to medium-term	Policy framework exists Monitoring and reporting required Needs infrastructural investment	A comprehensive sewerage system is proposed and sanctioned with 1,362 km of sewerage network length, three STPs (48 MLD) on Nag River and two STPs (43 MLD) on Pilli River targeting to make the rivers pollution free by 2023. Polluting streams are planned to be diverted to Bhandewadi STP for treatment. Unfortunately, even after getting the first approval in 2008, the project is yet to start for a number of administrative hitches (Numerical, 2019). Maharashtra Government has mandated the reuse of treated wastewater for cooling TPPs and introduced Maharashtra Water Resources Regulatory Authority Water Entitlement Transfer (WET) and Wastewater Reuse Certificates (WRC) Platform Regulations, 2019. NMC and MahaGenco have initiated a CETP of 130 MLD capacity under JNNURAM which is supplying the treated water to the Koradi TPP, run by MahaGenco.

Recommendations	Cross-cutting with	Qualifying priority		District scenario / case examples
		Time frame for the action to be accomplished	Framework for Implementation	
Action towards sustainable development of river basins: a) Research on interrelations between urbanisation, river basin ecosystem and climate, b) better administration of rivers including frequent testing and increased number of water quality parameters, c) evaluation according to regulatory standards.		Short to medium-term	Needs research collaboration	
Adoption of aggressive awareness campaigns, in localities. Digital water quality status, impact and advisory display boards at important points along the rivers and lakes. Launch a district specific 'pollution check' mobile application for the citizens to be informed and get engaged by notifying the authorities for cases of violation in their notice.		Short-term and continuous	Needs outreach strategy and collaborations	The rivers, Nag, Pilli and Pora flow through Nagpur district. Reportedly, heavy sewage, storm water and untreated industrial effluents are being discharged into these rivers making them highly polluted. Currently, MPCB publishes Annual Water Quality Report at the state level, which also includes Nagpur zonal status. MPCB has only three monitoring locations on Nag river and two on Pilli river.
Complete ban on direct intentional activities causing pollution, like, bathing, washing, waste dumping in rivers, etc.		Short term	Needs policy intervention Awareness and infrastructural investment	For the city range of Nag river, a Nag River Pollution Abatement Plan is under development, with proposals of several wastewater treatment plants (at Chikhali Khurd area, Hudkeshwar Narsada, NIT and one by NRCP). NMC also carried out Nag and Pilli river campaigns. NMC carries out de-silting activities from time to time in different lakes and river stretches within city limits, e.g., de-siltation of Gorewada lake, widening and de-siltation of Grenada 47 km stretch of Nag, Pilli and Pora river, etc.
De-siltation and river cleaning drives engaging the citizens for Nag, Pilli and Pora rivers. Demarcation of definite river and lake boundaries and immediate removal of encroachments.		Short-term and continuous	Policy framework exists Needs financial investment	
Development of buffer zones and green belts along the river banks and lakes to prevent soil erosion, run-off and to protect water quality.		Medium to long-term	Needs policy interventions and integration into developmental plans	
Creating potential revenue generating activities and alternative community livelihood sources from lake ecosystem, e.g., boating, fisheries, beautification of banks, aquatic plants, floating markets, etc.		Medium to long-term	Needs collaborative efforts and investment	

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

Sectors	Policies and programs that can push forward the recommendation	Primary departments/ agencies	Supporting departments/ agencies
Managing air pollution	1) Air (Prevention and Control of Pollution) Act, 1981 2) Environment (Protection) Act, 1986 3) National Clean Air Programme, 2020 4) Solid Waste Management Rules, 2016 and Amendment, 2018 5) Construction and Demolition Waste Management Rules, 2016	1) MPCB 2) All ULBs 3) All Gram Panchayats	1) District Administration and the proposed District Level Climate Change and Environment Committee 2) Department of Environment and Climate Change, GoM 3) Department of Forest, GoM 4) Department of Transport, GoM 5) RTO
Making brick kilns sustainable	1) Energy Efficient Enterprise (E3) Certification Scheme for Burnt Clay Brick Manufacturing Industry 2) Maharashtra Industrial Policy, 2019 3) Environment Protection Act, 1986 – Section 6 and 25. 4) Air (Prevention and Control of Pollution) Act, 1981 – Section 18(1) (b) for the prevention and control of air pollution in different types of brick kilns	1) Industries, Energy and Labour Department, GoM	1) Proposed District Level Climate Change and Environment Committee 2) MPCB 3) District Industries Centre 4) Land and Revenue Department
Thermal power plants: Operational and in pipeline.	1) Environment Protection Act, Amendment Rules, 2015 2) Air (Prevention and Control of Pollution) Act, 1981 3) National Clean Air Programme 4) PAT Scheme	1) Maharashtra State Power Generation Company 2) NTPC Limited (National Thermal Power Corporation Limited) 3) Vidarbha Industries Power Limited (VIPL) 4) Ideal Energy Power Limited 5) Abhijeet MADC Nagpur Energy Pvt. Limited	1) District Administration and the proposed District Level Climate Change and Environment Committee 2) Urban Development Department, GoM 3) All ULBs 4) Rural Development and Panchayat Raj Department, GoM 5) Department of Forest, GoM 6) Water supply and sanitation department, GoM
Water scarcity and water pollution	1) Model Bill for the Conservation, Protection, Regulation, Management of Ground Water, 2017 2) Water Prevention and Control of Pollution Act, 1974 3) National Water Mission, 2008 4) Maharashtra Groundwater Development and Management Rules, 2018 5) Maharashtra Water Resources Regulatory Authority Water Entitlement Transfer (WET) and Wastewater Reuse Certificates (WRC) Platform Regulations, 2019 6) Maharashtra State Water Policy, 2019 7) Jalyukt Shivar Abhiyaan Maharashtra 8) Water Resources Development and Management Plans (WRDMPs) 9) Integrated State Water Plan (ISWP)	1) Water Resources Department, GoM 2) Water Supply & Sanitation Department, GoM 3) MPCB 4) Maharashtra Water Resources Regulatory Authority 5) All ULBs 6) All Gram Panchayats	1) Proposed District Level Climate Change and Environment Committee 2) NMRDA 3) Urban Development Department, GoM 4) Rural Development and Panchayat Raj Department, GoM 5) Directorate of Industries, GoM 6) MIDC

Recommendations for phasing out coal mines in Nagpur district[28]

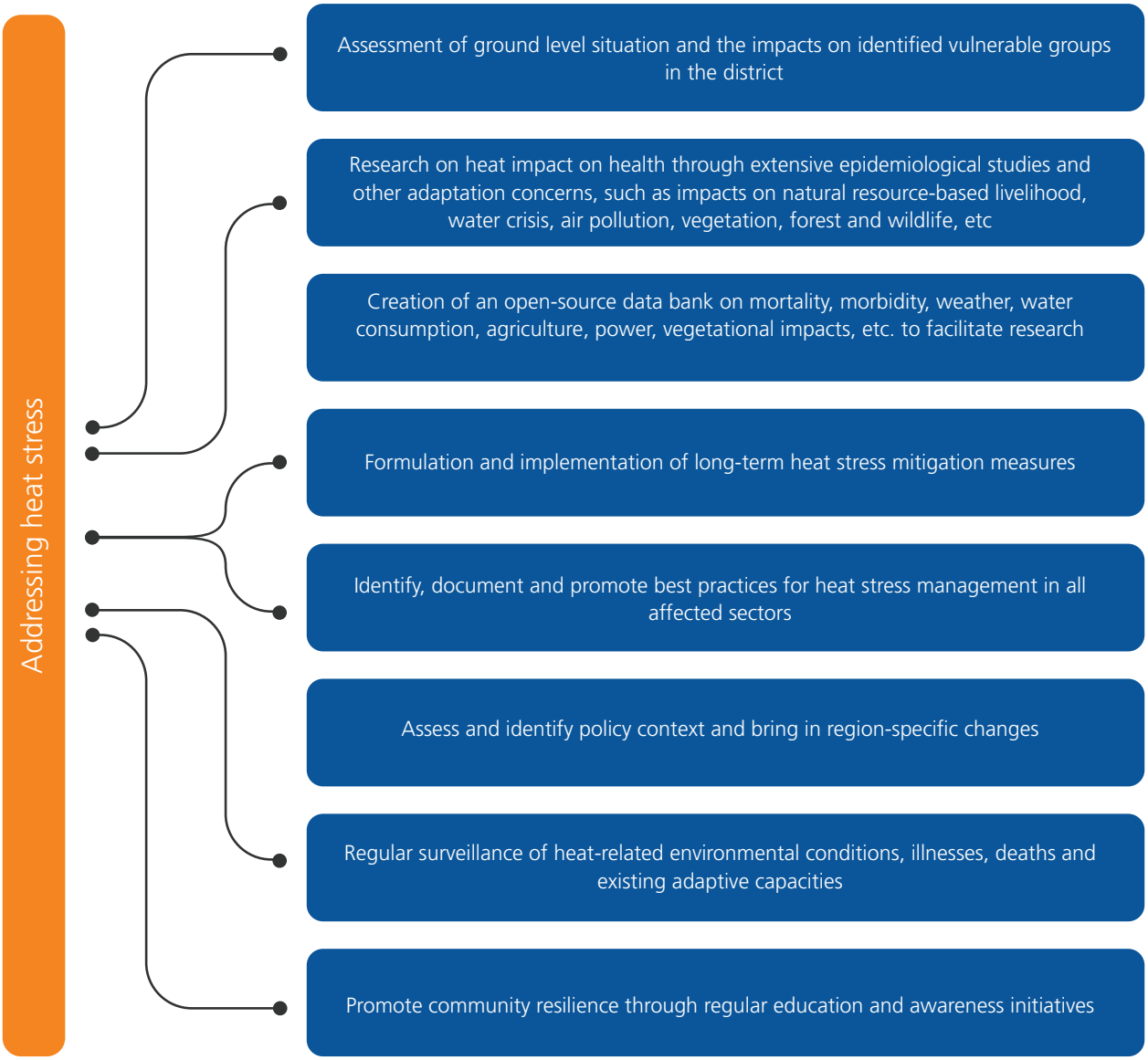
Besides the emissions from coal powered thermal plants, coal mining activities itself lead to GHG emissions in the form of fugitive emissions that occur during mining, transportation and processing. Nagpur district emitted around 3,98,000 tonnes of CO_2e. emissions due to coal mining in 2018.

In order to align with India's latest climate commitments under the UNFCCC Paris Agreement and to complement Maharashtra's State Action Plan on Climate Change (SAPCC), Nagpur district must plan to phase out the coal mining. Recommendations to work towards this aspect are as under:

- Prepare a viable coal phase-out roadmap with defined targets, timelines and proper monitoring and evaluation framework.
- Encourage a just and feasible transition for coal mining workers. Facilitate reskilling, provide platforms to access decent work and quality jobs. As well as ensure regional economic development, while at the same time limiting adverse impacts on consumers and energy-intensive industries.
- Discourage/ prevent new coal-fired power plants from being built in the district, and enhancing the capacity of RE (detailed recommendations given in sections 6.1.1 and 6.3).
- Devise cost-efficient alternatives, such as including carbon pricing or industry-internal schemes whereby remaining power stations pay out plants that are retiring ahead of their end of economic life.
- Ensure mine reclamation and rehabilitation:
  - Provisions related to environmental impact mitigation, mine closure, resettlement for locals and employment,
  - Open legal avenues for local communities and indigenous people affected by mining,
  - Ensure back-filling of pits regularly or in intervals to restore the land to its original state as far as possible,
  - Cover toxic wastes, barren waste rocks, tailings or any inhibition to vegetation with the previously stored top soil,
  - Effectively carry out tillage (provides aeration, mix fertilisers and mulches into the soil to reduce compaction in the soil and facilitate moisture infiltration,
  - Installation of effective drainage and sediment control system,
  - Devise suitable plans for rehabilitation of people.
- **Sand and other minor mineral mining**
  - Carry out effective river audits and develop detailed reports of all mining areas available in public domain.
  - Prevent ground water pollution by prohibiting sand mining on fissures, as it works as filter prior to ground water recharge.
  - Promote alternatives i.e., manufactured sand, artificial sand and alternative technologies in construction materials processing to reduce the dependence on naturally occurring sand and gravel.
  - Develop local supplier capacity, strengthen local value chains and integrate them into core business.
- **Environmental legislation with reference to mining in India**
  - Mineral Conservation and Development Rules, 2017
  - The Environment Impact Assessment (EIA) Notification, 2006
  - Provisions for mining operations under Forest (Conservation) Act, 1980 and the rules made in 1981
  - National Mineral Policy, 2019

28 District scenario for mining in Nagpur is given in Chapter-1

Recommendations for managing heat stress in Nagpur district[29]



29 The district scenario is given in Chapter 2

6.4. Actions district authorities can recommend to state departments

Recommendations that could be pursued by the district collector/state-level committee	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
POWER SECTOR: Upgrade DISCOM infrastructure and their supply network to reduce AT&C losses, billing inefficiencies etc. Furthermore, introduction of smart billing system would help curtail power thefts, and increase billing efficiency, helping the DISCOM generate more revenue.		Short to medium-term	Policy framework and targets exist (section 6.4.1)	The AT&C losses of MSEDCL for FY 2018-19 are 16.9%, well over the international standard range of 6% to 8%, there is a clear scope of improvement. MSEDCL needs to upgrade its infrastructure, introduce smart metering, smart billing, etc. to increase its efficiency. Case example: EESL has signed an MoU with Uttar Haryana Bijli Vitran Nigam and Dakshin Haryana Bijli Vitran Nigam for 10 lakh smart meters. The deployment of smart meters in the country has led to a 20% increase in monthly revenue per customer for DISCOMs, a 5% reduction in AT&C losses (on an average), remote disconnection provision for defaulters and has completely eliminated manual meter reading requirements, leading to reduced expenditure (as per EESL). Similar pilot projects can be introduced in Nagpur by MSEDCL.
HABITAT: Provide subsidies/tax rebates to builders/building owners to encourage adoption of ECBC or IGBC (e.g., property tax/water cess/ IT rebate).		Medium to long-term	Policy framework exists (section 6.4.1), but targets need to be set Needs inter-departmental collaboration	ECBC buildings deliver 20% to 25% energy savings, in different climates, when compared with the conventional buildings (BEE, 2017).
HABITAT: Energy efficient vertical urban development should be promoted instead of horizontal development to conserve green cover.		Medium to long-term	Policy level intervention required	Vertical urban growth facilitates more housing for the population, and contributes towards the environment. It averts the loss of agricultural land and open spaces and makes the transport mechanism much more efficient.

