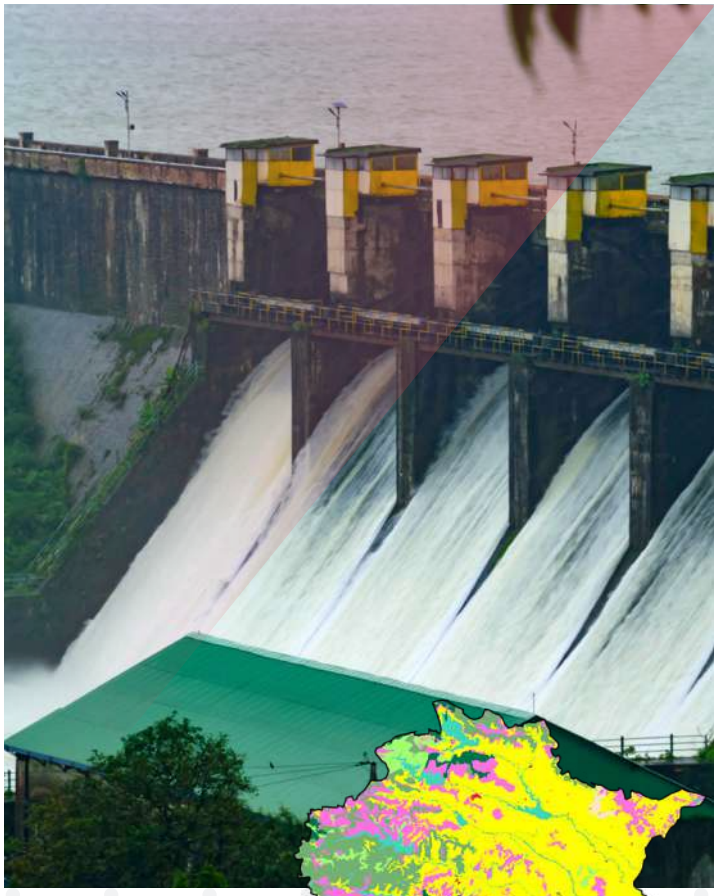
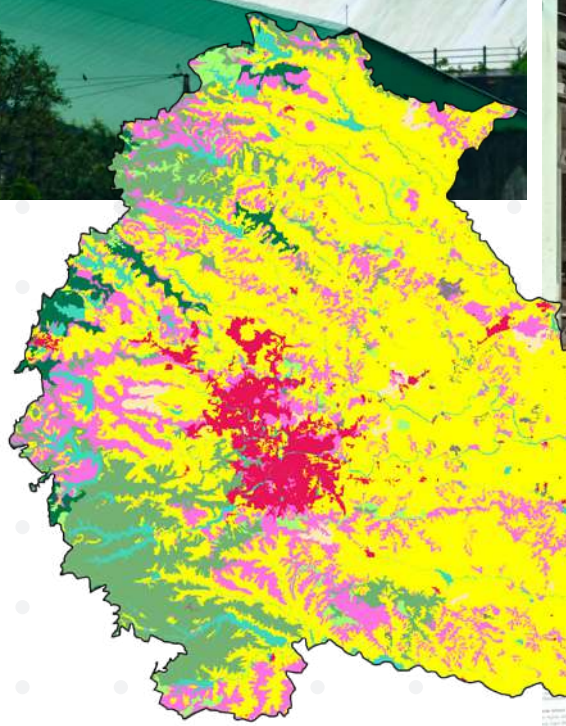
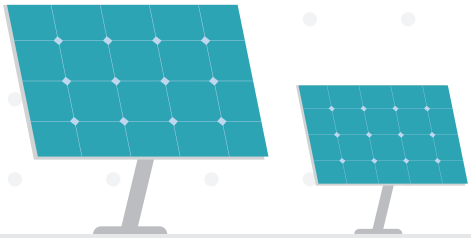
January, 2022



Climate Change and Environment Action Plan of

Pune District





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VASUDHA FOUNDATION
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SHAKTI SUSTAINABLE ENERGY FOUNDATION

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
Pune, Maharashtra

Cover page images

Top left image:
Pawna dam in Pune

Bottom right:
Car manufacturing unit of Mahindra, Pune

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

Forest (evergreen) | Forest (deciduous) | Forest (mixed) | Cropland | Fallow Land
Built-up Land | Shrubland | Barren Land | Waterbodies

Climate Change and
Environment Action Plan of

Pune District

Prepared By

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FOUNDATION

RAJESH PATIL I.A.S

Municipal Commissioner
Pimpri Chinchwad Municipal Corporation

सत्यमेव जयते

Date : 12/01/~~2202~~ 2022

Message

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

To achieve these goals, it is imperative that all the states commence their climate actions immediately and make their best contributions 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 Pune, have announced their commitment for Race to Zero, both international pledges aimed at sustainable and low carbon development. 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) for Pune district prepared by Vasudha Foundation with support from Shakti Sustainable Energy Foundation. This Action Plan has been developed in consultation with Pimpri Chinchwad Municipal Corporation, district administration, and other stakeholders, 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 the Sustainable Development Goals (SDGs), for various climate-related sectors and environmental issues of Pune district, as well as estimates mitigation potential of each sector.

I applaud the extensive efforts made towards developing the CCEAP for Pune district. This Action Plan can serve as a roadmap for mainstreaming climate action in alignment with the district's development priorities.

(Rajesh Patil)

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अतिरिक्त महापालिका आयुक्त
पुणे महानगरपालिका

Dr. Kunal Khemnar I.A.S.
Additional Municipal Commissioner
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Preface / Message

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 2070 at 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 commitmentsto ensure low carbon growth and sustainable development in its various initiatives. Following the concept of a bottom-up approach a "Climate Change and Environment Action Plan" for Pune district has been developed. This Action Plan captures the ground realities of the district as well as provides region specific recommendations for various climate relevant sectors.

I am certain that this Action Plan will serve as a roadmap for the 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 the Pune Municipal Corporation, district administration and other stakeholders.

Khemnar
(Dr.Kunal Khemnar)

ACKNOWLEDGEMENTS

We would like to thank Dr Rajesh Deshmukh, IAS (Collector & DM), Ram Kishore Naval, IAS (previous Collector, Pune), Dr. Kunal Khemnar, IAS (Additional Commissioner, PMC), Mangesh Dighe, Environmental Conservation Officer, PMC and Sanjay Kulkarni (Environment Head, PCMC) as their inputs and support have been vital in the development of the Climate Change and Environment Action Plan for Pune 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 civil organisations – officials from MEDA, Forest Department, MPCB, PSCDCL and Sanskriti Menon (CEE Maharashtra) for inputs and suggestions to refine the action plan.

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

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

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

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

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

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ACRONYMS

AFOLU	Agriculture, forestry and other land use
AMRUT	Atal Mission for Rejuvenation and Urban Transformations
APMC	Agricultural Produce Market Committee
ARR	Aggregate revenue requirement
ASP	Activated sludge process
AT&C	Aggregate technical and commercial losses
BAU	Business as usual
BCC	Behavioural change communication
BEE	Bureau of Energy Efficiency
BMW	Bio-medical waste
BOD	Biological oxygen demand
BRT	Bus rapid transport
C&D	Construction and demolition
CAGR	Cumulative annual growth rate
CAMPA	Compensatory Afforestation Fund Management and Planning Authority
CAPEX	Capital expenditure
CAAQMS	Continuous ambient air quality monitoring system
CBWTD	Common bio-medical waste treatment Disposal facility
CETP	Common effluent treatment plant
CFA	Central financial assistance
CGWB	Central Ground Water Board
CHP	Combined heat and power
CPCB	Central Pollution Control Board
CPEIR	Climate Public Expenditure and Institutional Review
CPP	Captive power plant
CSR	Corporate social responsibility
DDUGJY	Deen Dayal Upadhyaya Gram Jyoti
DG	Diesel generator
DISCOM	Distribution company
DRE	Decentralised renewable energy
EC	Electricity consumption
ECBC	Energy conservation building code
EEPS	Energy efficient pumping system
EESL	Energy Efficiency Services Limited
EF	Emission factor
ENVIS	Environmental Information System
ESCO	Energy Service Company
EV	Electric vehicle
FAME	Faster Adoption and Manufacturing of (Hybrid & Electric Vehicles)
FMCG	Fast moving consumer goods
FSI	Forest Survey of India
FY	Financial year
GDP	Gross domestic product
GHG	Greenhouse gas
GHGPI	GHG Platform India
GIM	Green India Mission
GoI	Government of India
GoM	Government of Maharashtra
GRIHA	Green Rating for Integrated Habitat
GSI	Geological Survey of India
GW	Gigawatt
HW	Hazardous waste
ICAP	India Cooling Action Plan
ICE	Internal combustion engine
IPDS	Integrated Power Development Scheme
	Information education and communication
IGBC	Indian Green Building Council
IISS	Indian Institute of Soil Science
IMD	India Meteorological Department
IOT	Internet of things
IPCC	Intergovernmental Panel on Climate
IPPU	Industrial Processes and Product Use
IPT	Intermediate public transport
ISRO	Indian Space Research Organisation
ISWM	Integrated solid waste management
JFM	Joint forest management
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
KUSUM	Kisan Urja Suraksha evam Utthaan Mahabhiyan
KW	Kilowatt
kWh	Kilowatt hour
LED	Light emitting diode
LMV	Light motor vehicle
M&E	Monitoring and evaluation
MCF	Methane correction factor
MEDA	Maharashtra Energy Development

MERC	Maharashtra Electricity Regulatory Commission
MGNREGS	Mahatma Gandhi National Rural
MI	Micro irrigation
MIDC	Maharashtra Industrial Development Corporation
MLD	Million litre per day
MPCB	Maharashtra Pollution Control Board
MRF	Material recycling facility
MSEDCL	Maharashtra State Electricity Distribution Company Ltd
MSKPY	Mukhyamantri Saur Krushi Pump Yojana
MSME	Micro, small & medium enterprises
MSRTC	Maharashtra State Road Transport Corporation
MtCO2e	Million tonnes of carbon dioxide equivalent
MU	Million units
MW	Megawatt
NASA	National Aeronautics and Space Administration
NDCs	Nationally determined contributions
NCAP	National Clean Air Programme
NEMMP	National Electric Mobility Mission Plan
NEX-GDDP	NASA Earth Exchange Global Daily Downscaled Projections
NMT	Non-motorised transport
NPK	Nitrogen, phosphorus and potassium
NRSC	National Remote Sensing Centre
NTPC	National Thermal Power Corporation
ORNL-DAAC	Oak Ridge National Laboratory
PAT	Perform, achieve and trade
PCCP	Personal care and cosmetic products
PCMC	Pimpri Chinchwad Municipal Corporation
PEG	Public electricity generation
PLF	Plant load factor
PM	Particulate matter
PMC	Pune Municipal Corporation
PMKSY	Pradhan Mantri Krishi Sinchai Yojana Pune Mahanager Parivahan
PMRDA	Pune Metropolitan Region Development Authority
PRI	Panchayati Raj Institution
PSCDCL	Pune Smart City Development Corporation Limited
PT	Public transport
PUC	Pollution under control
RCP	Representative concentration pathway
RDD	Rural Development Department
RDF	Refuse-derived fuel
RE	Renewable energy
REC	Renewable energy certificate
RESCO	Renewable Energy Service Company
RO	Reverse osmosis
RPO	Renewable purchase obligation
RTS	Rooftop solar
RWA	Resident Welfare Association
RWHS	Rainwater harvesting system
SBR	Sequencing batch reactors
SDG	Sustainable development goals
SEZ	Special economic zone
SLNP	Streetlight National Programme
SMB	Solar municipal bonds
STP	Sewage treatment plant
SUP	Single use plastic
SW	Solid waste
SWM	Solid waste management
T&D	Transmission and distribution
TOE	Tonnes of oil equivalent
TOU	Time of use
TPD	Tonnes per day
TSDF	(Hazardous waste) treatment, storage & disposal Facility
UDAY	Ujjwal DISCOM Assurance Yojana
UDD	Urban Development Department
UJALA	Unnat Jyoti by Affordable LEDs for All
ULB	Urban local body
W	Watt
W2E	Waste to energy
WSP	Waste stabilisation pond
WEEE	Waste electrical and electronic EquipmenI Regulation
WW	Wastewater
ZEV	Zero emission vehicle

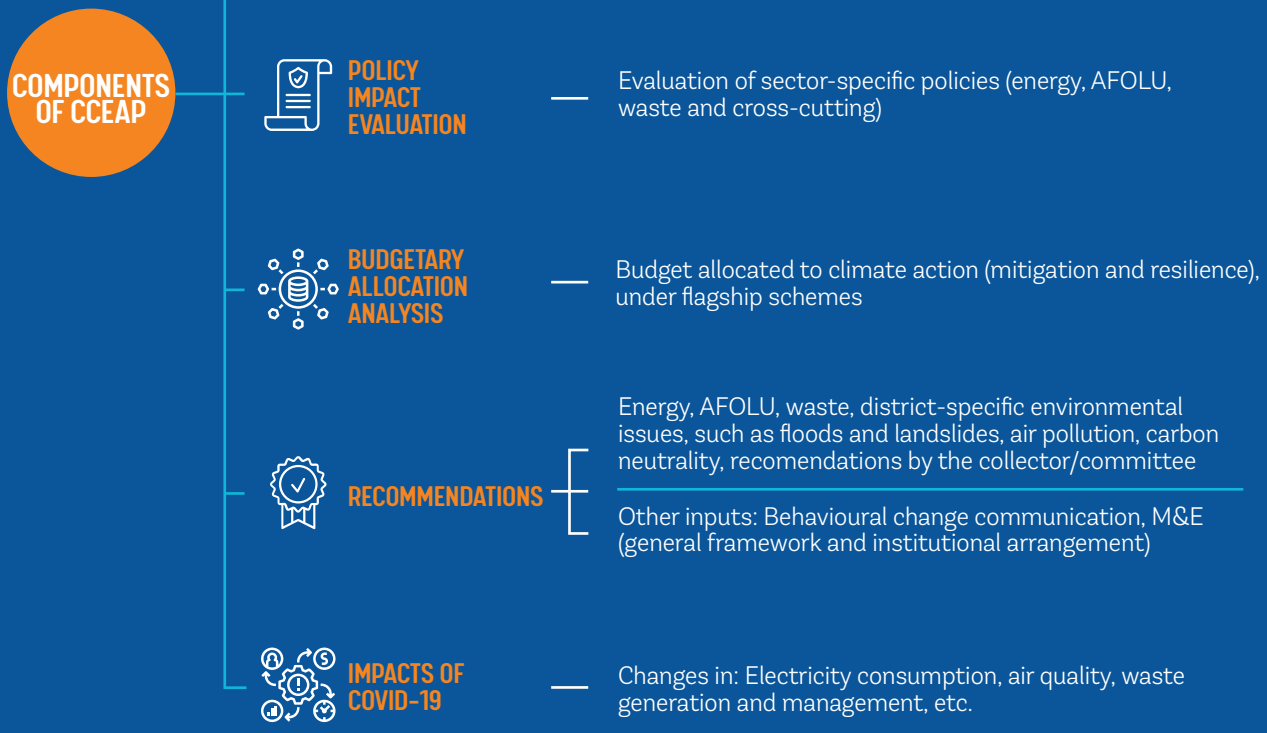
EXECUTIVE SUMMARY

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

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

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

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



CLIMATE PROFILE AND PROJECTIONS

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

- **Warm days have gone up by 10 percent:** The maximum temperature has been observed to show a significant increasing trend in April and May. The trend has accelerated over the last two decades. The mean percentage of warm days is more pronounced and has increased by 10 percent. Pune district is projected to experience warming of 1°C to 2°C under RCP4.5 and 1.2°C to 3.9°C under RCP8.5. The percentage of warm days is projected to increase by more than 65 percent.
- **Cold days are decreasing:** There is no trend in minimum temperatures in the wintertime. The cold days show a large variability and may decrease in all the epochs under changing climate conditions.
- **Rainy days are projected to increase:** The monsoon rainfall does not show any significant trend, other than a slight increase in the recent decade in individual months and also during the season as a whole. The number of rainy days has been highly variable in July and August in the recent decade, also showing a slightly decreasing trend in monsoon months during the period 1951-2018. The seasonal rainfall of the district is projected to increase by 6 to 17 percent under RCP4.5 and 10 to 33 percent under RCP8.5 emission scenarios. The number of rainy days is also projected to increase during the monsoon season, particularly in July and August.

SECTORAL GREENHOUSE GAS EMISSIONS PROFILE: CLIMATE CHANGE DRIVERS

- **Greenhouse gases have increased 2.5-folds since 2005:** Between 2005 and 2019, the total greenhouse gas (GHG) emissions of Pune district increased by 264 percent (from 2.75 Mt CO_2e. in 2005 to 9.99 Mt in 2019) with a CAGR of 9.66 percent. These estimates represent GHG emissions from 13 categories covering three major sectors – energy, agriculture, forestry and other land use (AFOLU), and waste.
- **Energy sector is the highest contributor of emissions:** Energy sector (direct fuel combustion in transport, agriculture, residential categories, etc.) is the highest contributor of GHG emissions. Although energy emissions of Pune district increased at a CAGR of 7.58 percent, its share has decreased from 89 percent in 2005 to 82 percent in 2019 due to increase in AFOLU emissions.
- **AFOLU sector was a net sink until 2011:** The agriculture, forestry and other land use (AFOLU) sector became an emitter post 2011. Its emissions peaked in 2013 and then started to decline again. Between 2012 and 2019, AFOLU emissions have reduced by 18 percent.
- **Waste sector's contribution to GHG emissions is decreasing:** Emissions from the waste sector have grown at a slow rate (CAGR of 2.66 percent) and its contribution has dropped from 11 percent (in 2005) to 6 percent (in 2019).
- **Business-as-usual scenario will be disastrous:** In business-as-usual scenario (i.e., no actions/policies are put in place to mitigate emissions), the total emissions of Pune district are likely to increase 168 percent by 2030, with respect to 2015 levels.

ASSESSMENT OF POLICIES THROUGH THE LENS OF CLIMATE CHANGE

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

- **Power and energy:** For this sector, 12 policies/programmes were evaluated, (UDAY/IPDS/R-APDRP scheme and clean energy schemes are the biggest contributors to GHG emissions mitigation).
  - Policies related to clean energy generation mitigated 8,37,400 tCO_2e. emissions.
  - Policies focusing on energy-efficient buildings and processes helped avoid, 41,65,724 tCO_2e. emissions.
  - Transportation interventions have led to an emission avoidance of 4,65,000 tCO_2e.

- **AFOLU and cross-cutting:** 13 policies were assessed.
  - Forestry policies alone led to a mitigation of 13,72,638 tCO_2e.
  - Policies pertaining to livestock, proved to be beneficial for climate action and helped in avoiding 11,819.71 tCO_2e/annum.
  - GHG impact of agricultural policies could not be computed due to lack of availability of required information/ data.
  - Cross-cutting sector: The National Mission on Micro Irrigation resulted in avoiding 914.45 tonnes of CO_2e emissions (from reduction in use of urea + reduction in energy consumption). The Pradhan Mantri Ujjwala Yojana has helped mitigate 12,14,393 tonnes of CO_2e.
- **Waste:** 15 policies were assessed.
  - Policies pertaining to sanitation added 4,78,590 tCO_2e. emissions.
  - Composting as a part of solid waste management practices has mitigated 38,927 tCO_2e.
  - Domestic wastewater treatment interventions have led to 2,11,430 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 Pune district. For the three years, the expenditure on climate relevant actions is 24.69 percent, 28.76 percent and 26.76 percent, respectively, of the total district budget. The distribution of expenditure on climate action in the district over the three years, i.e., from 2016-17 to 2018-19 is summarised in Figure 1a. 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.

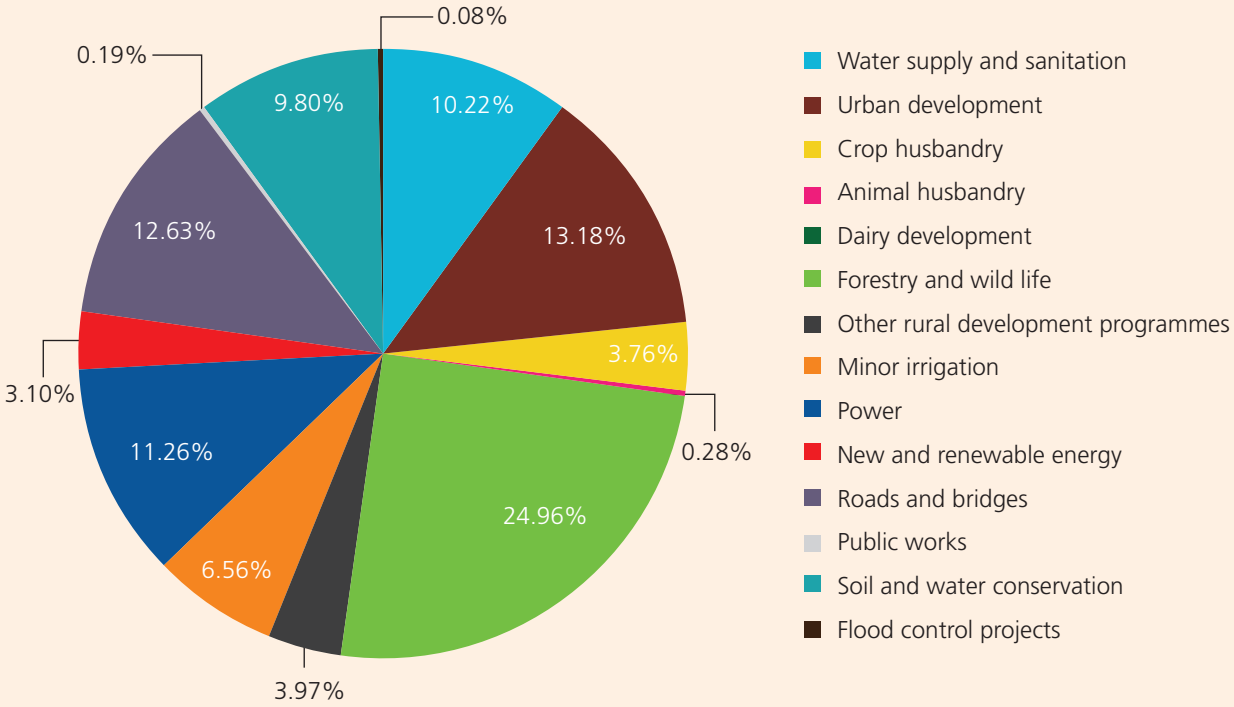


Figure 1a: Pune district: distribution of expenditure on climate action

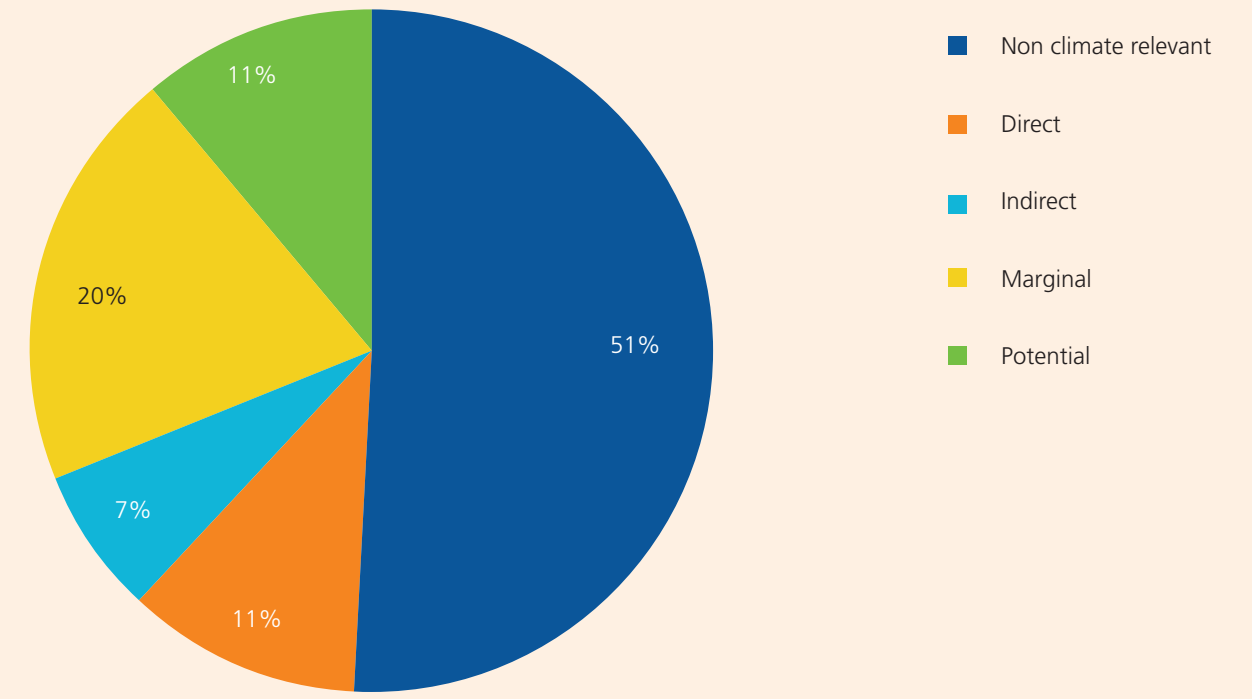


Figure 1b: Distribution of schemes by relevance to climate action in Pune district between 2016-17 and 2018-19

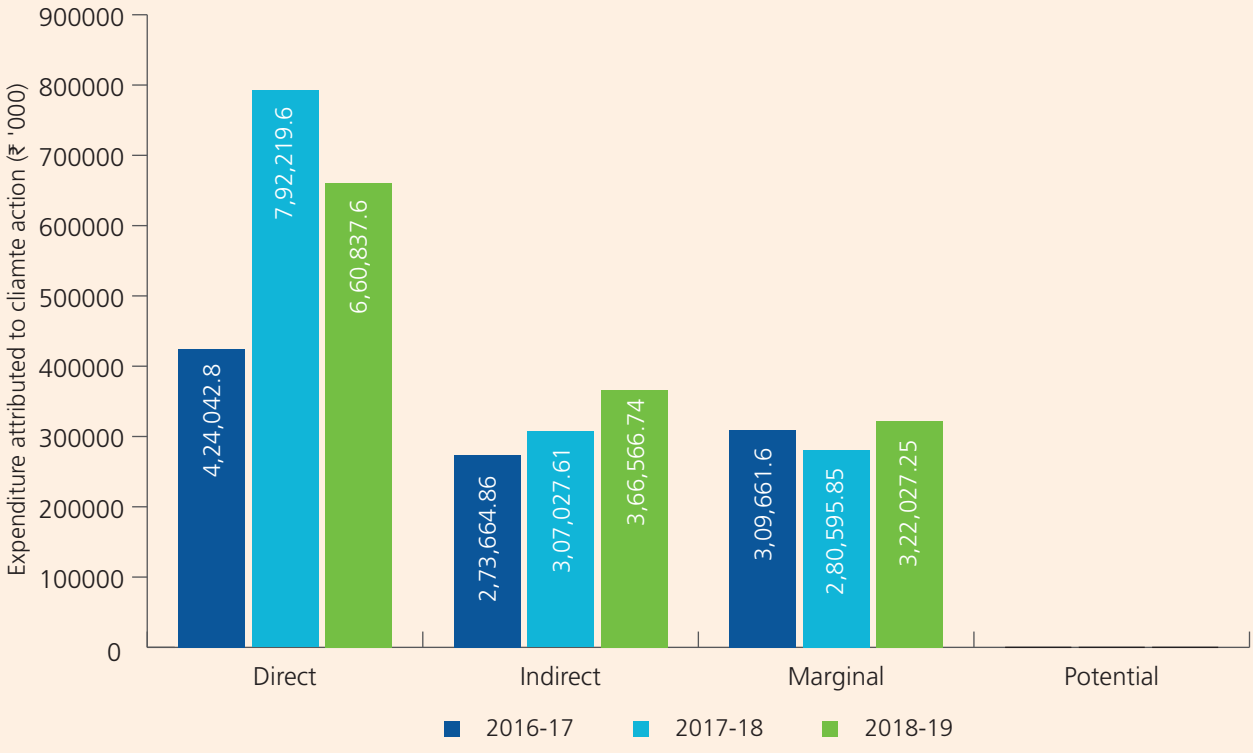


Figure 1c: Expenditure attributed to climate action by category of climate relevance in Pune district between 2016-17 and 2018-19

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 Pune district

Scheme	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 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	2,034.78	459.25	22.57
		2019-20	1,476.80	330.95	22.41
PMKSY	Micro-irrigation activities	2016-17	1,058.00	730.00	69*
		2019-20	617.00	425.00	
GIM	Enhancing forest cover, ecosystem restoration, agro-forestry, social forestry, wetland restoration, promoting alternative fuels	2017-18	165.24	165.24	100*
		2018-19	107.57	107.57	
		2019-20	40.00	40.00	
AMRUT	Water supply, sewage and septage management, urban transport, drainage, green spaces	2015-16	12,084.00	776.00	54*
		2016-17	12,670.00	626.00	
DDUGJY + Saubhagya	New and upgradation of substations, LT lines, feeder segregation, consumer metering, DTR metering, etc	Up to April 2020	8,577.00	4,288.00	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/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 11.4 Mt CO_2e. per annum. The sectoral breakdown of the same is as following:

GHG mitigation potential of CCEAP recommendations (tCO_2e)

Energy
79,50,325

AFOLU
32,87,303

Waste
2,42,797

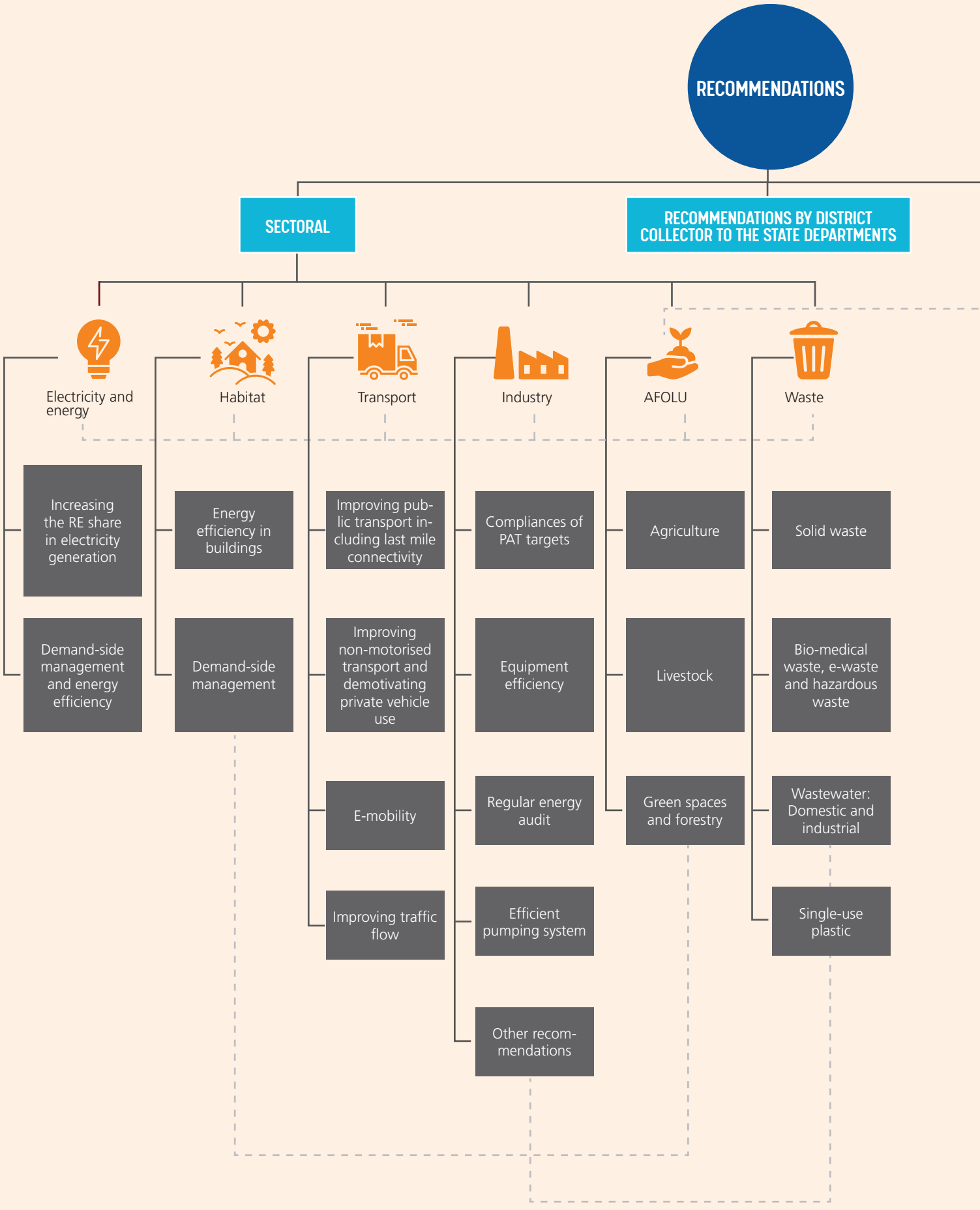
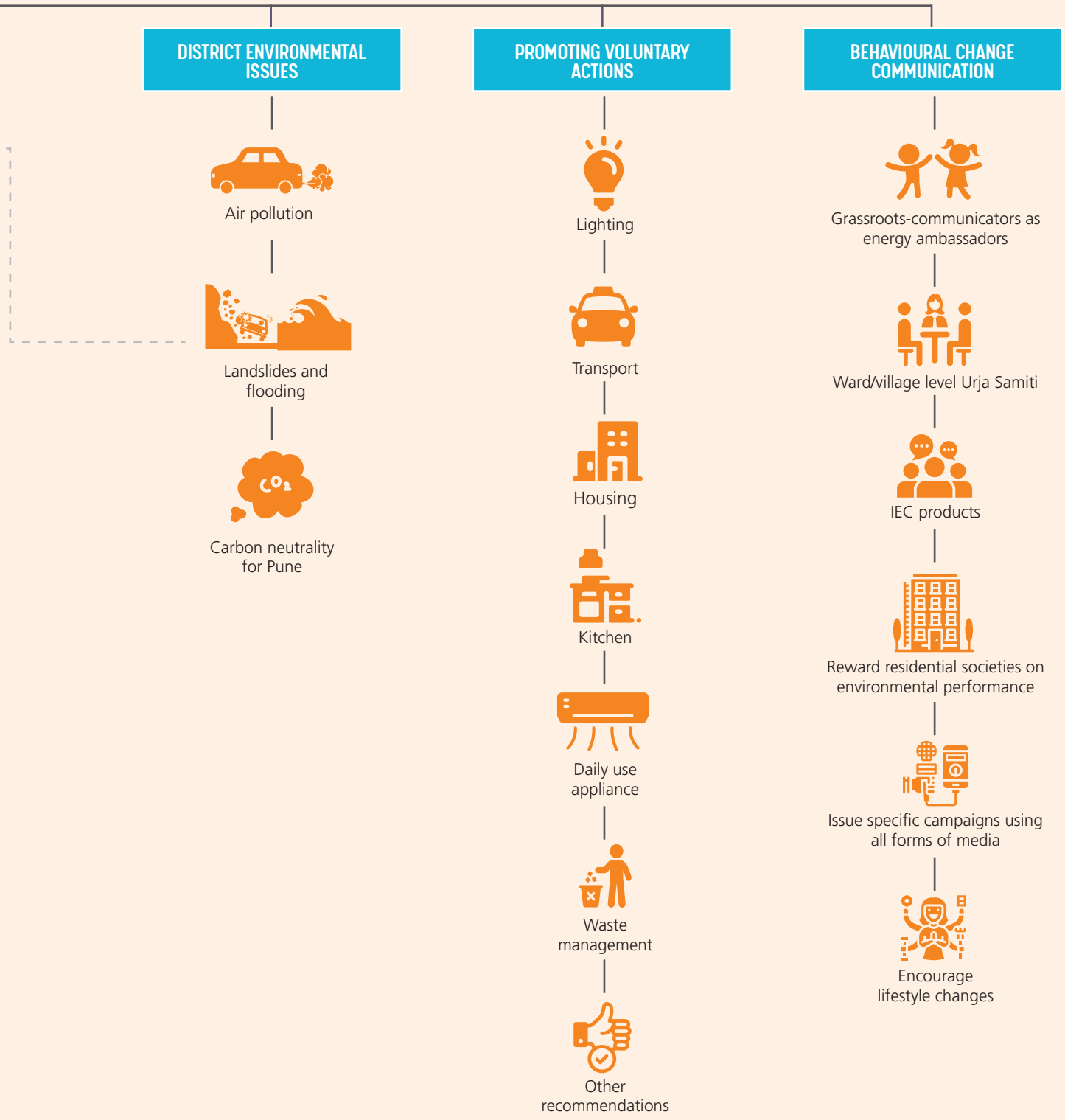


Figure 2 Recommendations for CCEAP Pune


DISTRICT ENVIRONMENTAL ISSUES
Air pollution
Landslides and flooding
Carbon neutrality for Pune
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)

Power and energy

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

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

Transport

Being one of the fastest growing sectors in India, transport contributes 12 percent to 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-motorized transport through dedicated cycle lanes, and (d) improving traffic flow.

AFOLU

For agriculture, forestry and other land use (AFOLU) sector, it is important to promote climate-conscious practices that do not have an adverse impact on the ecosystem, biodiversity and natural resource dependent communities. Our recommendations include: (a) promoting the use of organic fertilizers, solar pumps and practices such as micro-irrigation and alternative ways to manage crop-residue under agriculture, (b) having a good mix of high-yielding 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 Pune 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 channelization 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 periodical sludge removal facility.