Recommendations that could be pursued by the district collector/state-level committee	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
TRANSPORT: Energy efficiency of infrastructure in railways can be enhanced through the following measures: a) Installing solar panels along electrified tracks and on railway station rooftops, b) Installing optimal light control systems and appliances, smart sensors and building management systems at station buildings, c) Ensuring regeneration of energy (through rolling stock) parallel to the grid.		Medium-term	Needs inter-departmental collaboration	Rail Land Development Authority and National Building Construction Corporation have signed an MoU for the redevelopment of 10 railway stations across India as 'smart railway stations'. Railway stations in the district can also be developed along similar lines.
TRANSPORT: Use fiscal instruments to discourage the use of personal vehicles by: a) Increasing charges on registration of internal combustion engine (ICE) vehicles, b) levying congestion charges and other green tax, c) phasing out of older, more polluting vehicles.		Short-term and continuous	Proper policy backing based on research and inter-departmental cooperation is needed	In January 2021, the Ministry of Road Transport and Highways announced additional taxes on old vehicles that are unfit for roads as 'green taxes'.
TRANSPORT: Identify and shift key commercial / business centres from all the ULBs to outside city limits to reduce traffic load.		Long-term	Needs proper policy, based on research and inter-departmental cooperation	Need for the development of areas outside NMC limits to accommodate the shifting of industries, business centres, IT parks etc.
TRANSPORT: While gradually rolling out EV infrastructure, district authorities can recommend (to state and national governments) standardised EV cables and infrastructures. This would help put in place large-scale smart charging infrastructure that is easier to integrate and interoperable.		Medium to long-term	Needs policy intervention	

Recommendations that could be pursued by the district collector/state-level committee	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
INDUSTRY: a) Ensure regular PAT compliance of DISCOMs and other designated consumers (DCs) in the district. b) Increase the number of DCs for the PAT scheme in the district, and ensure the compliance of targets.		a) Short-term and continuous b) Medium to long-term	Policy framework exists (section 6.4.1), but targets need to be revised gradually Ensure M&E Collaboration required	Until PAT Cycle VI (2020-21) only eight DCs have volunteered under the scheme in Nagpur district.[30] Over the years, various DCs from the district have helped avoid around 2,11,009 tCO_2e emission by improving their systemic energy efficiency under the PAT scheme.
INDUSTRY/ENERGY: Ensure compliance to renewable purchase obligations (RPOs) while gradually increasing the RPO targets.		Medium to long-term	Policy framework exists (section 6.4.1)	For FY 2021-22, the RPO target for industries is 17.5% in the state, as set by MERC.
AGRICULTURE: Encourage millet cultivation (requires less water to grow, shows good productivity under extreme climate conditions and is rich in nutrition).		Medium to long-term	Needs creation of appropriate financial mechanisms to encourage farmers to grow millets Requires research collaboration This would also enable achievement of targets of SDG#2 (Zero Hunger): 2.1, 2.3, 2.4	The production of *jowar* decreased in Nagpur from 80,000 tonnes (2017-18) to 68,110 tonnes (2019-20).
AGRICULTURE: To compensate for predicted decrease in crop productivity, initiate research on high yield, drought and temperature resilient genotypes for various food and cash crops in association with agricultural institutes/ universities.		Medium to long-term	Needs research collaboration and capital investment This would also enable achievement of the following targets of SDG#2 (Zero Hunger): 2.1, 2.3, 2.4, 2.a.	Area under wheat cultivation in the district has decreased from 1.8 lakh ha (2017-18) to 1.56 lakh ha (2019-20) leading to decreased production from 3.02 lakh tonnes (2017-18) to 2.03 lakh tonnes (2019-20). The yield has reduced by 21.8%. In order to meet the food demand in the future, climate-smart agriculture is the key to reduce crop failures.

30 Names of designated consumers: Morarjee Textiles Ltd, Spentex Industries Ltd, Sunflag Iron and steel Co, Topworth Urja and Metal Ltd, Khaparkheda TPP, Koradi TPP, Mouda TPP, Butibori TPP

Recommendations that could be pursued by the district collector/state-level committee	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
AGRICULTURE: For overall reduction in electricity and water consumption in agriculture, subsidies need to be reduced in a phased manner.		Medium to long-term	Policy intervention needed Requires awareness generation and collaboration with the farming communities	Agricultural tariff in Maharashtra is only around 50% of the average cost of supply (ACoS). In addition, GoM is providing a substantial subsidy against even this lower tariff under Section 65 of the Electricity Act, 2003.[31] The approved tariff has decreased by 6% and 1% for high tension-agriculture and low tension-agriculture meters, respectively, for FY 2020-21.
FORESTRY/GREEN SPACES: Promote regeneration of degraded and open forest areas through corporate social responsibility (CSR) (or similar mandates) and encourage corporates to dedicate some percent of their profit for greening of open spaces in the district.		Long-term	Needs strengthening of the existing policy framework Needs stakeholder collaboration	Green belt on the boundaries of industries help in maintaining the green cover of the area. Moreover, it absorbs the pollution emitted from the industries (i.e., helps in carbon sequestration).
E-WASTE: Adopting 'green marketing' by: a) Promoting green products, b) displaying product lifespan on e-products labels to influence purchase decisions, thereby using the labels as behavioural intervention.		Medium to long-term	Needs policy intervention, collaborations and awareness	

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

Sub-sectors	Policies and programmes that can push forward the recommendation	Primary departments/ agencies	Supporting departments/ agencies
Power sector	1) Maharashtra State Energy Conservation Policy, 2017 2) National Smart Grid Mission 3) Smart Metering National Programme 4) Integrated Power Development Scheme (IPDS) 5) Restructured Accelerated Power Development and Reforms Programme (R-APDRP) 6) UDAY Scheme, 2015 7) National Mission on Energy Efficiency, specifically PAT (Perform, Achieve and Trade) Scheme 8) Maharashtra State Renewable Energy Policy, 2020 9) Policy for Decentralized Renewable projects, 2016 10) Standards and Labelling Programme	1) Industries, Energy and Labour Department, GoM 2) MSEDCL, GoM 3) MEDA, GoM 4) BEE (EESL)	1) Department of Environment and Climate Change, GoM 2) Central Railways – Nagpur Division 3) Proposed District Level Climate Change and Environment Committee

31 https://www.mahadiscom.in/consumer/wp-content/uploads/2020/03/Order-322-of-2019.pdf

Sub-sectors	Policies and programmes that can push forward the recommendation	Primary departments/ agencies	Supporting departments/ agencies
Habitat	1) ECBC, 2017	1) Urban Development Department, GoM 2) MEDA, GoM 3) All ULBs 4) Nagpur Smart and Sustainable City Development Corporation Limited (NSSCDCL).	1) Proposed District Level Climate Change and Environment Committee 2) MSEDCL
Transport	1) ECBC 2) JNNURM 3) Smart Cities Mission 4) AMRUT	1) Department of Motor Vehicles, GoM 2) All RTOs 3) All ULBs	1) MSRTC 2) MEDA 3) MSEDCL 4) Nagpur Smart and Sustainable City Development Corporation Limited 5) Central Railways: Nagpur Division
Industry	1) PAT Scheme 2) Industrial Promotion Policy, 2014 3) BEE-SME Program	1) Industry, Energy and Labour Department, GoM	1) District Industries Centre 2) Proposed District Level Climate Change and Environment Committee
AFOLU	1) National Mission on Food Security 2) Rashtriya Krishi Vikas Yojana: RAFTAAR 3) National Mission for Sustainable Agriculture 4) Price Support Scheme 5) National Afforestation Programme (NAP) 6) Green India Mission 7) CSR Act, 2013	1) Department of Agriculture, GoM 2) Maharashtra Forest Department, GoM	1) APMCs 2) MIDC 3) Energy Department, GoM 4) Maharashtra Agro Industries Development Corporation 5) Directorate of Geology and Mining, GoM 6) Maharashtra State Agriculture Marketing Board 7) Proposed District level Committee on Climate Change and Environment
Waste	1) E-waste Management Rules, 2016	1) Directorate of Information Technology, GoM	1) Proposed District Level Climate Change and Environment Committee

6.5. Sustainable Development Goals being addressed

SDGs	Targets	Sector (sub-sectors) addressing the recommendation
SDG 1: No Poverty 	Target 1.4: Ensure that all men and women, in particular the poor and the vulnerable, have access to basic services	Waste; water
SDG 2: Zero Hunger 	Target 2.1: End hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round	AFOLU (agriculture)
	Target 2.3: Double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment	AFOLU (agriculture), mining
	Target 2.4: By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality	AFOLU (agriculture), mining
	Target 2.a: Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research	AFOLU (agriculture), mining
	Target 2.a; Article 10.3.e: Development of sustainable irrigation programmes for both crops and livestock.	AFOLU (agriculture and livestock)
SDG 3: Good Health and Well-being 	Target 3.3: End the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases	Water pollution; co-benefits from waste (through cleaner neighbourhood, better access to sanitation)
	Target 3.4: Reduce by one third premature mortality from non-communicable diseases through prevention	Co-benefits from waste (by reducing pollution and providing better hygiene)
	Target 3.9: Substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination	Waste; water scarcity and pollution; air pollution
SDG 6: Clean Water & Sanitation 	Target 6.1: Achieve universal and equitable access to drinking water	Water scarcity and water pollution
	Target 6.3: Improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally	Waste; energy (industry); water pollution; mining; thermal power plants
	Targe 6.4: Substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals	Energy (habitat: demand side management, industry); AFOLU (agriculture and green spaces); water scarcity; mining, thermal power plants
	Target 6.5: Implement integrated water resources management at all levels	AFOLU (agriculture and green spaces/forestry); water scarcity and pollution, thermal power plants (TPP)
	Target 6.8: Support and strengthen the participation of local communities	Waste; AFOLU; transport; mining
	Target 6.a: Expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including wastewater treatment, recycling and reuse technologies	Waste; mining

SDGs	Targets	Sector (sub-sectors) addressing the recommendation
SDG 7: Affordable & Clean Energy 	Target 7.1: Ensure universal access to affordable, reliable and modern energy services	Energy (power, habitat); AFOLU (agriculture); TPP
	Target 7.2: Increase share of renewable energy in energy mix	Energy (power, transport, habitat: energy efficiency in building and bye-laws for new construction, industry); mining
	Target 7.3: Double the global rate of improvement in energy efficiency	Energy (power, habitat, industry); TPP
	Target 7.a: Enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology	Energy (power); mining; TPP
	Target 7.b: Expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries in accordance with their respective programmes of support.	Energy (power); AFOLU; TPP; mining
SDG 8: Decent Work and Economic Growth 	All targets	AFOLU (agriculture and livestock)
	Target 8.2: Achieve higher levels of economic production through diversification, upgradation and innovation	Energy; AFOLU (agriculture and livestock); mining
	Target 8.4: Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-year framework of programmes on sustainable consumption and production	Waste; mining
	Target 8.9: Devise and implement policies to promote sustainable tourism	AFOLU (forestry/green spaces)
SDG 9: Industry, Innovation and Infrastructure 	Target 9.1: Develop quality, reliable, sustainable and resilient infrastructure	Energy (habitat: energy efficiency in building, transport); waste; mining
	Target 9.2: Promote inclusive and sustainable industrialization	Energy (industry)
	Target 9.3: Improving access and connectivity to industries/other enterprises	Energy (transport)
	Target 9.4: Upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes	AFOLU (agriculture); waste; energy (industry); water scarcity
	Target 9.5: Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending	Energy (power); waste; mining;
	Target 9.b: Research and innovation in developing countries, including by ensuring a conducive policy environment	Waste; energy (power, industry); air pollution; mining

SDGs	Targets	Sector (sub-sectors) addressing the recommendation
SDG 11: Sustainable Cities and Communities 	Target 11.1: Ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums	Waste; water
	Target 11.2: Safe, affordable, accessible and sustainable transport systems for all	Energy (transport) air pollution
	Target 11.3: Enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management	Waste; energy (power, habitat: energy efficient building);
	Target 11.4: Strengthen efforts to protect and safeguard the world's cultural and natural heritage	AFOLU (forestry); water scarcity
	Target 11.6: Reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management	Waste; energy (power, transport, industry); air pollution; mining; TPP
	Target 11.7: Provide universal access to safe, inclusive and accessible, green and public spaces	AFOLU (green spaces); habitat; air pollution
	Target 11.a: Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening regional development planning	Energy (transport, industry); AFOLU
	Target 11.b: Substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change,	Energy; AFOLU; waste
SDG 12: Responsible Consumption and Production 	Target 12.1: Implement the 10-year framework of programmes on sustainable consumption and production, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries	Energy; waste
	Target 12.2: Achieve the sustainable management and efficient use of natural resources	Energy; AFOLU; waste; air pollution; water pollution; mining
	Target 12.3: Halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses	AFOLU; waste
	Target 12.4: Achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil	AFOLU; waste; air pollution and water pollution; mining
	Target 12.5: Substantially reduce waste generation through prevention, reduction, recycling and reuse	Waste; energy (habitat and industry); mining
	Target 12.6: Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle	Waste; Energy (industry); mining
	Target 12.8: Ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature	Individual action and behavioural change communication
	Target 12.a: Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production	Waste; AFOLU (agriculture and livestock)
SDG 13: Climate Action 	All targets	All sectors and sub-sectors
SDG 14: Life under Water 	Target 14.1: Prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution.	Waste (single use plastic)