Given the unique environmental issues of the district, the action plan recommends developing extensive infrastructure to monitor air pollution and interventions for preventive measures. It also identifies need to promote and practice sustainable land use plan and management, hazard mapping and implementation of early warning system in order to mitigate flooding and landslide incidences.

COVID-19 IMPACT

This section presents an assessment of how the COVID-19 pandemic has impacted various sectors and the development measures that can be adopted. During the national lockdown in 2020, the total energy demand in India went down considerably. The pandemic has only underscored the need to increase focus on renewable energy and strengthen its integration into the grid. Pune district needs to increase implementation of RE generation through solar rooftops, biogas, solar pumps for agriculture and water supply.

Overall, the pandemic resulted in significant reduction in air pollution owing to reduced transport and industrial activities during the lockdown and unlock period. A comparative study of the district air pollution ($PM_{2.5}$, PM_{10}, NO_2 and SO_2) for the period of January to October shows significant variation between 2019 and 2020.

Waste management has been the most impacted sector, 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.

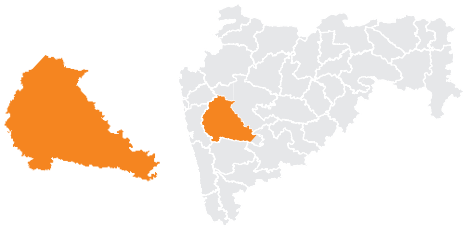

Thane
Ahmadnagar
Bid
Pune
Raigarh
Osmanabad
Solapur
Satara
Ratnagiri
Maharashtra

DISTRICT PROFILE

Skyline of Pune city

1. DISTRICT PROFILE

Pune, known as the 'Queen of the Deccan' for its historical, socio-cultural and political importance, is the second largest district in Maharashtra in terms of area, population and industrialisation. Situated in western Maharashtra's plateau region the district lies at the base of Sahya mountains on the west and Bhima and Nira river basins on the east and south-east.



Pune city is the administrative headquarters of the district. It is the largest non-capital city of India, the eighth largest city in the country and second largest in Maharashtra, and contributes around 3 percent of India's GDP. The city is an important hub for IT, a base for the armed forces, a centre for research and development, and is also known for automobile manufacturing and its industrial/trade centres at Pimpri-Chinchwad Municipal Corporation.

1.1 Key statistics

Table 2: District profile of Pune

General characteristics of the district (Census, 2011)			
Location	West Maharashtra, western Indian state		
Latitude	17°54' & 19°24' North	**Area**	15,643 sq km
Longitude	73°19' & 75°10' East	**Elevation**	559 msl (1,840 ft)
Agro-climatic zone (NICRA-ICAR, 2011)			
Agro ecological sub region (ICAR)	Deccan plateau for semi-arid eco region – AER		
Agro-climatic zone (Planning Commission)	Western plateau and hills region		
Agro climatic zone (NARP)	Western Maharashtra plain zone – ZARS, Ganeshkhind; Pune Western Ghat zone - ZARS, Igatpuri; District Nashik Western Maharashtra Scarcity Zone (MH-6), - ZARS, Solapur; Sub Montane Zone – ZARS, Kolhapur		
Administrative units (Pune District Administration, 2021)			
Block	14	**ULBs**	Municipal Corporation: 2 Municipal Council: 11
Constituency	21	**Census villages**	1,912
Demography (Census of India, 2011)			
Population (total)	94,29,408	**Population density**	603/sq. km
Population (urban)	57,51,182	**Household**	21,41,346
Population (rural)	36,78,226	**% urbanisation**	Population: 61.0%
Population growth (2001-2011/ decadal)	30.4%	**Women-headed household**	NA
Land utilisation statistics 2018-19 (Area in sq. km) (Department of Agriculture, 2019)			
Land under non-agricultural uses	3,036	**Other fallows**	245
Barren and uncultivable land	2,400	**Current fallow**	585
Permanent pasture	1,925	**Net sown area**	5,117
Misc. tree and groves	152	**Area sown more than once**	3,100
Culturable waste land	457	**Gross cropped area**	8,216

Agriculture profile (Department of Agriculture, 2020) (NICRA-ICAR, 2011)	
Major crop season	Kharif (rainfed) and rabi (rainfed/irrigated)
Major field crops	Food grain: Wheat, paddy, pearl millet, maize, ragi, bajra, jowar, pulses Oil seed: Soybean, niger seed Cash crop: Sugarcane, potato, onion, chili
Soil type (PMKSY, 2017)	Black soil (45%), red soil (5%), sandy soil (12%), sandy loam (30%)

Industrial profile (MSME, 2016)					
Registered industrial unit (up to July, 2012)	4,01,235	**Registered medium unit**	63,273	**No. of industrial areas**	10
				Cooperative industrial estate	6

Table 3: Pune vs. Maharashtra: A comparative profile

Particular	Pune District	Maharashtra	% contribution
Total population (2011)	94,29,408	11,23,74,333	8.39%
Urban population (2011)	57,51,182	5,08,18,259	11.3%
Percentage of urban population	61%	45%	Almost 1.4 times higher than the state
Geographical area (sq. km)	15,643	3,07,713	5%
Forest cover (sq. km) (FSI, 2019)	1,710.86 (Very dense: 0; Medium Dense: 760.93; Open forest: 949.93)	50,777.56 (Very dense: 8,720.53; Medium dense: 20,572.35; Open forest: 21,484.68)	3.37% (No dense forest in the district)
Per capita forest cover (ha/person)	0.018	0.045	2.5 times less than that of the state
Total registered vehicles*	49,75,559	3,00,83,092	16.54%
Total rice production (in tonnes) (2019-20)	1,36,586	31,82,602	4.29 %
Installed capacity of electricity generation (Conventional, MW)	0	27,983.5	0
Major types of industries (MSME, 2017)	Auto ancillary, engineering and allied, agro-processing, textile, electronic parts and goods, rubber, plastic and petrol based	Hindustan Aeronautics, Shipping Corporation, Hindustan Petroleum, Bharat Petroleum, Bharat Electronics, Chemical, Pharmaceuticals, Fertilisers, Textile, agro and food processing, automobiles, etc.	--
Existing industrial area (Ha): land acquired and developed (MSME, 2016)	6,127.81	66,000+	9.28%
Human development index (HDI) (UNDP, Maharashtra Human Development Report 2012, 2012)	0.814	0.752	Higher than the state

* As on 17-09-2021

1.2 Power and energy sector

Pune district gets its electricity from the state-owned DISCOM – Maharashtra State Electricity Distribution Company Ltd (MSEDCL). Industrial sector is the predominant electricity consuming sector in the district, followed by agriculture, domestic, and commercial sectors (Figure 3). The overall electricity consumption increased at a CAGR of 5.95 percent between 2008 and 2019, with the consumption mix remaining unchanged for that period (MERC, 2021).

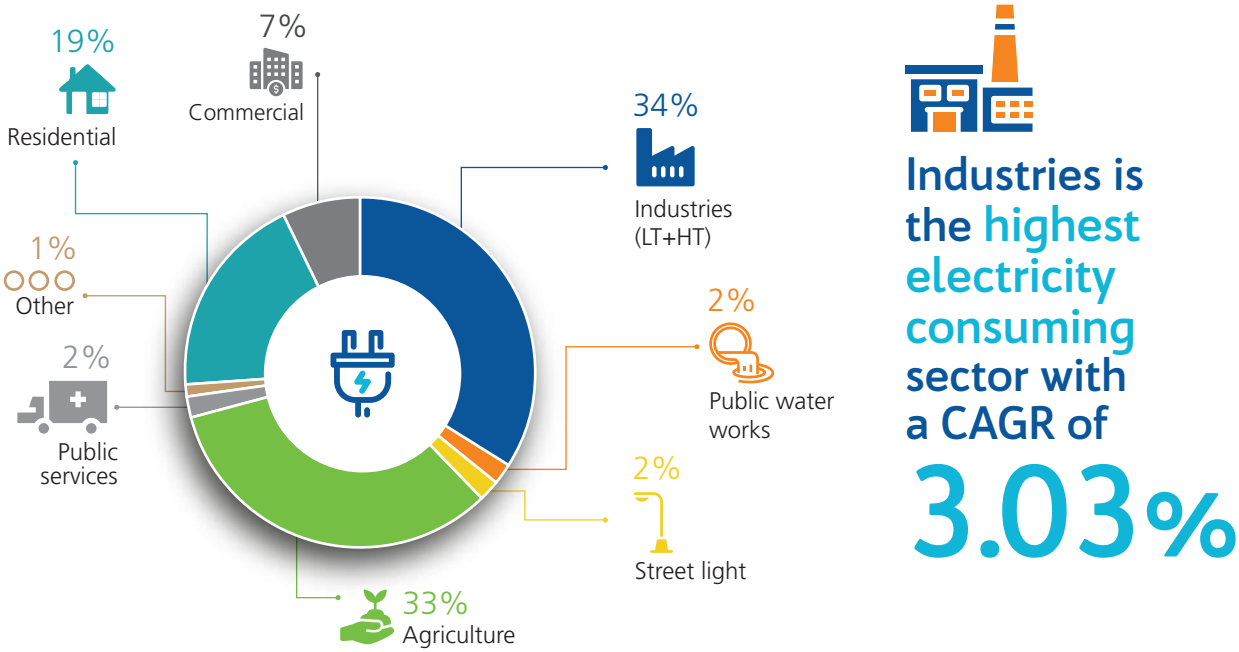


Figure 3: Consumer-wise electricity consumption in Pune (2019)

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 Figures 4 and 5 (MERC, 2020) (Vasudha Power, 2021). In the RE basket, solar power contributed to around 24.5 percent of the electricity purchase (ME RC, 2020) (Vasudha Power, 2021).

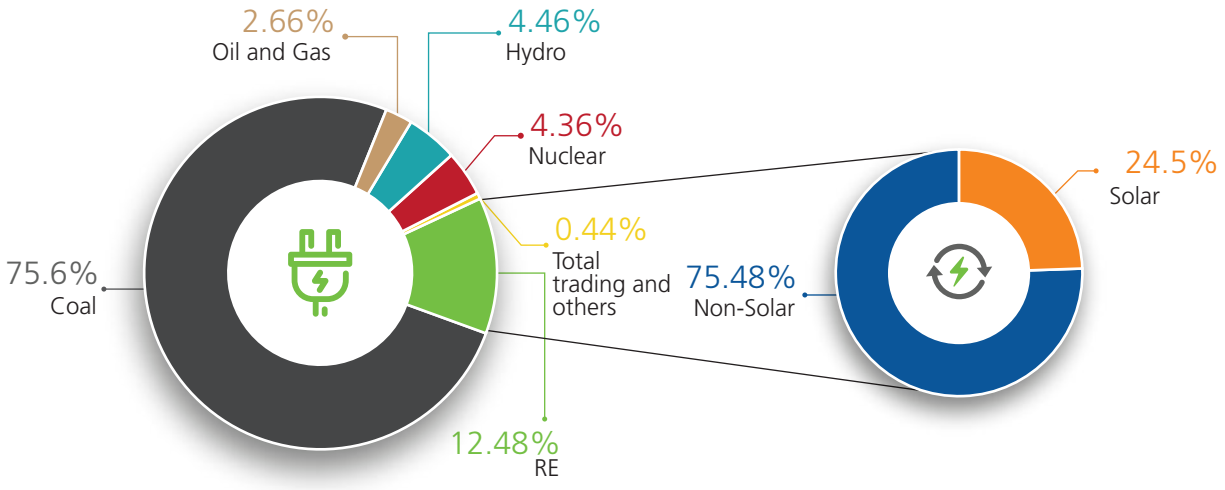


Figure 4: Electricity procurement mix of MSEDCL (2019-20)

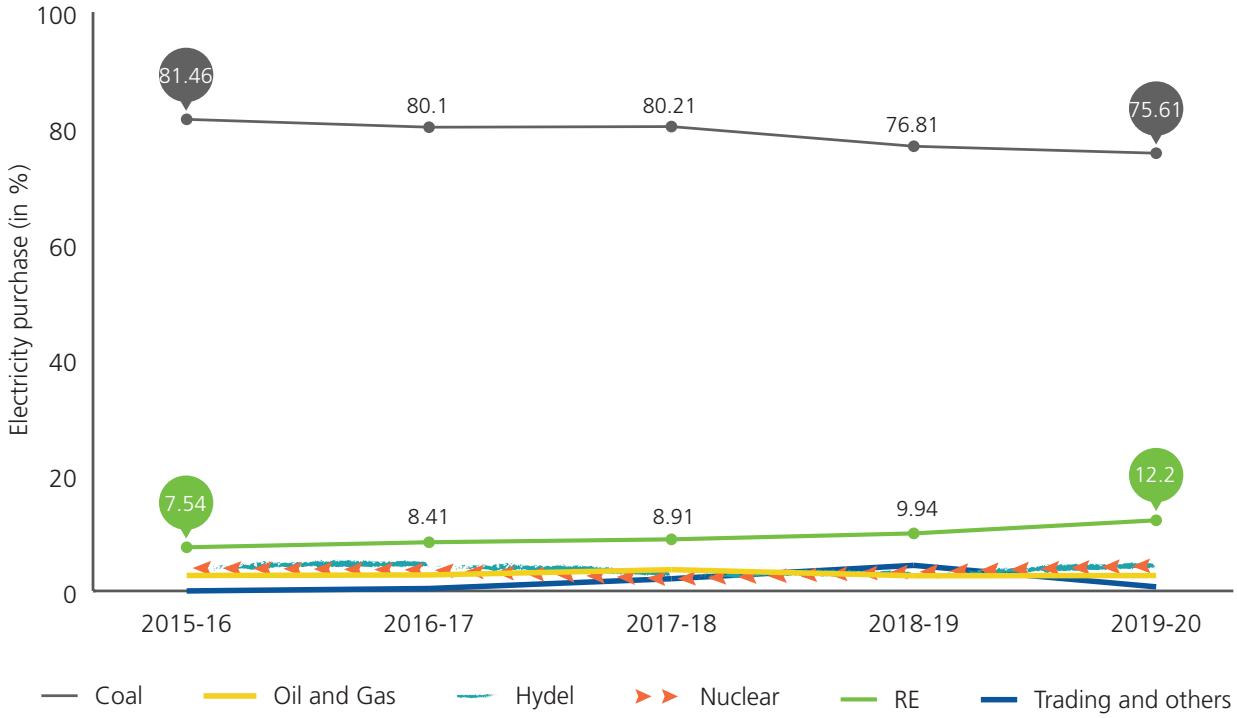


Figure 5: Electricity purchase mix (%) of MSEDCL over the years

The transmission and distribution losses (Figure 6), for MSEDCL were 15.95 percent during FY 2016-17 (MERC, 2018) - lower than the national average of 21.42 percent (CEA , 2019). For FY 2018-19, the T&D losses of MSEDCL stood at 14.70 percent (MERC, 2020).

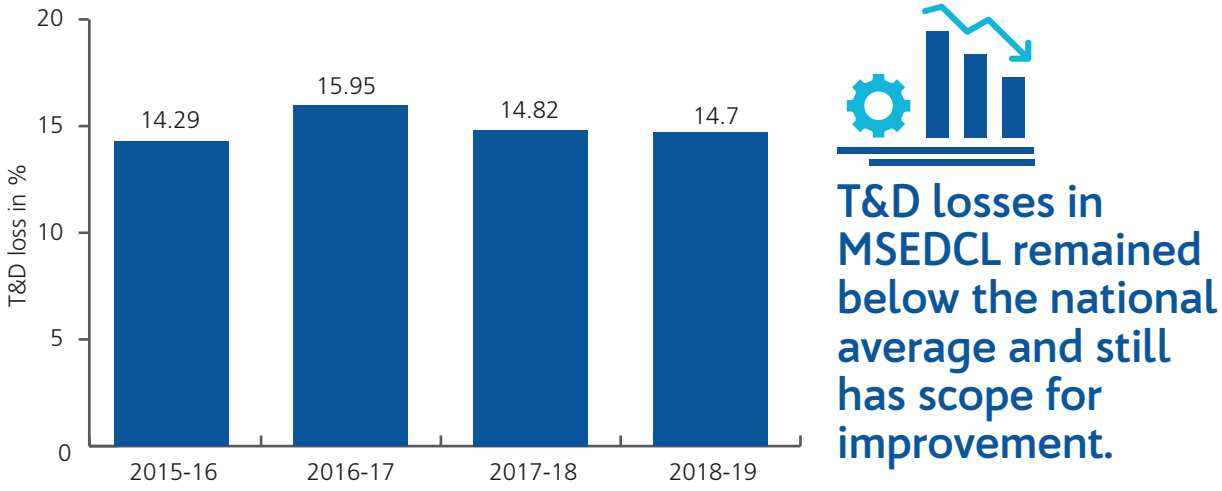


Figure 6: T&D losses (in %) for MSEDCL over the years

Information on category-wise electricity consumption (EC)[2] of Pune district and the projections of electricity consumption (based on long-term and short-term CAGR calculations i.e., CAGR between 2009 and 2015-19 respectively) are depicted in Figures 7, 8 and 9.

2 Electricity is supplied in the district by MSEDCL DISCOM.

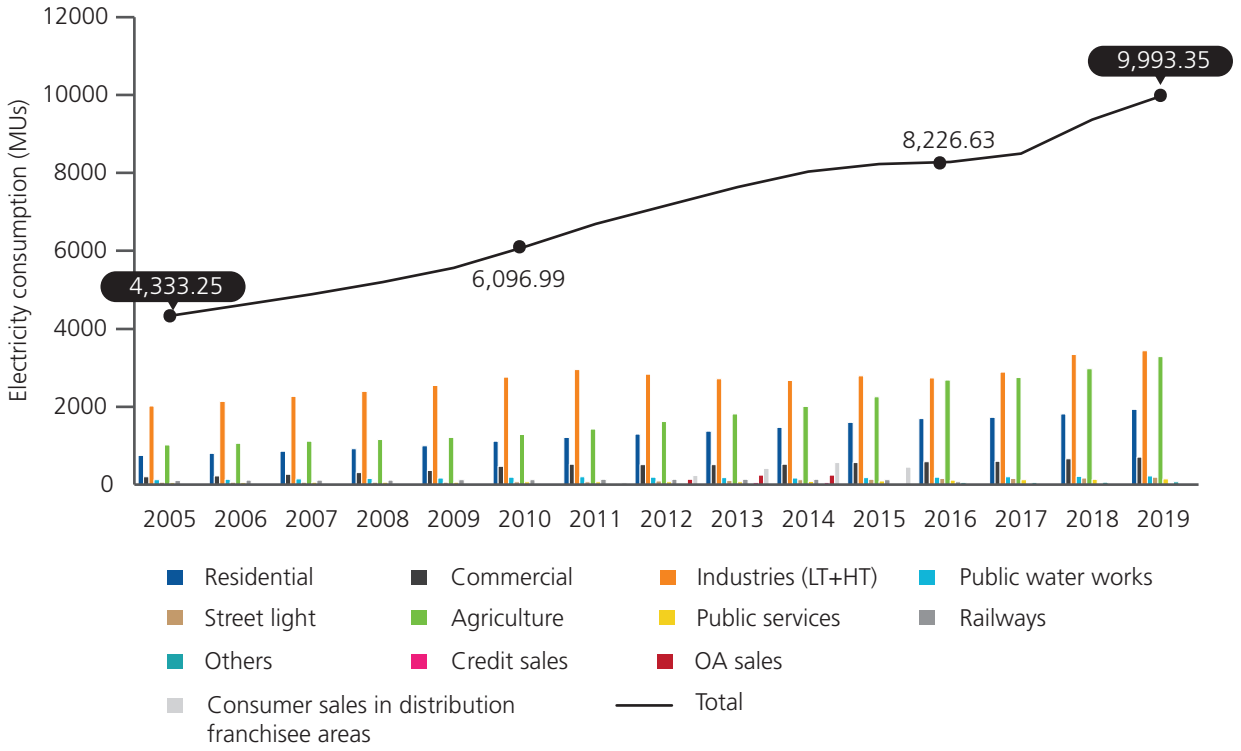


Figure 7: Electricity consumption in Pune over the years.

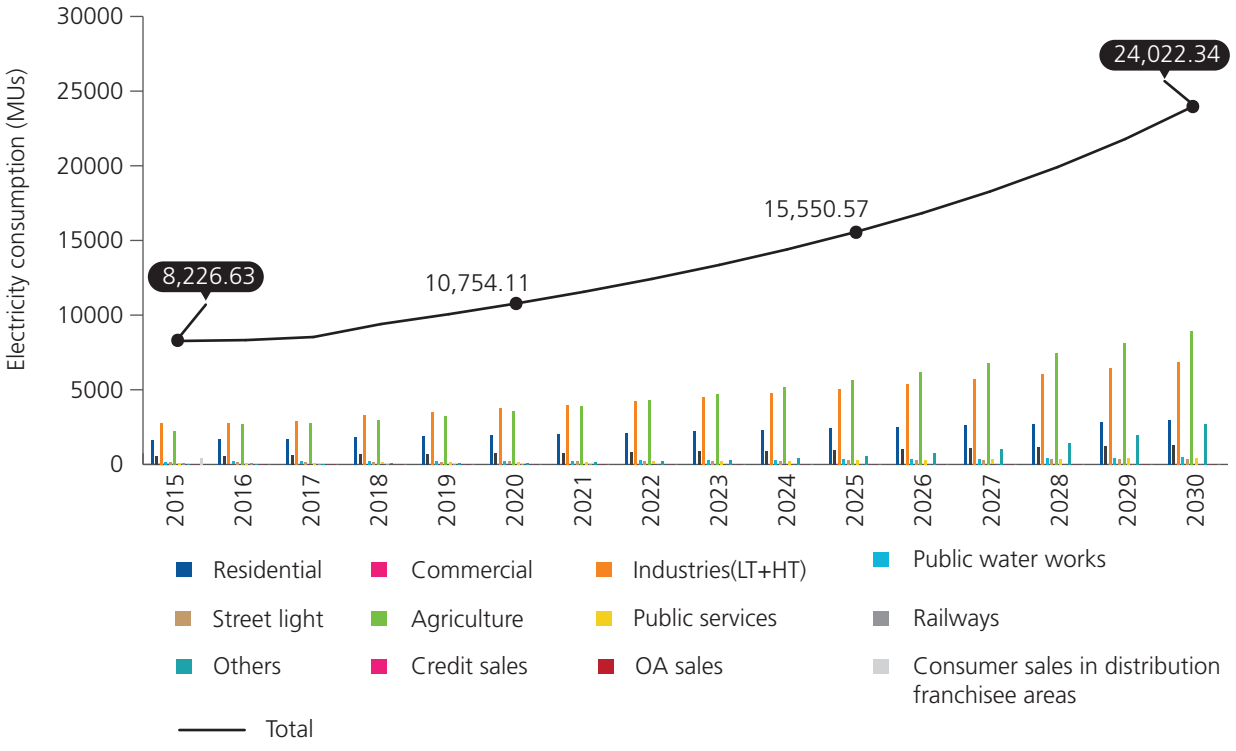


Figure 8: Projected electricity consumption in Pune district till 2030 (CAGR 2015-18)

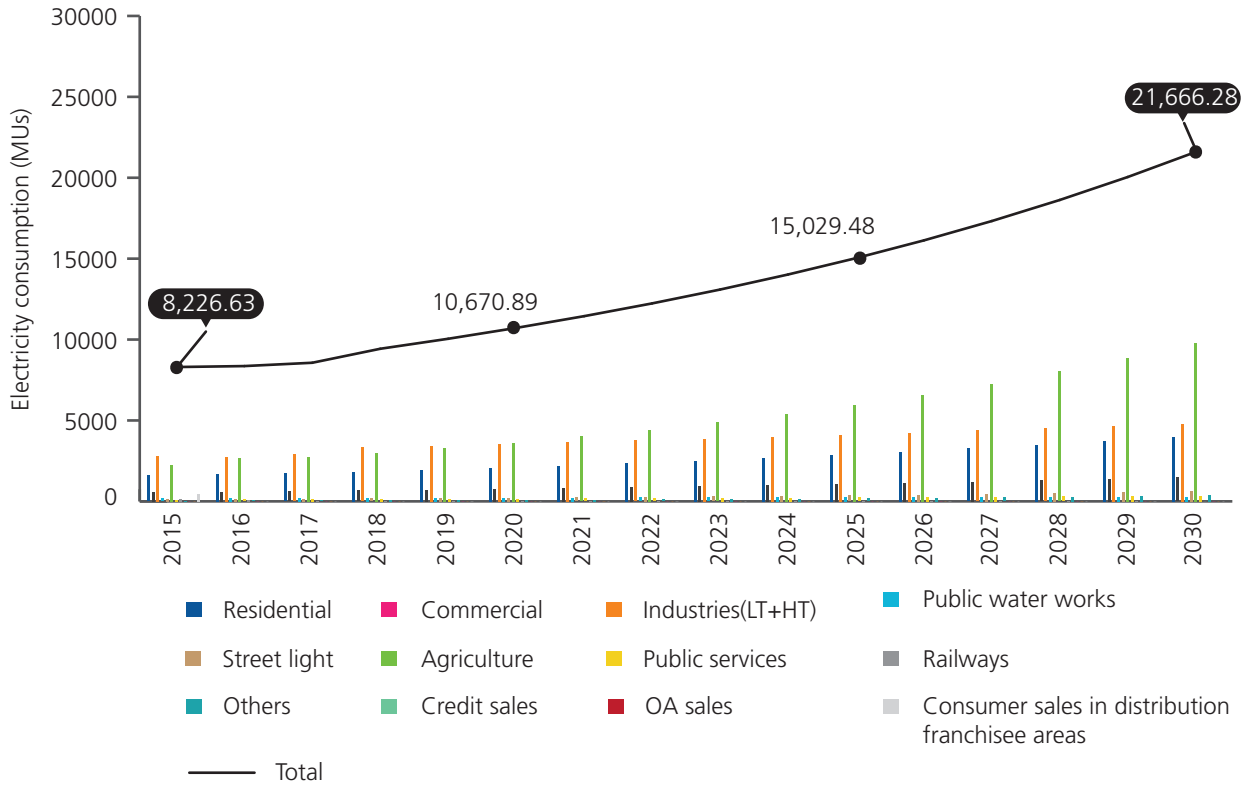


Figure 9: Projected electricity consumption in Pune district till 2030 (CAGR 2009-2018)

1.3 Transport and related infrastructure

Pune district is well connected to the rest of the state and the country by state and national highways. The Mumbai-Pune Expressway, India's first six-lane expressway, has significantly eased travel to and from the district.

The Pune Mahanager Parivahan Mahamandal Limited (PMPML) operates buses within Pune city and surrounding suburbs. The Rainbow Bus Rapid Transit System is the second BRTS launched in the country after Ahmedabad. It runs 61 km and serves approximately 1,20,000 people per day. The BRTS has quality design features and has brought more than 12 percent of its ridership from other modes, primarily private cars (ITDP, 2018). Additionally, state transport buses also connect the district to all major cities and towns in Maharashtra.

In 2018, Pune became the first city in the country where the vehicle numbers surpassed the population.

In 2018, Pune city's vehicle numbers surpassed its population, a first among all urban areas in the country. The Environmental Status Report (ESR) 2018-19 of the Pune Municipal Corporation (PMC) showed a drop in the number of registrations of two- and four-wheeler vehicles for the first time in at least 20 years. The report also claims that the use of public transport has increased. However, it has to be noted that private taxi and cab-sharing services were considered public transport in the report along with autorickshaws and buses.

According to the RTO data referred to in the ESR report, a total 2.61 lakh vehicles have been registered in 2018-19, as compared to 2.89 lakh vehicles registered in 2017-18. Everyday more than 1,084 new vehicles are being added to the study area (PMRDA, 2018).

Cab numbers have also increased, as per the ESR. In the year 2016-17, there were 10,076 private taxis registered with the RTO, but now, in 2018-19, the number of cab registrations have increased to 35,076. The same trend is observed with autorickshaws. A total of 45,004 auto rickshaws were registered with Pune RTO in 2016-17. In 2017-18, the figure rose to 53,227 and now, total rickshaw registration in 2018-19 is 69,271.

Table 4: Motor vehicle population in Pune (2011-2017) (PMRDA, 2018)

Category/Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Motor cycle	9,15,400	10,49,463	10,49,463	13,50,608	14,35,067	15,74,382	16,67,451	17,77,888	19,83,353	21,59,667
Scooters	3,08,733	3,07,220	3,05,796	3,05,575	3,63,973	3,83,439	4,54,907	5,23,729	5,23,827	5,23,827
Mopeds	1,94,452	1,94,515	1,94,567	1,94,565	1,94,947	1,95,090	1,95,312	1,95,726	1,95,967	1,95,967
Cars	2,46,286	2,84,780	3,31,797	3,77,564	4,23,482	4,57,698	4,96,811	5,46,556	6,02,957	6,50,574
Jeeps	39,527	40,205	41,216	41,699	42,067	41,950	4,18,40	41,850	41,850	41,850
Station wagons	950	950	877	987	876	876	876	876	876	876
Taxi Cabs	10,323	11,429	6,832	6,388	6,321	5,678	10,076	22,696	2,83,44	35,076
Auto rickshaw	61,531	62,889	43,965	42,644	45,004	45,004	45,004	45,004	5,32,27	68,271
Stage carriage	5,254	5,536	2,563	2,537	2,541	2,541	2,540	2,540	2,623	2,800
Contract carriage	5,866	6,002	2,822	2,975	4,143	4,419	6,339	11,278	12,261	12,896
School buses	441	903	1,159	1,455	1,540	1,604	2,186	2,281	2,564	3,003
Private service vehicles	1,380	640	1,196	1,170	1,261	1,297	1,272	1,282	1,302	1,341
Ambulances	1,091	1,145	1,035	1,035	1,088	1,155	1,167	1,199	1,275	1,323
Multi axle vehicles	53	53	885	914	1,142	2,461	3,994	7,035	8,077	10,071
Trucks and lorries	21,068	34,435	21,146	21,572	24,555	25,165	27,501	34,708	38,598	40,483
Tankers	3,011	4,330	2,825	2,817	2,976	3,200	3,184	3,221	3,365	3,701
Delivery vans (4W)	21,652	23,771	27,852	30,383	31,314	35,303	38,626	42,782	47,135	53,304
Delivery vans (3W)	24,781	26,889	25,132	26,028	28,192	29,091	30,493	32,373	33,895	35,130
Tractors	17,234	17,883	18,213	18,475	19,933	21,365	23,047	24,296	25,149	26,349
Trailers	9,831	9,887	11,514	11,491	11,639	12,225	12,569	12,759	12,794	13,086
Others	3,922	4,460	5,688	5,812	6,220	6,508	6,808	7,291	7,841	8,095
Total	19,03,786	20,87,385	22,51,926	24,46,694	26,48,281	28,50,451	30,72,003	3,33,7370	36,27,280	38,88,690

1.4 Habitat (urban and rural)

Pune district covers 5.08 percent of Maharashtra's area geographically and supports 8.39 percent of the state population, of which about 61 percent resides in urban areas. The high percentage of urban population indicates a huge pressure on its resources and infrastructures. The population density of the district (603/sq. km) is the fourth highest in Maharashtra which is around 1.6 times the state[3] average and more than 1.5 times the national[4] average (Census, 2011). The district has two urban local bodies – Pune Municipal Corporation and Pimpri Chinchwad Municipal Corporation. The increase in urban sprawl of Pune city is summarised in figure 10.

Pune is the second largest district in Maharashtra both by area and population.

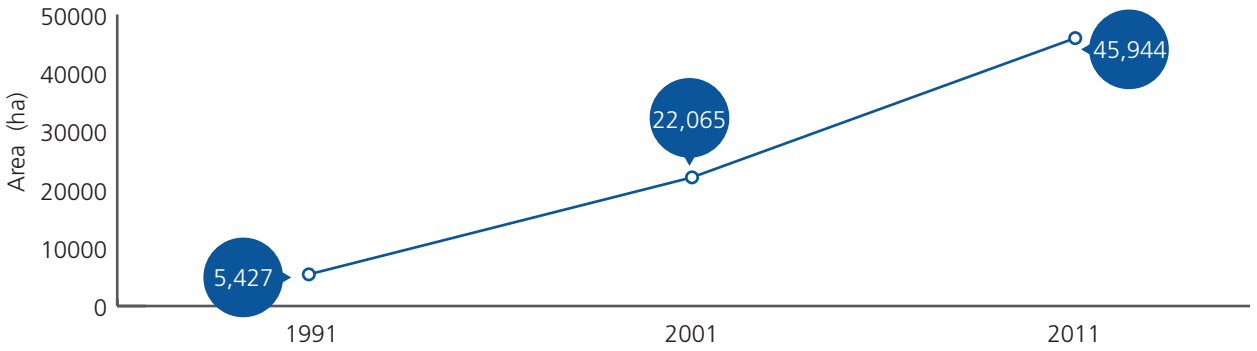


Figure 10: Urban sprawl (Atlas of Urban Expansion) in Pune city over the years

3 369/sq. km
4 382/sq. km

1.5 Industrial profile

There are 10 industrial areas and six cooperative industrial areas in Pune covering a total area of 6,282.18 hectares. The district attracts about 20 percent of the entire industrial investment in the country (CNBC, 2020). Maharashtra Industrial Development Corporation (MIDC) has launched additional industrial areas across the state in PPP mode, with some coming up near Pune.

Pune district has a total of 28,322 registered units, of which there are 639 large-scale units. These industrial units generate close to 3 lakh employment opportunities. The district also has industries, such as cement manufacture, chemical production, and glass and ceramic works, falling under the IPCC's industrial processes and product use (IPPU) category with GHG emission potential.

Further details about industrial units in the district are available in Annexure 1.1 and 1.2.

1.6 Natural resources

Pune district has four main agro-climatic zones – western Maharashtra plain zone, Western Ghat zone, western Maharashtra scarcity zone, and sub-montane zone. The district has a net sown area of 5,11,700 hectares with a cropping intensity of 161 percent (Department of Agriculture, 2019). The net irrigated area was 2,87,000 hectares and rainfed area was 8,35,000 hectares in 2017 (ICAR & MPKV, 2017). Major produce is sugarcane, paddy, wheat, mango and onion among others.

Total livestock population of Pune is 17,72,448 (Livestock Census, 2012).[5] Table 5 gives a summary of the livestock population in the district according to the 19th livestock census (MoAFW, 2020). There are 29 veterinary clinics, seven mobile clinics and 1,016 veterinary dispensaries in the district.

Pune's forest cover – at 10.94 percent of its geographical area – it is much below the state average of 16.50 percent (Forest Survey of India, 2019). As per the latest assessment by FSI (2019), Pune has maintained its forest cover at about 1,71,086 hectares.

Pune is a wetland rich district with 996 wetlands comprising 6.72 percent of Maharashtra's wetlands, covering an area of approximately 68,000 hectares in the district. Rivers/streams contribute 19.28 percent to the wetland area of Pune district. Reservoirs/barrages contribute a major share of 48,339 hectares and tanks/ponds contribute 6,314 hectares (ISRO, 2011).

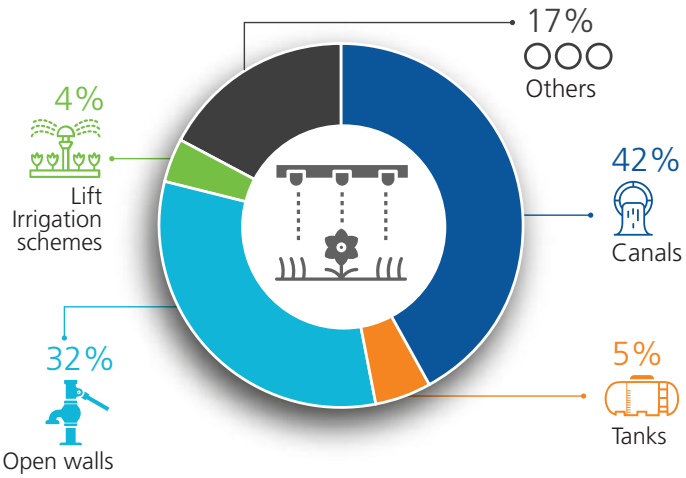


Figure 11: Percentage share of irrigation type in total irrigated area

Table 5: Livestock population by category in Pune district (2012)

Livestock Category	Population (in 2012)
Cattles	7,63,261
Buffaloes	2,94,171
Camels	30
Sheep	3,03,909
Goats	3,94,723
Horses	5,413
Donkeys and Mules	1,436
Dogs	1,00,481
Pigs	9,505
Rabbit	600
Poultry	1,85,37,999

5 Total Livestock covers Cattle, Buffalo, Sheep, Goat, pig, Horses & Ponies, Mules, Donkeys, Camels, Mithun and Yak and total poultry include total birds in the poultry farms and hatcheries. https://dahd.nic.in/sites/default/filess/Volume%20II.pdf

Ground water status in the district is an issue of concern. The stage of groundwater extraction is moderately high at 71.51 percent, putting the district in safe and some talukas in semi-critical categories. According to a CGWB study, the groundwater level during the pre-monsoon period indicates there is a rise as well as a decline in water level in the district. In general, rise in water level is in the range of 15.88 to 26.44 cm/year, whereas decline is in the range of 10.06 to 12.14 cm/year (CGWB, 2013).

As per the analysis based on IWRIS data[6], the pre-monsoon groundwater level data of 44 stations located in the 13 tehsils/blocks of Pune district indicates a significant decline in the water level below the ground, particularly in Shirur, Ambegaon, Junnar and Khed tehsils, and shows improvement in a few small pockets of Mulshi tehsil and remains constant in other parts of district (Figure 12). The post-monsoon trend analysis, on the other hand, indicates an improved groundwater level in Indapur, Shirur, Ambegaon, Khed and Purandhar tehsils and a constant level in the remaining parts of the district (Figure 13). This trend indicates high groundwater extraction rate and lower recharge rate. A situation of rain deficiency can potentially lead to severe groundwater deterioration as the pre-monsoon level is already declining.

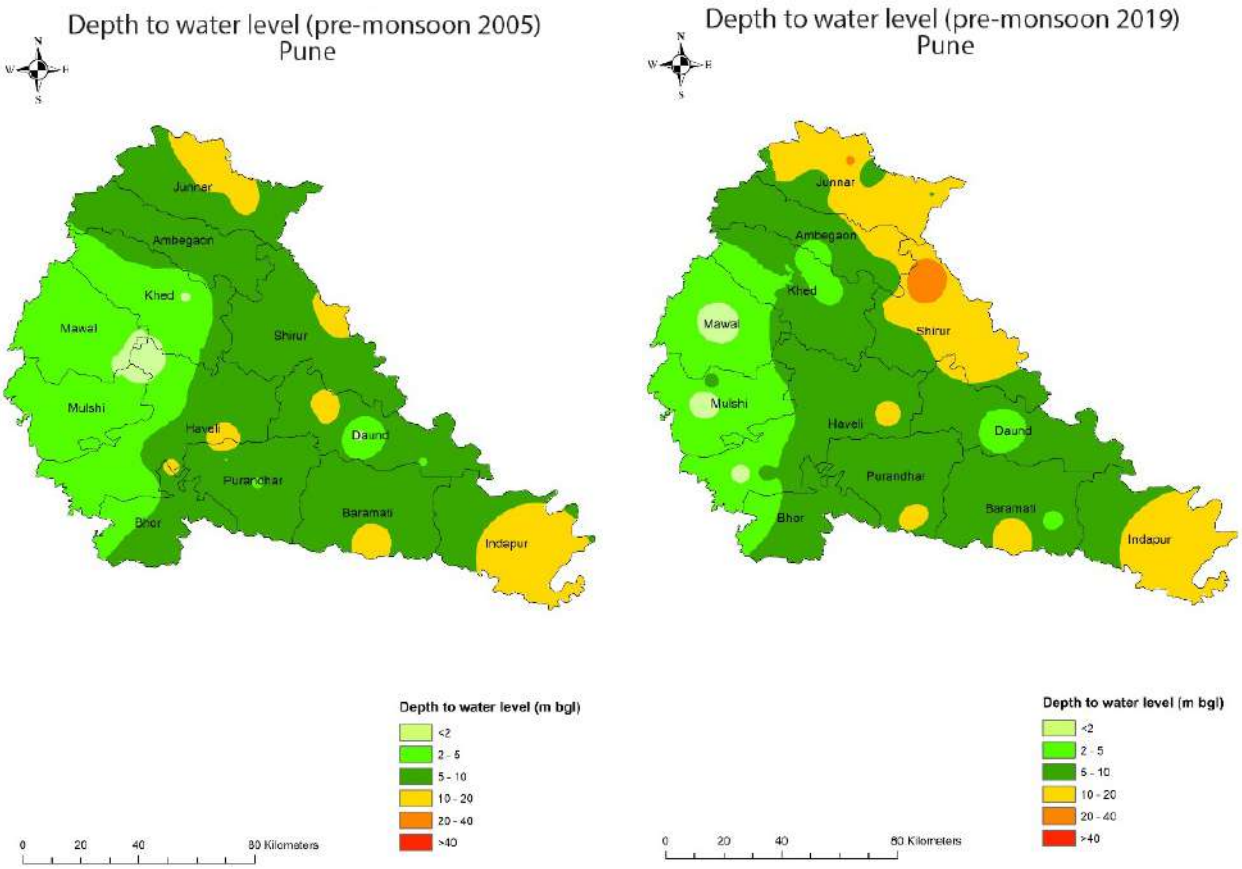


Figure 12: Pre-monsoon groundwater levels in Pune district a) 2005 and b) 2019

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

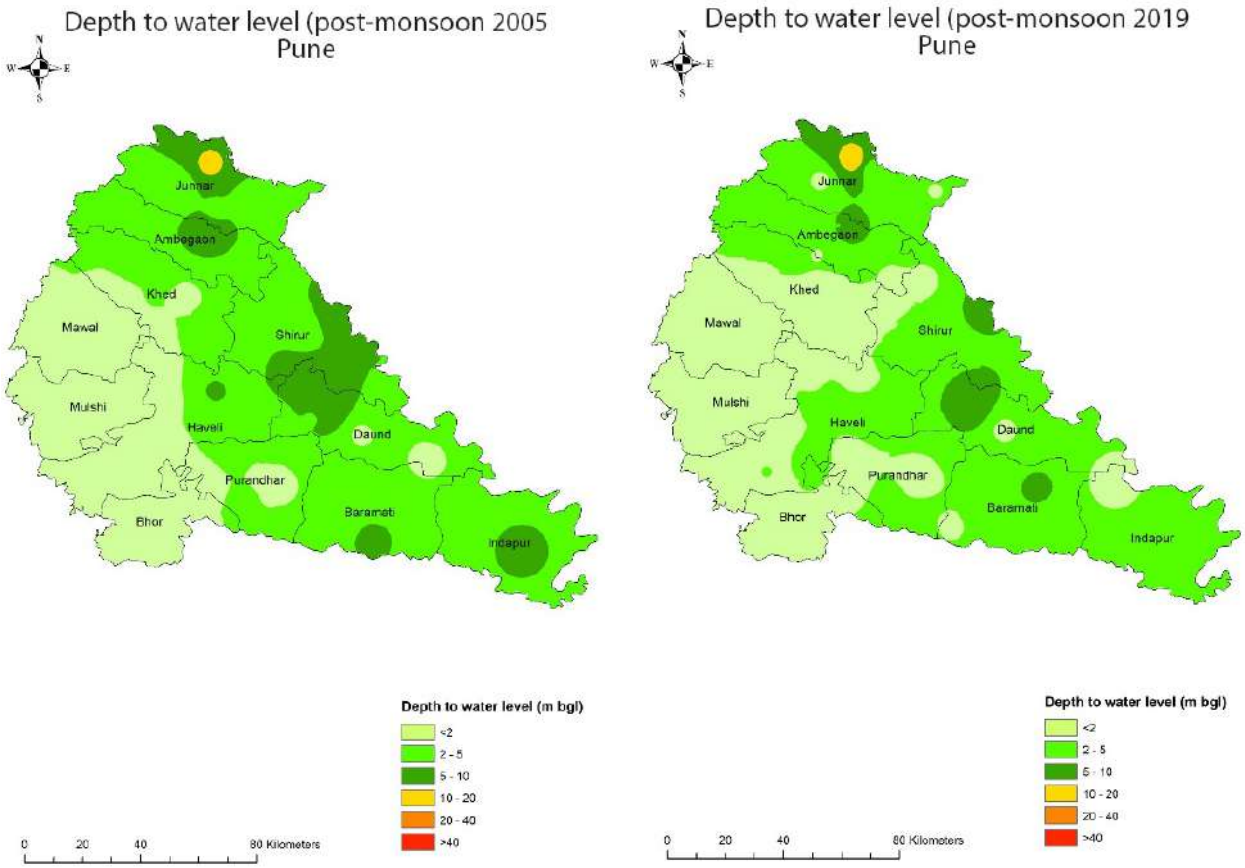
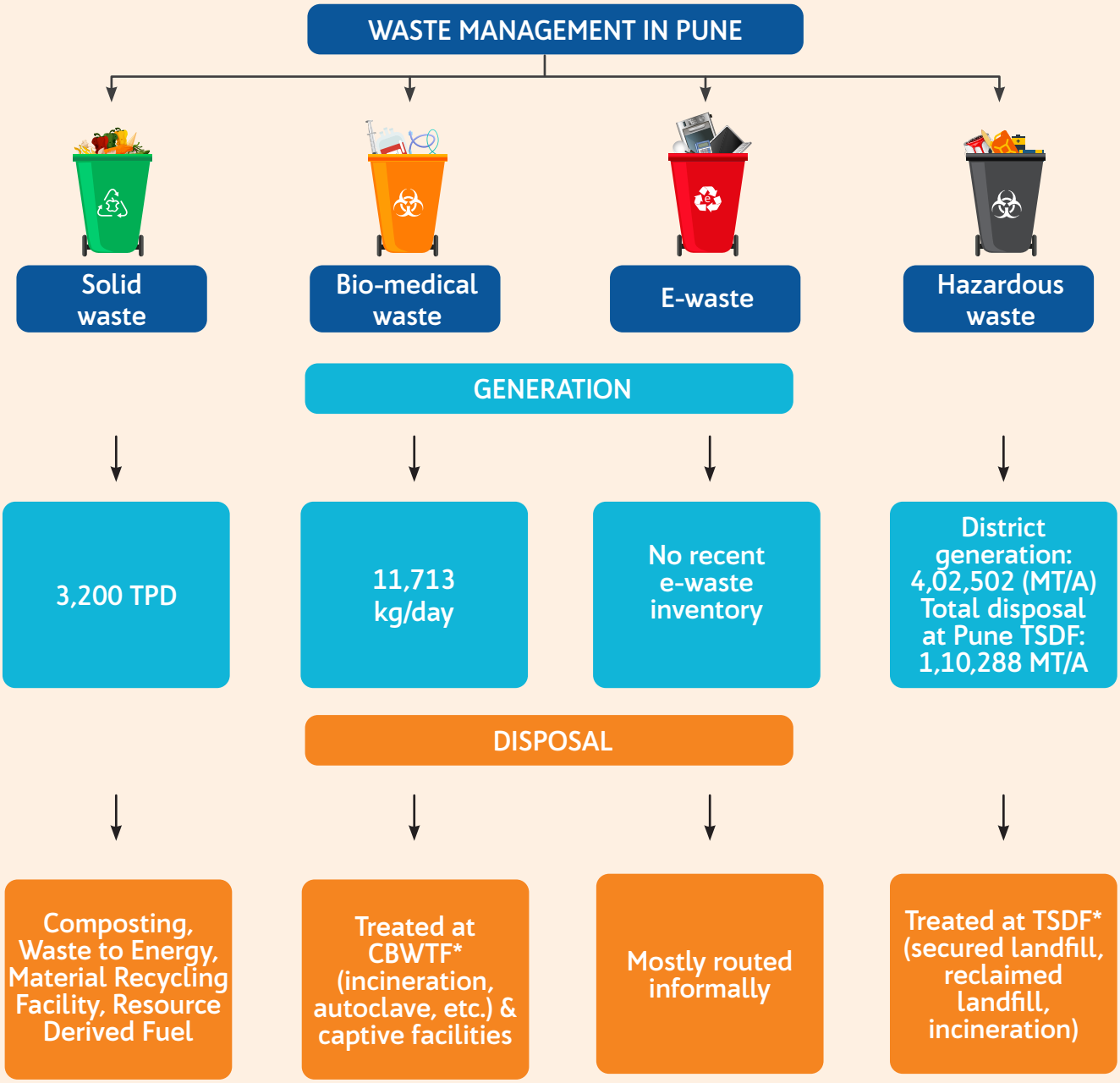


Figure 13: Post-monsoon groundwater levels in Pune district a) 2005 and b) 2019

1.7 Waste sector

Pune (city) is ranked 15th among 47 cities in India that have a population above 10 lakh by the sanitation survey 'Swachh Survekshan' (cleanliness, hygiene and sanitation survey), 2020. Rising from 37 in 2019, the city has improved its all-India rank. However, there is scope for further improvement, keeping in mind the emission mitigation aspects. As per MPCB, 73 percent of the total solid waste generated in Pune district ULBs is getting treated. About 45 percent of the solid waste generated in the district is biodegradable but currently only 19 percent of it is being treated biologically (MPCB, 2019). Pune Municipal Corporation has landfill sites at Uruli, Devachi, and Phursungi, where open dumping is prohibited. The Corporation has Effective Microorganism (EM) composting system and encourages its usage at household level composting units too through a decentralised system. The sewerage network covers 92 percent of Pune city. But for the district as a whole, the coverage is still less —it has 21 STPs of aerobic type for domestic liquid waste treatment with a total capacity of 700 MLD (CPCB, 2015). Though there are several industrial clusters in the district, data on industrial wastewater generation or treatment is not in public domain.



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

CLIMATE PROFILE AND PROJECTIONS

Landslide near Sinhagad fort

2. CLIMATE PROFILE AND PROJECTIONS

2.1 Observed climate variability over Pune 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 Pune district analysing the observed data of the past 68 years. Precipitation and temperature are used as the key climate variables in this analysis.[7]

2.1.1 Precipitation variability

Pune district is situated in the western part of the state of Maharashtra and lies to the leeward side of the Sahyadri mountain range (viz. Western Ghats), which forms a barrier across the Arabian Sea. Considering its geographical location, the climate of the district is broadly described as a tropical monsoon type. The mean monsoon rainfall in the district is around 970 mm. The number of rainy days (days with rainfall of ≥ 2.5 mm) in the district varies from 10 to 14 in a month during monsoon. The district receives more than 50 days of good rainfall during the season.

The year-to-year rainfall variability in monsoon months and seasonal mean for 1951-2018 over Pune district (area averaged) is depicted in Figure 14. The monsoon rainfall though does not show any significant trend; however, a slight increase is observed in the past decade during both individual months and season as a whole. It has been observed that the variability in the number of rainy days is higher in July and August in the recent decade, and shows a slightly decreasing tendency during the period of 1951 to 2018 (Figure 15).

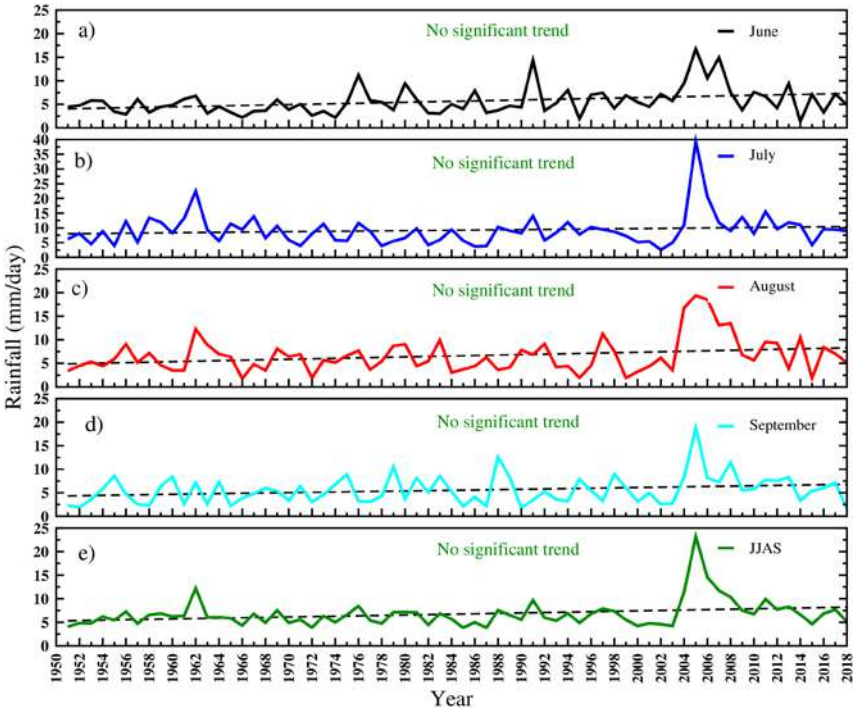


Figure 14: Inter-annual variability of rainfall (mm/day) over Pune for 1951-2018

Mean monsoon rainfall in Pune district is around 970 mm; slight increase observed in the past decade.

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

Slight decreasing trend in number of rainy days (1951-2018), with higher variability in July and August (in last decade)

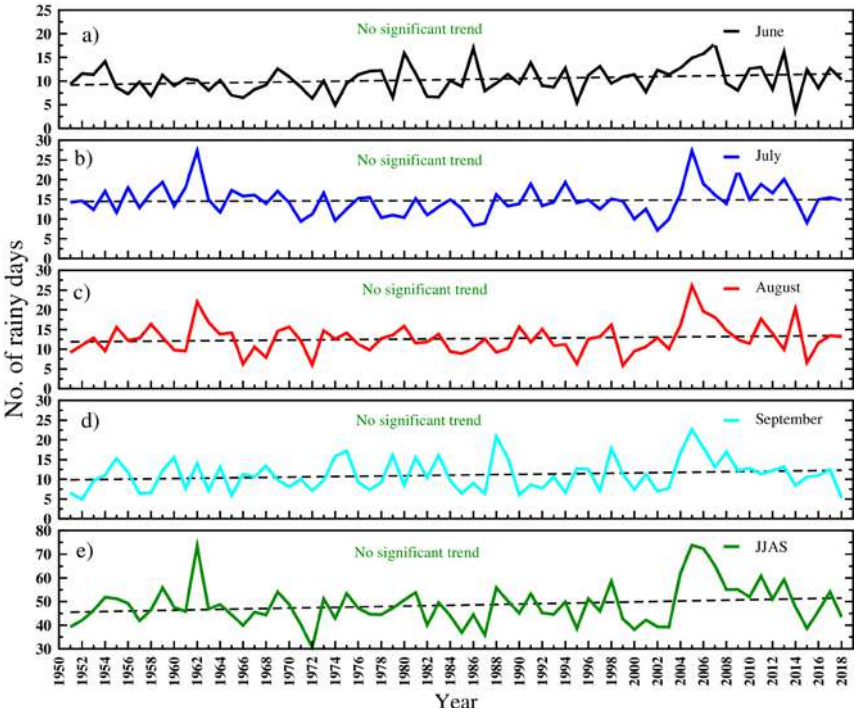
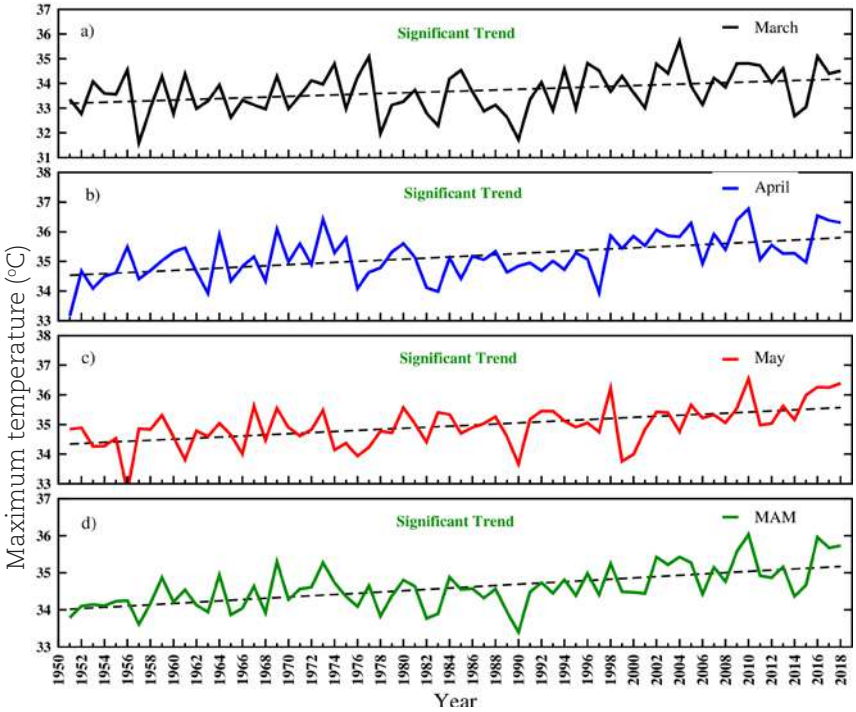


Figure 15: Inter-annual variability of rainy days (number of days) over Pune for 1951-2018

2.1.2 Temperature variability

The temperature starts shooting up from the beginning of March and reaches maximum in May. The daily maximum temperature in May goes up to 35°C with the mean monthly maximum temperature ranging from 33.5°C to 35°C during summer. The maximum temperatures show a significantly increasing trend during April and May, more so in the last decade (Figure 16). The mean percentages of warm days have also increased by about 10 percent over the district during the period of 1986-2005 (Figure 17).[8]



Maximum temperature in summer months show a significant increasing trend

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

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

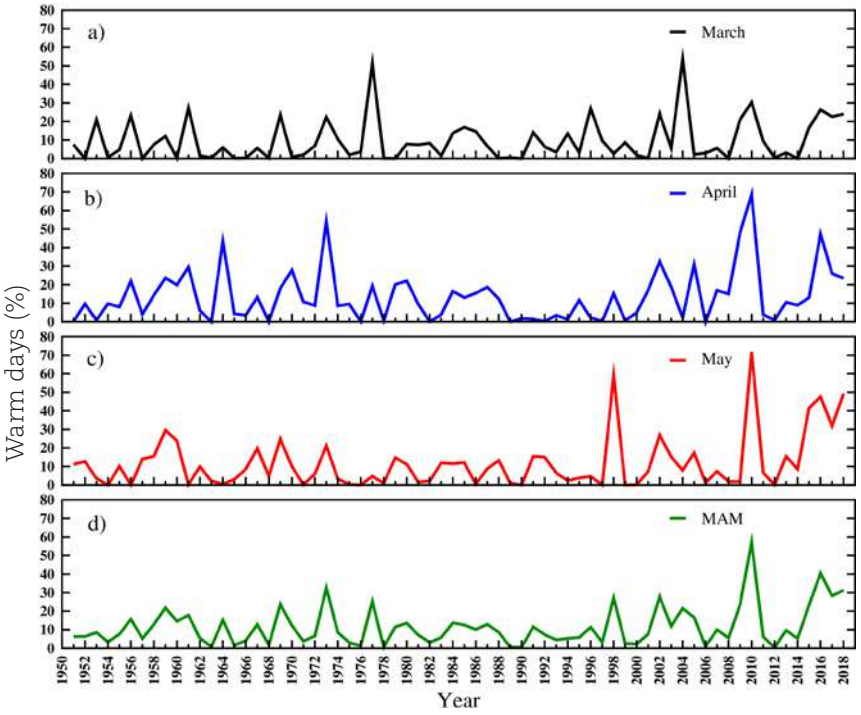


Figure 17: Inter-annual variability of warm days (%) over Pune for 1951-2018

Mean percentage of warm days increased by 10% in recent decades

The minimum temperatures during the winter season (December, January, and February) average to about 15°C with January being the coldest month. The year-on-year variability of minimum temperature shows a slightly decreasing tendency throughout the winter months (Figure 18) and the number of cold days show a large variability during all winter months with February experiencing higher number of cold days (Figure 19).[9]

Minimum temperature in winter season average about 15°C; slight decreasing tendency observed.

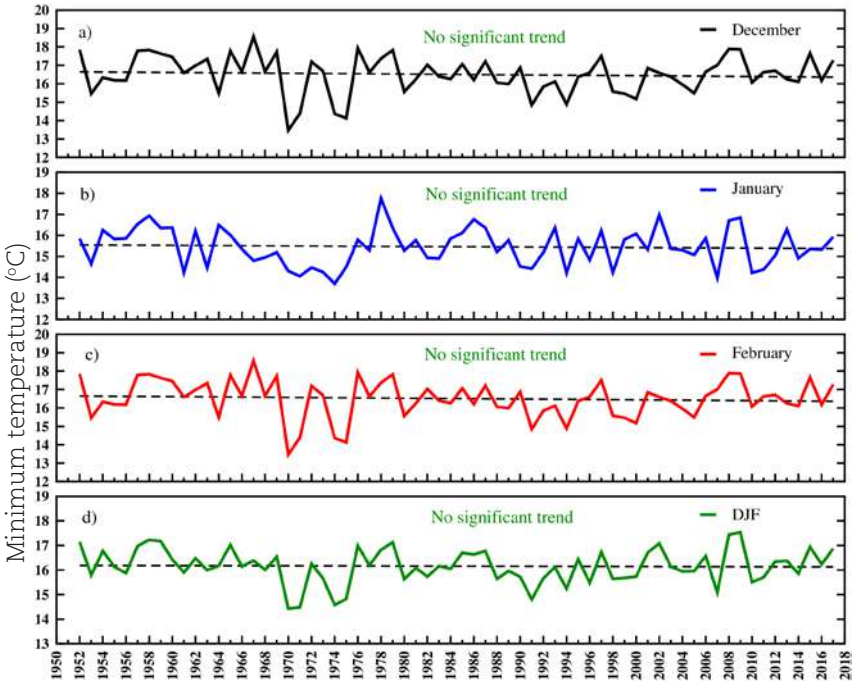


Figure 18: Inter-annual variability of minimum temperature (°C) over Pune for 1951-2018

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

Large variability observed in cold days; February experiences more number of cold days

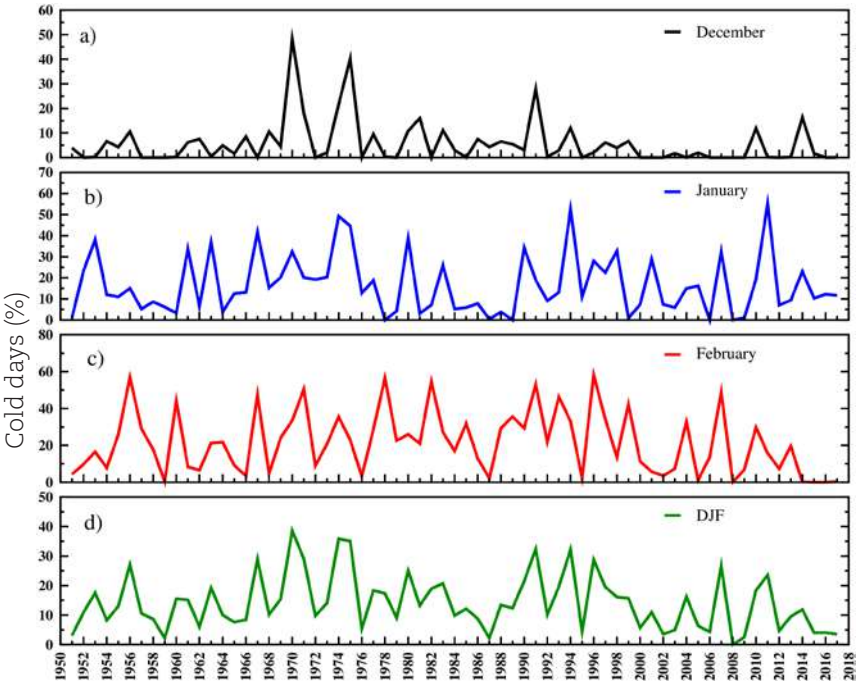


Figure 19: Inter-annual variability of cold days (%) over Pune for 1951-2018

2.2 Future climate projections for Pune district

Precipitation and temperature over the district for the period of 1986 to 2005 have been simulated using the multi model mean (MMM) ensemble.

Pune district is projected to experience an increase in the quantum of rainfall during the monsoon months and the season as a whole in different epochs (2021-2040, 2041-2060, 2061-2080 and 2081-2100) under medium (RCP4.5) and high (RCP8.5) emission scenarios (Table 6). The projection shows an increase in seasonal mean rainfall of 6 to 17 percent under RCP4.5 and 10 to 33 percent under RCP8.5 emission scenarios, respectively. The number of rainy days is also projected to increase with higher variability during the monsoon season, particularly in July and August (Table 7).

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

Rainfall (mm)	June	July	August	September	JJAS (total of June, July, Aug and Sept)
Observed	219	310	242	195	968
Simulated	164	253	184	152	756
RCP4.5					
2030s (2021-2040)	169	249	202	183	805
2050s (2041-2060)	176	260	203	191	832
2070s (2061-2080)	170	272	221	197	862
2090s (2081-2100)	178	285	218	195	879
RCP8.5					
2030s	165	270	225	175	838
2050s	171	278	234	227	917
2070s	166	318	248	219	953
2090s	178	310	267	248	1005

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

Rainy days (days with rainfall of ≥ 2.5 mm)	June	July	August	September	JJAS (total of June, July, Aug and Sept)
Observed	11	14	12	11	48
Simulated	11	16	14	12	53
RCP4.5					
2030s (2021-2040)	11	15	14	13	54
2050s (2041-2060)	11	16	14	14	55
2070s (2061-2080)	10	16	14	14	54
2090s (2081-2100)	11	17	14	13	55
RCP8.5					
2030s	10	16	14	13	53
2050s	10	15	14	14	54
2070s	10	15	14	15	55
2090s	10	16	14	14	55

The projected changes in maximum and minimum temperatures were analysed on a monthly scale during the summer/ winter season. The projections in different time epochs show that the maximum temperatures may increase by 1°C to 2°C under RCP4.5 and 1.2°C to 3.9°C under RCP8.5 over the district. In particular, temperatures in May are higher compared to the temperatures in other summer months. The percentage of warm days is also projected to increase over the district, more so by the end of the century (Table 9). In the winter season, the minimum temperatures also show a projected increasing trend with the percentage of cold days decreasing in all the epochs under changing climatic conditions. The analysis shows there is a clear increase in temperature towards the end of the century (Tables 10 and 11).

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

Temp max (°C)	March	April	May	MAM (average of March, April and May)
Observed	33.7	35.2	34.9	34.6
Simulated	34.5	36.5	36.7	35.9
RCP4.5				
2030s	35.5	37.5	37.5	36.9
2050s	36.1	38.1	37.9	37.4
2070s	36.4	38.4	38.3	37.7
2090s	36.6	38.7	38.5	37.9
RCP8.5				
2030s	35.6	37.7	37.7	37.1
2050s	36.5	38.5	38.5	37.8
2070s	37.8	39.6	39.4	38.9
2090s	38.6	40.6	40.3	39.8

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

Warm days (%)	March	April	May	MAM (average of March, April and May)
Observed	10	9	10	10
Simulated	10	10	10	10
RCP4.5				
2030s	41	40	34	38
2050s	58	57	49	55
2070s	64	65	60	63
2090s	72	71	64	69
RCP8.5				
2030s	44	44	40	42
2050s	69	68	64	67
2070s	88	88	84	86
2090s	95	96	93	94

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

Temp min (°C)	Dec	Jan	Feb	DJF (average of Dec, Jan and Feb)
Observed	16.0	15.5	16.1	16.0
Simulated	13.5	12.9	14.4	13.6
RCP4.5				
2030s	14.4	14.2	15.4	14.6
2050s	15.1	14.6	16.1	15.2
2070s	15.7	15.1	16.5	15.9
2090s	15.8	15.4	16.7	16.0
RCP8.5				
2030s	14.8	14.4	15.6	14.2
2050s	15.6	15.2	16.6	15.5
2070s	17.1	16.5	15.1	14.1
2090s	18.1	17.7	19.0	14.3

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

Cold days (%)	Dec	Jan	Feb	DJF (average of Dec, Jan and Feb)
Observed	5	16	24	14
Simulated	9	17	36	20
RCP4.5				
2030s	3	4	14	7
2050s	1	2	8	4
2070s	0	1	5	2
2090s	0	1	3	2
RCP8.5				
2030s	1	4	13	6
2050s	1	1	4	2
2070s	0	1	0	0
2090s	0	0	0	0

2.3 Sectoral impacts of climate change

2.3.1 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, sorghum and jowar among other crops. The mountain regions in districts of Pune, Satara and Raigad are experiencing and are projected to have highest increase in annual mean temperature.

Pune district is projected to experience warming of 1°C to 2°C under RCP4.5 and 1.2°C to 3.9°C under RCP8.5. The percentage of warm days is projected to increase by more than 65 percent. Minimum temperature is also projected to increase. The predicted rise in temperature 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 productivity.

Between 1970 and 2019, Maharashtra has witnessed a seven-fold increase in drought events and a six-fold increase in the frequency of extreme flood events (Mohanty, 2020) (Bhalerao, 2020). 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.

Further, increase in monsoon rainfall, in the Western Ghats region of the district, may also increase the rate of leaching (nitrates) in soil, thereby adversely impacting the decomposition of organic matter due to water saturation. Higher temperatures in combination with increase in rainfall, threaten agricultural productivity by catalysing an increase in fungal diseases and bacterial leaf-blight, among other plant diseases.

2.3.2 Water resources

Pune district is divided into two major river basins, Bhima and Nira. The Northeast, Eastern and Central part of the district comes under the Bhima River basin and the Southeast and Southern parts of the district come under the Nira River basin. Mula-Mutha is a major tributary of Bhima, which also flows through the district. The total length of rivers in the district is 1,296 km. Majority of the district is dependent on surface water for drinking, irrigation, fishing and industrial requirement. River cleaning and development projects are underway in Pune to revive the rivers affected by pollution in the district.

A survey of dug wells and borewells in Pune district revealed that groundwater extraction in Pune has doubled from 2,000 million cubic feet (2 TMC ft) in 2011 to 4 TMC ft in 2019. According to the survey, this can be attributed to the fact that 25 percent of the city's total demand of water is met through groundwater in peri-urban areas such as Aundh, Pashan, Singhad Road, Wadgainsheri and Dhayari being majorly dependent on groundwater.

Pune is affected by both droughts and floods. These disasters have had a major impact on agriculture and daily life in the districts. In April 2020, the dams in Pune region had only 21.43 percent water stock as compared to 33.87 percent during the previous year. The unpredictable rainfall pattern in the region due to rapidly changing climate, increases the risk of both floods and droughts as well as landslides caused by excess run off. 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.

Major flooding events in recent years have had devastating impacts on agriculture, infrastructure and human lives in the district. Further, floods can also trigger landslides, thereby exacerbating the damage. Climate change induced shifting rainfall pattern in the district could further aggravate these issues in the long run, unless prompt action is undertaken.

SECTORAL GREENHOUSE GAS EMISSIONS PROFILE

Traffic on a busy road in Pune

3. SECTORAL GREENHOUSE GAS EMISSIONS PROFILE: CLIMATE CHANGE DRIVERS

This section estimates greenhouse gas (GHG) emissions for Pune district using the guidelines laid down by the Intergovernmental Panel on Climate Change (IPCC).[10] Estimates have been provided for 13 categories, covering three major sectors – energy, agriculture, forestry and other land use (AFOLU), and waste – for the years 2005 to 2019.[11] Pune district has a few industrial units (especially chemical and glass manufacturing units) that lead to emissions from the industrial processes and product use (IPPU) sector as laid out in 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 sectors and wherever possible, country-specific emission factors were used in place of default-emission factors.[12]

3.1 Direct emission estimates

3.1.1 Economy-wide emissions

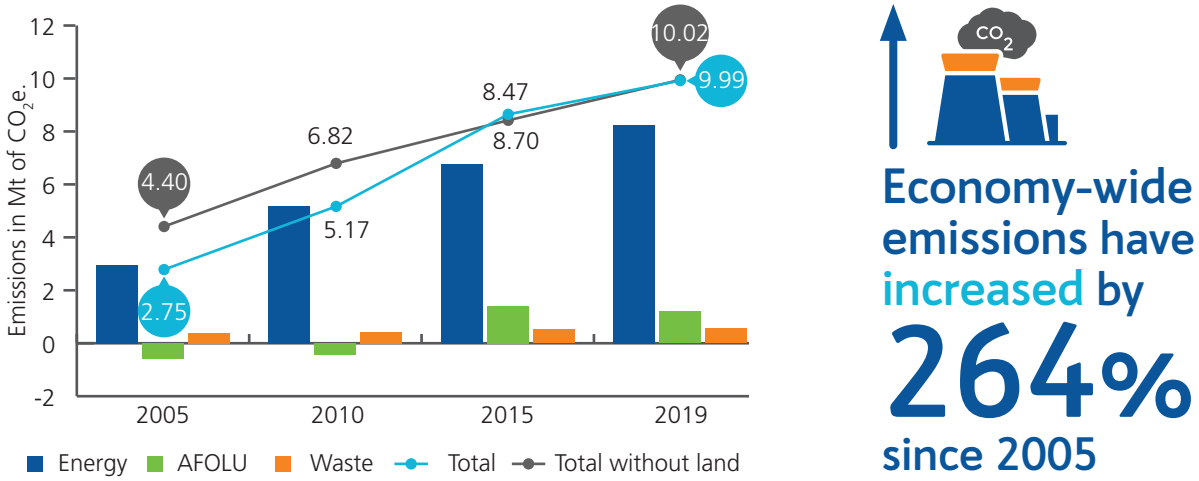


Figure 20: Economy-wide emissions of Pune district (Mt of CO_2e.)

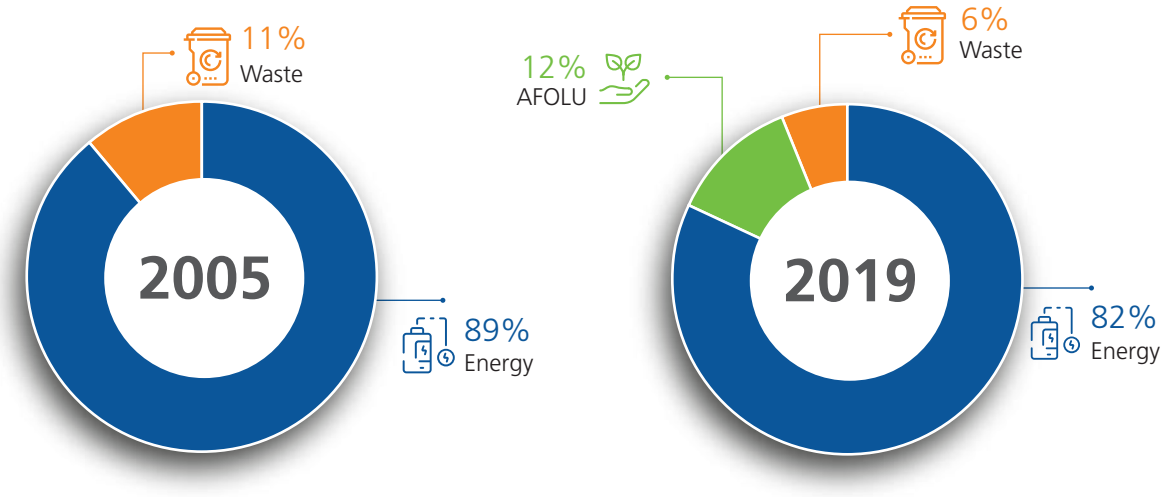


Figure 21: Percentage share of sectors in total emissions (in 2005 and 2019)

10 To the extent possible, 2006 IPCC guidelines were followed; and for a very few categories, the 1996 IPCC guidelines were referred. Background note on GHG inventorisation and its significance is given in Annexure 3.1.
11 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).
12 Emission category-wise activity data sources provided in Annexure 3.2.