SDGs	Targets	Sector (sub-sectors) addressing the recommendation
SDG 15: Life on Land	Target 15.1: Ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements	AFOLU; waste; water pollution; mining
	Target 15.2: Promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation	AFOLU (forestry/green spaces)
	Target 15.3: Combat desertification, restore degraded land and soil	AFOLU (forestry/green spaces)
	Target 15.5: Take urgent and significant action to reduce degradation of natural habitats, halt loss of biodiversity	AFOLU (forestry); water pollution; mining
	Target 15.9: Integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies	AFOLU; water scarcity; mining
	Target 15.a and 15.b: Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity, ecosystems and sustainable forest management	AFOLU and water scarcity
SDG 17: Partnerships for the Goals	Target 17.7: Promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries	Energy; AFOLU; waste; BCC; individual action
	Target 17.16: Enhance the global partnership for sustainable development, complemented by multi-stakeholder partnerships that mobilize and share knowledge, expertise, technology and financial resources, to support the achievement of the sustainable development goals in all countries, in particular developing countries	Energy; AFOLU; waste

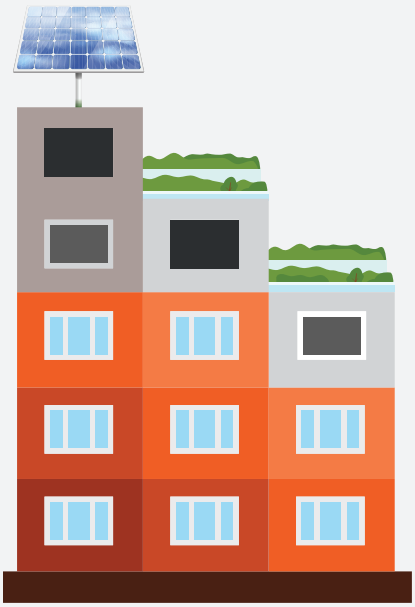
6.6. Promoting voluntary individual climate action

Waste management

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

Housing

1. Insulate the building as much as possible, ensure proper sealing of doors and windows, and install window shades, shutters, screens, etc. on windows for an extra layer of insulation and to prevent cooling loss.
2. Develop and maintain provision for rainwater harvesting
3. Install solar rooftop panels, if feasible
4. Adopt wastewater recycling and reuse
5. Rooftop gardens can considerably reduce space cooling requirement



Lighting

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

Kitchen

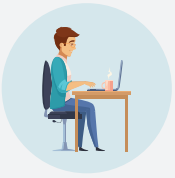
1. While cooking on gas stove, use moderate flame setting to conserve LPG
2. Prefer the use of pressure cookers
3. Keep the burner clean
4. Use lids to cover the pan while cooking
5. Use flat bottomed pan on electric stove
6. Turn off electric stove several minutes before the specified cooking time

Other climate-conscious precepts

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

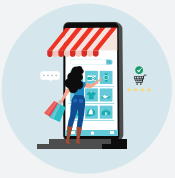
Carry your own bottled water, adopt minimalist lifestyle to reduce overconsumption of resource, purchase only when necessary.

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

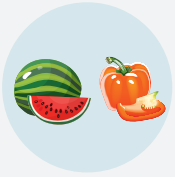


If possible, opt for work from home option for a few days in a week.

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



Choose standard shipping while ordering online.



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

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

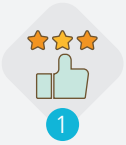
Develop a habit of repair and reusing appliances and products at home instead of buying new ones. Follow reduce, reuse and recycle principles in the household to reduce footprint.

Include more meat-free meals and limit food wastage.

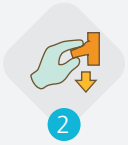
Buy local and organic food items not only for health but also to cut down emissions from transport and chemical fertilisers.

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

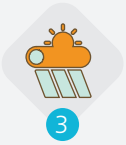
Daily use appliance



1. Purchase BEE star-rated energy efficient appliances



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



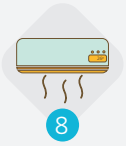
3. Replace electric water heater with a solar water heater, if feasible

4. Unplug idle devices/appliances.

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

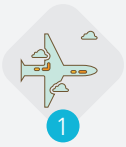
6. Proper maintenance of air conditioners helps to increase efficiency

7. Do not overload the refrigerator



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

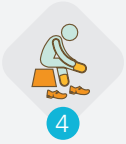
Transport



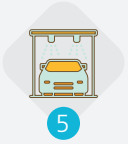
1. Choose direct flights to reduce carbon footprint

2. Travel light to reduce carbon emissions

3. Strictly abide by pollution norms

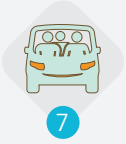


4. Put on your shoes for short trips



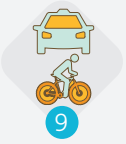
5. Ensure regular maintenance of vehicles

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



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

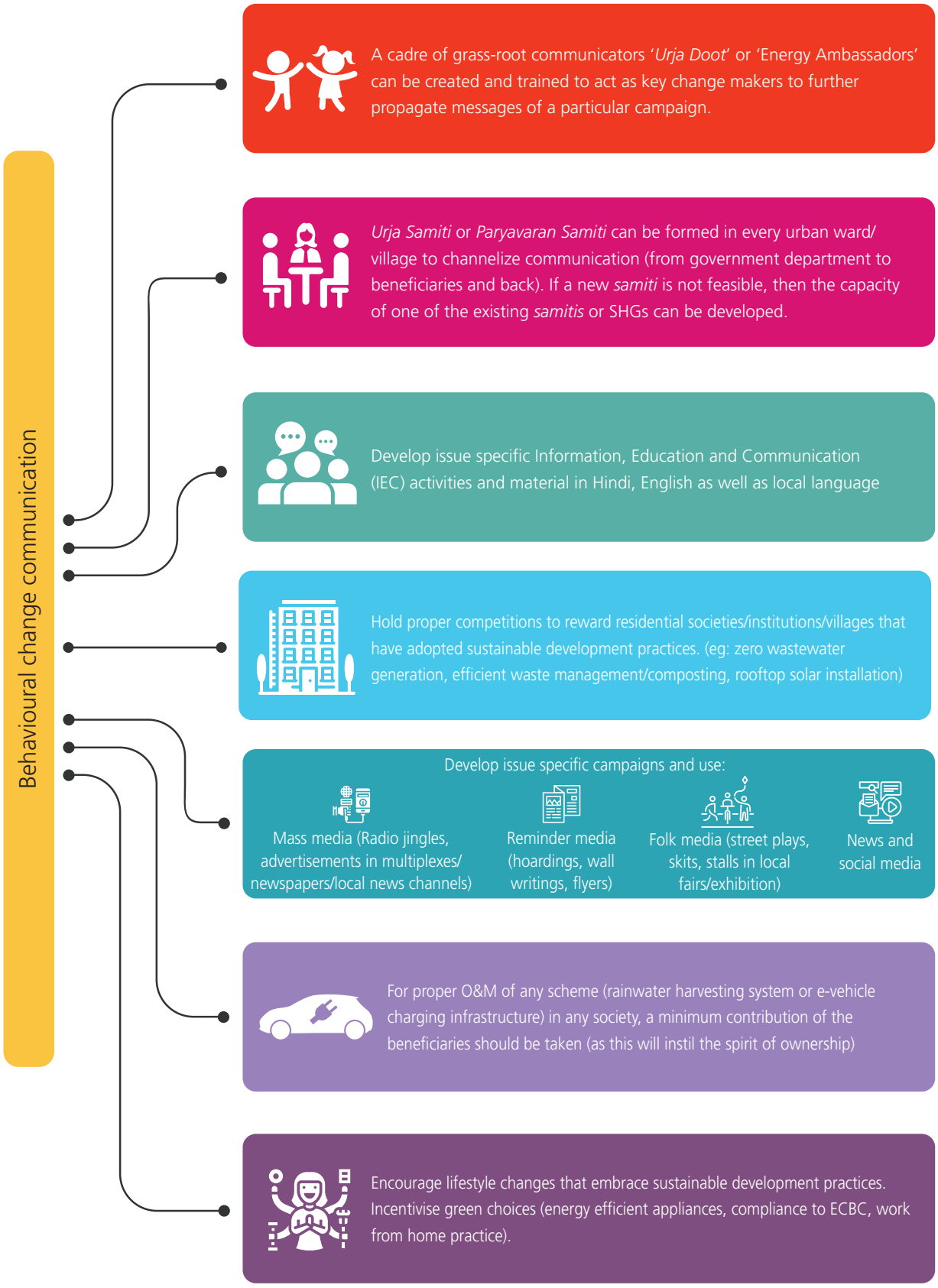
8. Shift to clean, non-petroleum fuels such as electricity (through RE) to power vehicles



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

10. Swicth off the ignition at traffic signals

6.7. Behavioural Change Communication (BCC) techniques



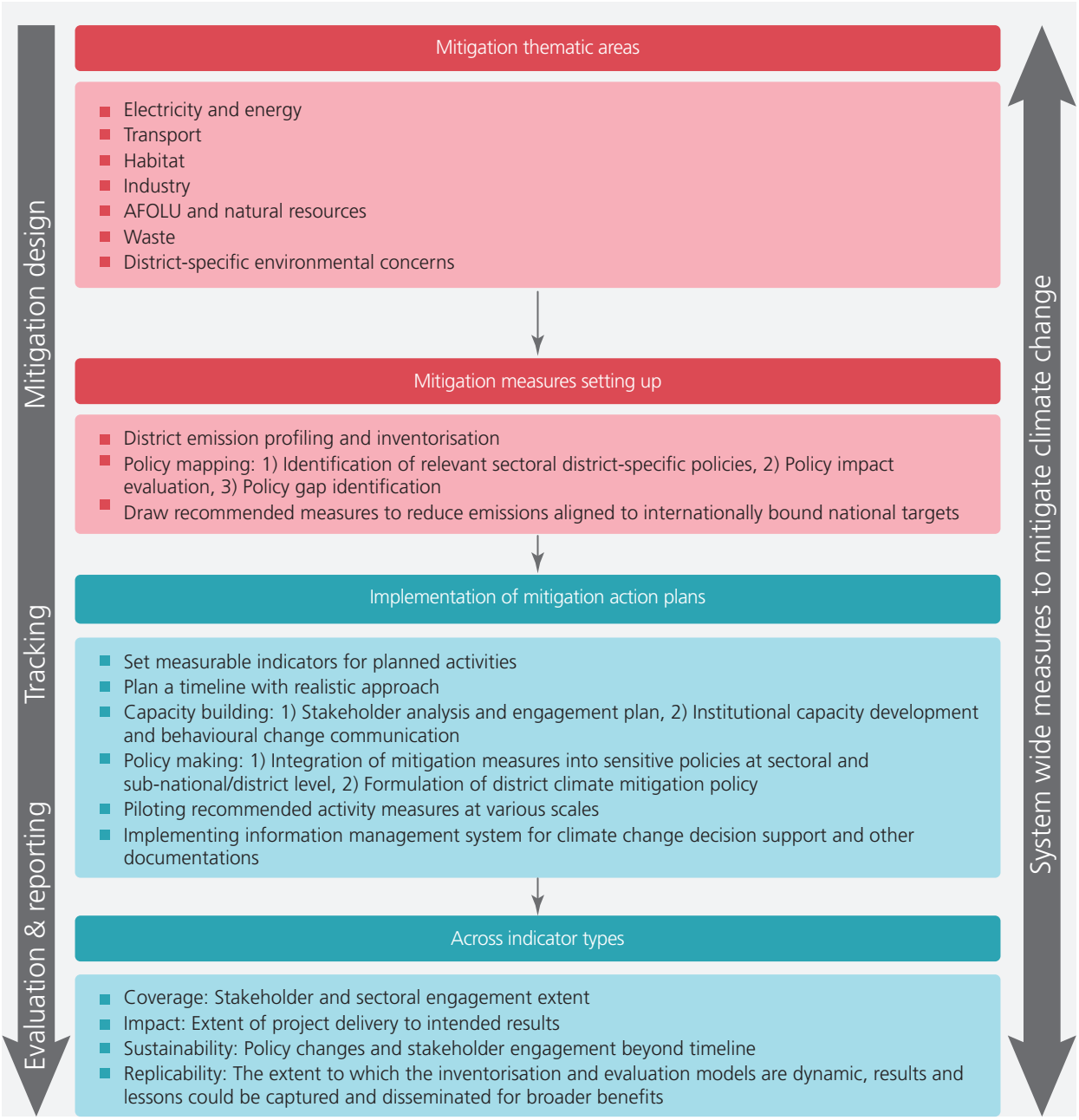
MONITORING AND EVALUATION PLAN

Model of Nagpur Mazi Metro platform

7. MONITORING AND EVALUATION PLAN

7.1. Framework for monitoring and evaluation

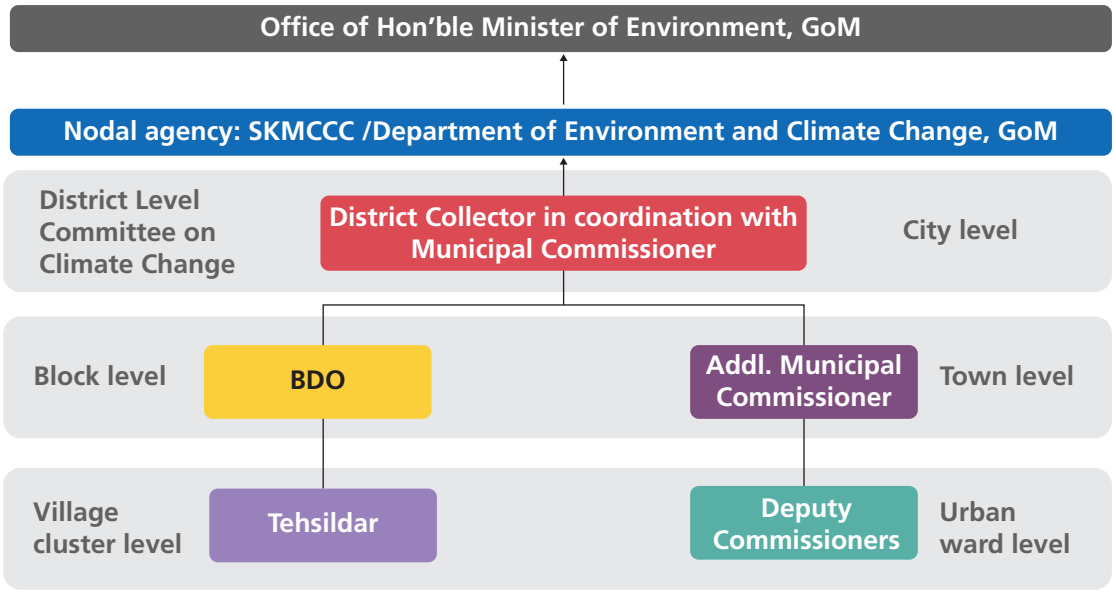
This section describes the planning for monitoring and evaluation (M&E) of the climate change mitigation measures that the district may adopt for sectors identified in the report. M&E is crucial to realise the achievement and track the effectiveness of results envisaged, in order to compliment the national endeavours to attain nationally determined contributions. The framework proposes to incorporate a) district-level mitigation profiling, b) planning for mitigation measures, c) tracking of implementation and integration to the national mitigation response, and d) evaluation of relevance and effectivity.[32]