- Between 2005 and 2019, total emissions of Pune district increased by 264 percent (from 2.75 $MtCO_2e$ in 2005 to 9.99 $MtCO_2e$ in 2019). The CAGR for the economywide emissions during this time frame grew by 9.66 percent.
- On excluding sink (or emission reductions) from the 'forest removals' category, Pune's emissions (without land) increased by 128 percent between 2005 and 2019 (from 4.4 to 10.02 $MtCO_2e$. respectively).
- Energy sector accounts for the highest emissions; although its share has reduced from 89 percent in 2005 to 82 percent in 2019 due to increase in AFOLU sector emissions.
- Until 2011, AFOLU was a net sink. Emissions from AFOLU peaked in 2013 and started to decline again (details for this trend are given in the AFOLU sub-section of this chapter).
- Waste sector has grown at a slow rate (of 2.66 percent CAGR) and its contribution has dropped from 11 percent (in 2005) to 6 percent (in 2019).
- Although Pune district has a few plants / setups that lead to emissions of / under the Industrial Processes and Product-Use (IPPU) sector, however due to unavailability of data IPPU emissions could not be estimated.
- Sectoral details and analyses are given in the following sections.

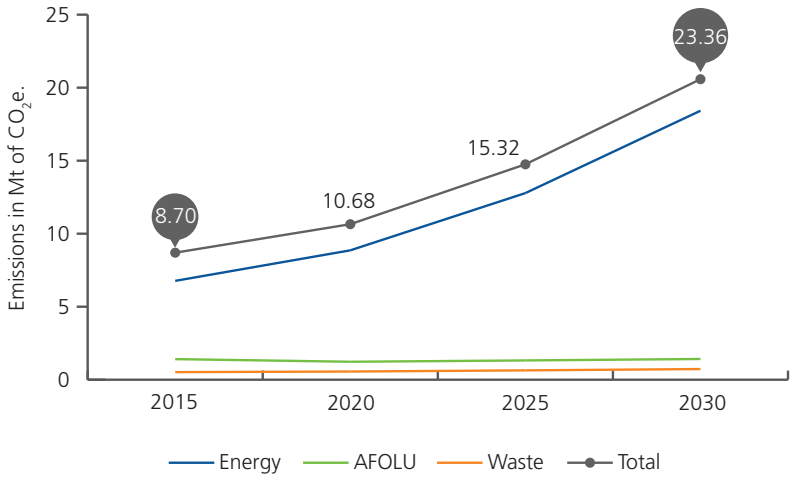
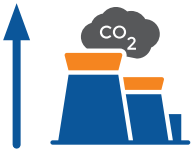


Figure 22: Projections of economywide emissions (BAU) for Pune district (Mt of CO_2e)



In 2030, under the BAU scenario, economy-wide emissions are expected to rise by 168% (w.r.t. 2015)

- In the business-as-usual (BAU) scenario (i.e., no actions/policies are put in place to mitigate the emissions), the total emissions of Pune in 2030 are likely to increase 1.6 times with respect to 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	6.77	8.89	13.36	21.21
AFOLU	1.41	1.23	1.32	1.42
Waste	0.52	0.56	0.64	0.73
Total	8.70	10.68	15.32	23.36

- 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 the transport category are curtailed.

3.1.2 Per capita emissions

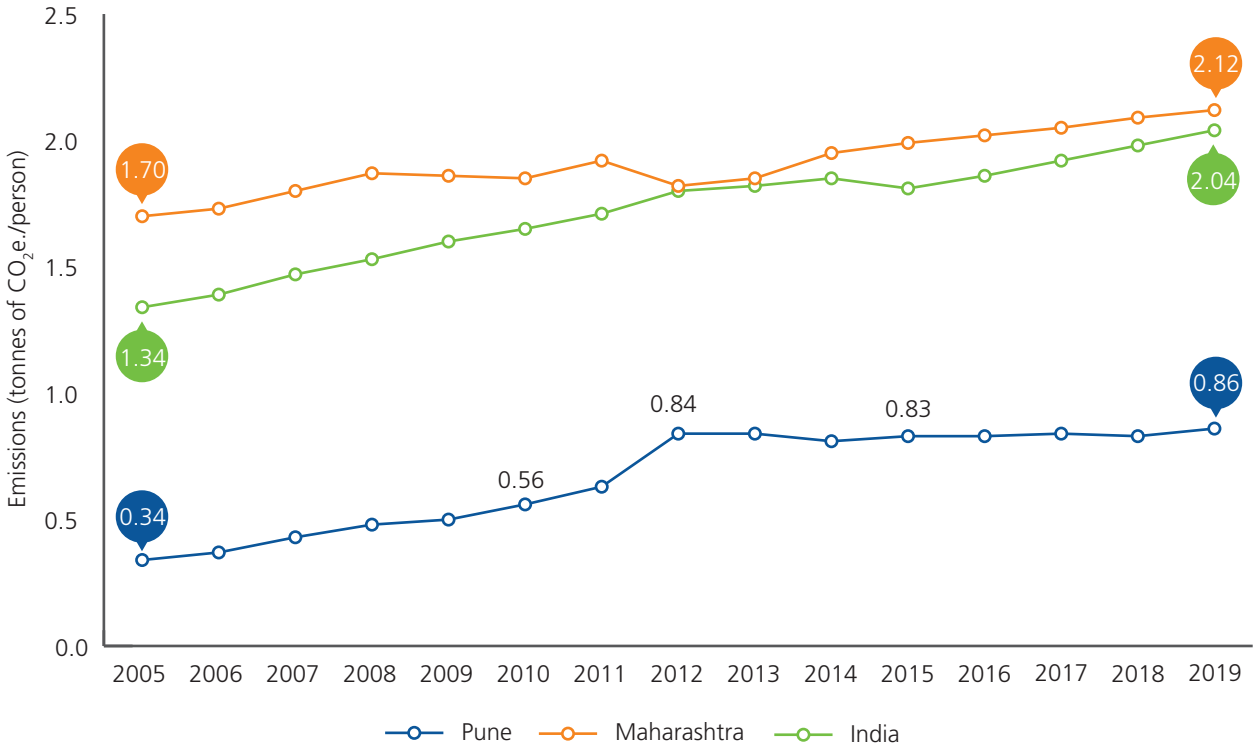


Figure 23 Per capita emissions (tCO_2e/person)-comparison

- Per capita emissions of Pune were computed using the district's total emissions that were estimated in this analysis (therefore, it does not include emissions from IPPU).
- Pune district's per capita emissions are modest in comparison to Maharashtra and the national average.
- Absence of thermal power plants in Pune district is a major reason for overall low emissions of Pune with respect to Maharashtra's emissions.
- It may be noted that Pune's per capita electricity consumption is approximately 787.50 kWh/person. However, Pune's electricity consumption leads to higher emissions in some other region.

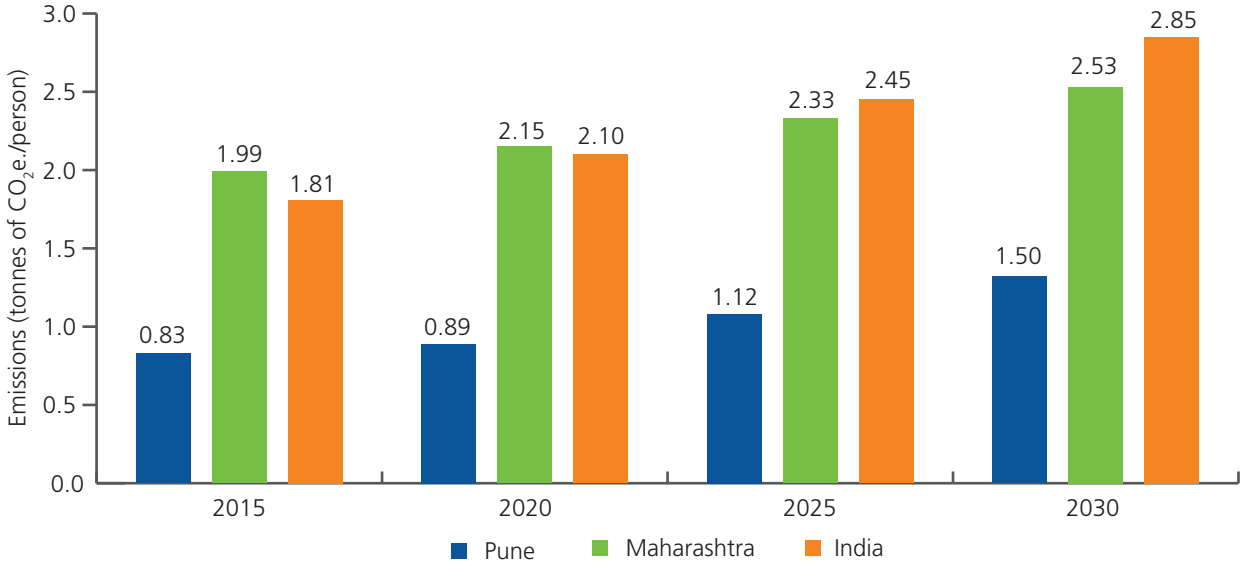


Figure 24 Projected per capita emissions (BAU) (in tCO_2e/person)

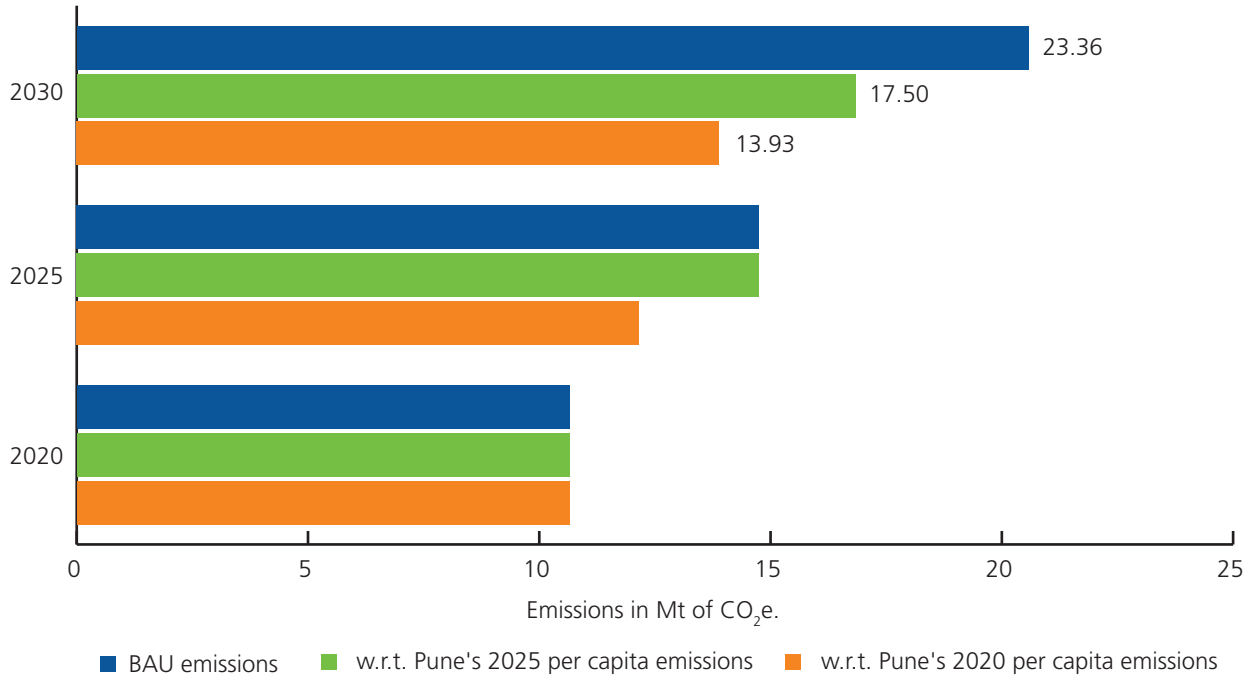


Figure 25 Projected total emissions (Mt of CO_2e) with different per capita emissions scenarios

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

40.4% less if 2020 per capita emission levels are maintained

25% less if 2025 per capita emission levels are maintained

- The business-as-usual projections of per capita emissions indicate that total emissions will increase by 119 percent in 2030 w.r.t. 2020 (as shown in economy wide projections as well).
- However, if the per capita emissions of 2020 are maintained, overall growth in emissions would only be around 31 percent.

3.1.3 Sectoral analysis and projections

Energy sector

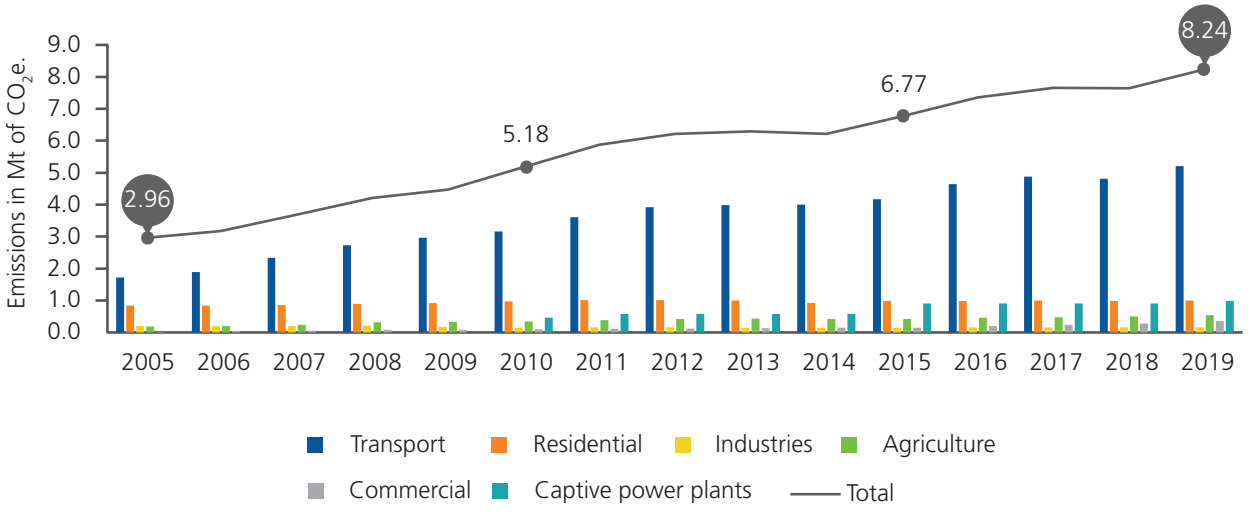
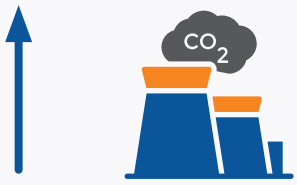


Figure 26: Energy sector emissions of Pune district (in Mt of CO_2e)

Energy sector emissions have increased by

179%

since 2005



- This sector estimates the emissions due to fossil-fuel consumption by various categories.
- Between 2005 and 2019, emissions from the energy sector have increased by 178 percent (from 2.96 Mt of CO_2e in 2005 to 8.24 Mt of CO_2e in 2019).
- Pune district does not have a thermal power plant (TPP) for public electricity generation. However, it does have a number of captive power plants (CPPs).
- Transport category is the highest contributor to energy emissions of the district.
- This is followed by emissions from residential, CPPs, agriculture, commercial and industries categories.
- Despite very low contribution to overall energy emissions, commercial category emissions have seen the highest growth rate between 2005 and 2019 (CAGR of 24.02 percent), followed by growth in CPP emissions (8.86 percent).

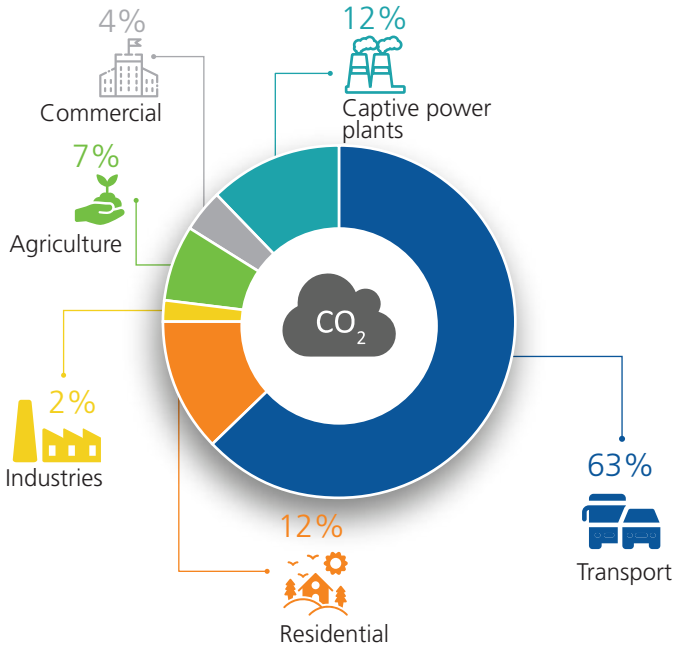
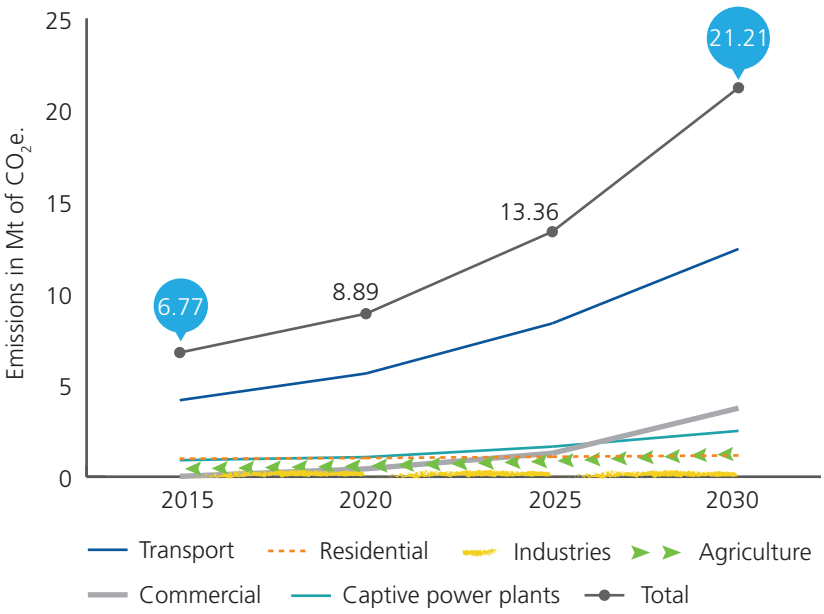


Figure 27: Percentage share in total energy emissions (2019)

Table 12: Growth in energy sector emissions (2005-18)

Category	Sub-category	CAGR (2005-18)	Percent share in energy emissions (2019)	
Transport CAGR: 8.23%	Road (86.7% in transport)	7.90%	54.47%	Total share of Transport is 63%
	Aviation (10.72%)	11.70%	6.74%	
	Railway (2.61%)	8.01%	1.65%	
Residential		1.33%	12.20%	
Captive power plant		8.86%	11.93%	
Agriculture		8.01%	6.50%	
Commercial		24.02%	4.25%	
Industries		-1.65%	1.95%	



Energy sector emissions to rise two-folds in the BAU scenario (by 2030, w.r.t. 2015 levels)

Figure 28 Projected energy sector emission (BAU)

- In the BAU scenario, total energy emissions of Pune district are likely to grow at 7.58 percent CAGR and the overall emissions will increase 213 percent by 2030 (w.r.t 2015 levels).
- Reduction in fuel consumption by the transport sector, increase in share of renewable energy for captive power generation, and decentralised solar power for commercial / agriculture categories would help curtail this growth in emissions.

Agriculture, forestry and other land use (AFOLU)

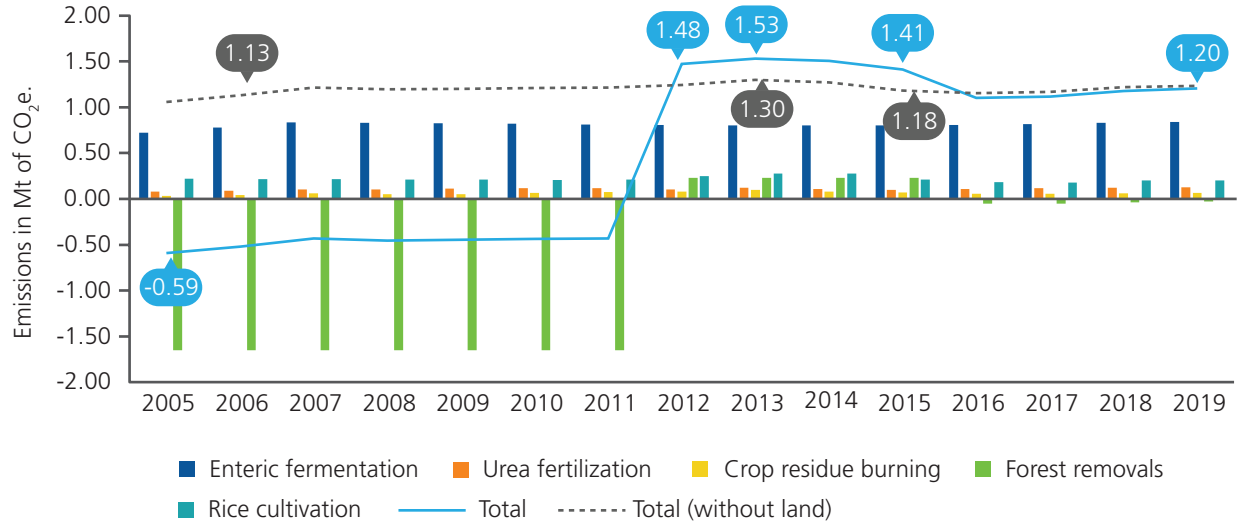


Figure 29: AFOLU sector emissions of Pune district (Mt of CO_2e)

AFOLU sector emissions reduced by 18.12% since 2012

However, before 2012, AFOLU was a net sink.

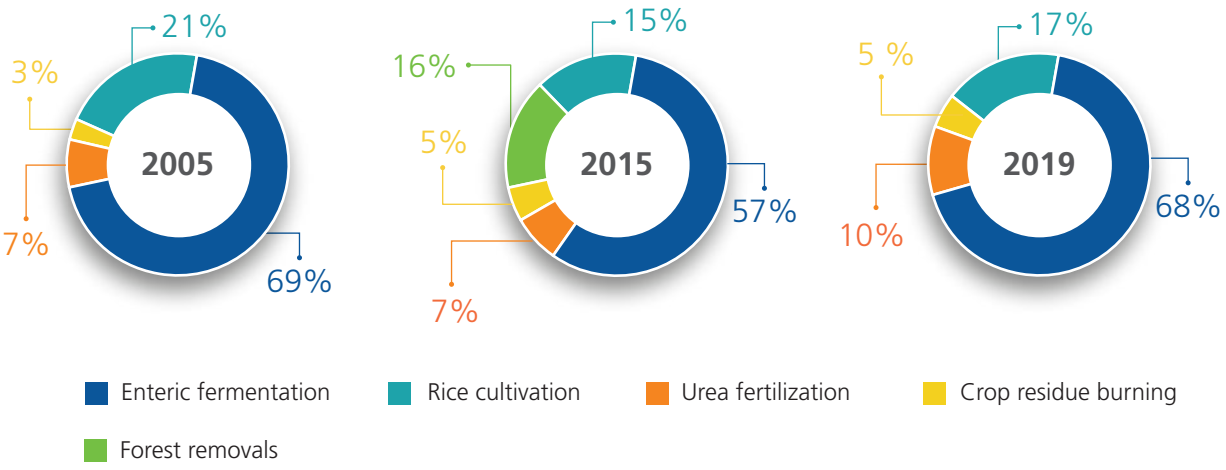


Figure 30: Category-wise contribution to total AFOLU emissions in 2005, 2015 and 2019

Table 13: Growth in AFOLU Emissions (2005-15) & % share

Category	CAGR (2005-17)	% share in AFOLU emissions (2005)	% share in AFOLU emissions (2015)	% share in AFOLU emissions (2019)
Enteric fermentation	1.07%	69%	57%	68%
Forest removals	-25.15%	Sink	16%	Sink
Urea fertilization	3.53%	7%	7%	10%
Rice cultivation	-0.70%	21%	15%	17%
Crop residue burning	4.65%	3%	5%	5%
Total emissions	- 2.86% (b/w positive values only; 2012 & 2019)	NA	NA	NA

- In 2005, AFOLU sector sequestered 0.59 Mt of CO_2e emissions; whereas in 2019 it emitted approximately 1.20 Mt of CO_2e emissions. This suggests that Pune district's AFOLU sector has seen a growth of 304 percent in emissions between 2005 and 2019.
- However, the good news is that the AFOLU sector has witnessed a declining trend in recent years – i.e., between 2012 and 2019, AFOLU emissions have reduced by 18 percent.
- AFOLU sector was a net sink until 2011. Emissions from this sector peaked in 2013 and post that they have shown a declining trend till 2017 (latest data availability as per FSI, 2019). As a result, the growth in total AFOLU emissions (positive values, post 2011) have recorded a negative trend.
- Pune district's forest cover increased 27 percent between 2004 and 2007. This forest cover was well maintained. The lowest forest area was recorded for the year 2015. The latest 2019 FSI Report which gives information for the year 2017 suggests that the forest area (in 2017) has slightly improved in comparison to 2015.
- Overall, for the time-frame of 2005 to 2017, the 'forest removal' category has acted as a sink (except for a slight rise between 2012-15).
- Emissions from enteric fermentation of livestock is the key source category in AFOLU; though it has recorded a nominal increase in emissions (between 2005 and 2017). Therefore, its share in total economy-wide emissions has decreased from 26 percent to 8 percent from 2005 to 2019.

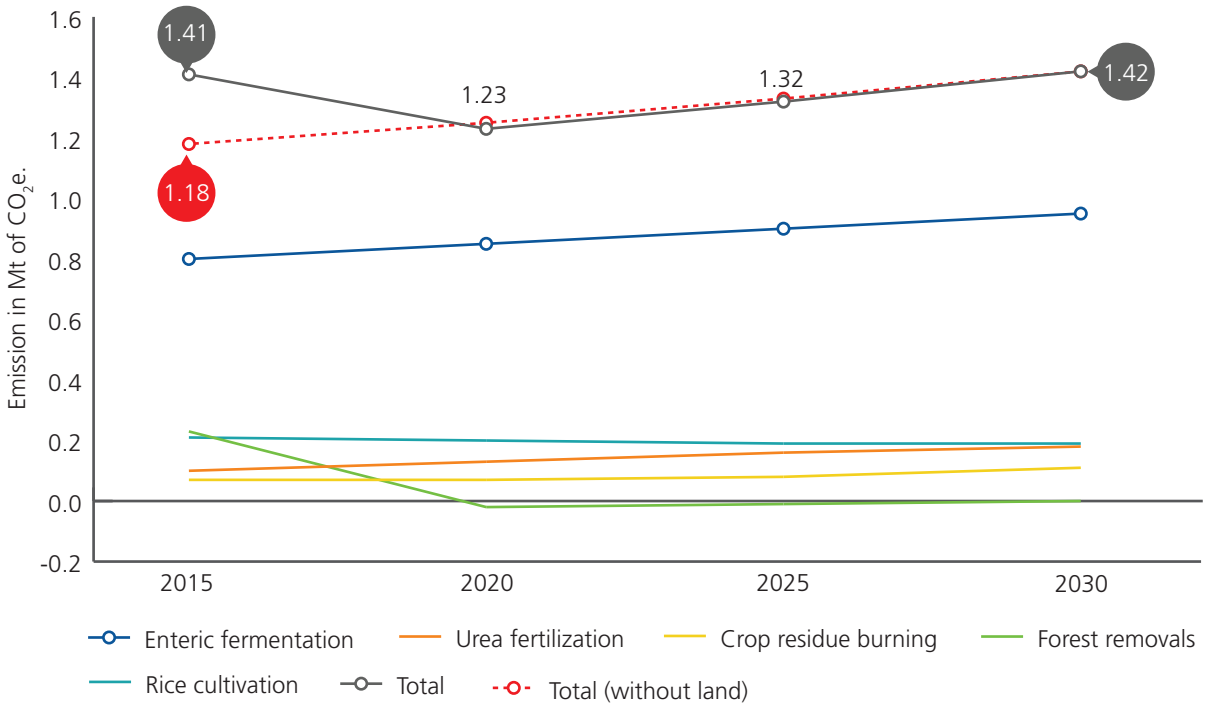


Figure 31: Projected emissions of AFOLU sector (BAU)

- In business-as-usual scenario (i.e., following the current trend, wherein growth in livestock population is nominal and the forest area is atleast maintained, even if not enhanced), total AFOLU emissions will remain more or less constant in 2030 w.r.t. 2015.

Projections for livestock sector

Bovine population density	
Region/district	**Cattle count/sq. km**
India 	91.23
Maharashtra 	68.50
Pune 	85.39

- Density of bovine animals in Pune is higher than the state average; though lower than the national average.
- A scenario has been assumed that Pune will reach the national average of bovine density by 2030.
- Based on this scenario, enteric fermentation calculations are undertaken and compared with BAU projections.
- Under this scenario, emissions will be 40 percent higher than the BAU projections for enteric fermentation.

Year	2005	2010	2015	2020	2025	2030
Projected population (BAU i.e., w.r.t Pune's bovine population growth)	9,36,381	10,73,319	10,58,771	10,44,444	10,30,311	10,16,369
BAU projected emissions (Mt of CO_2e)	0.72	0.82	0.80	0.85	0.90	0.95
Projected population (assuming Pune's 2030 bovine population density is equivalent to the current bovine population density of India)	9,36,381	10,73,319	11,15,956	12,11,297	13,14,783	14,27,111
Projected emissions (bovine population & emissions increases w.r.t. India's bovine population density) (Mt of CO_2e)	0.72	0.82	0.85	0.99	1.14	1.33

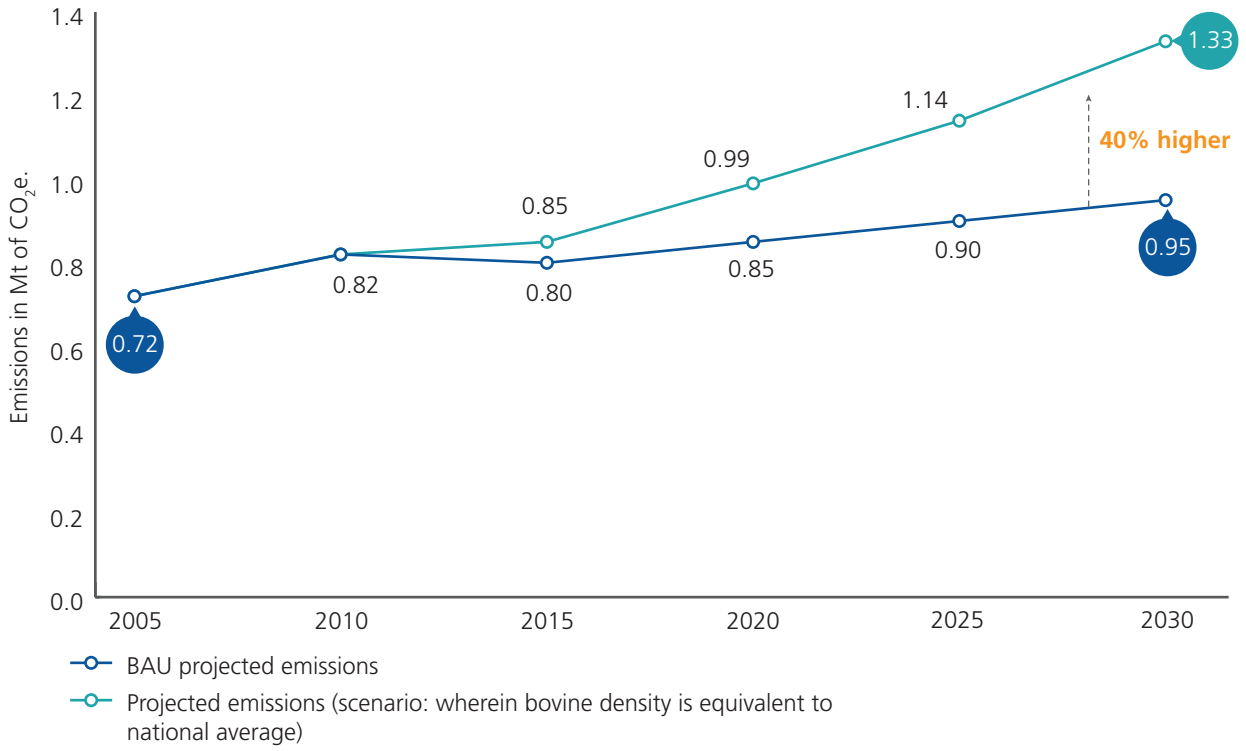


Figure 32: Projected emissions from enteric fermentation – a comparison

Waste Sector

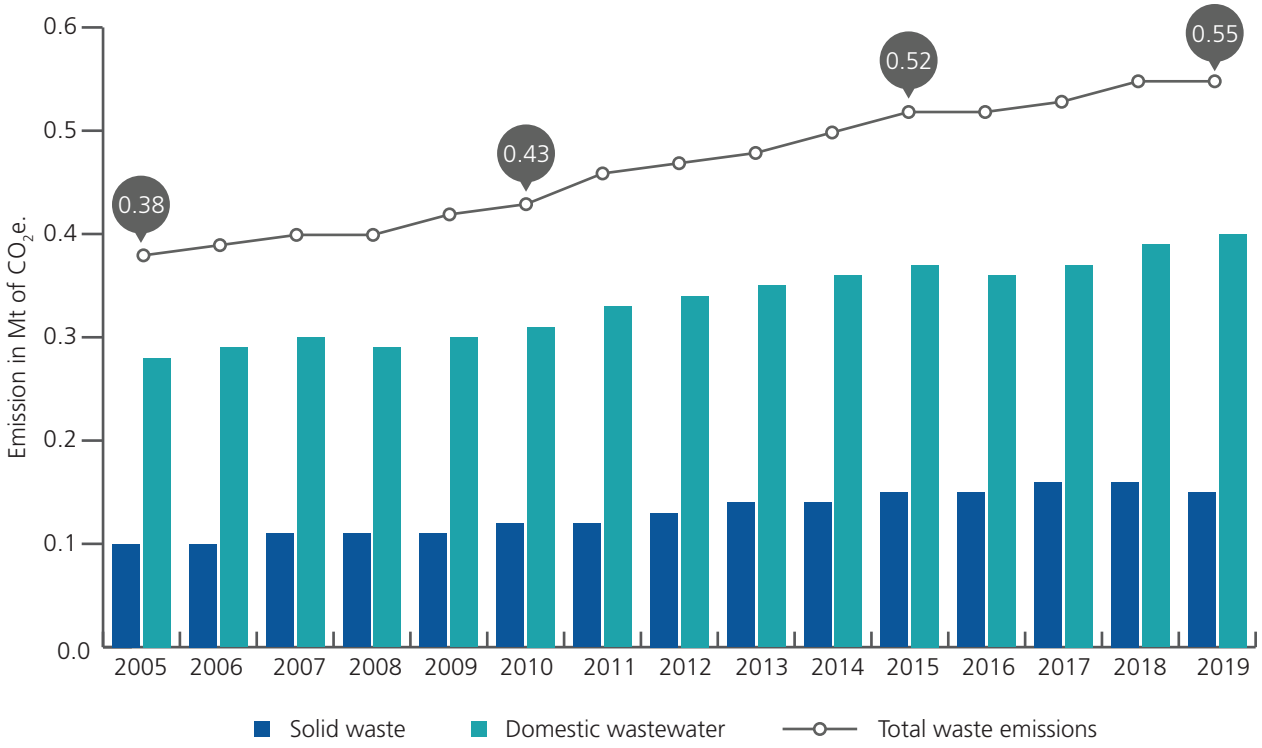


Figure 33: Waste sector emissions of Pune district (Mt of CO_2e)

Waste sector emissions have increased by

44%

since 2005

Growth in emissions (2005-19)		
Category	**CAGR**	**% share in waste emissions**
Solid waste	3.03%	27%
Domestic wastewater	2.53%	73%

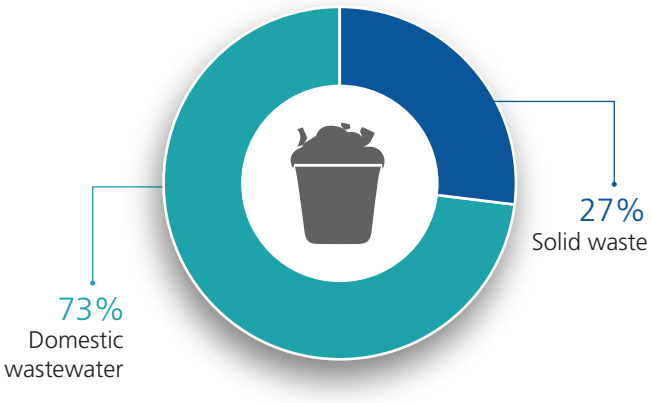


Figure 34: Percentage share of categories in total waste (2019)

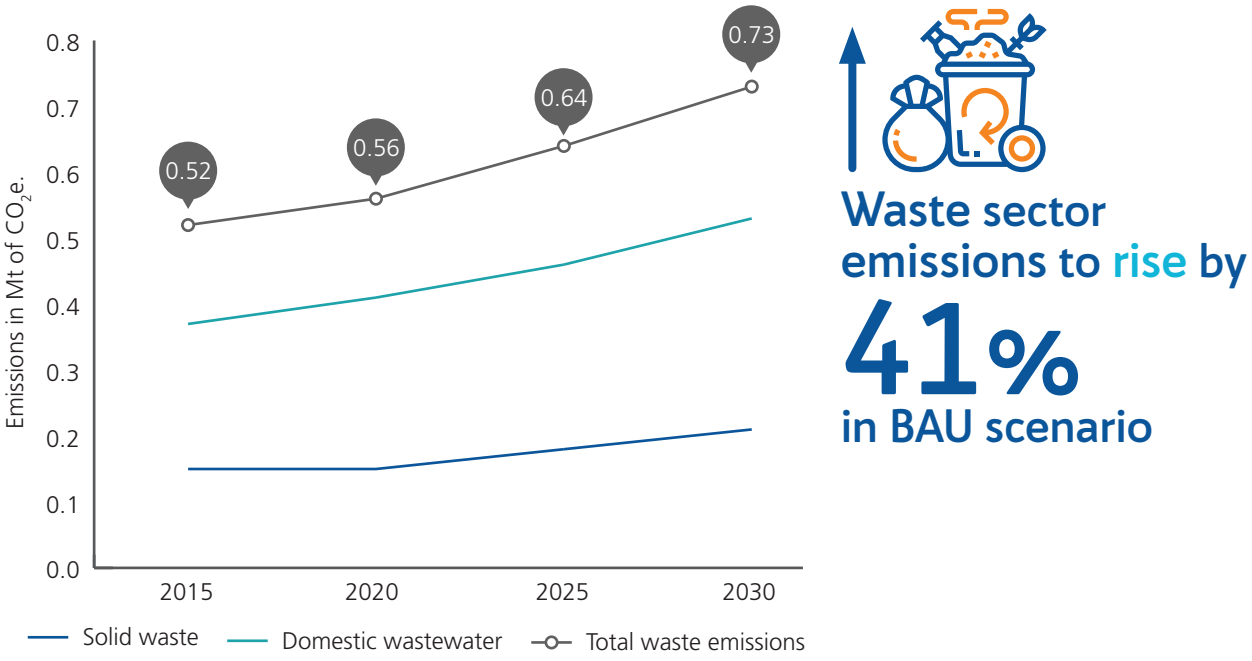


Figure 35: Projections for waste sector emissions (BAU)

- Overall, the waste sector emissions have increased by 44 percent between 2005 and 2019 (at a CAGR of 2.66 percent).
- With improvement in solid waste management practices, the percentage of waste generated that reaches landfill sites has reduced from 70 to 27 percent in 2017. Enhancements to the following practices in the district have proven to be beneficial towards reducing emissions from solid waste: Composting, waste to energy, resource derived fuel, material recycling recovery, 100 percent collection efficiency.

3.2 Carbon footprint due to electricity consumption

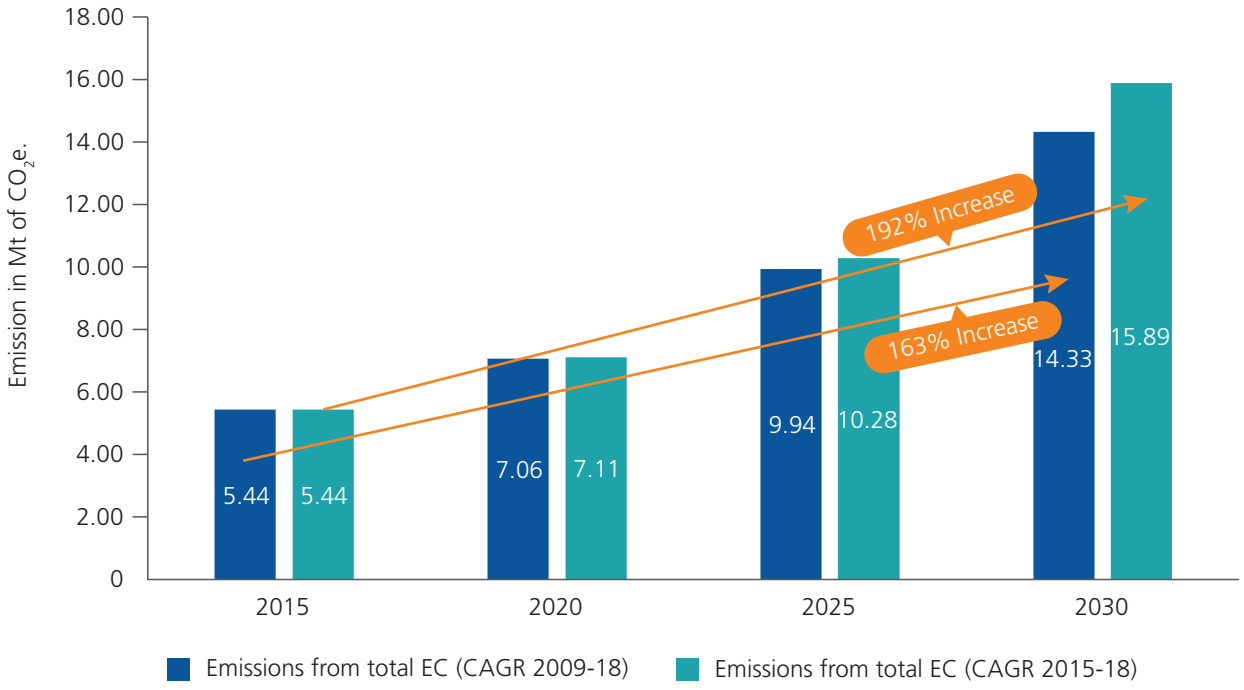


Figure 36: Carbon footprint of electricity consumption (EC) in Pune district (Mt of CO_2e.)

- An exercise has been done to determine electricity consumption of Pune district (by analysing Maharashtra's DISCOM data; details given in Chapter-1: District profile).
- After finding the total million units consumed in Pune district (over the years), emissions from the electricity generation 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 besides the emissions from the energy sector (7.65 Mt of CO_2e in 2018), electricity consumption in Pune led to another 8.40 Mt of CO_2e emissions (at the site of electricity production, which is outside the district and hence not included in Pune's emissions profile).
- 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 2018 (longer time-frame) and another from 2015-18 (shorter time-frame).
- Emissions from electricity consumption in Pune district are likely to grow by 192 percent (if the CAGR of longer time-frame i.e., between 2009 and 2018 is applied) and by 163 percent (if the CAGR of shorter time-frame i.e., between 2015 and 2018, is applied).

ASSESSMENT OF POLICIES THROUGH THE LENS OF CLIMATE CHANGE

Buses of Pune Mahanagar Parivahan Mahamandal Ltd

4. ASSESSMENT OF POLICIES THROUGH THE LENS OF CLIMATE CHANGE

This section evaluates the impacts of various national and state-level policies/programmes of three sectors (energy, AFOLU and waste) – that have been implemented in Pune from the perspective of climate change mitigation. A total of 40 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[13]

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 12 policies/programmes were evaluated for analysing the climate impact by computing GHG emissions added or avoided by these policies.

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) Grid-connected wind power policy

Energy Efficiency in buildings, public infrastructure and industrial processes

1) UJALA Scheme, 2015, 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) State Energy Conservation Policy, 2017, 7) PAT (Perform, Achieve and Trade) Scheme

Transport

BRTS Pune, Rainbow

Emissions evaluation

Amongst the policies evaluated,

- Policies on clean energy have helped avoid 8,37,400 tonnes of CO_2e. emissions, of which 3,44,000 tonnes of CO_2e. emissions were avoided by solar energy generation, and policies on wind power have helped circumvent 4,90,000 tonnes of CO_2e. emissions.
- The remaining 3,400 tonnes of CO_2e emissions were avoided by combined solar and wind plants.
- Enhancing energy efficiency in buildings and processes has led to the avoidance of 41,65,724 tonnes of CO_2e. emissions (UJALA Scheme- 3,35,393 tCO_2e; SLNP- 44,631 tCO_2e; IPDS, R-APDRP, UDAY – 37,67,600 tCO_2e; PAT Scheme- 18,100 tCO_2e), and 4,65,000 tCO_2e. emissions have been avoided due to efficient interventions in the transport sector.

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) Electricity generation from the solar, wind, and solar + wind plants are not available; b) Information on W2E is unavailable.
2) Energy efficiency: a) Year-on-year data on number of UJALA LEDs distributed and number of LED streetlamps installed in the district, is not available; b) Electricity consumption for the district is unavailable. Electricity consumption has been calculated by apportioning the population to the electricity supplied by the DISCOM.
3) Transport: Latest modal share of transport is required, annual utilisation factor of vehicles is required for the particular region.

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 together as AFOLU sector initiatives to understand their impact on climate mitigation.

List of policies evaluated

For Pune district, a total of 11 policies/programmes under AFOLU sector and two additional policies of cross-cutting sector (agriculture and energy) have been considered for this evaluation.

Agriculture

(1) Soil Health Card Scheme; (2) National Food Security Mission; (3) Dr. Babasaheb Ambedkar Krushi Swavalamban Yojna; and (4) National Bamboo Mission

Livestock

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

Forestry

(1) Maharashtra State Forest Policy, 2008, (2) Diversion of forests for non-forest purpose under the Forest Conservation Act, 1980, and (3) Wildlife Protection Act, 1972, (4) Social Forestry Scheme, (5) Green India Mission, and (6) 33 crore sapling plantation mission

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 and energy) 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/programmes it could not be computed due to lack of required data/information.

- This exercise helped identify the total emissions avoided due to forestry policies is 13,72,638 tonnes of CO_2e.
- The breed improvement programmes proved to be beneficial for climate action as well by avoiding 11,819.71 tonnes of CO_2e.
- Agricultural policies could not be computed due to lack of required data for input indicators.
- Under the cross-cutting sector, the National Mission on Micro Irrigation resulted in avoiding approximately 914.45 tonnes of CO_2e. emissions (from reducing the use of urea alone). Whereas, the Pradhan Mantri Ujjwala Yojana has helped mitigate 12,14,393 tonnes of CO_2e.

Information gaps

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

(1) Area covered under Green India Mission.
(2) The type of species planted for the '33 crore sapling plantation missions' and their rate of success.
(3) Area covered under Soil Health Card Scheme.
(4) Reduction in consumption of chemical fertilizer use due to recommendations (followed by farmers) given in the soil health cards.
(5) Information on sustainable irrigation facilities provided under 'Dr. Babasaheb Ambedkar Krushi Swavalamban Yojna'.
(6) Percentage of pulses production that can be attributed to National Food Security Mission.
(7) Area brought under bamboo cultivation.

4.1.3 Waste management[15]

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

List of policies evaluated

A total of 15 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 & Amendment 2018: Integrated Solid Waste Management Projects (ISWM), Pune Smart City Development Corporation, 2) Bio-medical Waste Management Rules, 2016 & 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) MP Urban (ADB) Project, 4) Atal Mission for Rejuvenation and Urban Transformation (AMRUT), 5) Common Effluent Treatment Plant (CETP) for Medium & Small-Scale industries, 6) Online Monitoring of Industrial Emission & Effluent (OCEMS)

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

- Emission of 83,500 tCO_2e. from individual household latrines (IHHL: two pit latrine) and 3,95,090 tCO_2e. from community latrines (septic tank) constructed under sanitation programmes/policies,
- Emission mitigation of 38,927 tCO_2e. for biological treatment (composting) of MSW, emission of 610 tCO_2e for incineration of bio-medical waste and 14,598 tCO_2e. for incineration of hazardous waste,
- Emission of 2,11,430 tCO_2e. for STPs constructed under sewerage connection programmes. It must be noted that the implementation of these activities has actually avoided an annual average emission (with respect to baseline)[15] of 89,561 tCO_2e. and 27,603 tCO_2e. by sanitation and liquid waste (domestic) management developmental/policy initiatives respectively in the district.

Information gaps

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

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. Pune, 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 bye-laws for Maharashtra.
- Transport sector policies:
  - The modal share of public transport in Pune, by ridership is 34 percent. However, currently most of the buses in the district still run on CNG, indicating a critical gap in addressing easing out of policy restriction on the procurement of e-buses.
  - Policy-level intervention is needed to improve BRTS and other public transport modes in terms of robustness, reliability, frequency and better reach in the district.
  - There is also a need of policies or programmes for greening of transport sector in the district.

AFOLU

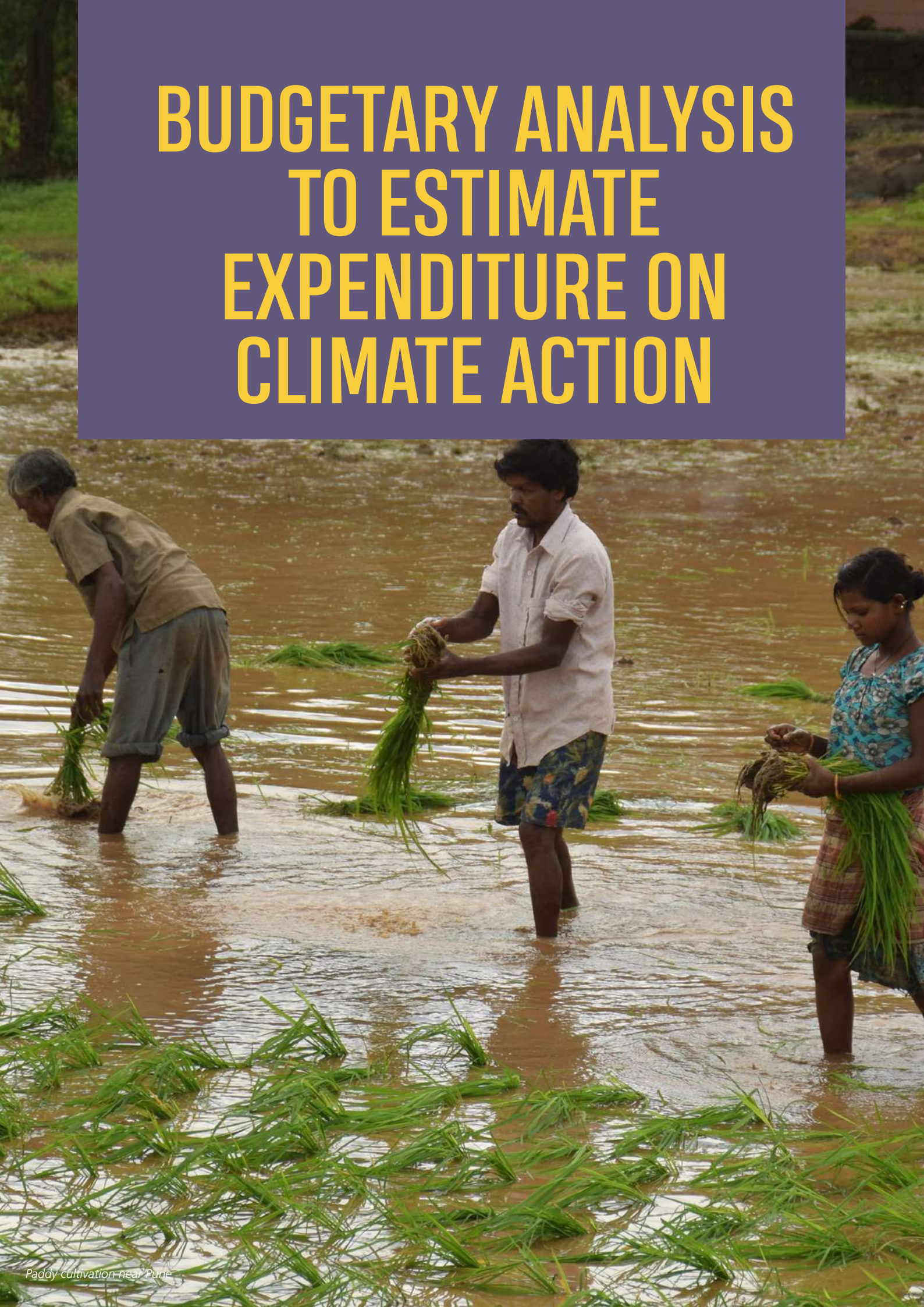
- Although Pune's Forest cover has recently shown a slight improvement (between 2015-2017), it has overall decreased in comparison to 2008 levels, despite the 'Maharashtra State Forest Policy' coming into force in 2008. This indicates that the implementation of the policy needs to be strengthened. To ensure that the district's forest cover is not further impacted by rapid urbanization, district level initiatives are needed to not only curb the loss of forest cover but also to enhance it. These interventions, in form of rigorous implementation of existing schemes and policies as well as through creation of more focussed programmes and campaigns would help in following:
  - The green cover will act as a sink for the district's GHG emissions.
  - Control landslides, occurrences of which have recently increased in Pune.
  - Reduce the urban 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.
- Crop residue burning and emissions associated with it have significantly increased between 2005-18. Contribution of emissions from crop residue burning in total AFOLU emissions of Pune is higher when compared with the 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 between power and agriculture sector has a gap in policy-level interventions. 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 doesn't cover all districts, thereby not representing the current situation. An e-waste inventory with district-level information, as per the 2016 rules, needs to be developed.

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

BUDGETARY ANALYSIS TO ESTIMATE EXPENDITURE ON CLIMATE ACTION



Paddy cultivation near Pune

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 Pune 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 and findings of district budgets

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, 45, 38, and 44 schemes were identified to be climate relevant out of 86, 82, and 90 schemes, respectively, 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. As seen in the Figure 37, approximately a quarter of the attributed expenditure across the three years was under the 'forestry and wildlife' head, activities under which have had a direct impact on climate mitigation. This is followed by expenditure attributed to roads and bridges, urban development, and power sub-heads. Urban development can have some indirect climate mitigation and resilience co-benefits.

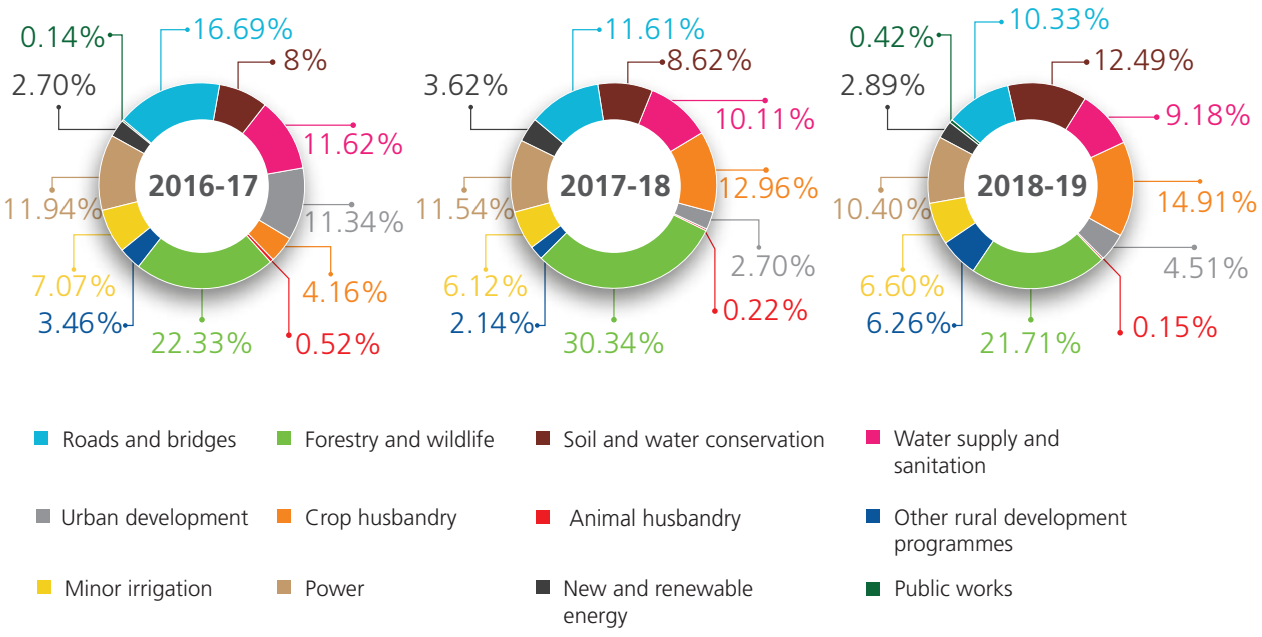


Figure 37: Distribution of expenditure attributed to climate action in Pune District (2016-17, 2017-18, 2018-19)

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*. Figure 38 details the number of schemes in each category over the three years of analysis. For all the three years, the number of schemes under each category proportionally remained the same. A larger number of schemes were categorised as either marginal or potential, indicating that a majority of the schemes identified have a scope for development, inclusion and prioritisation of climate-oriented actions and strategies.

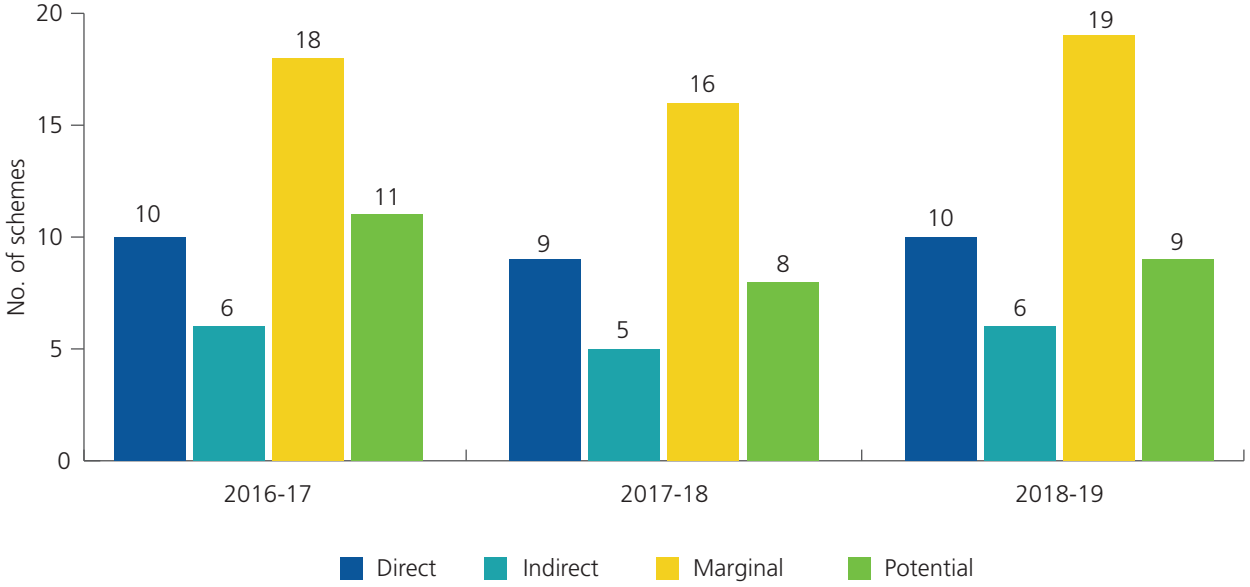


Figure 38: Climate relevant schemes by category in Pune district budget

- Direct schemes and programmes whose principal objectives, activities and outcomes have direct climate resilience and mitigation implications or are aligned with climate SDGs.
- Indirect schemes and programmes that have significant climate components in terms of activities and outcomes building climate resilience, climate mitigation and/or climate SDG co-benefits. However, the objectives do not have climate action as a primary objective.
- Marginal schemes and programmes that have some small number of indirect climate mitigation and/or resilience co-benefits and have scope for including more climate-oriented actions.
- Potential schemes and programmes that currently have no climate implication. However, they have been identified to have scope for including climate-oriented development activities in the future.

The expenditure on climate relevant actions in the district for the three years is 24.69 percent, 28.76 percent, and 26.76 percent. Figure 39 details these expenditures by the type of impact the schemes (Mitigation - M, Resilience - R, Mitigation and Resilience – M+R) have on the climate, thereby highlighting the need to increase spending on programmes that focus on climate resilience.

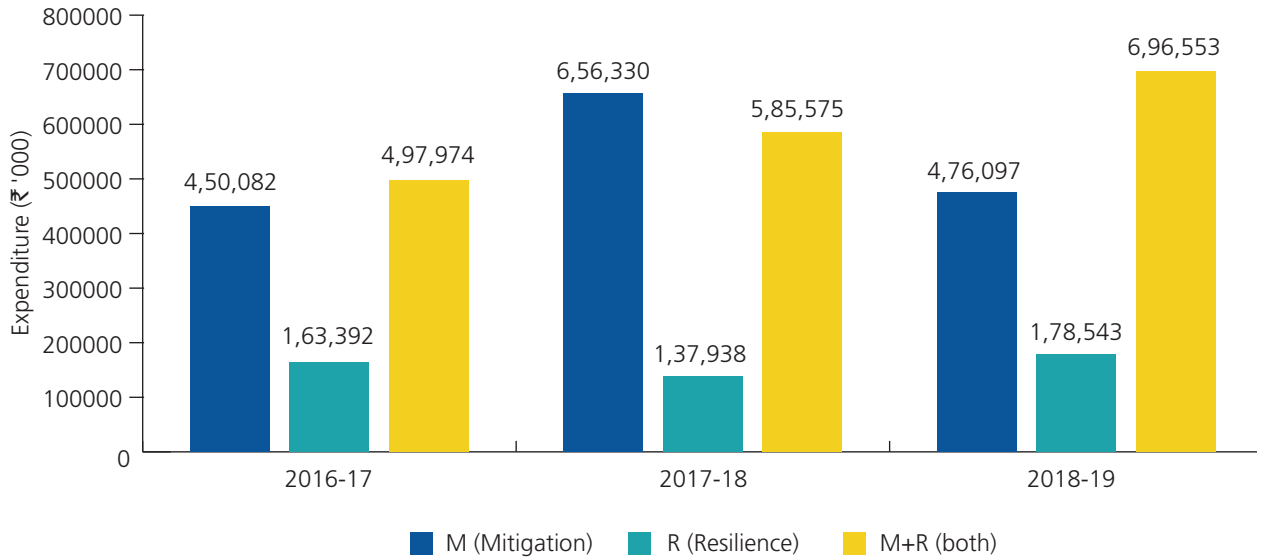


Figure 39 Pune district expenditure by impact of climate action (M: Mitigation, R: Resilience, M+R: Both)

5.3 Analysis and findings of flagship schemes

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

5.3.1 Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS)

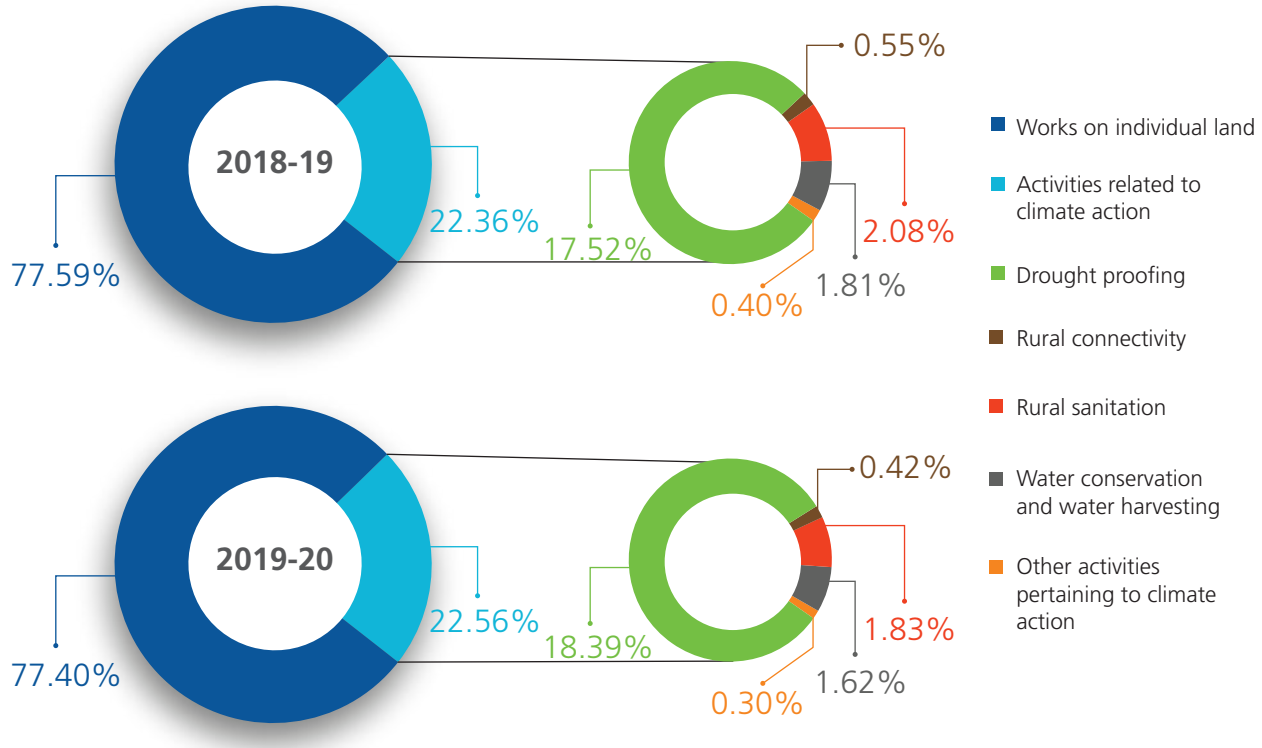


Figure 40: Expenditure on climate action under MGNREGS in Pune (2018-19, 2019-20)

Annual expenditure (₹ 000)

	Drought proofing	Flood control and Protection	Land development	Micro irrigation works	Renovation of traditional water bodies	Rural connectivity	Rural drinking water	Rural Sanitation	Water conservation and water hanvesting
2018-19	35,632.88	281.44	140.72	31.27	469.06	1,110.11	15.64	4,221.54	3,689.93
2019-20	27,155.39	156.62	36.14	24.10	253.00	614.43	0	2,698.67	2,397.48

Figure 41: Comparing annual expenditure under MGNREGS in Pune between 2018-19 and 2019-20

5.3.2 Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)

The micro-irrigation techniques employed in the Pune 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.

Table 14: Allocations to Pune district under PMKSY

Budget allocation	2016-17	2019-20
Budgetary spending in the district on micro-irrigation activities (₹ lakh)	1,058	617
Budget attributed to climate action out of the PMKSY budgetary spending (69%) (₹ lakh)	730	425
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 PMKSY budget	2.2	1.8

5.3.3 Green India Mission (GIM)

For the Pune district, the Department of Forests provides a five-year plan over the expenditure on the six sub-missions under GIM.[17] Figures 42 and 43 details the fund allocation in Pune district under GIM. As observed, the major activities under the mission have been to enhance the quality of forest cover and improve ecosystem services, i.e., Sub-Mission 1 under the GIM.

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

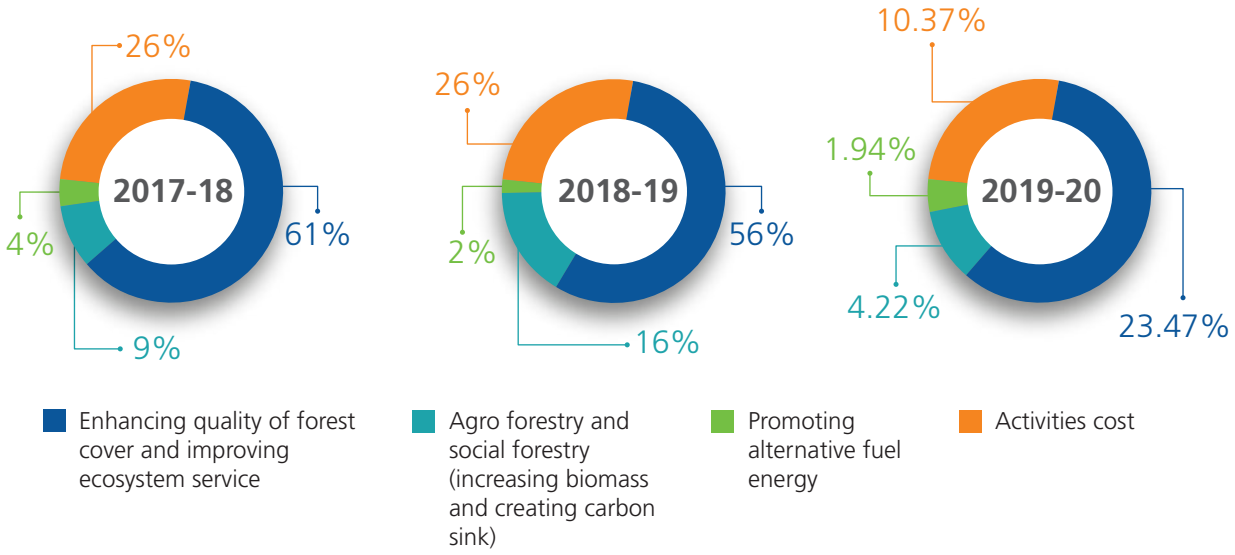


Figure 42: Mission-wise fund distribution under GIM in Pune district in 2017-18, 2018-19 and 2019-20

Fund allocation (₹ lakh)

	Enhancing quality of forest cover and improving ecosystem service	Ecosystem restoration and increase in forest cover	Enhancing tree cover in urban and peri-urban areas (including institutional lands)	Agro forestry and social forestry (increasing biomass and creating carbon sink)	Restoration of wetlands	Promoting alternative fuel energy	Activities cost
2017-18	100.50	0	0	14.77	0	7.13	42.84
2018-19	60.22	0	0	16.88	0	2.58	27.89
2019-20	23.47	0	0	4.22	0	1.94	10.37

Figure 43: Sub-mission-wise fund allocation under GIM in Pune district

5.3.4 Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY) and Saubhaya scheme

Till April 30, 2020, an amount of ₹ 8,577 lakh has been released to carry out the activities under DDUGJY and Saubhagya Scheme. An amount of ₹ 4,288 lakh can be attributed towards climate action for district Pune (See Annexure 5.2 for methodology and assumptions).

5.3.5 Atal Mission for Rejuvenation and Urban Transformation (AMRUT)

Based on the methodology and assumptions mentioned in Annexure 5.2 as well as information on work completed, amounts of ₹ 8.39 crore, and ₹ 6.26 crore can be attributed to climate action, for Pune district, in FY 2015-16 and FY 2016-17 respectively, from a total of ₹ 120.84 crore and ₹ 126.70 crore allocated for the same period (see Figures 44 and 45 for budgetary expenditure on climate action).