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

7.2. Proposed institutional set-up

As a central authority or body to steer the wheels of climate mitigation, it is recommended to formulate a district climate cell/committee or include the perspective of climate change in the existing District Environment Committee.[33] The committee shall assign tasks according to stakeholder analysis and engagement as outlined in the following model. This monitoring and evaluation committee shall comprise of representatives from concerned administrative bodies, sectoral experts, civil society organisations and civic/other associations (as applicable) and shall similarly be formed at the block, ULB, cluster and ward level. The committee shall oversee implementation of deliverables, following the prescribed recommendations/framework and the outputs. A proposed set-up of the committee at each of the levels is as follows:



District level committee

Chairman: District Collector

Members: Municipal Corporation Commissioner, District Development Officer (DDO), District Planning Officer (DPO), District Agriculture Officer (DAO), Superintendent of Police, Deputy Collector, district-level officers/representatives of: Pollution Control Board, MSMEs, Agriculture & Animal Husbandry, Department of Statistics and Planning, District Urban Development Agency, Industry Department, Urban Development Department (UDD), Water Supply, RDD, Health Care Department, Regional Transport Officer (RTO), etc.

Block level

Members: Representatives of the departments at the Block level.

Town level

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

Tehsil level

Members: Sarpanch and other PRI members, Self-help group members, head of women committee, Village water sanitation committee (VWSC), grassroots communicators

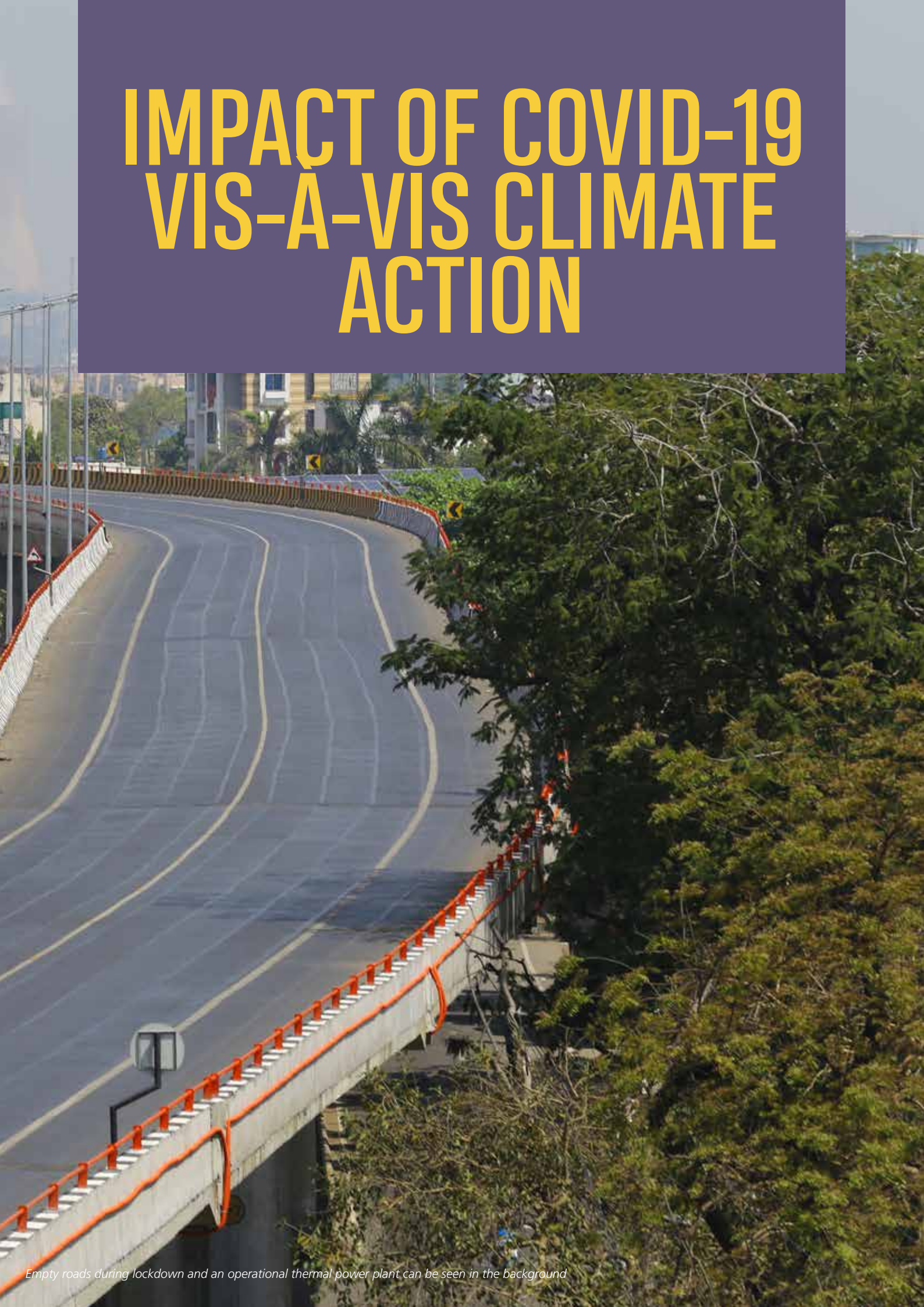
Urban ward level

Members: Department representatives, president of RWAs, grassroots communicators, civil societies

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


Prestige
Hospital

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



Empty roads during lockdown and an operational thermal power plant can be seen in the background

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

8.1. Introduction

The ongoing COVID-19 pandemic has gravely affected the country. Nagpur reported a total of 4,93,445 cases as of Sep 30, 2021, making up for 7.5 percent of the state's total case load (Covid19India, 2021). This has affected the management of climate crisis.

Positive impacts: Lockdowns have had several positive impacts on the environment. For the first time in nearly four decades, India has seen a reduction in CO_2 emissions by 30 million tonnes CO_2 in FY2019-20 due to a slowdown in economic activity and restrictions (Lauri & Dahiya, 2020). In April 2020, aerosol levels were at a 20-year low for that time of the year in north India, one of the most polluted regions in the world (NASA, 2020). Improved water quality and biodiversity sightings were also reported from different parts of the country during mid-March to June, 2020 (Goswami, 2020).

However, the economic and social (both direct and indirect) costs of the pandemic are likely to take priority over climate goals and commitments. The following are some likely impacts of COVID-19 vis-à-vis climate action, inferred from observations across the country and drawn for the district of Nagpur.

8.2. Energy consumption

8.2.1 Electricity demand

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

The total energy demand reduced largely due to decreased demand from services and industry sectors (IEA, 2020). Maharashtra's electricity consumption declined by 13 percent in the first eight months of 2020. In the long run, India's electricity demand is projected to be 7 to 17 percent lower by 2025 due to the downward revision of its GDP growth, partly due to the COVID-19 economic shock (Spencer, 2020).[34]

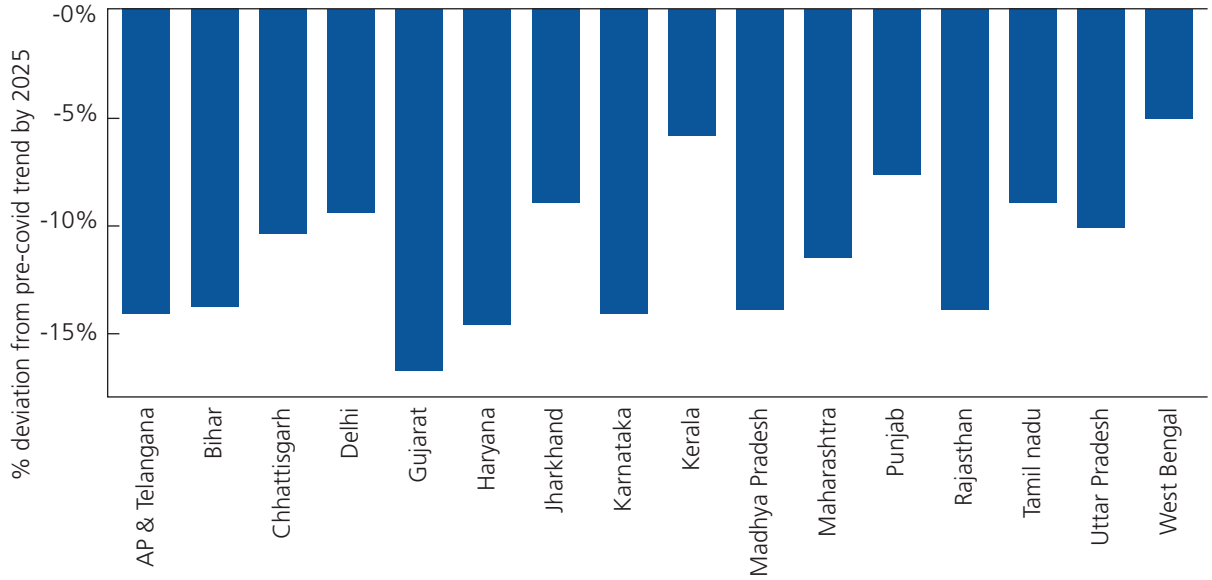


Figure 46: 2025 deviation of electricity demand from pre-COVID trends projected from major Indian states

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

Outlook for Nagpur

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

8.2.2 Electricity generation in Nagpur district

Nagpur district has six coal-fired thermal power plants (TPP), namely: Mauda thermal power station (TPS), Koradi TPS, Khaparkheda TPS, Mihan TPS, Butibori TPP, and Bela TPS. Butibori TPP has been non-functional since February 2019, while Mihan TPS and Bela TPS have been non-functional for the whole of 2019 and 2020.

In order to determine the impact of lockdowns and reduced demand (due to COVID-19) on electricity generation, a month-on-month comparison was drawn on the total electricity generated by the TPPs in the district from January, 2019 till December, 2020.

This exercise shows that electricity generation took a hit post March 2020. A stark difference in electricity generation is visible in the months of April 2020 (69.37 percent decrease), May 2020 (61.94 percent decrease) and June 2020 (63.68 percent decrease), with respect to 2019. The findings are presented in Figure 47.

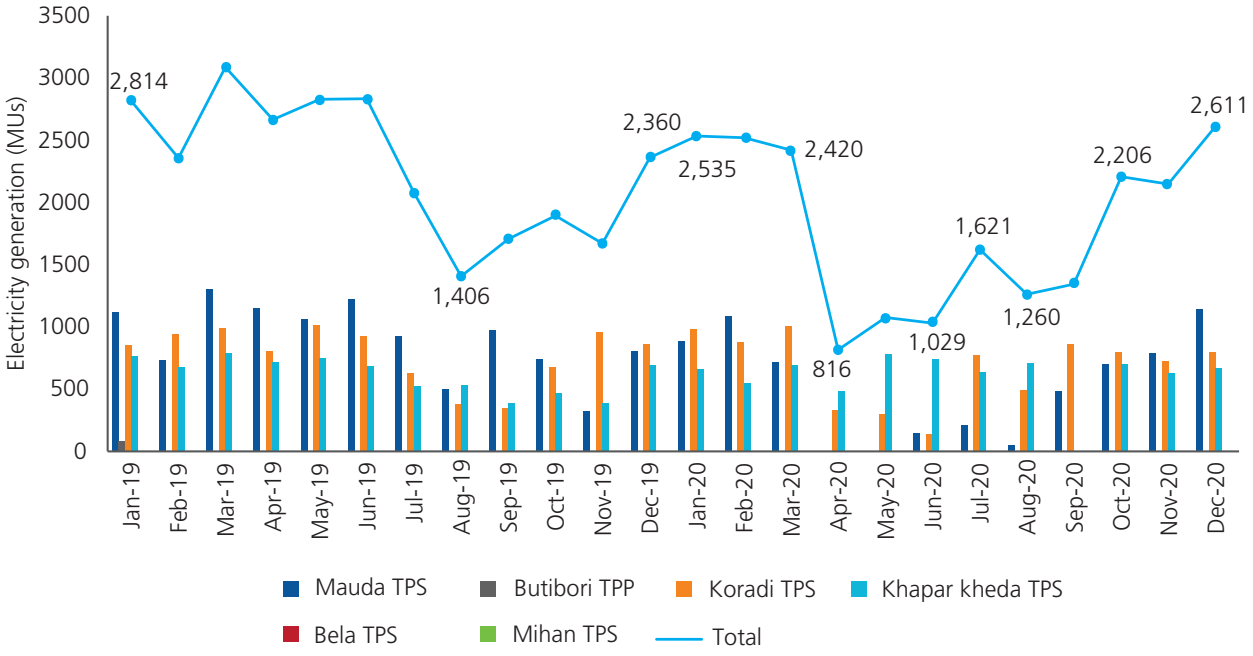


Figure 47: Monthly total electricity generated (Jan 2019 till Dec 2020) from the TPPs in Nagpur district.