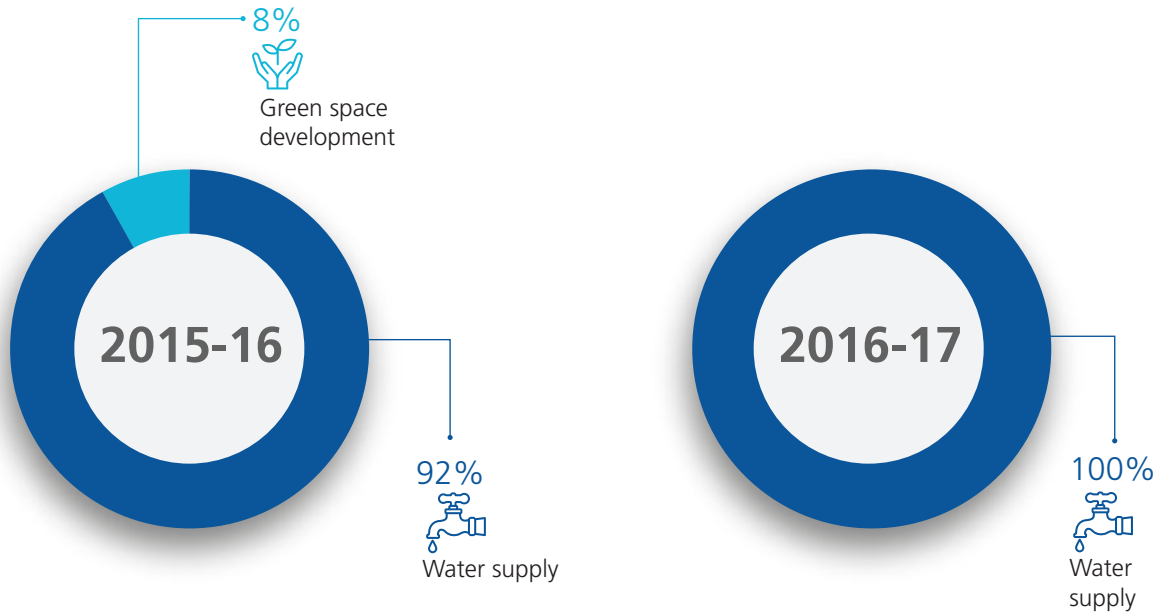


Figure 44: Distribution of expenditure in Pune District under AMRUT scheme in Pune between 2015-16 and 2016-17

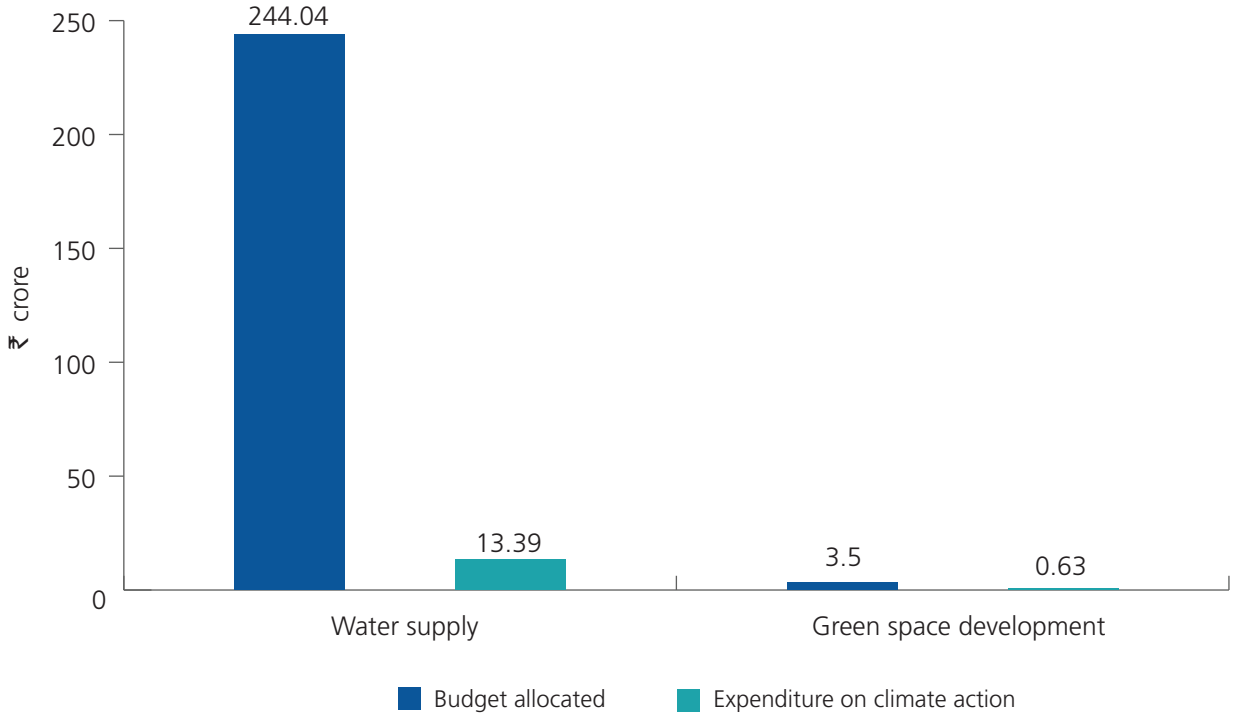


Figure 45: Comparison of budgetary expenditure on climate related activities under AMRUT scheme in Pune for 2015-16, 2016-17 and 2017-20

RECOMMENDATIONS

Colourful coaches of Pune Metro at Kharalwadi

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 Climate Change and Environment Plan of Pune District. 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 79,50,325 tCO_2e in the energy sector, 7,53,303.33 tCO_2e in AFOLU and 2,42,797 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 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 initiative.
- Information provided on timeframe and framework for implementation would enable the district authorities and concerned departments to prioritise actions.
- List of existing policies, programmes, and schemes that can help streamline the actions is provided along with the concerned primary and supporting departments in separate table, following each sectoral recommendation matrix.
- Additionally, this section provides information on SDGs and other co-benefits that can be addressed through the recommendations given 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

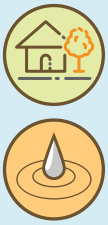
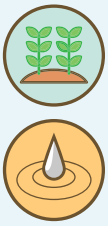
6.1 Sector-specific recommendations

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 generate awareness about RE in the residential sector	India has a target of 40 GW for solar rooftop (2022). As of February 28, 2021, only 4.32 GW has been achieved. Maharashtra has only 647.73 MW (as of February 2021) of solar rooftop capacity. In Maharashtra, in 2020, off-grid solar rooftops have been installed by MEDA in 26 out of the targeted 31 government buildings, with an upper cap of 20 kW. Case example calculation: a) If eqipped with solar rooftops, the government schools in Pune district alone can generate 103 MUs electricity avoiding 89,019 tCO_2e emissions, annually. b) If 50% households in the district are equipped with solar rooftops, total potential installed capacity would be 7,025 MW, which can help avoid 7.52 $MtCO_2e$ emissions, annually. Meeting the solar rooftop targets can be expedited by making it mandatory for hospitality industry and other new constructions (having a built-up area greater than 20,000 sq. ft) like 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). Pune district has a huge potential for solar power generation, both rooftop and ground mounted. In the highly industrialised and urbanised Pune city, solar rooftop installation can be promoted. In the remaining parts of the district, ground mounted solar installations can be more viable.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for Implementation	
Battery storage for RE to be aggressively promoted.		Short to medium-term	Needs additional financial support	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 battery/RE installation up to a particular load, and on increased load demand, switch to the grid supply.
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 Need to build public awareness	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 network and other rural non farm productive use appliances across the district can be powered by DRE. Cold storage networks 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 93,000 conventional lamps in Pune district with LED lamps under SLNP can potentially avoid 48,982 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 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) Awareness to be built 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 Advanced Metering infrastructure (AMI) project. These smart meters have proven 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. During this period, the company managed to raise over 3,50,000 bills, and avoided over 1,50,000 visits to consumer premises per month. MSEDCL can implement a similar smart-metering project in Pune and 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 Pune district.		Short to medium-term	Relevant schemes and programmes can help achieve this goal (section 6.1.1.1) Inter departmental collaboration required	One of the objectives of the 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 consumption 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 Pune, in co-ordination with the relevant departments can avail the financial assistance/ benefits of the scheme to make their systems energy efficient.
In agriculture sector, promote energy efficient water pumps (provided by EESL), and solar pumps, wherever possible (through PM-KUSUM).		Short to medium-term	Policy framework exists (section 6.1.1.1)	According to BEE, 30% to 40% energy savings is possible in agriculture sector 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 Pune district could substantially reduce 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 -- habitat, industry and other recommendations that can be made by 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 Pune district.

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

Sub-sectors	Policies and programmes that can push forward the recommendation[18]	Primary departments/ agencies	Supporting departments/ agencies
Increase RE share in the electricity generation basket	1. Maharashtra State Renewable Energy Policy, 2020 2. Maharashtra Policy for Grid-connected Solar Projects 3. Maharashtra Off-Grid Policy, 2020 4. Maharashtra Grid Connected Wind Projects, 2015 5. National Solar Mission 6. i-SMART Project 7. PM KUSUM 8. Majhi Vasundhara	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, GoM 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 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 14. Majhi Vasundhara	1. MSEDCL, GoM 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. Pune Smart City Development Corporation Limited (PSCDCL) 5. Proposed District level Committee on Climate Change and Environment

18 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 ensure green building rating compliance in all new construction activities 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 Pune contribute to around 27% of the total electricity consumed in the district. MEDA is working to incorporate ECBC into building compliance systems in Maharashtra. The Building Permission Department of PMC encourages all new buildings to comply with ECBC/ IGBC rating system /GRIHA rating system. However, this incorporation is completely voluntary and no mandate has been issued by PMC as of now.
District administration, in collaboration with the ULBs can implement the India Cooling Action Plan (ICAP) and achieve its objectives. District administration can also explore the possibilities of piloting solar-passive architecture/other renewable energy technologies in a few of its iconic buildings. Implementing this at the district level could help avoid significant GHG emissions.		Medium-term	Policy framework exists (section 6.1.2.1) Needs inter-departmental collaboration Capital incentives/ relevant exemptions from the district administration required	In September 2018, India became the first country in the world to have a Cooling Action Plan which seeks to: (i) Reduce cooling demand across sectors by 20% to 25% by 2037-38, (ii) Reduce refrigerant demand by 25% to 30% by 2037-38, (iii) Reduce cooling energy requirements by 25% to 40% by 2037-38, (iv) Recognise "cooling and related areas" as a thrust area of research under national S&T Programme, (v) Training and certification of 1,00,000 servicing sector technicians by 2022-23, 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 its Paris targets Needs inter-departmental collaboration	A DG set of 200 kW (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, 58,854 tCO_2e emissions can 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	Pune district can adopt and implement initiatives, similar to the one in Lucknow, where the municipal corporation has planned setting up 200 solar-powered bus stops.
Promoting formulation of energy communities in existing RWAs/other residential committees where residents have ownership over their energy supply. Energy communities can host wind and solar generation installations, or a self-sufficient system functioning as a microgrid/undergrid-minigrid. These committees can make agreements between the community, the private developer and the utility company. Digitalisation can create innovative billing mechanisms and generate data that will provide important investment information to the energy market.		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.	
Encourage fast penetration of UJALA scheme in every household of Pune 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 estimate of the number of LED bulbs to be installed in households of Pune district under UJALA scheme can potentially avoid emission of 0.22 $MtCO_2e$. annually.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/Case examples
		Time frame for the action to be accomplished	Framework for implementation	
Enhance public awareness towards energy-efficient BEE star labelled home appliances.		Short-term and continuous	Need collaborations and awareness	
Demand side management for habitat				
Promote and subsidise good practices for all ULBs. For instance, installing rainwater harvesting setups in buildings can considerably reduce energy dependence on submersible motors for groundwater pumping.		Short-term	Schemes and programmes exist (section 6.1.2.1) Public awareness building required	Since 2007, RWH is mandatory for larger societies in Pune. PMC provides a 5% rebate in property tax to societies with an operatable RWH system and another 5%, if societies have solar energy and vermicompost. Since 2016, RWH is also mandatory for all new residential and commercial buildings with an area greater than 20,000 sq. m in Pimpri Chinchwad.
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 and public awareness building required	To check wastage of water, PMC commenced installation of water meters in November, 2020. Of 11.5 lakh properties in PMC area, 3.5 lakh water meters have been installed, free of cost. As per the report, this has been implemented at the society level. PMC can scale this operation to individual household level.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/Case examples
		Time frame for the action to be accomplished	Framework for implementation	
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	According to BEE, multi-storey (up to 12 storeys) residential buildings can meet around 70% of the annual electricity requirement for water heating 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	Existing 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, Pune can counteract on heat islands through tree plantations that provide shade and reduce the power demand for cooling in buildings.

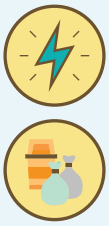
6.1.2.1 Habitat: Policy framework and concerned departments/agencies

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 10. Majhi Vasundhara	1. Department of Housing, GoM 2. MEDA, GoM 3. All ULBs 4. Pune Smart City Development Corporation (PSDCL) 5. Panchayati Raj Institutions (PRIs)	1. MSEDCL, GoM 2. Department of Environment and Climate Change, GoM 3. Urban Development Department, GoM 4. Department of Rural Development and Panchayat Raj, GoM 5. BEE (EESL) 6. Maharashtra State Road Development Corporation Limited (MSRDCL) 7. Department of Motor Vehicles, GoM 8. Proposed District level Committee on Climate Change and Environment
Demand-side management	1. Maharashtra State Energy Conservation Policy, 2017 2. Maharashtra State Water Policy, 2019 3. ECBC 4. Building bye-laws 5. Majhi Vasundhara	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, GoM 4. Pune Smart City Development Corporation (PSCDCL) 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

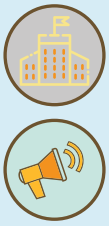
Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for implementation	
Promote e-mobility				
Build awareness and disseminate information encouraging adoption of electric vehicles.		Short-term and continuous	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 Pune. 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 Pune, 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 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	The Pune Mahanagar Parivahan Mahamandal Limited (PMPML) has announced procurement of a fleet of 650 electric buses by 2022 in phases under FAME II. PMPML can avoid up to 318 gCO_2/km emissions per bus by switching to electric buses. The Maharashtra EV Policy, 2021 aims to electrify 25% of all public transport in major cities of the state including Pune. 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.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for implementation	
Similarly, initiate transition of intermediate public transport (IPT) vehicles to electric by incentivising IPT operators through: a) subsidies, b) separate lanes, c) dedicated parking spaces, d) replacement of lead acid battery-powered electric IPT vehicles with more sustainable Li-ion battery e-vehicles, in a phased manner.		Medium-term	Policy framework exists	If 5000 autos are replaced with e-autos (less than 10% of the total autos) in Pune, then it saves 13,470 tCO_2e emission. 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.[19] 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.
District administration, ULBs (for office use + 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	In its latest budget (2021-22), PMC announced plans to convert half of its total office fleet to electric vehicles. Further, expanding such an initiative to departments and government offices across the district can help in this transition. In addition, 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.

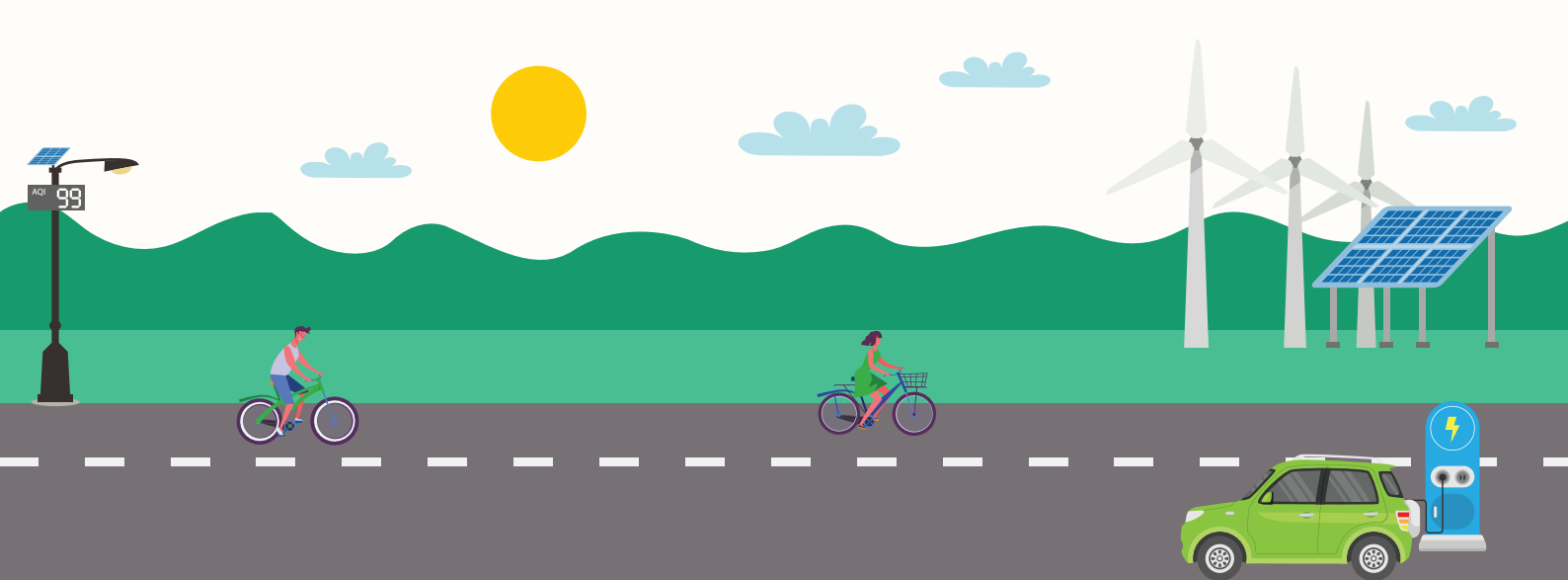
19 A parking spot is defined as EV ready when it is provided with charging infrastructure and a separate meter connection.

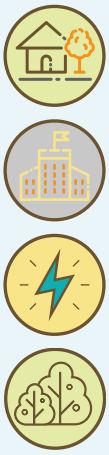
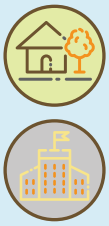
Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for implementation	
Develop robust and widespread charging infrastructure: a) Charging infrastructure to be at strategic locations – commercial hubs, public 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 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	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 installation of 10 electric charging stations across Pune. This can be further scaled up in the district in order to facilitate reduction in tail pipe emissions. The Maharashtra EV Policy, 2021 aims to establish 500 charging stations in Pune 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.
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, c) Additional subsidy scheme for women and students.		Short-term	Policy framework exists. Enhancing it 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 3,00,000 electric vehicles in the state by 2025 and has recommendations suggesting means to promote EVs (as listed in the point above). Pune 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.

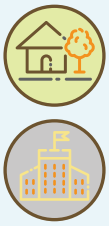
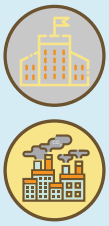
Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for implementation	
Encourage development of local network of rental e-vehicles across the district, including cars and bikes as well as a battery rental network for faster adoption of EVs. Further, this can be integrated with smart cards.		Medium-term	Policy framework required	In 2020, PMC approved an e-bike rental scheme to develop an e-bike rental network across the city. Around the same time, Pimpri-Chinchwad Municipal Corporation (PCMC) also approved a pilot e-scooter rental initiative within its boundaries. Expansion of such a service to different parts of the district, as per the requirement, can help promote this sustainable means of transport.
Encourage and promote adoption of EVs for all delivery operations within the district.		Short to medium-term	Requires policy framework and inter-departmental coordination	Currently, most delivery partners for food, courier and other kinds of services rely on self-owned fossil fuel-based two or four wheelers. In some cities, certain companies are working towards developing an electric vehicle fleet. The district can recommend a transition to electric vehicles for such delivery persons. 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	
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	

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for implementation	
Public transport (PT) and intermediate public transport (IPT)				
Increase reliability, accessibility and enhance last mile connectivity of public transport (PT) and intermediate public transport (IPT) through: a) Integrated ticketing and smart cards that work across all transport modes (IPT, cycle hire, etc), entry to tourist sites, payment for rental vehicles, among other things, can make PT and IPT more popular with increased ease of use, b) Increasing fleet strength, c) Increasing frequency, d) Adding more stops, e) Enhanced reach to low or non-serviced areas to peri-urban and rural areas, f) Developing dedicated parking spaces for IPT.		Medium to long-term	Existing policy framework can be enhanced Inter-departmental collaboration required	As of 2018, the share of public transport in Pune is 19% and is relatively low compared to India's most populous cities. Public transport services in Pune include PMPML bus fleet, private fleets and Rainbow BRTS, which was the second BRTS programme launched in the country. PMPML bus network consists of: approximately 1,400 buses (including 25 electric), 371 routes, 2392 stops. Rainbow BRTS: approximately 1200 buses (125 electric), 6 routes, 61 km, 102 stops. The option of smart card, called 'Mi', for PT payments is available. However, as the awareness is low, its utilisation is low with only 2% to 3% passengers opting for this payment option. Further, introducing a smart card that works across all transport modes (IPT, cycle hire etc), entry to tourist sites, payment for rental vehicles among other things can make PT and IPT more popular with increased ease of use. Peri-urban areas are currently connected through MSRTC services. The frequency of services can be enhanced, as well as the number of stops can also be expanded to these areas. The share of IPT by ridership in Pune city is <10% with majority of the population opting for private vehicles for commuting. 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, omni vans and jeeps. Residents in city outskirts/ peri-urban areas majorly rely on private vehicles or walking.
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 inter-departmental cooperation	While the existing Pune Parking Policy, 2016 has a pricing scheme for parking of vehicles, efforts need to be made to upgrade the pricing scheme to a variable one based on peak hours, to particularly discourage the use of private vehicles during those hours.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for implementation	
Implement policy measures to discourage the use of private vehicles through: a) A parking policy for vehicle ownership, b) No car days on certain roads, c) By allowing parking only in dedicated areas.		Short to medium-term	Requires proper policy backing based on research and inter-departmental cooperation	Pune has the highest rate of two-wheeler ownership and the second highest rate of car ownership in India. To discourage the 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) In February 2016, Gujarat University announced that the first and the fifteenth of each month will be observed as no vehicle days, when only public transport and pedestrian movement would 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) and needs stricter implementation	
Awareness campaigns to popularise PT and IPT modes.		Short-term and continuous	Dedicated awareness campaigns required	
Augment Non-Motorized 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 backing based on research and inter-departmental cooperation is required	Current modal split in Pune indicates that the share of NMT is approximately 30%, and has been on a decreasing trend over the years. Efforts need to be made to make NMT a preferred and viable option.



Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for implementation	
Regular O&M of NMT infrastructure: a) Developing and maintaining well-lit, clean and safe pathways for pedestrians and cyclists. b) Consulting and engaging local experts and community for development and maintenance. c) Removing encroachments.		Short-term and continuous	Policy framework exists Requires inter-departmental cooperation	
Promote cycle hire service in key locations across the district.		Short-term	Policy framework needs to be enhanced Further, PPP models can be explored for successful implementation.	Various private bicycle hire services are available in Pune city. Further, Pune has a cycle plan to promote the use of bicycles. Additionally, 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	Needs proper policy based on research along with multi-stakeholder and inter-departmental cooperation	Pune district can adopt the following best practices to minimise congestion at 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 slots to avoid parking on roads, service lanes and other public spaces.		a) Medium-term b) Short-term and continuous	Policy framework exists Multi stakeholder and inter-departmental cooperation is required	The Pune Parking Policy, 2016 has measures in place to discourage street parking. Further, development of parking zones in a strategic manner and popularising the parking spaces through awareness initiatives can popularise the parking structures developed by PMC.

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 to free up the pavements, so that traffic congestion on the roadsides can be minimized.		Short to medium-term	While the policy framework exists, implementation is irregular and for short timeframes. Multi stakeholder and inter-departmental cooperation is required.	Providing dedicated areas for their business can ensure their livelihoods as well as help in decongestion. Town vending committee(s) in the district could help in identifying all street vendors and be of aid in formulating an effective plan of action for rehabilitation.
Regular maintenance of roads to ensure smooth flow of traffic can help reduce GHG emissions while extending the life of the road.		Short to medium-term and continuous	While the policy framework exists, implementation is lacking in some areas Multistakeholder and inter-departmental cooperation is required.	

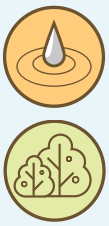
6.1.3.1 Transport: Policy framework and concerned departments/agencies

Sub-sectors	Policies and programmes which 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 national e-vehicle Policy (as per 2021-22 Union Budget) 8. National Urban Transport Policy, 2006 9. Majhi Vasundhara	1. All ULBs 2. RTOs 3. MSEDCL 4. EESL	1. Housing and Urban Development Department, GoM 2. MEDA, MSEDCL 3. Department of Motor Vehicles, GoM 4. Roads and Buildings Department, GoM 5. State Knowledge Management Centre on Climate Change (SKMCC) Department of Environment, GoM 6. Rural Development Department, GoM 7. Pune Smart City Development Corporation Limited 8. PRIs 9. Airport Authority of India 10. Western Railways - Pune Division 11. Proposed District level Committee on Climate Change and Environment
Public transport and intermediate public transport	1. BRTS 2. JNNURM 3. ECBC 4. Smart Cities Mission 5. AMRUT 6. National Urban Transport Policy, 2006 7. Majhi Vasundhara	1. All ULBs 2. Pune Smart City Development Corporation Limited (PSCDCL) 3. PMRDA 4. MSRTC	1. Housing and Urban Development Department, GoM 2. Department of Motor Vehicles, GoM 3. RTOs 4. Roads and Buildings Department, GoM 5. State Knowledge Management Centre on Climate Change (SKMCC)- Environment Department, GoM 6. Rural Development Department, GoM 7. MEDA, MSEDCL 8. Proposed District level Committee on Climate Change and Environment

Sub-sectors	Policies and programmes which can push forward the recommendation	Primary departments/ agencies	Supporting departments/agencies
Augment non-motorised transport	1. Smart Cities Mission 2. AMRUT 3. Maharashtra State Urban Transport Policy, 2017 4. National Urban Transport Policy, 2006 5. Majhi Vasundhara	1. All ULBs 2. Pune Smart City Development Corporation Limited (PSCDCL) 3. PMRDA	1. Housing and Urban Development Department, GoM 2. Roads and Buildings Department, GoM 3. State Knowledge Management Centre on Climate Change (SKMCC)- Environment Department, GoM 4. Rural Development Department, GoM 5. PRIs 6. MEDA, MSEDCL 7. PMRDA 8. Police Department 9. 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. Pune Smart City Development Corporation Limited (PSCDCL) 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, GoM 4. Rural Development Department, GoM 5. Police Department 6. Industries, Energy and Labour Department, GoM 7. PRIs 8. MIDC 9. PMRDA 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 incentivising system, similar to a "Cap and Trade" system for enhancing energy efficiency of MSMEs, in coordination with the state energy department.		Medium-term	Requires policy 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 Awareness is needed to popularise the initiative	CHP systems can achieve system efficiencies close to 80% as compared to around 60% by conventional technologies.

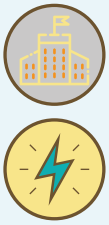
Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for implementation	
Optimise equipment efficiency. Equipment that are not usually turned off during down time, such as heating or cooling equipment, pumps, 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 Industries, Energy and Labour Department 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 already exists Inter-departmental collaboration is required for successful implementation	
Encourage industries to use recycled water from their plants rather than freshwater.		Short-term	Policy framework exists. However, it needs to be upgraded in collaboration with the responsible agencies and departments	

6.1.4.1 Industry: Policy framework and concerned departments/agencies

Sub-Sectors	Policies and programmes which 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 5. Proposed District level Committee on Climate Change and Environment

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

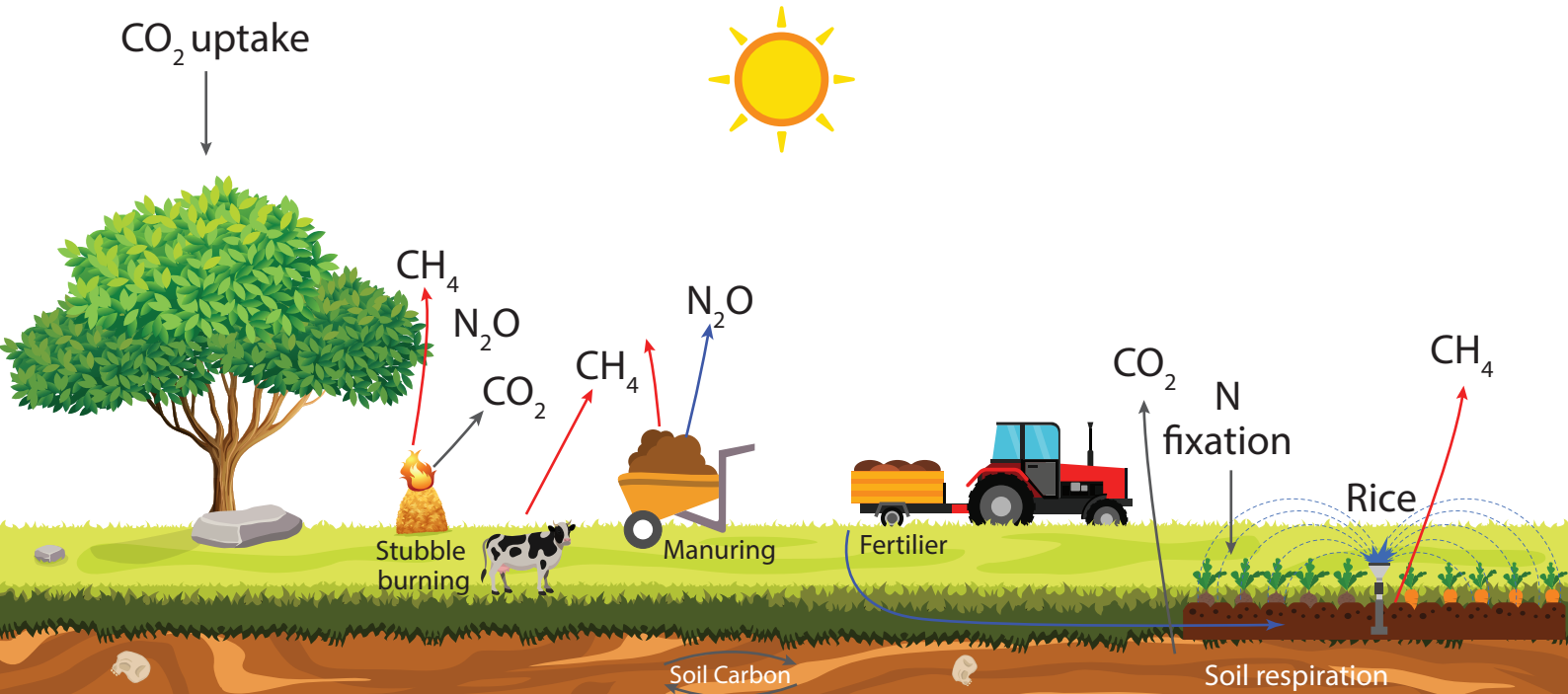
Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for implementation	
Agriculture				
Promotion of sustainable farming practices and programmes, like use of non-chemical fertilisers and 'zero budget natural farming' in the district.		Short to medium-term	Policy framework exists (section 6.1.5.1) Budget provisions are available	In 2017-18, Pune used approximately, 1.6 lakh tonnes of urea in agriculture. If 10% of current urea used in Pune is replaced with non-chemical fertilisers, it will help avoid 11,769.53 tonnes of CO_2 emissions/annum. This initiative will also contribute towards: a) Cutting down of compostable solid waste from landfilling/ dumping and converting it to organic waste which can further be used to make organic fertilisers, (thereby, reducing emission from 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 which will act as an alternative source of income for the farmers.		Short to medium term	Policy framework required Collaboration required Farmers need easy access to markets/ industries that would take crop residue/stubble	Improved harvesting practices like use of Happy Seeder, which has a capacity to eliminate 78% of the GHG emissions (from crop residue burning). It also has the potential to add at least 10% profit to the farmers. Feasibility studies may be undertaken for cost-benefit analysis to support the farmers with such improved harvesting machines and practices. Direct sowing of rice reduces the soil disturbance, enabling it to retain more nutrients, moisture and organic content. It also, removes the need to stubble burning, thereby reducing air pollution. Other feasibility studies or projects can be initiated. For example, the development of biofuel pellets from crop residue.
Farmers should be encouraged to follow the recommendations given in soil health cards.		Short to medium-term	Can be implemented by raising awareness	According to Soil Health card portal, so far 28,51,525 samples have been tested in cycle-II in Maharashtra. In Pune, 21% of the soil samples tested have reported very low nitrogen and 9% of them have reported very low phosphorous content. The micronutrient (Zn, Fe, Cu, Mn, B, S) status is reported to be sufficient by Soil Health Card information under Department of Agriculture Cooperation & Farmers' Welfare, Ministry of Agriculture & Farmers Welfare, GoI.

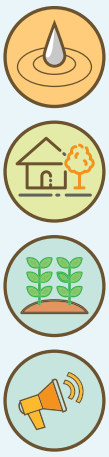
Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for implementation	
Promote micro-irrigation (MI) to improve water use efficiency. It saves water, energy and fertiliser consumption.		Short to medium-term	Policy framework is available (section 6.1.5.1) Enable swift procedures and subsidy disbursement for adoption of micro-irrigation District may consider providing additional subsidies	According to PMKSY Achievement Report, 4,550.38 ha of land in Pune was brought under MI between 2019-20. This helped in averting approximately 3,846.84 tonnes of CO_2e emissions per annum (w.r.t to conventional irrigation through groundwater).
Encourage adoption of latest technologies, such as: a) Solar pumps (under PM KUSUM Yojana), b) Star-rated Energy Efficient Pump System (EEPS), c) Smart control panels and internet of things (IoT) based systems for optimum resource utilisation (water, energy).		Short to medium-term	Policy framework is available (section 6.1.5.1) Support in capital investment over and above the existing policy can be considered	In order to facilitate daytime irrigation and to promote use of renewable sources of energy, the GoM has declared 'Mukhyamantri Saur Krushi Pump Yojana' (MSKPY) to install 1,00,000 off-grid 3 HP and 5 HP Solar Photovoltaic Water Pumping Systems in a phased manner. With the implementation of MSKPY, farmers will get day time solar power to operate agriculture pumps. Further, it will reduce interruptions due to breakdown/ transformer failure. Replacement of 1 lakh diesel pumps with solar pumps over a period of 5 years can cut 900 million litres of diesel consumption over the life cycle of solar pumps which can potentially save ₹ 840 crore of diesel subsidy and 2.53 million tonnes of CO_2 emission. These initiatives will increase farmers' income, provide reliable source for irrigation and reduce dependence on diesel in the farm sector.
Enhance the efficiency/ network of cold storage systems and wherever possible power them with renewable energy.		Medium to long-term	Policy framework exists and can be enhanced (section 6.1.5.1.) Capital investment required Align with solar rooftop policies and ECBC	According to Press Information Bureau's press release dated September 23, 2020, Maharashtra has 619 total number of 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	
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%.[20] Straws from millets, corn and maize have better feeding quality than straws from rice, barley and wheat. This change in quality of forage species leads to better productivity, estimated to reduce emissions by 30%. ICAR-NIANP has recently developed a feed supplement - Harit Dhara and Tamarin Plus, for cattle, buffalo and sheep. It is found effective in cutting down methane emissions by 20%. Use of this feed supplement can be encouraged by Pune at the district level.[21]
Promote cattle breeds with higher productivity. Moreover, productivity of indigenous cattle should also be improved (for instance, through provision of Nand Ghars). However, it's essential to maintain the balance between resilience and productivity. Currently, in most areas, flock sizes are negatively impacting the climate and ecology.		Medium to long-term	Policy framework exists (section 6.1.5.1) Research collaboration required (to ensure that the biodiversity of the region is not impacted) Need to generate awareness Provide monetary support to the pastoral community	These initiatives will help meet the growing demand of milk while keeping the livestock headcount low. If there is a 10% decrease in the number of indigenous cattle over a period of 5 years, the loss in milk production will be 14 lakh litres. To compensate for this loss in milk production, a total of 87,846 new crossbreed cattle need to be introduced, which will lead to 79,325.4 tCO_2e. emissions. The net emissions avoided per year will be 1,534 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 like sugarcane, potato etc. for enhancing crop production.		Short to medium-term	Policy framework is available (section 6.1.5.1) Collaboration between different communities (farming and pastoral) is needed	Poultry manure fertiliser is rich in nitrogen and contains all the 13 essential nutrients required for crop production. In comparison to cow manure, it is 2-3 times richer than inorganic fertiliser content.

20 Earagariyanna M.Y. et. al., 2017, Fodder Resource Management in India-Critical Analysis
21 http://nianp.res.in/harit-dhara-tamarin-plus

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for implementation	
AFOLU: Forestry and green spaces				
Ensure minimum diversion of forest land for any activity or project and promote compensatory afforestation (of the same species) from the funds given by the user agency. Funds for continuous tree improvement and tree breeding programmes can be ensured through the Compensatory Afforestation Fund Management and Planning Authority (CAMPA).		Short to medium-term	Policy framework and budget provisions exist (section 6.1.5.1) Policy implementation required Stringent monitoring and evaluation required	According the Environmental Clearance Report 2019, 624.66 ha of total forest area in Pune 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.
Measures to increase trees outside forest (TOF) area and green spaces in Pune: 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) MGNREGS can take up plantations along village roads. g) Development of a green belt along the major terrain roads, and those surrounding industrial areas.		Medium to long-term	Policy framework is available (section 6.1.5.1) Requires capital investment, research collaboration, and inter-departmental cooperation	As per the FSI report 2019, Maharashtra has the largest extent of TOF at 26,945 sq. km. This includes both forest cover outside the recorded forest area/ green wash and tree cover. Pune Tree Census Project, involving a team of 120 people including surveyors, taxonomist and technical staff, was carried out for two years using geo-tagging technology. According to the Pune Tree Census Project, the civic body has counted 40.1 lakh trees in 2019. In the 2013 census, PMC counted 38.60 lakh trees. Common tree species found in Pune were Ashoka, Neem, Giripushpa, Subabul, Nilgiri, Babool, Arjun, etc.



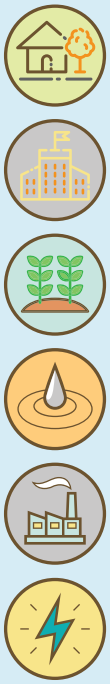
Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for implementation	
Enhance forest cover by promoting agro-forestry and social forestry to increase forest biomass and soil moisture along with adoption of the following measures: a) Control illegal timber trade. b) Carry out mapping of agroforestry areas to monitor the coverage c) Create provisions of financial instruments/relaxation in other taxes (over and above the existing schemes) to encourage the farming community to adopt agroforestry 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 is required Stringent monitoring and evaluation	Currently, the forest cover of Pune district is only 10.94% of the total geographical area. If 16.5% of the geographical area of Pune (equivalent to the state's percentage of forest cover to total geographical area) is to be converted to forest over a period of 10 years, emissions of around 27.68 $MtCO_2e$ can be avoided. Miyawaki urban forestry method has reported 15% faster growth rate per year compared to other reforestation methods.
Ensure ULBs regularly monitor the survival of trees under plantation drives. 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 State Forest Minister, between 2017 and 2019, a target of 28.50 crore trees was set and approximately 28.34 crore trees were planted. Out of these, 81.63% survived.
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 Requires multistakeholder collaboration	According to the 2019 Forest Survey of India, there is an increase in forest cover by 2.86 sq. km in Pune from 2017 assessment.

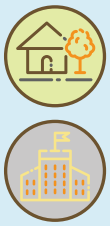
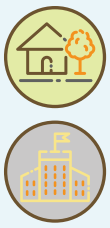
Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Time frame for the action to be accomplished	Framework for implementation	
Various aspects of joint forest management (JFM) need to be promoted: a) Capacity Building and skill development of the JFM committees in tribal and non-tribal areas by conducting workshops and training. b) Initiate participatory forest management programmes at micro scale.		Short to medium-term	Exclusive communication strategy and IEC material to be developed and used Provisions of monetary support available	As per ENVIS-Committees and Forest Area Under JFM, until 2015, total area covered under JFM in Maharashtra is 24,03,344 ha. There are about 12,665 joint forest management committees in the state.
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, M&E, stakeholder collaboration	*Prosopis juliflora, Lantana camara, Parthenium hysterophorus, Gliricidia sepium* are some major invasive alien species in Maharashtra. Preventing seed production helps in managing spread of invasive species. Removing flower heads prior to seed set will reduce the number of seeds available for spread by birds or other animals.
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 regarding forest fires. b) Training local communities to tackle forest fires. c) Organizing awareness programmes in local schools. d) Building capacities 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 Requires M&E and collaboration among different stakeholders	According to Technical Information Series Volume-II (2019), published by the Forest Survey of India, in Maharashtra, 3.4% of the total forest cover area lies in the extreme fire prone area, 16.65% under moderately fire prone area and 60.34% under least fire prone area.

6.1.5.1 AFOLU: Policy framework and concerned departments/agencies

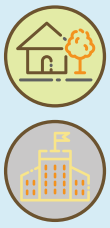
Sectors	Policies and programmes which can push forward the recommendation	Primary departments/ agencies	Supporting departments/agencies
Agriculture	1. Rashtriya Krishi Vikas Yojana: Remunerative Approaches for Agriculture and Allied Sector Rejuvenation (RAFTAAR) 2. National Mission for Sustainable Agriculture 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. Maharashtra Agriculture Pump Electricity Policy, 2020 10. Integrated Cold Chain, Value Addition and Preservation Infrastructure Scheme 11. Majhi Vasundhara	1. Department of Agriculture, GoM	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 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. 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: Remunerative Approaches for Agriculture and Allied Sector Rejuvenation (RAFTAAR)	1. Department of Animal Husbandry, GoM	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 9. Majhi Vasundhara	1. Maharashtra Forest Department, GoM	1. Department of Agriculture, GoM 2. Department of Environment and Climate Change, GoM 3. All ULBs (PMC + PMRDA + other Municipalities) 4. Directorate of Geology and Mining, GoM 5. Department of Housing, GoM 6. UDD & RDD 7. Proposed District level Committee on Climate Change and Environment 8. All PRIs

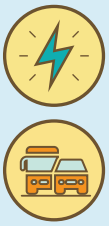
6.1.6 Waste Management: Recommendations, cross-cutting sectors, qualifying priority and district scenario

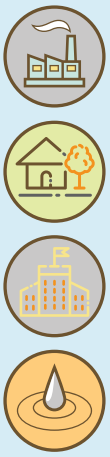
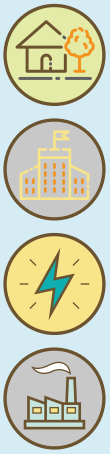
Recommendations	Cross-cutting with	Qualifying priority		District scenario/ case examples
		Time frame for the action to be accomplished	Framework for implementation	
Solid waste				
Waste prevention: Reducing landfilling				
Minimising landfill waste disposal by: a) Promoting waste reduction at source through product reuse, extending lifetime (maximum use of resources), and putting in place consumers' right to repair, b) Ensuring efficient and 100% segregated waste collection across the district (both urban and rural) by distributing colour-coded bins, monitoring waste collected from household and penalising households not practicing segregation. c) Ensuring and maximising recycling, recovery, optimum resource utilisation throughout product lifecycle and treatment. d) Promoting resource efficiency and circular economy practices across sectors.		a) Medium to long-term b) Short to medium-term c) Medium-term d) Long-term	a) Needs policy intervention, awareness building and incentivisation b) Policy framework exists (section 6.1.6.1), needs resource allocation and execution c) and d) Need policy intervention and execution (Resource Efficiency Policy has been drafted by NITI Aayog but not implemented as of date)	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 Pune (mostly the city area) that will reduce landfill emissions in the city and can be adopted in the district as well. Pune region generates 3,627.82 TPD solid waste, of which 2,672.85 TPD, i.e., about 74% gets treated (MPCB Annual Report, 2018-19). Pune city has 100% waste collection efficiency. Treatment facilities include composting or bio-methanisation, material recycling facility (MRF), refuse derived fuel (RDF), bio-mining, etc. PMC has proposed a waste to energy (W2E) plant of 200 TPD capacity at Ramtekdi Industrial Estate. The zero-garbage project of PMC has significantly reduced waste dumping to the landfill at Uruli Devachi, Phursungi. PCMC too has proposed a W2E plant at Moshi with 1000 TPD waste processing capacity and 11.5 MW power generation potential. A bio-mining project is also under implementation at Moshi garbage depot that aims to reduce the legacy landfill waste. Pune city ranked 5th and Pimpri-Chinchawd ranked 19th out of the 48 cities with million+ population in India by Swachh Survekshan, 2021 (cleanliness, hygiene and sanitation survey).

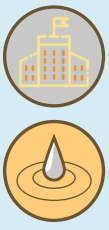
Recommendations	Cross-cutting with	Qualifying priority		District scenario/ case examples
		Time frame for the action to be accomplished	Framework for implementation	
Minimising single use plastic (SUP): Detailed information and recommendations on SUP are given in section 6.1.6.2.		Short to medium-term	Already a national priority Policy framework exists (section 6.1.6.1), but can be accelerated with district level interventions/ implementation	Disposable SW take-back has not been implemented in Maharashtra as of now. About 34% of the total waste generated in Pune is inert waste and 6% paper waste, much of which can be treated/recycled, thereby (potentially) leading to a significant landfill waste reduction. Currently, 180 TPD plastic waste is being treated at MRF.
Implementing producers (manufacturers/brand owners, etc) take-back mechanism (Solid Waste Management 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. This will reduce inert landfill 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 facility (MRF), refuse derived fuel (RDF), waste to energy, 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) Mandatory procurement of C&D materials (10% to 20%) in municipal and government contracts (subject to quality control).		Short to medium-term	Mandated by the rules, CPCB guidelines exist (section 6.1.6.1) Needs state-level policy formulation and implementation Capital investment in infrastructure needs to be enforced	

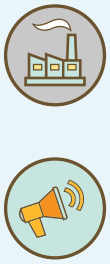
22 Guidelines given by Indian Roads Congress in this regard can be followed. https://pib.gov.in/PressReleasePage.aspx?PRID=1736774

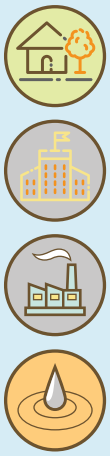
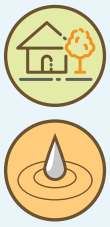
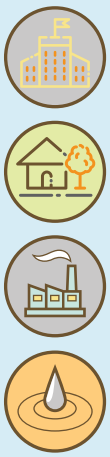
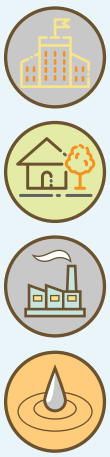
Recommendations	Cross-cutting with	Qualifying priority		District scenario/ case examples
		Time frame for the action to be accomplished	Framework for implementation	
Increasing consumer awareness and access to recycling facilities and repair options.		Short to medium-term	Dedicated awareness campaign required	About 10% to 15% of global GHG emissions can be reduced through improved waste management following a lifecycle assessment approach (Global Waste Management Outlook - UNEP/ISWA, 2015). 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, water conservation.		Short-term and continuous	Needs sustained campaign for 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	

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 (for treatment) is required, which can be obtained from the producers	
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 a basket of choices.		Medium-term and continuous	Needs alternative business models, collaborations and awareness	
Reducing emissions from waste transportation: a) Encourage shifting to electric or zero emission vehicles (ZEVs) 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	PMC has 396 garbage collection vehicles, of which there are 160 trucks for house-to-house collection. Thus, waste collection and transport are potentially leading to significant emission which can be avoided by transitioning to ZEVs. Though, there are several specifications for CBWTF vehicles to ensure efficient management and monitoring of BMW, it does not account for the emissions from transport.

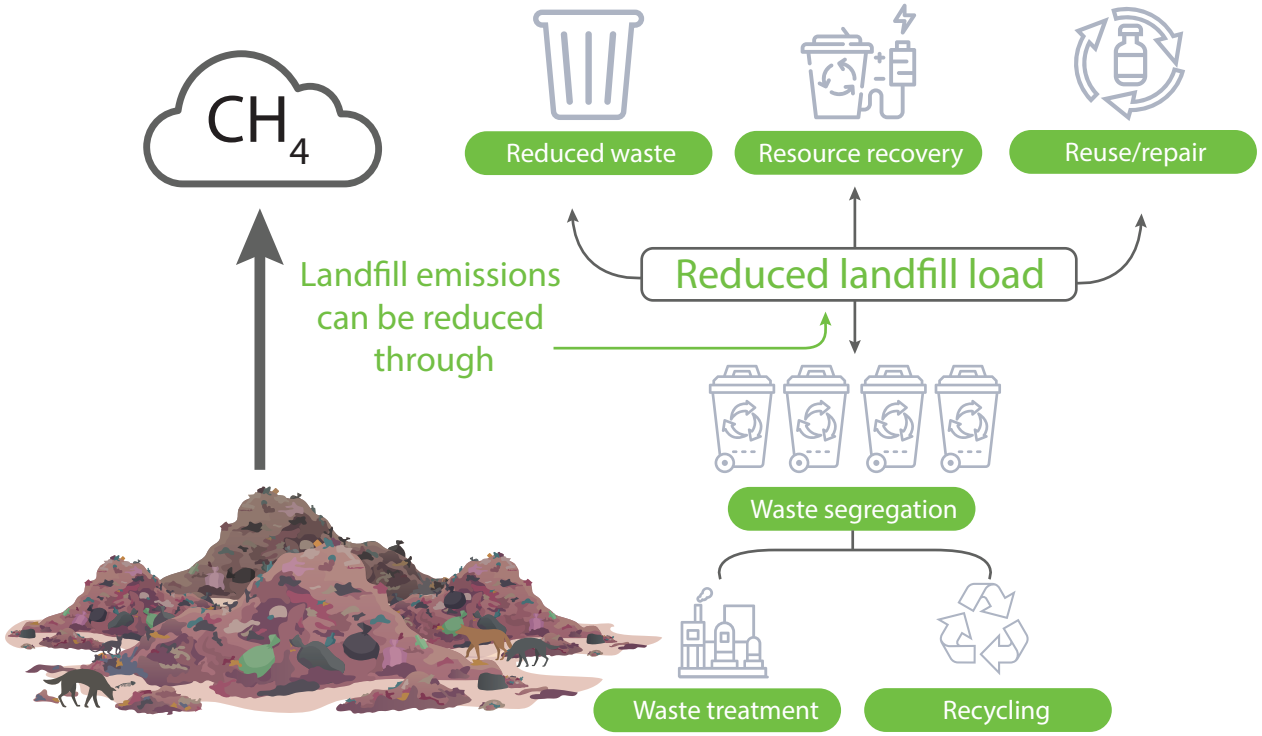
Recommendations	Cross-cutting with	Qualifying priority		District scenario/ case examples
		Time frame for the action to be accomplished	Framework for implementation	
Waste treatment: Composting				
Encourage 100% conversion of organic waste to biological waste processing (composting, bio-gas, etc.).		Short to medium-term	Policy framework exists (section 6.1.6.1) Needs awareness and infrastructure development	Organic treatment of compostable waste initially leads to emission, but reduces GHG emissions drastically in the long-run, when compared to landfill emissions. However, it takes at least three decades of 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 a gas management system, composting is considered more environmentally sustainable practice than methane capturing from landfilling of organic waste, simply to avoid its multi-layered pollution potentials and reduce landfill loads. About 45% of the solid waste generated in the district is biodegradable. However, currently only 19% is getting treated biologically. Pune Municipal Corporation has an effective microorganism (EM) composting system. It encourages household-level composting units too through a decentralised system. However, none of these composting units have any gas management system to capture CH_4 emissions. Composting emission potential (for 606.6 TPD reported by MPCB AR 2018) is 18,598 tCO_2e/year. Maharashtra is the only state to have registered its own brand "Harit Maha City Compost" for promotion of marketing and sale of city compost which is as per the Fertiliser (Control) Order (FCO), 1985 standards, and SWM Rules, 2016. Composting with gas management of 100% of the organic waste going to landfill can reduce emission by 31,367 tCO_2e/year in Pune 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, and b) reduce waste transport emissions.		Medium-term	Needs land and infrastructural investment at ULB level	
a) Equip new composting units and upgrade/convert existing composting units with gas management systems for gas capture after conducting feasibility studies. b) Biomethane produced from wastewater and solid waste processing can be used as a fuel for industrial production, to provide energy services in buildings or as a transport fuel. A benefit of biomethane is that existing gas infrastructure can be utilised for transport and distribution. As a local, sustainable source of power and heat, biomethane offers communities and municipalities a flexible option that can contribute to lowering emissions.		Long-term	Needs policy intervention District level capital investment required Research collaboration required	

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 emissions 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 (like, use of recovered heat for preheating of waste to be burnt or use of incinerator steam to generate electricity) for new CBWTFs and TSDFs and upgradation of the existing ones. b) Using smart controls, waste treatment plants equipped with energy recovery incineration facilities can be integrated as distributed energy sources into the electricity grid and as heat sources into the district energy network.		Long-term	Needs policy formulation and investment in infrastructure	Though not a very well 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) and is the best available and recommended practice currently in India. Current annual BMW incineration emission in the district is 1,418 tCO_2e/year. Energy recovery incineration is not practiced. Pune has one TSDF which received 1,10,288.43 MT/year hazardous waste during 2018-19, out of which 25,712 MT/year was incinerated leading to an annual emission of 21,213 tCO_2e. However, only Pune region generated 4,02,502.77 MT/year hazardous waste during 2018-19, of which 83,546.9 MT/year was incineration waste.
Strict monitoring of adherence to recommended incineration technologies, standards and practices through regular monitoring by District Bio-medical Waste Management Monitoring Committee.		Short-term and continuous	Mandated by the Rules (section 6.1.6.1) Needs monitoring by district-level BMWM committee	
Ensure 100% segregation, collection and treatment of bio-medical waste through coverage and registration of all healthcare facilities to CBWTFs.		Short-term and continuous	Mandated by the rules (section 6.1.6.1)	

Recommendations	Cross-cutting with	Qualifying priority		District scenario/ case examples
		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 (largely through 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 emissions reduction targets. An assessment of e-waste in Mumbai-Pune area by MPCB conducted in 2007 that considered only four categories (cell phone, TV, PC, refrigerator) projected 50,000 tons and 3,500 tons of e-waste generation in Mumbai and Pune respectively, in 2015. The assessment was done before even the first rules (2011) came. The current rules (2016) include 22 categories of electrical and electronic products as e-waste. Widely regarded as the second major IT hub of India, Pune's current e-waste generation will outgrow this projection with a large margin. During 2018-19, only 9,475 tons of WEEE was collected formally as reported by MPCB) in the entire state, which clearly indicates informal routing of most of the e-waste generated.
Ensure stringent policy implementation: trace informal routing, ensure proper collection, restrict informal processing of e-waste (open burning, metal smelting, etc.), ensure proper disposal of electrical waste (lighting infrastructure including mercury containing lamps) and strict monitoring to stop landfilling of the same.		Short-term and continuous	Policy framework exists (section 6.1.6.1) Needs monitoring, research and 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 (manufacturers), producer responsibility organisations or local e-waste collection drives at the district level.		Short-term and continuous	Mandated by the rules for the producers (section 6.1.6.1) Dedicated awareness campaign required Can be achieved by collaborating with producers	
Formulation of district level E-waste management programmes.		Short to medium-term	Needs state and district 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) 100% closed and underground sewer collection network coverage of both rural and urban areas of the districts, b) Shift 100% domestic wastewater treatment (STP) to aerobic set ups by having only aerobic STPs for new constructions and transitioning the old anaerobic STPs to aerobic set up. c) Operation and regular maintenance of sludge removal facilities of all STPs. The sludge can be used again for the bio-methanation of compost.		Medium to long-term	Policy intervention and capital investment required	Wastewater, if treated anaerobically, can be a huge source of methane and even nitrous oxide emissions. Being stagnant and subject to heating, open sewers create anaerobic conditions, leading to CH_4 emissions. Closed underground sewers, on the other hand, are considered to be an insignificant source of CH_4. Currently, Pune district has 21 aerobic STPs of 700 MLD capacity. Pune city is covered with 92% sewerage network of 2,200 kms length with 6 intermediate sewage pumping stations (IPS) and 9 STPs (aerobic). The district sewerage network coverage is less and is proposed to be expanded until 100% coverage. No specific information is available on the rural sewerage coverage. Japan International Cooperation Agency (JICA) project with Pune Municipal Corporation proposed augmentation of existing sewage treatment capacity by adding 11 new STPs (396 MLD capacity) to cover sewage generation up to 2027 (under construction now). 100% closed and underground sewer connection and centralised aerobic well-managed STPs can potentially reduce 2,11,430 tCO_2e emission from STPs to negligible in Pune. The Maharashtra government has mandated the reuse of treated wastewater for cooling thermal power plants and has introduced 'Maharashtra Water Resources Regulatory Authority Water Entitlement Transfer (WET) and Wastewater Reuse Certificates (WRC) Platform Regulations, 2019'. Example: Ahmedabad Municipal Corporation has set up the first sewage sludge hygienisation plant in the country at Pirana (operational from 2019) which can convert 100 tonnes of dry sludge into fertiliser per day. A similar plant can be developed for Pune.
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 provisions to industries, healthcare, hospitality sectors for implementation of 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 needs to 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, inter-departmental collaboration	
Encourage data transparency by the industries for wastewater generation, treatment and discharge information including those of CETPs.		Short to medium-term	Needs collaborative efforts	Pune region has five operational CETPs with collective treatment capacity of 13 MLD. The total industrial effluent generated in this region during 2018-19 was 4.85 MLD. The quantity of effluent received and treated at these CETPs during 2018-19 was 4.45 MLD. Data transparency on wastewater generation by industries is key to reducing water pollution, which can be further enhanced 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.



6.1.6.1 Waste Management: Policy framework and concerned departments/agencies

Sectors	Policies and programmes which can push forward the recommendation	Primary departments/ agencies	Supporting departments/ agencies
Solid waste	1. Solid Waste Management Rules, 2016 and Amendment, 2018 2. Plastic Waste Management Rules, 2016 and Amendment Rules, 2021 3. Construction & Demolition Waste Management Rules, 2016 4. Integrated Solid Waste Management Project 5. Swachh Bharat Mission - Urban & Rural 6. Pune Master Plan 2041 & City Development Plan 7. Pune Smart Cities Mission 8. National Resource Efficiency Policy (draft) 9. Guidelines on Environmental Management of C&D Waste Management in India, 10. Maharashtra Water Resources Regulatory Authority Water Entitlement Transfer (WET) and Wastewater Reuse Certificates (WRC) Platform Regulations, 2019 11. MPCB Annual Report 12. Majhi Vasundhara	1. Urban Development Department, GoM 2. All ULBs (Pune Municipal Corporation, Pimpri Chinchwad Municipal Corporation, Lonavala Municipal Council, Indapur Municipal Council) 3. Rural Development and Panchayat Raj Department, GoM 4. All Gram Panchayats 5. Maharashtra Pollution Control Board (MPCB)	1. Pune District Administration & the proposed District Level Climate Change & Environment Committee 2. Maharashtra Urban Infrastructure Development Company Limited (MUIDCL) 3. Pune Metropolitan Region Development Authority (PMRDA) 4. Department of Environment and Climate Change, GoM 5. Community or Residential Associations
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 (for data availability) 5. Revised Guidelines for Common Bio-medical Waste Treatment and Disposal Facilities, 2016, CPCB	Research funding can be obtained from Department of Environment and Climate Change, GoM, MPCB, etc.[23]	1. MPCB 2. Pune District Administration & the proposed District Level Climate Change & Environment Committee 3. Healthcare facilities 4. CBWTF
Waste-electrical and electronic equipment (WEEE)	1. E-Waste (Management Rules), 2016 2. Implementation Guidelines for E-Waste (Management) Rules, 2016,	Only implementation monitoring and research needs resources which can be obtained from the Department of Environment and Climate Change, GoM, MPCB, etc.[24]	1. MPCB 2. Pune District Administration and the proposed District Level Climate Change & Environment Committee 3. Electronic and Electrical Producer Manufacturers/ Producers/Brand owners, Producer Responsibility Organisations

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

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

Sectors	Policies and programmes which 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. Pune Smart City Mission 8. Pune Master Plan, 2041	1. Urban Development Department, GoM 2. Water Resources Department, GoM 3. Rural Development and Panchayat Raj Department, GoM 4. All ULBs	1. PMRDA 2. MUIDCL 3. Pune Smart City Development Corporation 4. All Gram Panchayats 5. Pune District Administration and the proposed District Level Climate Change & Environment Committee
Wastewater: industrial	1. Common Effluent Treatment Plant System 2. Online Continuous Emission Monitoring System 3. MPCB Annual Report 4. Majhi Vasundhara	1. MPCB 2. MIDC	1. City and Industrial Development Corporation (CIDCO) 2. Department of Environment and Climate Change, GoM 3. Pune 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; and c) block waterways and intensify natural disasters.
- They have high carbon footprint and cost for collection, transport and treatment/recycling requirement.
- SUPs release harmful toxic chemical additives at their end-of-life disposal (unscientific) and further contaminate soil, water and the food chain.

Easily replaceable SUP, their alternatives and key user industries

SUPs	Type of plastic majorly used	Key user industries	Alternatives	Pros and cons of various alternatives
Polythene bags	Low Density Polyethylene (LDPE)	Fast Moving Consumer Goods (FMCG)	Cotton bags, jute bags, bio-plastics	**Cloth (cotton)** • Pros: Natural fibre, durable, reusable, biodegradable, profitable and non-food crop • Cons: High consumption of chemical fertilisers and pesticides in cotton farming, high cost, water intensive crop, not moisture resistant, needs to be reused many times to offset high degradation/recycling carbon footprint **Jute** • Pros: Natural fibre, durable, reusable and biodegradable, high carbon assimilation rate • Cons: Expensive, water-intensive crop, highly dependent on rainfall, product not moisture-resistant **Bio-plastics** • 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/bio-degradable face shield	
Sticks of cotton buds	--	FMCG (PCCP)	Recycled paper, other eco-designed materials, bamboo	
Cigarette butts	Cellulose acetate	Tobacco industry	--	
Freezer bags	LDPE	Hospitality, healthcare, R&D	Glass container, sealable stainless steel	

Microplastics

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

Regulatory provisions in India for single-use plastics

- Plastic Waste Management (Amendment) Rules, 2021 (announced on March 11, 2021): a) The manufacture, import, stocking, distribution, sale and use of the SUP commodities: Ear buds with plastic sticks, plastic sticks for balloons, plastic flags, candy sticks, ice-cream sticks, polystyrene (thermocol) for decoration shall be prohibited from January 1, 2022, b) The manufacture, import, stocking, distribution, sale and use of the SUPs (including polystyrene and expanded polystyrene) items – plates, cups, glasses, cutlery such as forks, spoons, knives, straw, trays, wrapping/packing films around sweet boxes; invitation cards; and cigarette packets, plastic/PVC banners less than 100 micron, stirrers shall be prohibited from July 1, 2022.
- Plastic Waste Management Rules, 2016 and Amendment Rules, 2018: a) Puts the onus on the producers, through extended producer responsibility (EPR), to collect plastic waste either individually or through the concerned local body; b) The primary responsibility is on producers, importers and brand owners (who introduce the products in the market) to collect used multi-layered plastic sachet, pouches and other packaging; c) Manufacturing and use of multi-layered plastic, which is non-recyclable or non-energy recoverable or with no alternate use, should be phased out in two years.
- Solid Waste Management Rules, 2016 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.
- 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[25]

- 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.

25 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

- Formulate policies with provisions to: a) mandate producer responsibility for awareness, labelling requirement on disposal, clean-up, collection and treatment of SUP products/packaging; b) mandate collection target (can be a differential target for different products) for SUP producers as part of EPR; c) penalise consumers for accepting banned SUP carrier bags or products; d) strict and random monitoring for implementation of bans in supermarkets, street vendors, shopping malls, large organised markets, etc; e) gradual phasing out of other selected categories of SUP products (by granting the producers some transition time). The phasing out can be achieved by sensitising key producers and sectors and encouraging them to take voluntary action.
- Promote eco-friendly alternatives to SUPs through: a) identifying alternative sustainable products; b) identifying micro-enterprises and cottage industries for the products; c) integrating them into the mainstream business models through connecting/cross-cutting policies; d) providing financial incentives for the alternative industries and for integrating sustainable products into mainstream business models, such as in the hospitality industry; e) strict quality control and certification requirement for plastic-free alternatives (for instance, resin or plastic powder should not be mixed in the product as an alternative).
- 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	In June 2017, Pune Municipal Corporation raised ₹ 200 crore through municipal bonds (listed on BSE) at an interest of 7.59% to finance its 24x7 water supply project. PMC's plan was to issue municipal bonds worth ₹ 2,300 crore over a period of five years, of which bonds worth ₹ 200 crore were issued in 2017.
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_2e since 2019 and generated carbon credits.

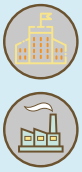
6.3 Recommendations based on district-specific environmental problems: Recommendations, cross-cutting sectors, qualifying priority and district scenario

Recommendations	Cross-cutting with	Qualifying priority		District scenario / case examples
		Time frame to attain the recommend.	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 in the city. Increase the number of air quality display facilities in public places.		Short to medium-term	Policy framework and budgetary provisions exist	Air quality in Pune is considered to be an urgent public health issue and has been deteriorating since 2013 with $PM_{2.5}$ consistently exceeding the limits. Pune is also one of the 124 non-attainment cities in India under the National Clean Air Programme (NCAP). An IITM-SAFAR inventory identified transport (49%), dust (29%), industrial operations (17%) and solid fuel combustion (5%) as the major sources of local air pollution in the city (IITM, CEE, IIPH, & NRDC, 2019). Pune currently has 15 air pollution monitoring stations of which five are operated by MPCB, SAFAR, and 10 are operated by IITM. In addition, Pune Smart City Development Corporation also maintains an independent network of 50 environmental monitoring stations. As a non-attainment city, air pollution prevention measures such as, dust suppression through deployment of mechanical sweeper, water sprinkler, traffic synchronisation system, electric/ gas-based crematorium, proper collection and disposal of horticulture waste, such as composting-cum-gardening approach, promoting e-mobility, controlling C&D waste etc., are identified under the city action plans of PMC along with other non-attainment cities of Maharashtra.
Enforce environmental standards on exhaust fumes/emissions from industries.		Short-term and continuous	Robust M&E required	
Sprinkling of water (preferably, recycled grey water) to settle suspended road dust during peak pollution episodes.		Short-term and continuous	Inter-departmental co-operation required	
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 management of construction and demolition waste (as per CPCB guidelines).		Short to medium-term	Policy framework exists	
Facilitate source apportionment studies to identify the sources and develop specific containment measures.		Short to medium-term	Needs research collaboration	
Ensure installation and operation of air pollution control devices in industries and adherence to emission standards.		Medium to long-term	Implementation of existing rules/ regulations Robust M&E	

Recommendations	Cross-cutting with	Qualifying priority		District scenario / case examples
		Time frame to attain the recommend.	Framework for implementation	
Increase the modal share of public and non-motorised transportation (see detailed recommendation under Transport Sector). Further, promote transition to e-vehicles. 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, capital investment and inter-departmental coordination required	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 Pune city to Control Air Pollution. Auto-rickshaws that run on diesel, petrol, and LPG dual combination are still available in the district. Several provisions in the latest Maharashtra state E-vehicle Policy, 2021 can aid these recommendations (detailed recommendations under transport sector).
Better traffic management, redirection 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 Implementation of existing rules/ policies Capital investment required	
Increase/create green cover or green buffers along the major traffic corridors, circles and industrial areas in the district.		Medium to long-term	Inter-departmental coordination required Efficient maintenance and monitoring of plantation sites required	
a) Shifting of industries from non-conforming zones (refer Development Control and Promotion Regulations for Pune Metropolitan Regional Development Authority and the same for Pimpri-Chinchwad New Town 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	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 to attain the recommend.	Framework for implementation	
Landslides and flooding				
Design and implement early warning system (EWS) for flood and related disasters in the district. Further, improving weather and rainfall monitoring network and ensuring information dissemination to the public can significantly help reduce damage due to these disasters.		Short-term	Policy provisions exist Requires inter-departmental collaboration	
Biological reclamation of land/soil: Improved and area specific agriculture/ soil management practices, such as broadcasting of grass seeds, growing cover crops, bio-technical measures like using micro culture and plantation to avoid further land degradation.		Short to medium-term and continuous	Needs research, stakeholder collaborations and capacity building	Landslide hazards rank high among the hydro-geological hazards because of the threat and widespread loss they pose to lives, livelihoods and resources. National Institute of Disaster Management (NIDM) lists the Malin landslide of Pune district in 2014 as one of the 10 major landslides in India in the last three decades (NDMA, 2019). Landslide is a severe problem in the Western Ghats of Maharashtra, particularly in the upland region of Deccan Volcanic Provinces (DVP) due to its topography, human interference (construction, ecologically unsuitable land use, agricultural practices, etc.) and heavy rainfall. The part of the State Highway-70 between Bhor of Pune district and Mahad of Raigad, a neighbouring district, is highly landslide prone and frequently blocked during the rainy season (Khamkar, Mhaske, & Sabale, 2018). In a report by PMC, 9 of the 41 wards (Aundh, Warje Karvenagar, Ghole Road, Kothrud, Bhavani Peth, Kasba Vishram, Tilak Road, Kondhwa Wanawdi, Dhanakawadi) of the city are identified as highly vulnerable to landslides (PMC, 2015).
Promote and restore ecosystems with higher carbon sequestration potential (e.g., wetlands, rangelands, forests), agro-forestry, afforestation, etc. and providing incentives for maintenance of ecosystem services. Initiate studies to adopt metrologies like The Economics of Ecosystems and Biodiversity Services (TEEB).		Medium to long-term	Policy framework exist Needs research, inter-departmental collaboration	

Recommendations	Cross-cutting with	Qualifying priority		District scenario / case examples
		Time frame to attain the recommend.	Framework for implementation	
Promote coordination between different government departments and projects, formulation of localised integrated action plans for holistic development of the local area in line with central and state programmes (mentioned in case example).		Medium-term	Needs inter-departmental coordination	In a recent initial evaluation based on National Landslide Susceptibility Mapping (NLSM), projects of GSI, Tamhini Ghat hill route section of Pune-Mangan Road (a hilly pass cutting across Western Ghat Escarpment to join Pune to Konkan region) and parts of Ambegaon Tal in Pune district have been identified for 1:10,000 scale landslide susceptibility zonation (NDMA, 2019). Independent research has been carried out to develop landslide hazard zonation mapping of landslide prone areas of Pune district, which can be used for landslide mitigation programmes and developmental planning (Gujarathi & Mane, 2013). GSI has also done a survey of 200 villages in Maharashtra, including some from the hilly areas of Pune district. Land degradation is addressed by several central and state programmes, for example, Integrated Wastelands Development Programme (IWDP), National Watershed Development Project for Rainfed Areas (NWDPRA), NABARD projects, etc.
Research and identification of best practices and sustainable development technologies for landslide management of areas with similar geo-climatic conditions and adoption/ implementation of the same through policy formulation.		Medium-term	Needs research and cross-cutting policy integration Capacity building of relevant department officials through cross exposure visits	
Development of zone-wise ecologically sensitive land-use plan (land-use zoning), integrated landscape planning and district-specific land policies (community mapping, co-management, decentralisation, etc.) to reduce land-use intensification.		Medium to long-term	Existing policy framework needs to be enhanced Research and inter-departmental coordination required	
Develop region and ward specific strategies for landslide management in urban areas, such as relocation of slum population residing in the steep slopes of Parvati hills (Warje Malewadi ward, Dhankawdi ward), sustainable road construction in Dhankawadi (population of 7,000 at risk), restrictions on stone mining in the vulnerable Yerawada Sangamwadi Ward, etc.		Short to medium-term	Needs inter-departmental collaboration and financial investment required	

Recommendations	Cross-cutting with	Qualifying priority		District scenario / case examples
		Time frame to attain the recommend.	Framework for implementation	
Flood hazard mapping with anticipated inundation area and landslide susceptibility mapping with areas of landslide risk and information for safe evacuation and intimation of the same to the identified areas through rural and urban local bodies.		Short-term	Needs research and interdepartmental collaboration	Central Pune is located at the confluence of the Mula and Mutha rivers. In addition, Pavana and Indrayani rivers, and the tributaries of the Bhima River, flow along the north-western outskirts of the Pune Metropolitan Region. Moreover, there are three dams in the upstream. During heavy monsoon, Mula and Mutha rivers flood and the dams release water when their capacity goes full (PMC, 2015). PMC and the Irrigation Department have marked low and high flood lines. Constructions are not allowed in flood zone of the PMC. However, there are old and unauthorised constructions and slums in flood zones. The Khadakwasla Dam poses the highest flood risk in Pune. PMC has identified 9 wards (Aundh, Kothrud, Bhavani Peth, Kasva Vishram, Tilak Road, Bibvewadi, Hadapsar, Kondhwa Wanawdi, Dhanakawadi) as highly vulnerable to flooding and three wards (Warje Karvenagar, Ghole Road, Sahakarnagar) with medium vulnerability to flooding (PMC, 2015). PMC has an SOP, Flood Control Action Plan for floods and flash floods, an early warning system in coordination with the Police and the Fire Department, and a system for relocating flood zone population along with temporary shelters.
Building embankments around rivers (preferably natural embankments) to protect low lying areas in the district.		Short-term and continuous	Policy framework exists	
Ensure sustainable construction and development (of bridges, dams, etc) along the rivers. Consider the river hydrology, river flow and catchment area ecosystems, in adherence with existing norms, for any new or existing C&D.		Continuous	Policy framework exists Needs area-specific research	
Identify and map all wastewater sources to the rivers and waterbodies, ensure proper functioning of STPs and ETPs to prevent direct release of untreated wastewater from industries, commercial and residential sector to surface water sources.		Medium-term	Policy framework exists Strict monitoring and reporting required.	
Promote rainwater harvesting: a) Renovation of existing rainwater harvesting structures, b) Ensure rainwater harvesting structures in new construction of residential buildings, institutional, commercial centres, and industries in the district as per building bye-laws.		Short to medium-term	Policy framework exists Align with existing regulations.	

Recommendations	Cross-cutting with	Qualifying priority		District scenario / case examples
		Time frame to attain the recommend.	Framework for implementation	
Efficient planning, operation and maintenance of storm water drainage is required to halt flooding situations.		Short- term	Policy provisions exist	PMC has initiated Pune River Development Project aiming to reduce the threat of flooding.
Create programmes for the revival of local lakes/ ponds and rejuvenation of polluted river stretches through desilting, aquifer recharging, and integrated watershed development.		Medium-term and continuous	Requires long-term planning and financial investment	Maharashtra Water Resources Department has a Pune Flood Control Portal maintained with all emergency contacts.

6.3.1 District-specific recommendations based on identified environmental problems: Policy framework and concerned departments/agencies

Sectors	Policies and programmes which 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 4. Solid Waste Management Rules, 2016 & Amendment, 2018 5. Construction & Demolition Waste Management Rules, 2016 6. Majhi Vasundhara	1. Department of Environment and Climate Change, GoM 2. MPCB	1. District Administration and the proposed District Level Climate Change & Environment Committee 2. Maharashtra Forest Department, GoM 3. Motor Vehicles Department, GoM 4. RTO 5. All ULBs 6. All Gram Panchayats
Landslide and flooding	1. Disaster Management Act, 2005 2. Landslide Risk Management Strategy, 2019 3. Pune River Development Project 4. Development Control & Promotion Regulations, 2018 5. Flood Management Action Plan, 2017 6. Landslide Hazard Zonation, National Landslide Susceptibility Mapping (NLSM) 7. Majhi Vasundhara	1. District Disaster Management Authority (DDMA) 2. All concerned ULBs 3. District Administration and the proposed District Level Climate Change & Environment Committee 4. Urban Development Department, GoM	1. State Disaster Management Authority, GoM 2. Department of Housing, GoM 3. Maharashtra State Road Development Corporation 4. Maharashtra Forest Department, GoM 5. Maharashtra Krishna Valley Development Corporation 6. Maharashtra Water Resources Regulatory Authority (MWRRA)

Initiatives by Pune Smart City Development Corporation

Good practices of PSCDCL so far

- **E-mobility** Out of the 150 smart e-buses planned for the Pune city (PMPML), 125 had been launched in 2019. In Pune, only 10% of the public transport fleet runs on diesel.
- **Efficient street lighting** A total of 90,000 LED streetlights were installed in Pune. More streetlights are being planned to cover the road stretch of 4.2 km in Aundh, 10.2 km in Baner and 16.5 km in Balewadi.
- **Community farming:** In a self-sustained project, 1500 sq. m of barren/ waste land of PMC was converted into community farms where vegetables are grown by the community. The revenue generated is shared among the community.
- **Greening:** a) Green medians created by planting 8,000 sq. m of shrubs along a road-stretch of about 12 km. b) The city has planted 5,000 trees of different native species. Main species planted include, Bakul, Champaca, Karanja, Mahogany, Kanchan, Gulmohar, Saptaparni, etc (see Table 12 for a list of tree species and their sequestration potential in Pune).
- **Biodiversity parks:** Seven theme biodiversity parks have been developed in Pune. Water conservation structures have been created in one of the theme parks with IEC display on the significance of efficient water management.
- **Waste management:** PSCDCL is running a zero-waste project in an effort to ensure no organic waste goes to the landfill by implementing composting units at the society level. Bulk organic waste generators, such as housing complexes generating >100 kg waste, are currently running their own composting units. Pune currently has 236 bulk generator housing complexes with 80+ flats, and 318 with 60+ flats, out of which 109 and 131, respectively, are practicing composting of organic waste at the premises.
- **Pune Integrated Command Control Centre (ICCC)** is formed with 800 smart elements. The system has a network of 136 public address centers across the city with emergency call box for citizens to reach out to ICCC for any emergency. This network is being used to monitor the Covid 19 situation in the city and has the potential to be used for a number of awareness campaigns.