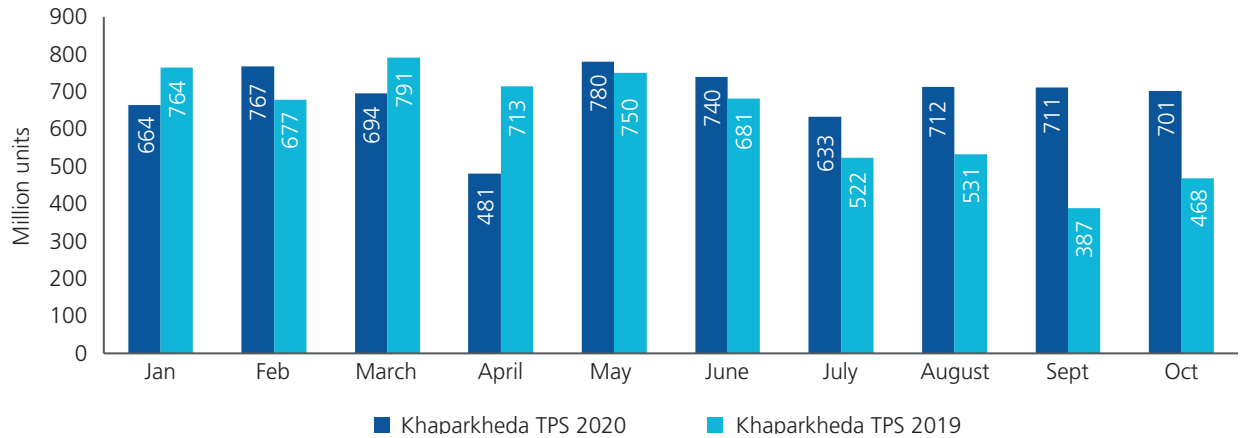


Figure 48: Monthly comparison of electricity generated at Khaparkheda TPS (Jan to Oct, 2019 and 2020)

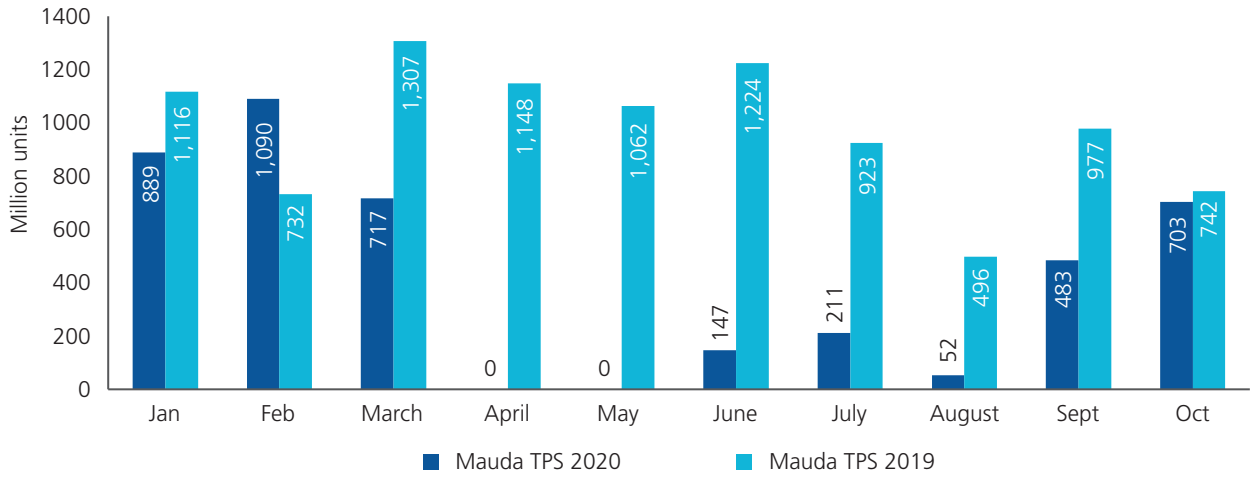


Figure 49: Monthly comparison of electricity generated at Mauda TPS (Jan to Oct, 2019 and 2020)

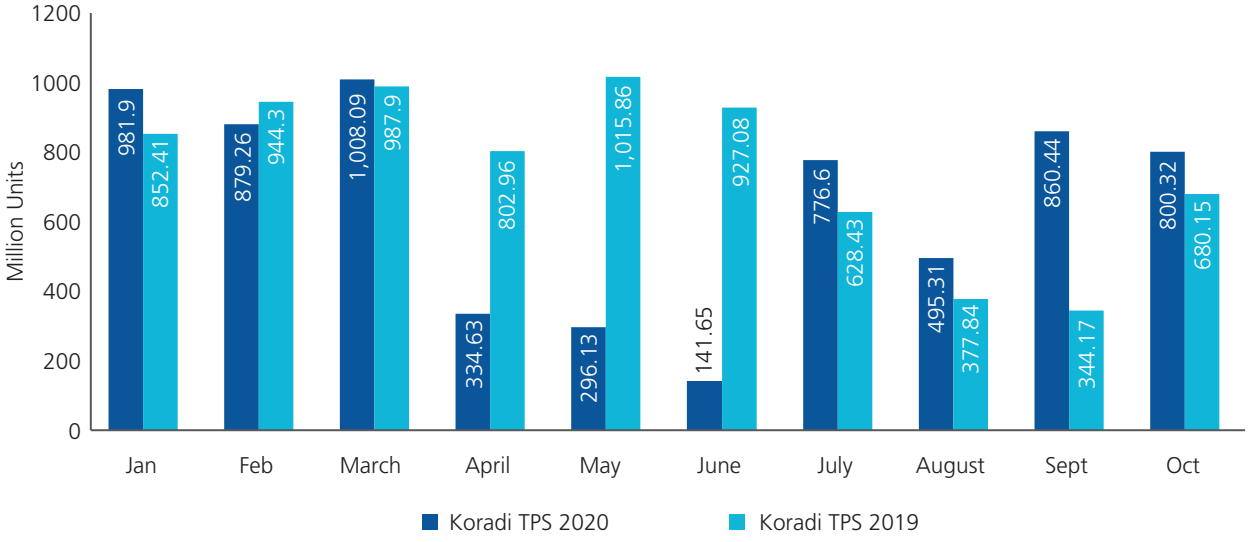


Figure 50: Monthly comparison of electricity generated at Koradi TPS (Jan to Oct, 2019 and 2020)

8.2.3 Fuel consumption

India's fuel consumption fell by 45.8 percent to 9.93 million tonnes in April, down from 18.32 million tonnes of fuel consumed in the same month a year back (Business Standard, 2020). The only fuel that showed growth was LPG as the government dole of free cooking gas cylinders to poor households fired up consumption by 12.2 percent to 2.13 million tonnes in April 2020.

Outlook for Nagpur

As of September 2020, the sale of petrol and diesel was 70 percent of the pre-COVID levels. This was due to reduced movement of private vehicles since most people were staying home to prevent the spread of the disease (The Times of India, 2020). During this time, the reliance on fossil fuels was clearly decreasing. This provides an opportunity to bring about a paradigm shift in the transport system towards e-mobility. The district needs to take up planning and phase-wise implementation of e-mobility infrastructure and incentives on a priority basis.

8.3. Agriculture

COVID-19 caused disruption to agriculture and supply chains. Inability to hire harvester and other machinery interrupted harvesting activities for wheat and pulses (during *rabi* season). The closure of hotels, restaurants, sweet shops, and tea shops during the lockdown caused a depression in milk sales. Shortage of staff at cold storage and food processing units also impacted the supply chain for milk and milk products. Meanwhile, poultry farmers were also badly hit due to misinformation on social media.

While the lockdown impacted the availability of seeds, machinery and irrigation equipment, however, reverse migration proved beneficial for kharif (monsoon) crops. As of July 2020, total kharif crops have been sown on 691.86 lakh ha area against 570.86 lakh ha area during the corresponding period of last year, an increase of 21.20 percent (WBCSD, 2020) (PIB, 2020).

Outlook for Nagpur

In order to prevent loss of yield, the district administration must ensure availability of irrigation facilities, composts, seeds, and farming machines during sowing and harvesting periods and provide support where necessary, in consultation with farmer bodies. Small farmers must be prioritised while provisioning facilities. Further, the prices paid to farmers must be regulated to ensure steady income.

8.4. Migration

India witnessed a national migrant crisis resulting from the nationwide lockdown, leading to widespread job loss, particularly for daily wage labourers. The huge migrant exodus from cities to villages added pressure on energy, food and water resources in rural areas, thereby increasing the waste footprint. Post the commencement of the lockdown, the Madhya Pradesh-Maharashtra border saw a massive movement of migrants. Nagpur district faced a massive outflux of migrants during the lockdown period.

Outlook for Nagpur

With unlocking and renewed opportunities of employment, some migrants may return to the city. The district administration must understand the migration pattern in Nagpur and plan allocation and management of resources accordingly. Agriculture sector schemes, MGNREGS and state employment guarantee programmes can be used to fast-track incorporation of these migrants into the state roll to open employment opportunities for them. To ensure safety of immigrants, the should continue rapid testing and have adequate isolation centres.

8.5. Waste management

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

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

8.6. Air pollution[35]

The term "PM" refers to particulate matter i.e., tiny particles suspended in air in the form of either solid or liquid droplets. They comprise of various organic and inorganic components including acids, ammonia, black carbon, water, mineral dust, etc. The major sources of particulate matter are vehicular, industrial, domestic fuel burning, construction, natural sources including soil dust (re-suspended) and other anthropogenic sources. PM can be primary – mechanically generated including carbonaceous fly-ash particles produced from high temperature combustion of fossil fuels in coal power plants, and secondary - formed in the atmosphere through reactions of primary gaseous pollutants (NO_2, NH_3, SO_2, non-methane volatile organic compounds). The size of these particles is critical in defining their potential for causing health problems. Particles less than 10 µm in diameter penetrate deep into the lungs causing serious health concerns and reduce visibility (cause haze). Of this, particles having diameter less than 2.5 µm ($PM_{2.5}$) pose greater risk to respiratory and cardiovascular mobility and mortality over the long term.

Comparisons of 24-hour average of $PM_{2.5}$ over Nagpur district between Jan to May for the years 2019 and 2020 show that $PM_{2.5}$ concentration has reduced significantly during the lockdown months (Figure 51 and 52) and the air quality remained in the good category (0-30 and 30-60 µg/m^3) according to Indian standards. A similar reduction in PM_{10} concentration was observed during the lockdown months in India in comparison to the previous year. Except for the months of winter i.e., January and February, the PM_{10} concentration remained under 0-100 µg/m^3 range (Figure 53 and 54).

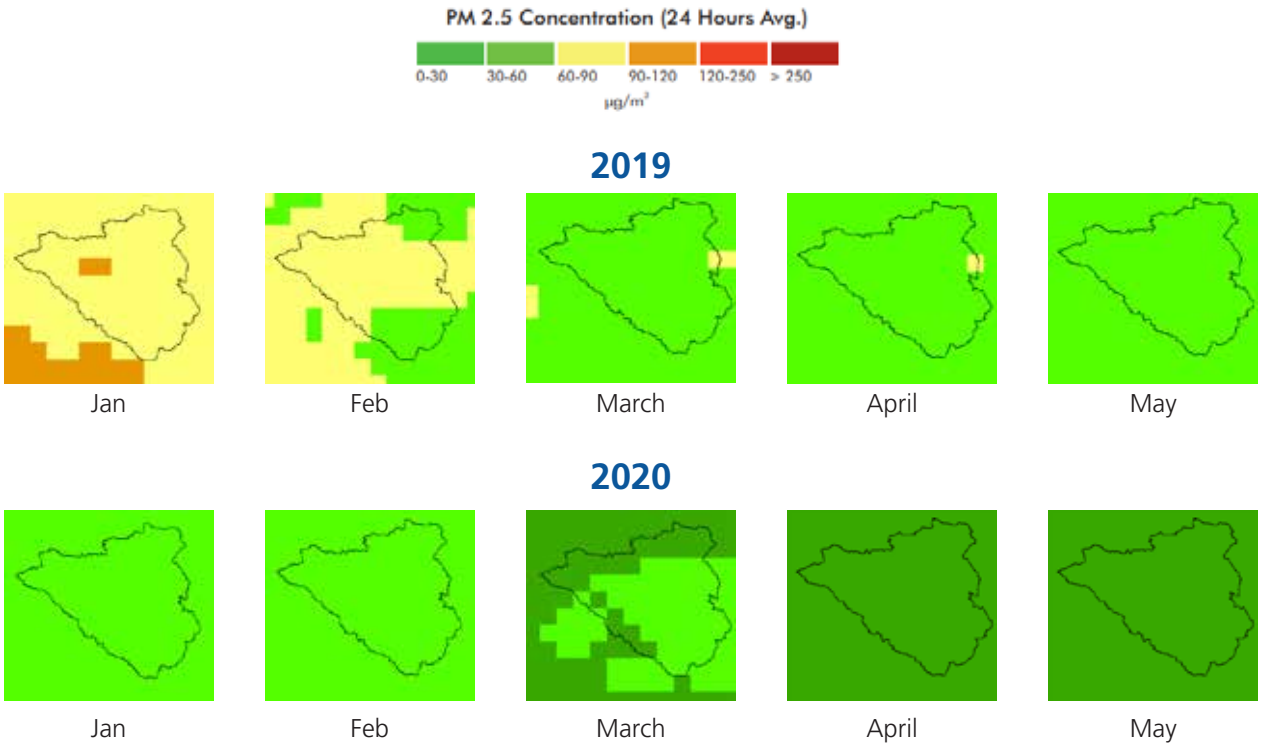


Figure 51: $PM_{2.5}$ concentration in Nagpur for January to May, 2019 vs. 2020

35 The $PM_{2.5}$ and PM_{10} modal forecast data obtained from European Centre for Medium-Range Weather Forecasts (ECMWF) and analysed at GIS platform for mapping of monthly mean values.
The data can be accessed from https://apps.ecmwf.int/datasets/data/cams-nrealtime/levtype=sfc/
For the mapping of NO_2 and SO_2 the data were obtained from following URLs. https://developers google.com/earth-engine/datasets/catalog/COPERNICUS_S5P_OFFL_L3_NO2
https://developers google.com/earth-engine/datasets/catalog/COPERNICUS_S5P_OFFL_L3_SO2

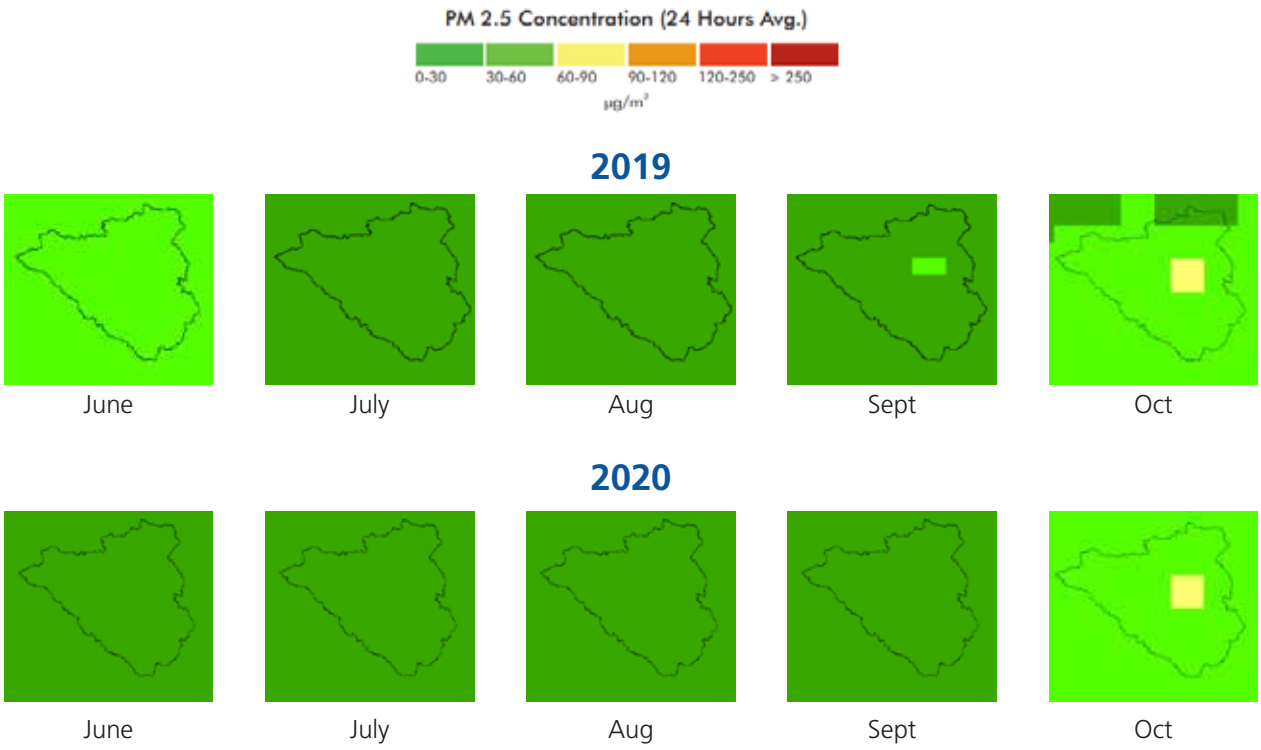


Figure 52: $PM_{2.5}$ concentration in Nagpur for June to October, 2019 vs. 2020

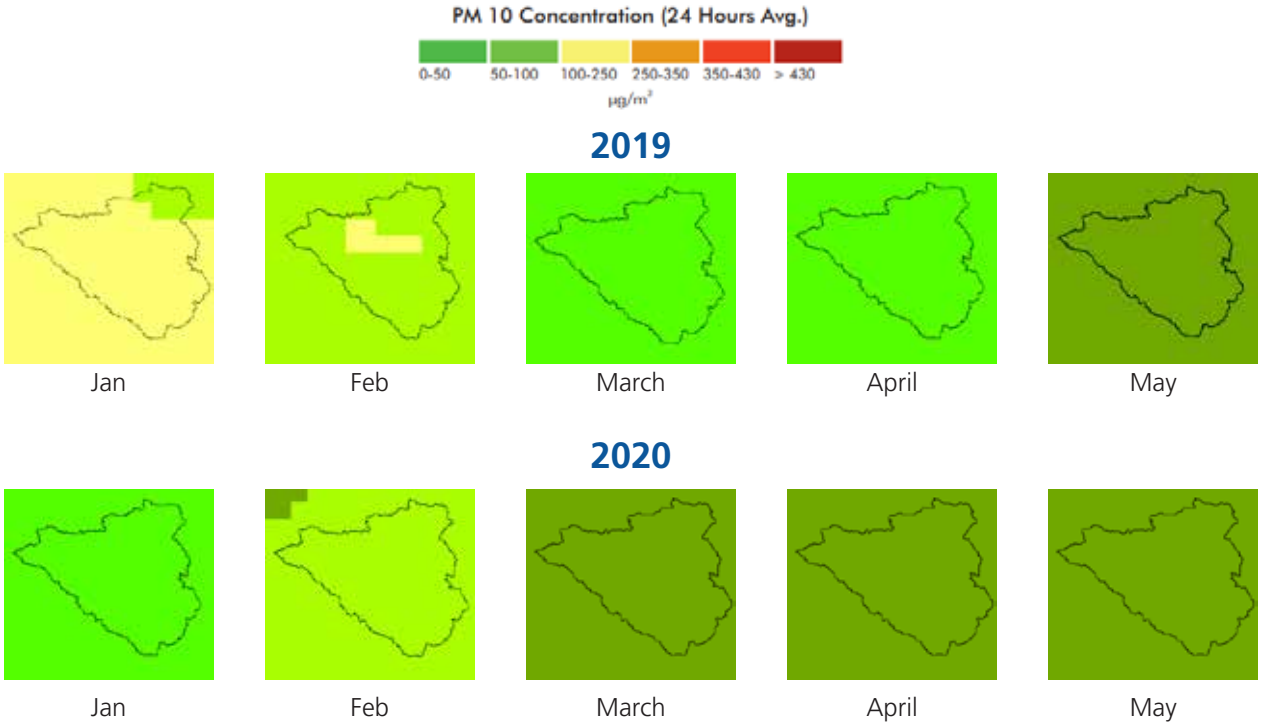


Figure 53: PM_{10} concentration in Nagpur for the months of January to May 2019 vs. 2020

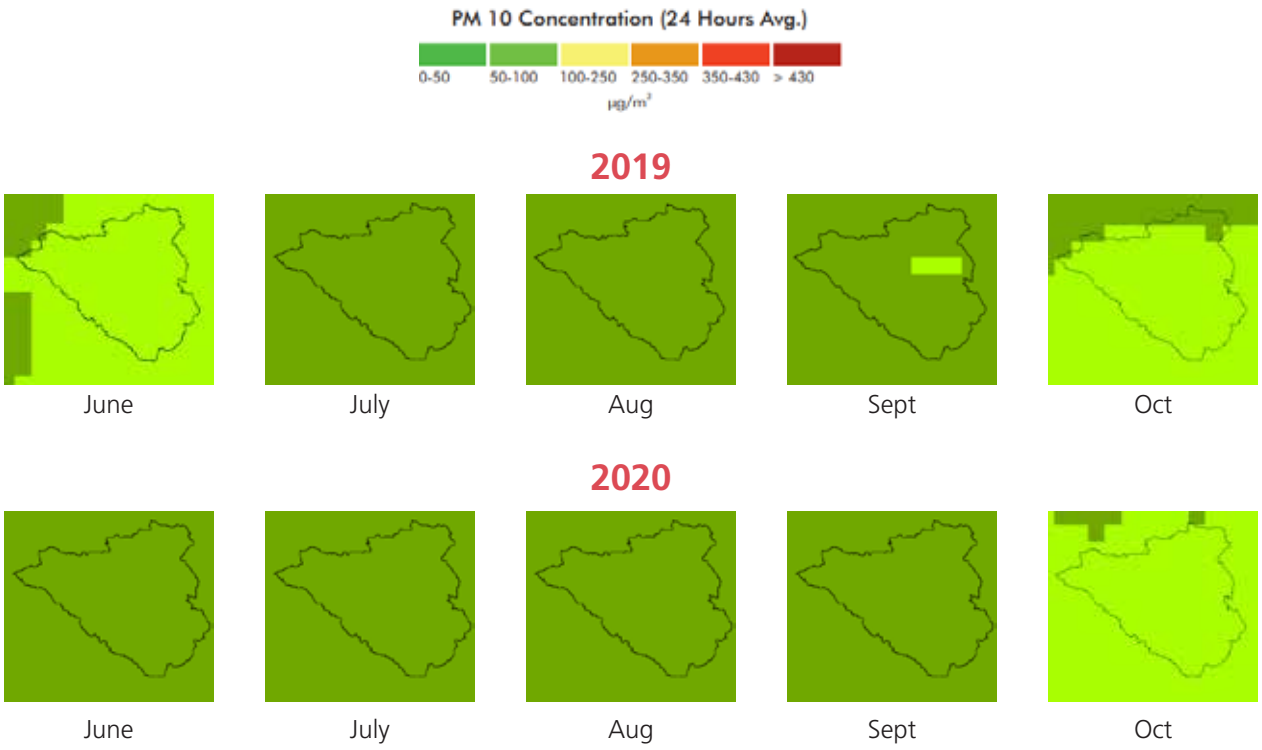


Figure 54: PM_{10} concentration in Nagpur for the months of June to October 2019 vs. 2020

During the lockdown, most anthropogenic activities were at a standstill or were limited. Therefore, the concentration of nitrogen dioxide over Nagpur city (upper region) reduced significantly in comparison to 2019, (especially from March to September). From a range of 172-200 µmole/m² in 2019, the concentration decreased to the range of 57-85 µmole/m² in 2020 (Figure 55).

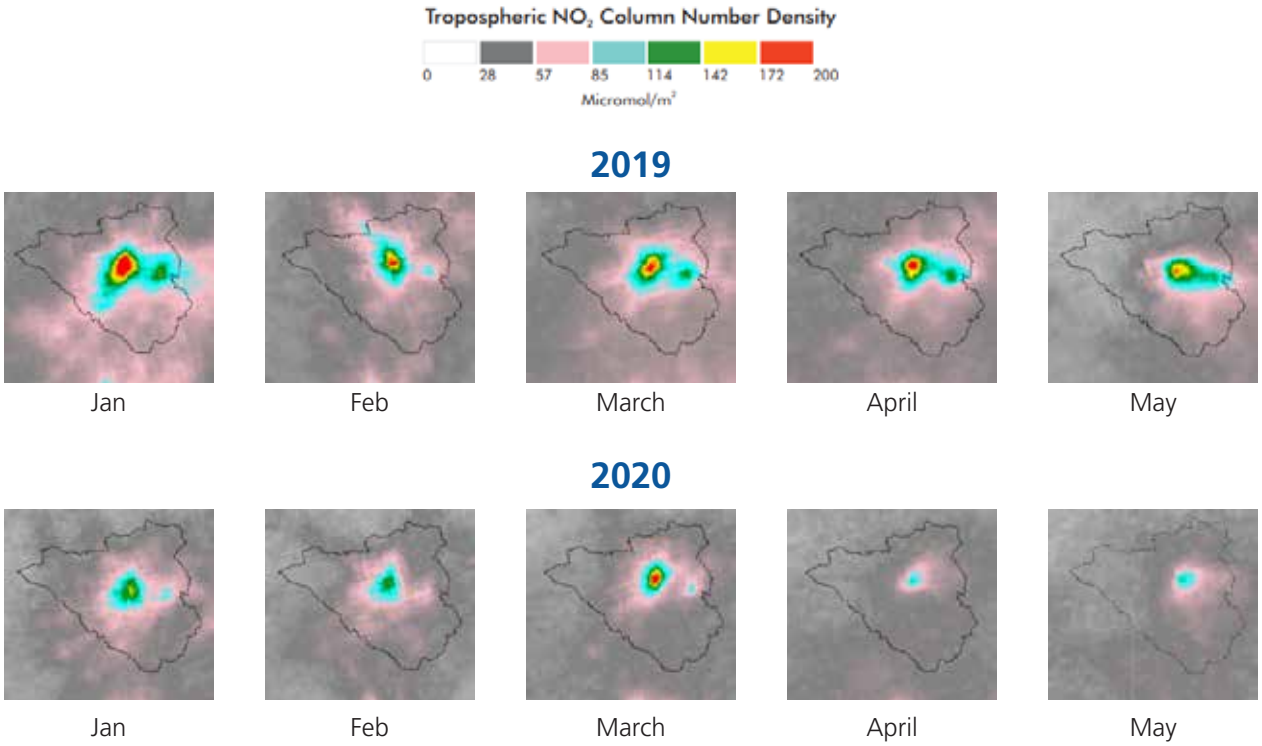


Figure 55: NO_2 concentration in Nagpur during January to May 2019 vs. 2020

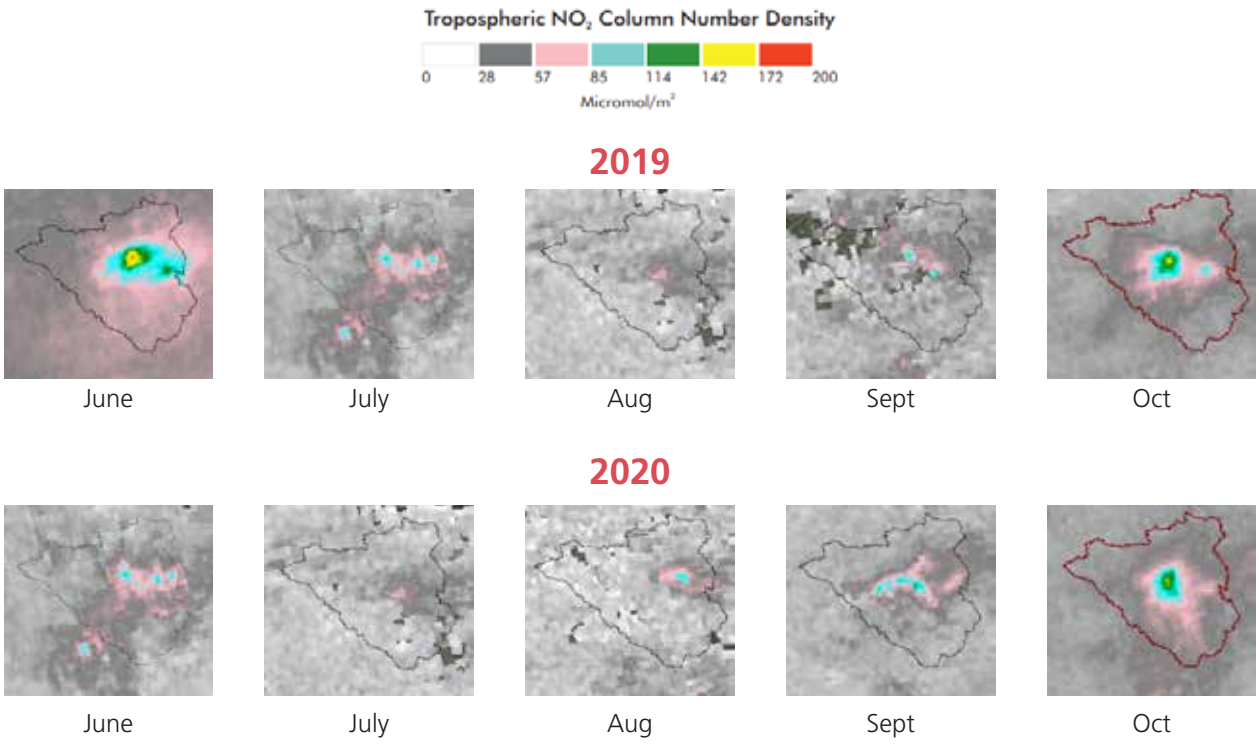


Figure 56: NO_2 concentration in Nagpur during June to October 2019 vs. 2020

Similar effect was observed on the SO_2 concentration over Nagpur with a sharp decline in April and May 2020 from its usual high 500-420 µmole/m² to 0-140 µmole/m² (Figure 57). Patches of SO_2 were observed over the entire district and were particularly dense near urban agglomerations (Figures 57 and 58).

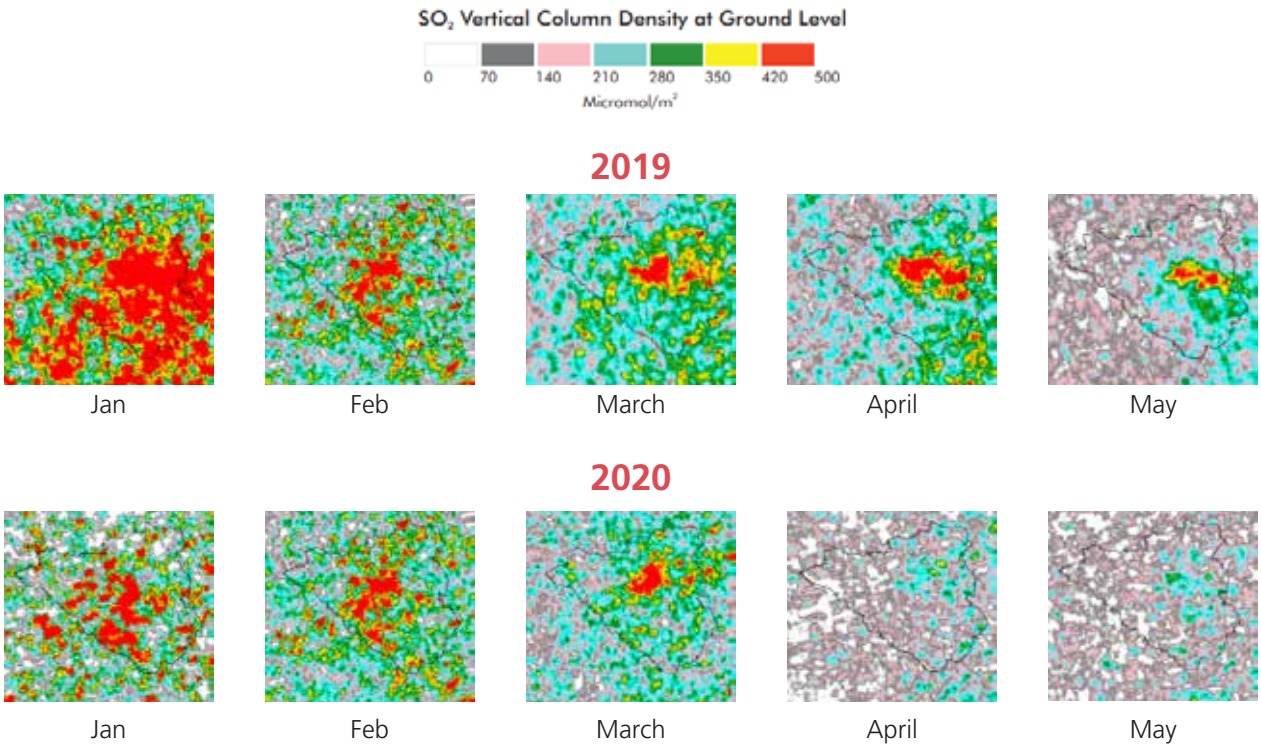


Figure 57: SO_2 concentration in Nagpur during January to May 2019 vs. 2020

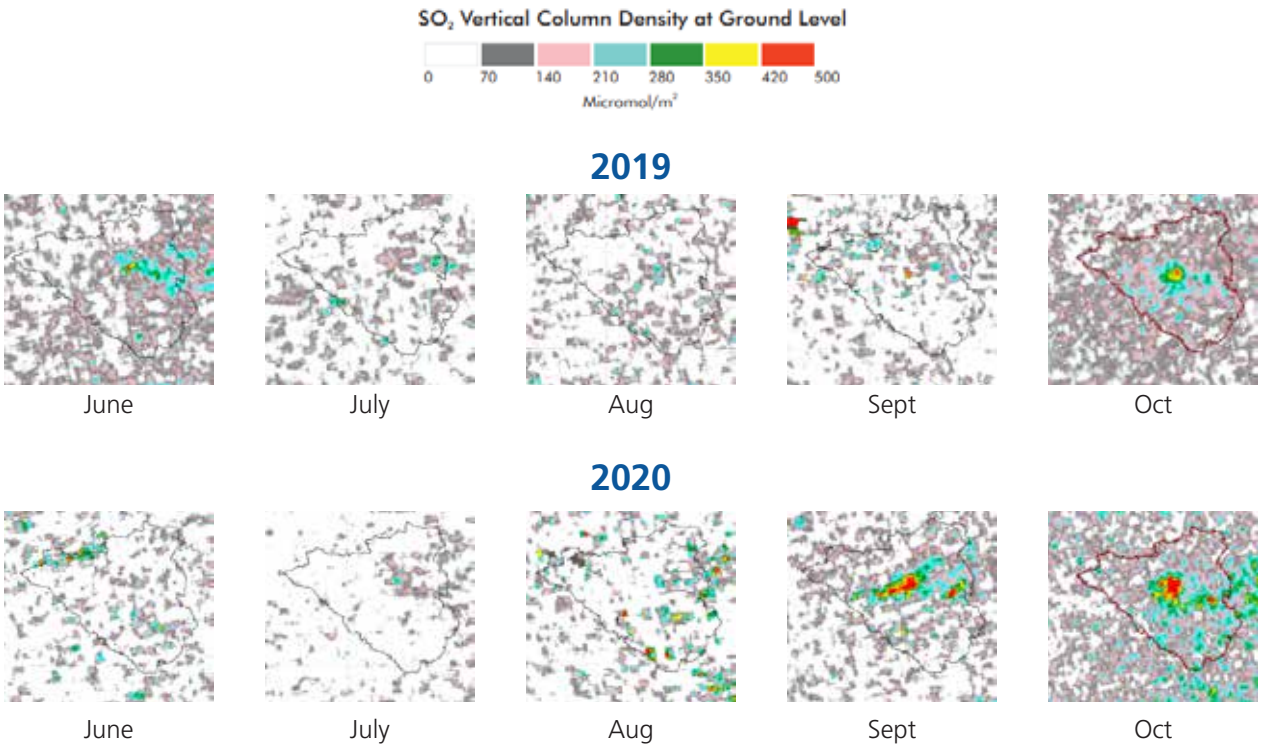


Figure 58: SO_2 concentration in Nagpur during June to October 2019 vs. 2020

Outlook for Nagpur

The COVID-19 lockdown provided a temporary relief from air pollution in most Indian cities. However, with the unlock process, air pollution levels increased gradually, reaching pre-Covid levels post-October 2020, when normal life resumed. Source apportionment studies can help identify air pollution hotspots in the district. Authorities in Nagpur can focus on measures to minimise and/or optimise industrial processes in order to reduce emissions. Further, authorities must work towards decreasing and distributing traffic during peak hours and encourage the use of public transport to minimise vehicular emissions.

THE WAY FORWARD

Nagpur metro

THE WAY FORWARD

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

Nagpur district has displayed its commitment towards mitigating climate change. The district has been a pioneer in undertaking several measures to address climate change. For instance, Nagpur was one of the first cities in India to introduce electric vehicle charging stations among other sustainable transport interventions in the past, such as biofuel buses. Together with the Nagpur Metro (which was launched in March 2019) and improvement in last-mile connectivity, the district has the potential to emerge as a leader in public transport connectivity in India. In terms of promoting e-mobility, the Maharashtra EV Policy, 2021 provides multiple incentives including subsidies, ease of parking, exemption from taxes, etc. to promote and fast track EV integration into the modal share. In July 2021, Nagpur was one of the winners in India Cycles4Change Challenge, this feat can act as a precursor to promote NMT in the district. Nagpur is also one of the first cities in India to introduce a heat action plan that strengthens response towards heat stress conditions in the city.

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

The analysis of district-level policy and scheme-wise budgetary allocation with respect to climate action can help in understanding the available avenues for financing climate action by streamlining existing policies and programmes.

However, this must be treated as a dynamic document and the action plan can be updated regularly with the latest emissions profile and mitigation potential of the district. Organising periodic stakeholder consultations would help strengthen the action plan, as per the changing requirements of the district.

Citizen participation in Cycles4Change Challenge, an initiative by Smart Cities Mission, MoHUA, GoI Source: smartnet.niua.org

REFERENCES

Albert, G., & Mahalel, D. (2006). Congestion tolls and parking fees: a comparison of the potential effect on travel behavior. *Transport Policy, 13*(6), 496-502. doi:https://doi.org/10.1016/j.tranpol.2006.05.007

Business Standard. (2020). *COVID-19: India's fuel consumption fals 46% in April, may rebound in May.* Retrieved from https://www.business-standard.com/article/economy-policy/covid-19-india-s-fuel-consumption-falls-46-in-april-may-rebound-in-may-120051000308_1.html

CEA. (2020, October). *GROWTH OF ELECTRICITY SECTOR IN INDIA FROM 1947-2020.* Retrieved from Central Electricity Authority: https://cea.nic.in/wp-content/uploads/pdm/2020/12/growth_2020.pdf

CEA Executive summary on Power sector. (2019). Retrieved from www.cea.in: http://cea.nic.in/reports/monthly/executivesummary/2019/exe_summary-03.pdf

Census of India. (2011). District Census Handbook: Nagpur. Retrieved from https://censusindia.gov.in/2011census/dchb/DCHB_A/27/2709_PART_A_DCHB_NAGPUR.pdf

CGWB. (2013). *District Profile - Nagpur.* Retrieved from http://cgwb.gov.in/District_Profile/Maharashtra/Nagpur.pdf

Covid19India. (2021). *Covid 19 Maharashtra.* Covid19India.org. Retrieved from https://www.covid19india.org/state/MH

CPCB. (2015). *Inventorisation of sewage treatment plants.* Govt of India, Central Pollution Control Board. Delhi: CPCB. Retrieved from https://nrcd.nic.in/writereaddata/FileUpload/NewItem_210_Inventorization_of_Sewage-Treatment_Plant.pdf

CPCB. (2020). *Guidelines for Handling, Treatment and Disposal of Waste Generated during Treatment/Diagnosis/ Quarantine of COVID-19 patients.* Central Pollution Control Board. Retrieved from https://www.mohfw.gov.in/pdf/63948609501585568987wastesguidelines.pdf

DACNET. (2018). *Total area and classification of area in each district of MP state for the year ending 2017-18.* DACNET: Web based Land Use Statistics Information System. Retrieved from http://aps.dac.gov.in/LUS/Public/Reports.aspx

Department of Agriculture. (2019). *Land Utilization Statistics 2018-19.* Govt of Maharashtra, Department of Agriculture. Retrieved from http://krishi.maharashtra.gov.in/Site/Upload/Pdf/Lan_utilization_statistic_2018-19.pdf

Department of Agriculture. (2019). *Scheme for Timely Reporting of Agril. Intelligence Land Utilisation Statistics 2018-19.* Govt of Maharashtra, Department of Agriculture. DACNET: Web based Land Use Statistics Information System. Retrieved from http://krishi.maharashtra.gov.in/Site/Upload/Pdf/Lan_utilization_statistic_2018-19.pdf

Department of Agriculture. (2020). *Fourth advance estimates of area, production & productivity of principal kharif and rabi crops during 2019-20 in M.S. .* Govt of Maharashtra, Department of Agriculture. Retrieved from http://krishi.maharashtra.gov.in/Site/Upload/Pdf/Final_DISTRICTWISE_FORTH_ADVANCE_ESTIMATE__Kh_2019-20_as_on_09-07-2020.pdf

Department of Agriculture. (2020). *Fourth advance estimates of area, production & productivity of principal kharif and rabi crops during 2019-20 in Maharashtra.* Govt of Maharashtra, Department of Agriculture. Retrieved from http://krishi.maharashtra.gov.in/Site/Upload/Pdf/Final_DISTRICTWISE_FORTH_ADVANCE_ESTIMATE__Kh_2019-20_as_on_09-07-2020.pdf

Department of Heavy Industry. (2020). *FAME India Scheme Phase II.* Ministry of Heavy Industries & Public Enterprises, Govt of India. Retrieved from https://fame2.heavyindustry.gov.in/ModelUnderFame.aspx

Electrical India. (2018). *Transmission losses in India.* Electrical India. Retrieved from https://www.electricalindia.in/transmission-losses-in-india/#:~:text=Reducing%20T%26D%20losses%20can%20be,technical%20requirement%20of%20system%20elements

Financial Express. (2020). *Covid-19 lockdown effect: electricity use in August 2.2% lower than July.* Financial Express. Retrieved from https://www.financialexpress.com/industry/covid-19-lockdown-effect-electricity-use-in-august-2-2-lower-than-july/2078303/

Forest Survey of India. (2019). *India State of Forest Report 2019 (Vol. II).* Dehradun: Forest Survey of India, Ministry of Environment, Forest and Climate Change.

FSI. (2019). *India State of Forest Report 2019.* Forest Survey of India, Ministry of Environment, Forest & Climate Change, Govt. of India.

FSI. (2019). *India State of Forest Report Volume II: Maharashtra.* Forest Survey of India, Ministry of Environment, Forest & Climate Change, Govt. of India. Retrieved from https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-maharashtra.pdf

Hindustan Times. (2018). One way corridors, cogenstion fee soon on busy Delhi roads. Retrieved from https://www.hindustantimes.com/delhi-news/one-way-corridors-congestion-fee-soon-on-busy-delhi-roads/story-MBiCfXwT0ax0c7PaISzuiM.html

Hindustan Times. (2020). *12.7S% dip in diesel demand in July.* Hindustan Times. Retrieved from https://www.hindustantimes.com/india-news/12-7-dip-in-diesel-demand-in-july/story-A785vDisice69yD3KCz9QJ.html

ICAR. (2016). *Agriculture contingency plan for district: Nagpur.* Department of Agriculture, Cooperation & Farmers Welfare, Govt. of India. Retrieved from http://agricoop.nic.in/sites/default/files/MH18-%20Nagpur.pdf

ICCT. (2010). Congestion charging: challenges and opportunities. Retrieved from https://theicct.org/sites/default/files/publications/congestion_apr10.pdf

IEA. (2020). *Covid-19 impact on electricity.* International Energy Agency. Retrieved from https://www.iea.org/reports/covid-19-impact-on-electricity

India Times. (2019). *Delhi govt unveils electric vehicle policy, proposes subsidy on buying and e-vehicles.* Times of India. Retrieved from https://www.hindustantimes.com/cities/delhi-govt-unveils-electric-vehicle-policy-proposes-subsidy-on-buying-and-e-vehicles/story-yYt4dRzgz50JaHsfUkyhmJ.html

India today. (2020). *Covid-19: 4 unbelievable environmental changes seen in India since lockdown.* Indiatoday. Retrieved from https://www.indiatoday.in/education-today/gk-current-affairs/story/covid-19-4-vital-environmental-changes-evidenced-in-india-since-lockdown-1673726-2020-05-02

International Energy Agency. (2021). *Empowering cities for a net zero future: unlocking resilient, smart, sustainable urban energy systems.* Retrieved from https://iea.blob.core.windows.net/assets/4d5c939d-9c37-490b-bb53-2c0d23f2cf3d/G20EmpoweringCitiesforaNetZeroFuture.pdf

IPCC. (2014). Climate Change 2014 Synthesis Report. Retrieved from https://www.ipcc.ch/site/assets/uploads/2018/02/SYR_AR5_FINAL_full.pdf

ISRO. (2011). *National Wetland Atlas.* MoEFCC & ISRO. Retrieved from http://saconenvis.nic.in/publication%5CNWIA_National_atlas.pdf

Knowlton, K., Kulkarni S, P., Azhar, G. S., Mavalankar, D., Jaiswal, A., Connolly, M., . . . Hess, J. (2014). Development and implementation of South Asia's first heat-health action plan in Ahmedabad (Gujarat, India). *International Journal of Environmental Research and Public Health, 11*. doi:10.3390/ijerph110x0000x

Kumar, M. (ND). *India experiments with car free Sunday Streets and Bus Day to popularize people friendly cities.* SMARTCITIESDIVE. Retrieved from https://www.smartcitiesdive.com/ex/sustainablecitiescollective/india-experiments-car-free-sunday-streets-and-bus-day-popularize-people-friendly/211016/

Lauri, M., & Dahiya, S. (2020). *Analysis: India's CO2 emissions fall for first time in four decades amid coronavirus.* CarbonBrief. Retrieved from https://www.carbonbrief.org/analysis-indias-co$_2$-emissions-fall-for-first-time-in-four-decades-amid-coronavirus

MERC. (2018, December 3). *MERC Orders : MTR Order for Truing-up for FY 2015-16 and FY 2016-17.* Retrieved from MAHARASHTRA ELECTRICITY REGULATORY COMMISSION: https://www.merc.gov.in/mercweb/faces/merc/common/outputClient.xhtml

MERC. (2021, March 1). *MERC Orders: Final truing-up of Aggregate Revenue Requirement (ARR) of FY 2017-18 and FY 2018-19, provisional truing-up of ARR of FY 2019-20.* Retrieved from Maharashtra Electricity Regulatory Commission: https://www.merc.gov.in/mercweb/faces/merc/common/outputClient.xhtml

MERC. (n.d.). *MERC Orders.* Retrieved from Maharashtra Electricity Regulatory Commission: https://www.merc.gov.in/mercweb/faces/merc/common/outputClient.xhtml

Ministry of Urban Development, GoI & World Bank. (2015). *City Development Plan for Nagpur, 2041*. Retrieved from https://www.nmcnagpur.gov.in/assets/250/2018/10/mediafiles/Final_CDP_Nagpur_-Mar_15.pdf

MoHUA. (2019). *Amendments in model building bye-laws (MBBL-2016) for electric vehicle charging infrastructure.* Ministry of Housing & Urban Affairs, Govt of India. Retrieved from http://mohua.gov.in/upload/whatsnew/5c6e472b20d0aGuidelines%20(EVCI).pdf

MoHUA. (2020). *Swachh Survekshan 2020.* Govt of India, Ministry of Housing & Urban Affairs. Retrieved from https://swachhsurvekshan2020.org/ImpDocs/SS2020fullreport.pdf?id=j3gfyu64hvx6d2cc

MoHUA. (2020). *Swachh Survekshan 2020 Rankings*. Retrieved from Swachh Survekshan 2020: http://www.swachhsurvekshan2020.org/Rankings/Morethan1Lakh?category=10L

MoRTH. (2016). *Road TRansport Yearbook (2015-16).* Transport REsearch Wing, Ministry of Road Transport and Highways. Retrieved from https://morth.nic.in/sites/default/files/other_files/Road_Transport_Year_Book_2015_16.pdf

MPCB. (2019). *Implementation of Solid Waste Management Rules, 2016 for the state of Maharashtra, 2018-2019.* Maharashtra State Pollution Control Board.

MSME. (2013). *Brief Industrial profile of Nagpur district, Maharashtra 2012-13.* Ministry of MSME, Govt of India. Retrieved from http://dcmsme.gov.in/old/dips/Nagpur%20dips%2012-13.pdf

MSME. (2017). *Industrial state profile of Maharashtra 2016-17.* Ministry of MSME, Govt of India. Retrieved from http://dcmsme.gov.in/dips/state_wise_profile_16-17/Maharashtra%20Industrial%20State%20Profile%202016-17-Final.pdf

NASA. (2020). *Airborne Particle Levels Plummet in Northern India.* NASA, Earth Observatory. Retrieved from https://earthobservatory.nasa.gov/images/146596/airborne-particle-levels-plummet-in-northern-india

NITI Aayog. (2019). *Composite Water Management Index.* Retrieved from http://social.niti.gov.in/uploads/sample/water_index_report2.pdf

Pandey, K. (2020). *COVID-19 lockdown, imports force MP farmers to sell maize at half price.* Down to Earth. Retrieved from https://www.downtoearth.org.in/news/agriculture/covid-19-lockdown-imports-force-mp-farmers-to-sell-maize-at-half-price-71447

Parivahan Sewa. (2021, August 18). *Vahan Sewa Dashboard*. Retrieved August 2021, from Parivahan: https://vahan.parivahan.gov.in/vahan4dashboard/vahan/view/reportview.xhtml

PIB. (2020). *Sowing area of Kharif crops 21.2 % more compared to last year.* Govt of India, Ministry of Agriculture & Farmers Welfare. Press Information Bureau. Retrieved from https://pib.gov.in/PressReleasePage.aspx?PRID=1639340

Pillay, A. (2020). *Lockdown knocked power consumption down by upto 40% in large cities.* The Business Standard. Retrieved from https://www.business-standard.com/article/printer-friendly-version?

Pipalatkar, P., Khaparde, V., Gajghate, D., & Bawase, M. (2014). Source Apportionment of PM2.5 Using a CMB Model for a Centrally Located Indian City. *Aerosol and Air Quality Research, 14*. doi:10.4209/aaqr.2013.04.0130

Renewable Energy World. (2017). *Time-of-Use Means It's Time for Storage.* Retrieved from https://www.renewableenergyworld.com/2017/01/24/timeofuse-means-its-time-for-storage/#gref

Roychowdhury, A., & Dubey, G. (2018). *The urban commute and how it contributes to pollution and energy consumption.* Delhi: Centre for Science and Environment.

Select Energy. (ND). *REDUCING PEAK DEMAND WITH SOLAR ENERGY.* Select Energy. Retrieved from https://solect.com/reducing-peak-demand-solar-energy/

Soni, S. (2016). Smart Mobility Plan of Indore. *9th Urban Mobility India.* Retrieved from http://www.urbanmobilityindia.in/Upload/Conference/adfe087e-8fcc-4393-b5d2-fce6f279239a.pdf

Spencer, T. (2020). *Bending the curve: 2025 forecasts for electricity demand by sector and state in the light of the COVID-19 epidemic.* Delhi: The Energy and Resources Institute. Retrieved from https://www.teriin.org/sites/default/files/2020-07/Bending-the-Curve_Report.pdf

Surya, S. (2020). *Impact of COVID-19 on the power sector.* PRS Legislative Research. Retrieved from https://www.prsindia.org/theprsblog/impact-covid-19-power-sector

Tejas, S., Mavalankar, D., Azhar, G. S., Jaiswal, A., & Connolly, M. (2014). *Addressing heat-related health risks in urban India: Ahmedabad's Heat Action Plan.* Ahmedabad Municipal Corporation, Indian Institute of Public Health, Natural Resources Defense Council. Climate & Development Knowledge Network. Retrieved from cdkn.org: https://cdkn.org/wp-content/uploads/2014/05/Ahmedebad_Inside_Story_final_web-res1.pdf

The Climate Group. (2019, May). *Driving Climate Action: State Leadership in India.* Retrieved September 12, 2019, from https://www.theclimategroup.org/sites/default/files/india_report_web_singles.pdf

The Economic Times. (2020). *Lockdown pulls down power consumption by 22.75% to 85.05 BU in April 2020.* The Economic Times. Retrieved from https://economictimes.indiatimes.com/industry/energy/power/lockdownpulls-

Times of India. (2012). Vehicle free Sunday on CG Road, Law Garden. Retrieved from https://timesofindia.indiatimes.com/city/ahmedabad/Vehicle-free-Sundays-on-CG-Road-Law-Garden/articleshow/12590305.cms

TWC. (2019, May 31). Heat takes heavy toll across India. *The Weather Channel*. Retrieved from https://weather.com/en-IN/india/news/news/2019-05-31-heatwave-maharashtra-telangana-andhra-pradesh-rayalaseema-vidarbha

UMTC. (2018). *Comprehensive Mobility Plan for Nagpur.* Retrieved from https://www.metrorailnagpur.com/pdf/FINAL%20REPORT%20CMP%20NAGPUR%2002.08.2018.pdf

UNDP. (2012). *Maharashtra Human Development Report 2012.* United Nations Development Program. Retrieved from https://www.in.undp.org/content/dam/india/docs/human-development/MHDR%20English-2012.pdf

Vasudha Power Info Hub. (2021). *Vasudha Power Info Hub: DISCOMS*. Retrieved August 2021, from Vasudha Power: https://vasudhapower.in/analytics/power-cost

Water Resource Department, GoM. (2019). *Jalyukt Shivar Maharashtra*. Retrieved 04 21, 2021, from http://mrsac.maharashtra.gov.in/jalyukt/

WBCSD. (2020). *Impact of COVID-19 on smallholder farmers - insights from India.* World Business Council for Sustainable Development. Retrieved from https://www.wbcsd.org/Overview/News-Insights/WBCSD-insights/Impact-of-COVID-19-on-smallholder-farmers-in-India

WHO. (2014). *Chapter 8: Treatment and disposal technologies for healtch-care waste. In, Safe management of wastes from health-care activities.* World Health Organisation. Retrieved from https://www.who.int/water_sanitation_health/medicalwaste/077to112.pdf

WRI India. (2016). *Re-imagining rickshaws: lessons from the rickshaw rising challenge.* WRI India, ROSS Centre for Sustainable Cities. WRI India. Retrieved from https://wricitieshub.org/sites/default/files/WRI%20Auto%20Rickshaw%20Challenge.pdf

WRI. (ND). Better Bus Systems & Car-free Days Improve Life in India's Cities. Retrieved from https://www.wri.org/our-work/top-outcome/better-bus-systems-car-free-days-improve-life-india%E2%80%99s-cities

Xin, C., Zhang, T., Tsai, S.-B., Zhai, Y.-M., & Wang, J. (2020). An empirical study on greenhouse gas emission calculations under different municipal solid waste management strategies. *Applied Sciences*. doi:10:1673. doi:10.3390/app10051673

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

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

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