Proposed projects of Smart City Pune

In addition to the above projects, Pune Smart City Development Corporation (PSCDCL) has proposed 34 projects for area-based development in Aundh-Baner-Balewadi region of Pune and 18 pan-city projects. These projects are aimed at upgradation of the transport infrastructure and modal share, water use efficiency and treatment, energy efficiency, and sustainable infrastructure development in Pune city.

Race to Zero – achieving carbon neutrality in Pune

In September 2021, Pune, along with 42 other major cities in Maharashtra, joined the Race to Zero, a commitment to achieve carbon neutrality by 2050. The following recommendations can enable the city as well as the district head in this direction.

1. Enhancing urban energy infrastructure
    a. Transitioning the current fossil fuel-based energy regime to renewable and waste-based energy regime:
        i. Government schools in Pune district, if equipped with solar rooftops, can generate 103 MUs electricity, thereby avoiding 89,019 tCO_2e annually.
        ii. If 50 percent of the households (having a potential of 7,025 MW) install solar rooftops, 7.52 Mt CO_2e can be avoided annually.
    b. Modernising grids and moving to a demand-based energy supply structure.
    c. Transitioning towards climate neutral buildings by (a) retrofitting old buildings to become energy and water efficient in compliance with the ECBC norms; and (b) ensuring new buildings are compliant with 'net zero' or 'plus energy' standards. These measures would lead to considerable drop in emissions.
    d. Design energy tariffs, incentive packages and taxes in a manner that encourage investment in energy-efficient infrastructure and eliminate energy imbalances in the residential, commercial, and industrial sectors.

2. Urban planning and spatial strategies
    a. Limit horizontal urban sprawl by achieving appropriate building density.
    b. Limit car dependency by enhancing public transport facilities.
    c. Promote sustainable and low carbon transport modes.
    d. Encourage eco-towns and sustainable settlements.
3. Low carbon mobility
    a. Developing a comprehensive network of bicycle routes and bicycle hire facilities across the city.
    b. Ensuring safe and convenient cycling and walking infrastructure, particularly for the elderly, children and those with reduced mobility.
    c. Making public transport attractive, convenient, and affordable.
    d. Developing no-vehicle pedestrian friendly zones.
    e. Encouraging a transition to electric fuel-based public and intermediate transport and installing RE-based charging infrastructure for the same.
4. Enhancing lung spaces
    a. Green spaces should represent a considerable portion of land use while being integrated into the city design in a manner to protect the city infrastructure from natural disasters, mitigate urban heat island effect and to provide ample recreation space.
    b. Enhance trees outside forest and urban forestry initiatives.
        i. Table 15 gives the CO_2 sequestration potential by a single tree of common tree species.
    c. Installing green roofs and converting brownfield sites into green areas.
    d. Green spaces also reduce the risks of floods, droughts and heat waves.
5. Waste and wastewater management:
    a. Promoting recycle and reuse to minimise waste generation.
    b. Ensuring 100 percent waste segregation from residential, commercial and industrial sectors.
    c. Treating waste as valuable feedstock for energy generation and developing infrastructure for material recycling, 100 percent organic waste treatment by composting with a methane capturing facility, waste-to-energy generation, heat recovery of incinerators.
    d. Achieving 100 percent underground sewerage network coverage with aerobic sewerage treatment.
    e. Promote reuse of treated wastewater in industrial sector and for landscaping and gardening.
6. Building urban resilience
    a. Undertaking a climate risk assessment exercise to investigate exposure and impacts of climate, energy and environmental risks.
    b. Identifying vulnerable groups and locations through social impact assessment.
7. Awareness

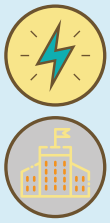
    Well-designed awareness campaigns with widespread reach through social media, radio, newspapers and other local media, *nukkad nataks*, wall paintings and school programmes. This will help ensure people's participation for advancing towards carbon neutrality that is based on the principles of social inclusion.

Table 15: Indicative CO_2 sequestered by different tree species of Pune[26]

Species	Girth class (cm)	Carbon sequestered by one tree (kg/tree)	Average carbon sequestered by one tree (carbon-kg/tree)	Total no. of trees in Pune	CO_2 sequestered by all trees of each species (tonnes) = Avg.*no. of trees*44/12*10^3
Mangifera indica (Aam/Mango)	10 to 30 cm	11.3	334.64	53,164	65,292.24
	31- 60 cm	40.5			
	61 – 90 cm	83.3			
	91 – 200 cm	727.4			
	> 200 cm	810.7			
Leucaena leucocephala (Subabul)	10 to 30 cm	1.9	98.44	5,85,401	2,11,490.63
	31- 60 cm	72.3			
	61 – 90 cm	112			
	91 – 200 cm	140			
	> 200 cm	166			
Prosopis juliflora (Mesquite)	10 to 30 cm	6.13	300.3	82,980	91,452.341
	31- 60 cm	91.50			
	61 – 90 cm	192.51			
	91 – 200 cm	401.36			
	> 200 cm	810			
Acacia nilotica (Babul)	10 to 30 cm	3.2	250.3	78,025	71,673.84
	31- 60 cm	38			
	61 – 90 cm	294.1			
	91 – 200 cm	374.2			
	> 200 cm	542			
Cocos nucifera (Coconut)	10 to 30 cm	45	81.04	50,458	15,007.05
	31- 60 cm	51.1			
	61 – 90 cm	69.7			
	91 – 200 cm	99.4			
	> 200 cm	140			
Polyalthia longifolia (Ashopalav)	10 to 30 cm	7.4	465.18	63,662	1,08,684.44
	31- 60 cm	100.2			
	61 – 90 cm	130.9			
	91 – 200 cm	497.4			
	> 200 cm	1590			
Azadirachta indica (Neem)	10 to 30 cm	11.7	105.47	72,187	2,79,41,775.8
	31-60 cm	56.2			
	61 – 90 cm	248.5			
Total CO_2 sequestered by all the trees of the mentioned species					**28,505.37 million tonnes**

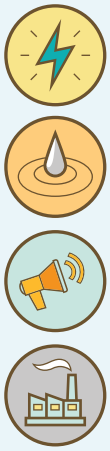
26 Indicative CO_2 sequestered by different tree species of Pune: An exercise has been done to estimate CO_2 sequestered by the commonly found species in Pune city. Species-wise data on total number of trees was given by PMC. Whereas, the carbon sequestration potential has been taken from the species-wise information provided in "Carbon Stock Assessment of Selected Tree Species in Urban and Sub Urban Areas of Gujarat (Report-II)" published in 2013 by the Forest Department, Gujarat State, in collaboration with GEER Foundation. Carbon dioxide sequestration is calculated by taking an average of girth-wise carbon sequestered and multiplying it with the total number of trees counted during the Pune Tree Census Project (2019). The carbon sequestered is then converted into CO_2 by multiplying it with the ratio of molecular weight of CO_2 to carbon. This is a basic methodology and this can be further refined if girth-wise number of trees for each species is available. This is just an indicative calculation for the most common tree species found in Pune (for which carbon sequestration potential was available). This exercise can be scaled up with the availability of the required data/information.

6.4 Actions district authorities can recommend to state departments

Recommendations that can 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%. This is way higher than the international standard range of 6% to 8%. However, for Pune zone, AT&C losses of MSEDCL stood at just 5.31% for April 2018. MSEDCL needs to upgrade its infrastructure, introduce solutions, such as smart metering and smart billing, etc. to increase its efficiency. For example: EESL has signed an MoU with Uttar Haryana Bijli Vitran Nigam and Dakshin Haryana Bijli Vitran Nigam for 10 lakh smart meters. The deployment of smart meters in the country has led to a 20% increase in monthly revenue per customer for DISCOMs, on average a 5% reduction in AT&C losses, 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 Pune 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% of 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 contributes, not only in facilitating more people for living, but also towards the environment. It averts the loss of green cover and makes the transport mechanism much more efficient. High-rise building construction has been allowed in Pune since November, 2007.
TRANSPORT: Energy efficiency of infrastructure in railways can be enhanced through the following measures: a) Installing solar panels along electrified tracks and on railway station rooftops. b) Installing optimal light control systems and appliances, smart sensors and building management systems at station buildings. c) Ensuring regeneration of energy (through rolling stock) parallel to the grid.		Medium-term	Needs inter-departmental collaboration	Rail Land Development Authority and National Building Construction Corporation have signed an MoU for redevelopment of 10 railway stations across India as 'smart railway stations.' Railway stations in the district can also be developed along similar lines.

Recommendations that can 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: Use fiscal instruments to discourage the use of personal vehicles, such as: a) Increase charges on registration of internal combustion engine (ICE) vehicles, b) Levy congestion charges and other green tax, c) Phase out 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 the imposition of additional taxes on old vehicles that are unfit for roads, calling them 'green taxes.'
TRANSPORT: Identify and shift key commercial / business centres from all the ULBs to areas outside city limits to reduce traffic load.		Long-term	Needs proper policy, based on research and inter-departmental cooperation	
INDUSTRY: a) Ensure regular PAT compliance of DISCOMs and other designated consumers in the district. b) Increase the number of designated consumers for 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	Till PAT Cycle VI (2020-21) only four designated consumers had volunteered under the scheme in Pune district.[27] Over the years, these designated consumers from Pune district have helped avoid around 53,536 tCO_2e of emissions by improving their systemic energy efficiency, under the PAT scheme.
INDUSTRY/ENERGY: Ensure compliance of renewable purchase obligations (RPO) and increase the RPO targets gradually.		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 nutritionally rich).		Medium to long-term	Needs creation of appropriate financial mechanisms to encourage farmers to grow millets, Requires research collaboration This would also help meet the following targets of SDG#2 (Zero Hunger): 2.1, 2.3, 2.4	In Pune, the production of Bajra increased from 63,100 tonnes (2015-16) to 1.91 lakh 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 help meet the following targets of SDG#2 (Zero Hunger): 2.1, 2.3, 2.4, 2.a	Area under oilseed cultivation in Pune increased from 1.29 lakh ha (2015-16) to 1.82 lakh ha (2019-20), leading to increased production from 1.19 lakh tonnes (2015-16) to 1.33 lakh tonnes (2019-20). However, the yield reduced by 20.8%. In order to meet the food demand of future, climate-smart agriculture is the key to reducing crop failures.

27 Names of Designated Consumers- Century ENKA Ltd, Bombay Dyeing and Manufacturing Co., BILT Graphic Paper, Padamjee Paper Products Ltd.

Recommendations that can 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 consumption and water savings in agriculture, subsidies must be reduced by some percentage in a phased manner		Medium to long-term	Policy intervention needed Need to create both awareness and collaboration among the farming communities	The 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. [28] The approved tariff has decreased by 6% and 1% for high tension-agriculture and low tension-agriculture metered, respectively for FY 2020-21.
FORESTRY/GREEN SPACES: Promote regeneration of degraded and open forest areas through CSR/similar mandates and encourage corporates to dedicate some percent of their profit for greening the spaces around their units/factories.		Long-term	Needs strengthening of the existing policy framework Needs different stakeholder collaboration	Green belts 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: Adopt 'green marketing' approach by promoting green products through displaying product lifespan on the label on e-products to influence purchase decisions, thereby using the labels as a behavioural intervention.		Medium to long-term	Needs policy intervention, collaboration and awareness generation	

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

6.4.1 Actions district authorities can recommend to state departments: Policy frameworks and departments

Sub-sectors	Policies and programmes which 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. West Central Railways – Pune Division 3. Proposed District Level Climate Change and Environment Committee
Habitat	1. ECBC	1. Urban Development Department, GoM 2. MEDA, GoM 3. All ULBs 4. Pune Smart City Development Corporation Limited (PSDCL)	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. Pune Smart City Development Corporation Limited 5. West Central Railways - Pune Division (implementation support for relevant recommendations)
Industry	1. PAT Scheme 2. Industrial Promotion Policy, 2014 3. BEE-SME Program	1. Department of Industry, Energy and Labour, 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. Farmers' Welfare and Agricultural Development Department, GoM 2. Forest Department, GoM	1. APMCs 2. MIDC 3. Energy Department, GoM 4. Maharashtra Agro Industries Development Corporation 5. Department 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	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
SDG 2: Zero Hunger 	Target 2.1: End hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round.	AFOLU (agriculture)
	Target 2.3: Double Agricultural Productivity.	AFOLU (agriculture)
	Target 2.4: 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); landslide and flooding
	Target 2.a: Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research.	AFOLU (agriculture)
	Target 2.a; Article 10.3.e: Development of sustainable irrigation programmes for both crops and livestock.	AFOLU (agriculture and livestock)
SDG 3: Good Health and Well-being 	Target 3.3: End the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases.	Co-benefits from waste
	Target 3.4: Reduce by one third premature mortality from non-communicable diseases through prevention.	Co-benefits from waste
	Target 3.9: Substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination.	Waste; air pollution
SDG 6: Clean Water & Sanitation 	Target 6.3: Improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally.	Waste; energy (industry)
	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)
	Target 6.5: Implement integrated water resources management at all levels.	AFOLU (agriculture and green spaces/ forestry)
	Target 6.8: Support and strengthen the participation of local communities.	Waste; AFOLU; transport
	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

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)
	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)
	Target 7.3: Double the global rate of improvement in energy efficiency.	Energy (power, habitat; industry)
	Target 7.a: Enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology.	Energy (power)
	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
SDG 8: Decent Work and Economic Growth 	Target 8.2: Achieve higher levels of economic production through diversification, upgradation and innovation.	Energy; AFOLU (agriculture and livestock)
	Target 8.4: Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-year framework of programmes on sustainable consumption and production.	Waste
	Target 8.9: Devise and implement policies to promote sustainable tourism	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 buildings); waste; transport
	Target 9.2: Promote inclusive and sustainable industrialization.	Energy (industry)
	Target 9.3: Improving access and connectivity to industries/other enterprises.	Energy (transport)
	Target 9.4: Upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes.	AFOLU (agriculture); waste, energy (industry)
	Target 9.5: Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending.	Energy (power); waste
	Target 9.b: Research and innovation in developing countries, including by ensuring a conducive policy environment.	Waste; energy (power, industry)

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; habitat
	Target 11.2: Safe, affordable, accessible and sustainable transport systems for all.	Energy (transport, habitat); 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 buildings)
	Target 11.4: Strengthen efforts to protect and safeguard the world's cultural and natural heritage.	AFOLU (forestry)
	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, habitat, industry) and 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
	Target 12.3: Halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses.	AFOLU; waste
	Target 12.4: Achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil.	AFOLU; waste; air pollution
	Target 12.5: Substantially reduce waste generation through prevention, reduction, recycling and reuse.	Waste; energy (habitat and industry)
	Target 12.6: Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle.	Waste; energy (industry)
	Target 12.8: Ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature.	Individual action and behavioural change communication
	Target 12.a: Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production.	Waste; AFOLU (agriculture and livestock)
SDG 13: Climate Action 	All targets.	All sectors
SDG 14: Life under Water 	Target 14.1: Prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution.	Waste (single use plastic)

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
	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, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world.	AFOLU (forestry/ green spaces); landslide and flooding
	Target 15.9: Integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies.	AFOLU
	Target 15.a and 15.b: Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity, ecosystems and sustainable forest management.	AFOLU
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 (transport); AFOLU; waste

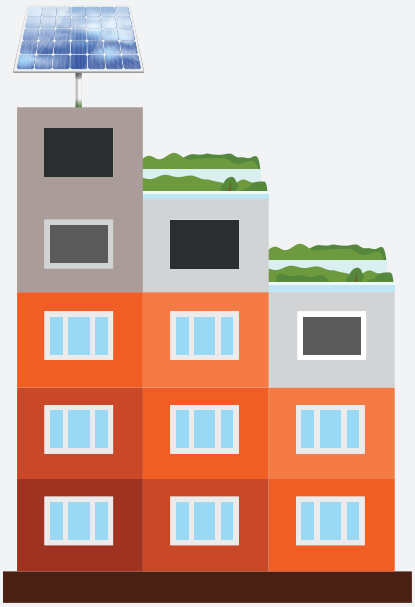
6.6 Promoting voluntary individual climate action

Waste management

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

Housing

1. Insulate the building as much as possible, ensure proper sealing of doors and windows to avoid cooling/heating leakage.
   In areas with warm climate, installing window shades, shutters, screens, etc. on the windows can provide an extra layer of insulation, hence less 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

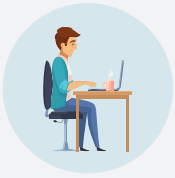
1. While cooking on gas stove, use moderate flame setting to conserve LPG.
2. Prefer the use of pressure cookers.
3. Keep the burner clean.
4. Use lids to cover the pan while cooking.
5. Use flat bottomed pan on electric stove.
6. Turn off electric stove several minutes before the specified cooking time.

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.

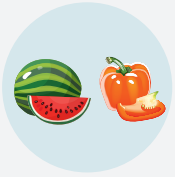
Go for climate conscious producers/ manufacturers. Develop a knowledge and preference for locally available and sustainably produced and designed products.



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.

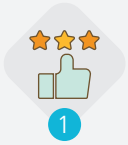
Develop a habit of repair and reusing appliances and products at home instead of buying new ones. Follow reduce, reuse and recycle principles in the household to reduce footprint.

Include more meat-free meals and limit food wastage.

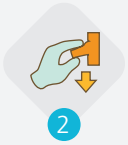
Buy local and organic food items not only for health but also to cut down emissions from transport and chemical fertilisers.

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

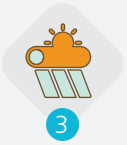
Daily use appliance



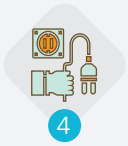
1. Purchase BEE star-rated energy efficient appliances



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

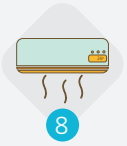


4. Unplug idle devices/appliances.

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.

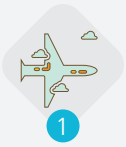
6. Proper maintenance of air conditioners helps to increase efficiency

7. Do not overload the refrigerator



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

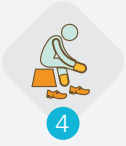
Transport



1. Choose direct flights to reduce carbon footprint

2. Travel light to reduce carbon emissions

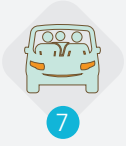
3. Strictly abide by pollution norms



4. Put on your shoes for short trips

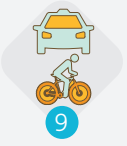
5. Ensure regular maintenance of vehicles

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

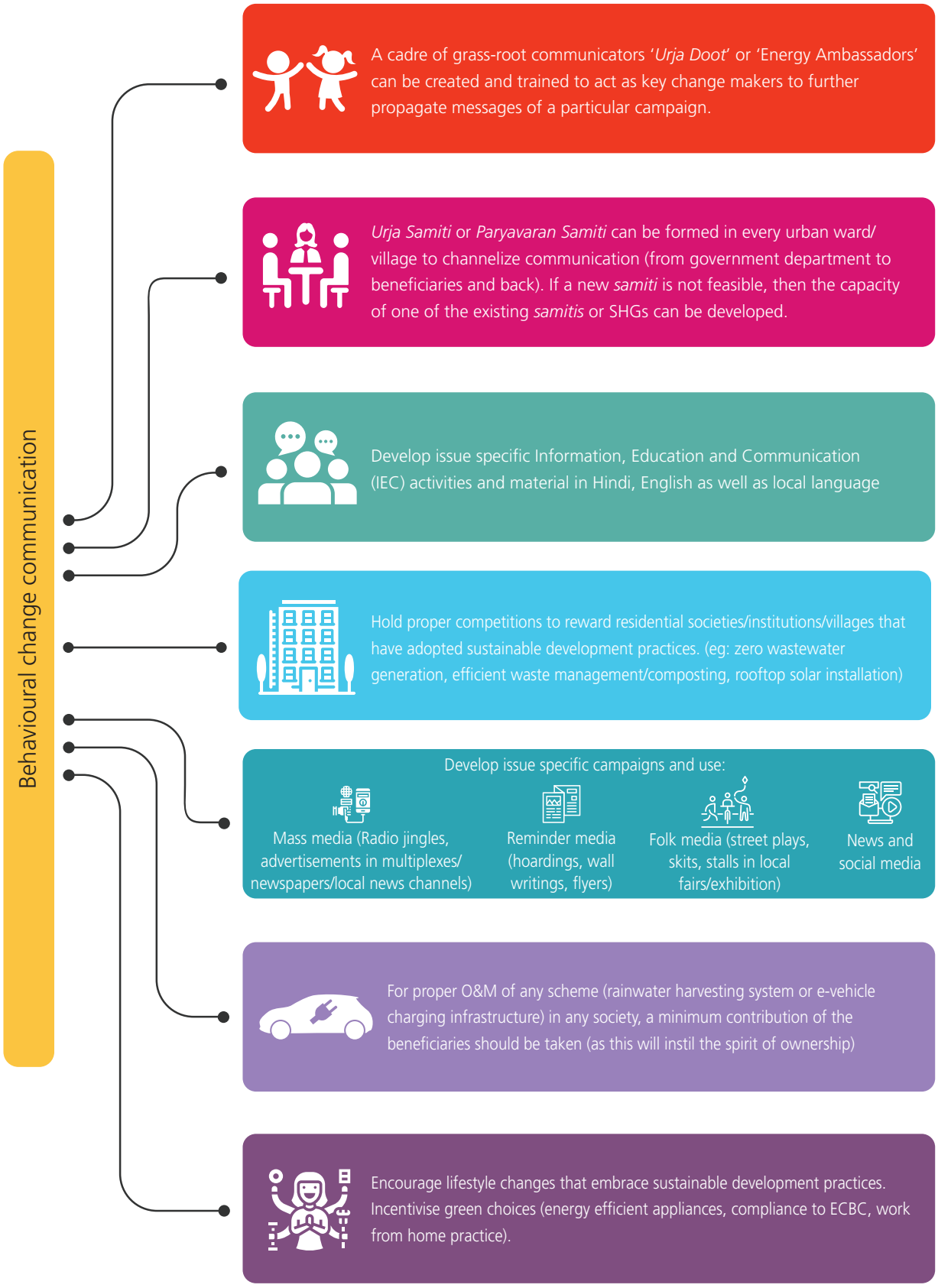
8. Shift to clean, non-petroleum fuels such as electricity (through RE) to power vehicles



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



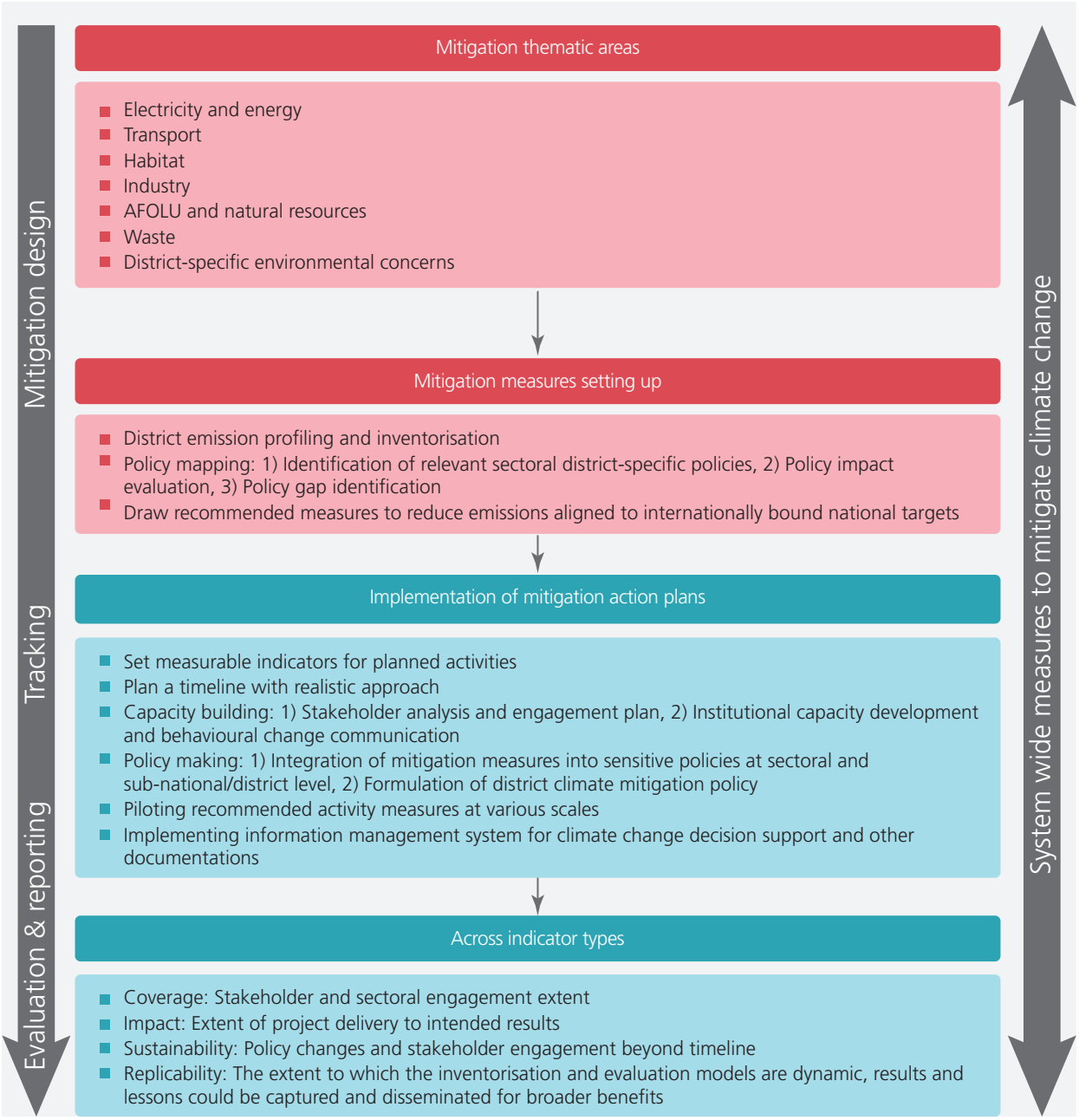
MONITORING AND EVALUATION PLAN

Flood sensor, Pune Source: Pune Smart City website

7. MONITORING AND EVALUATION PLAN

7.1 Framework for monitoring and evaluation

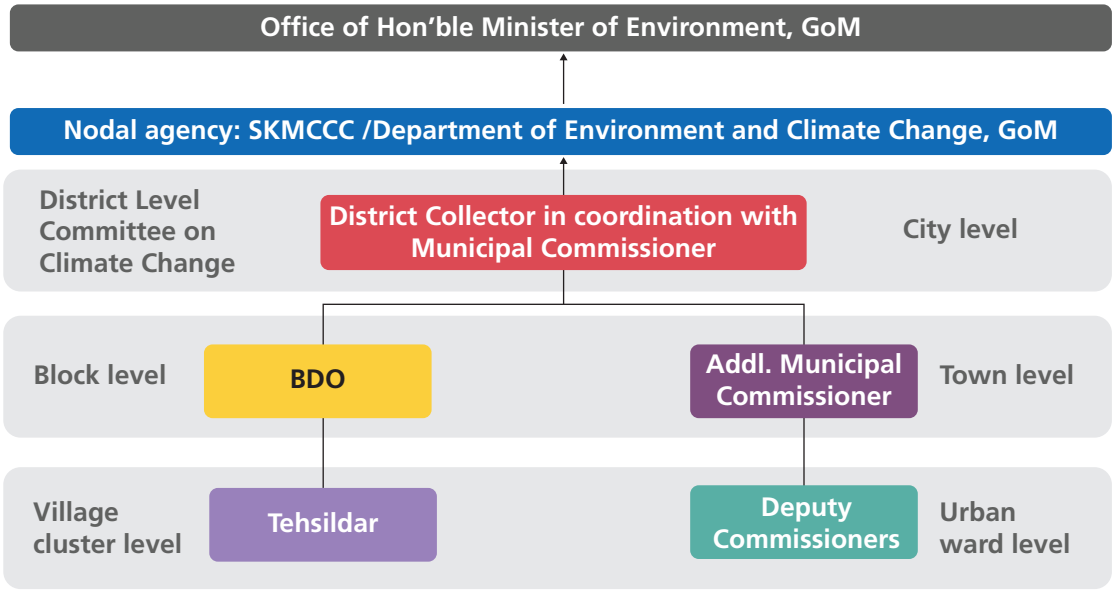
This section describes the planning for monitoring and evaluation (M&E) of the climate change mitigation measures that the district may adopt for sectors identified in the report. M&E is crucial to realise the achievement and track the effectiveness of results envisaged, in order to compliment the national 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.[29]



29 Activities that are already covered in the current CCEAP for Pune 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 for implementing the recommendations

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. 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


COVID-19
SARS-CoV2
COVID-19
Vaccine
SARS-CoV2
COVID-19

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

Representative image of COVID-19 vaccine vials

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

8.1 Introduction

The ongoing COVID-19 pandemic situation has gravely affected the country. Pune district reported 11,42,351 cases (September 30, 2021) accounting for 17.44 percent of the state's total case load (Covid19India, 2021). This has affected 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 (1.4 percent) in FY 2019-20 due to the economic slowdown and restricted activities (Lauri & Dahiya, 2020). In April 2020, aerosol levels were at 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 Pune.

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.

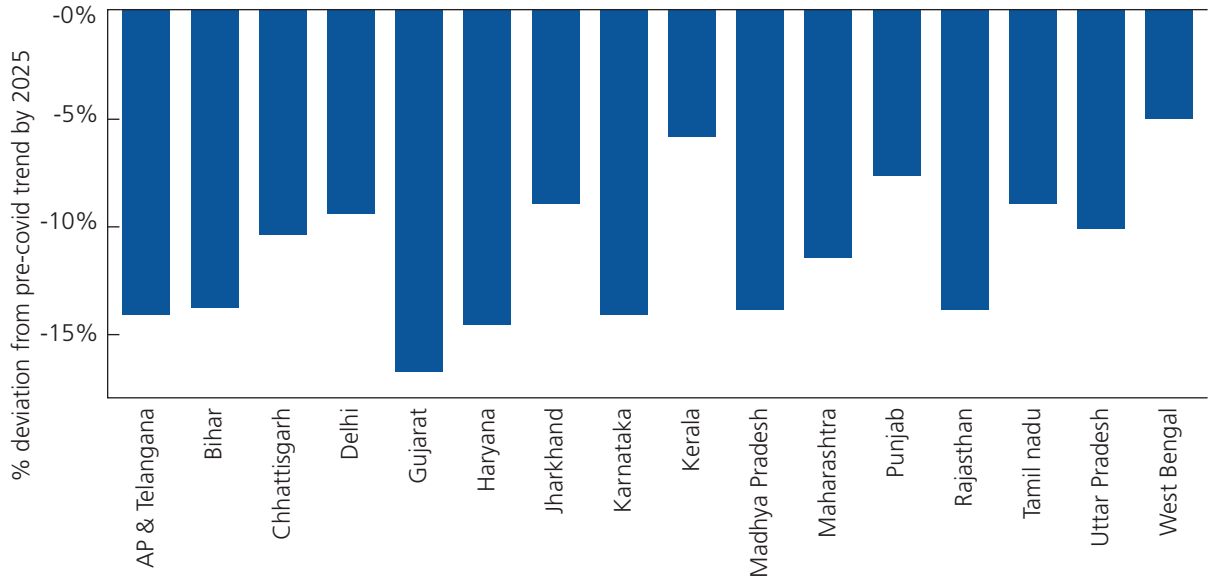


Figure 46: 2025 Deviation of electricity demand from pre-COVID trends projected from major Indian states

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).[30]

30 However, as per Central Electricity Authority's Power Supply Report, the national energy requirement in August, 2021 was 128,519 MU, recording a 14 percent rise in comparison to the same month in 2019.

Outlook for Pune

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. Pune district can contribute to Maharashtra's RE generation capacity by encouraging projects such as solar rooftops, biogas and solar pumps for agriculture.

8.2.2 Fuel consumption

India's fuel consumption fell 45.8 per cent to 9.93 million tonnes in April, down from 18.32 million tonnes fuel consumed in the same month (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 12.20 percent to 2.13 million tonnes in April 2020.

Outlook for Pune

Early in the lockdown, the Maharashtra government had imposed restrictions on buying petrol in several parts of the state. This was done to limit fuel consumption. Further, petrol and diesel prices surged during this period as state governments lost many other revenue streams due to the pandemic. This presents an uncertainty in fuel prices. 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, reverse migration proved beneficial for kharif (monsoon) crops. As of July 2020, total kharif crops have been sown on 691.86 lakh ha area across the country 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 Pune

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. Pune faced an outflux of migrants to rural parts of the district, the state as well as to other states in the country.

Outlook for Pune

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

8.5 Waste

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 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[31]

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. 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 long term.

Comparisons of 24-hour average of $PM_{2.5}$ over Pune district between Jan to May for the years 2019 and 2020 show that $PM_{2.5}$ concentration reduced significantly during the lockdown months (Figure 47 and 48) and the air quality remained in the 'good' category (0-30 and 30-60 µg/m^3) according to Indian standards. Concentration of PM_{10} also reduced significantly during the lockdown months in Pune as compared to the previous year. The concentration remained below 0-100 µg/m^3 (Figure 49 and 50).

31 The PM2.5 and PM10 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 NO2 and SO2 the data were obtained from following URLs. https://developers google.com/earth-engine/datasets/catalog/COPERNICUS_S5P_OFFL_L3_NO2
https://developersgoogle.com/earth-engine/datasets/catalog/COPERNICUS_S5P_OFFL_L3_SO2

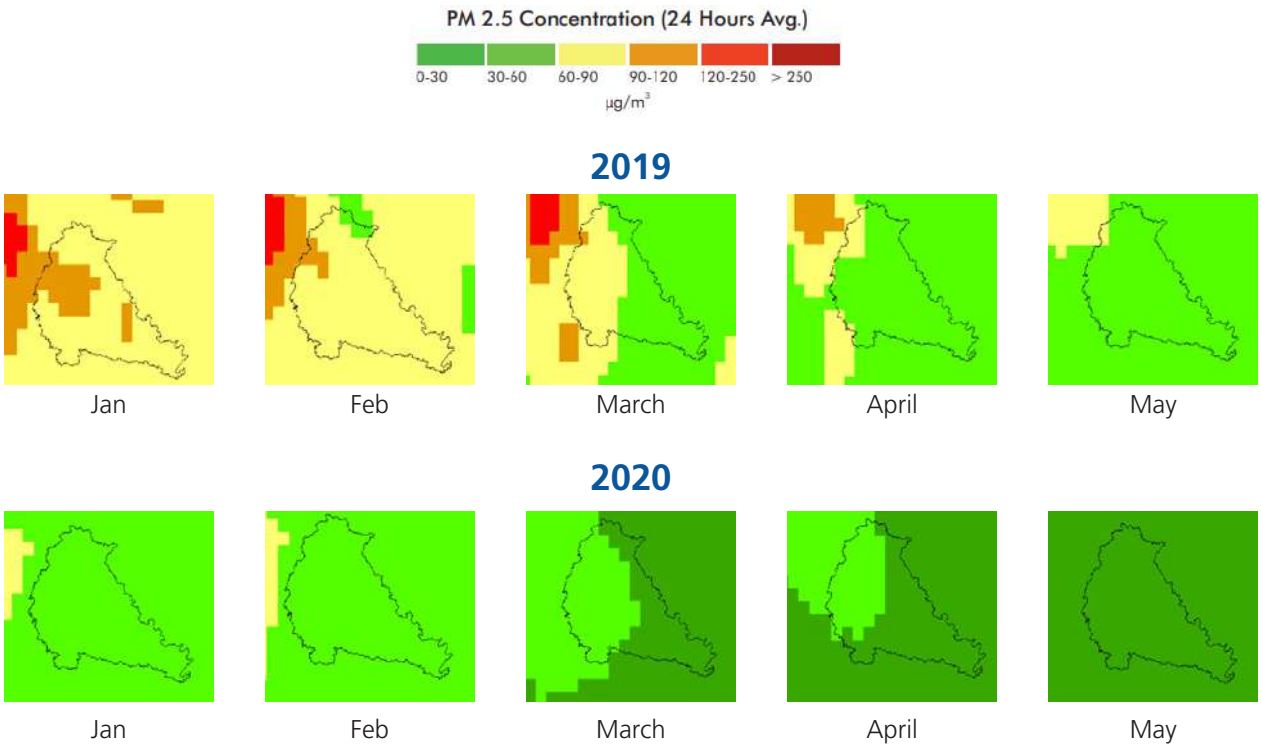


Figure 47: $PM_{2.5}$ concentration over Pune for January to May, 2019 vs 2020

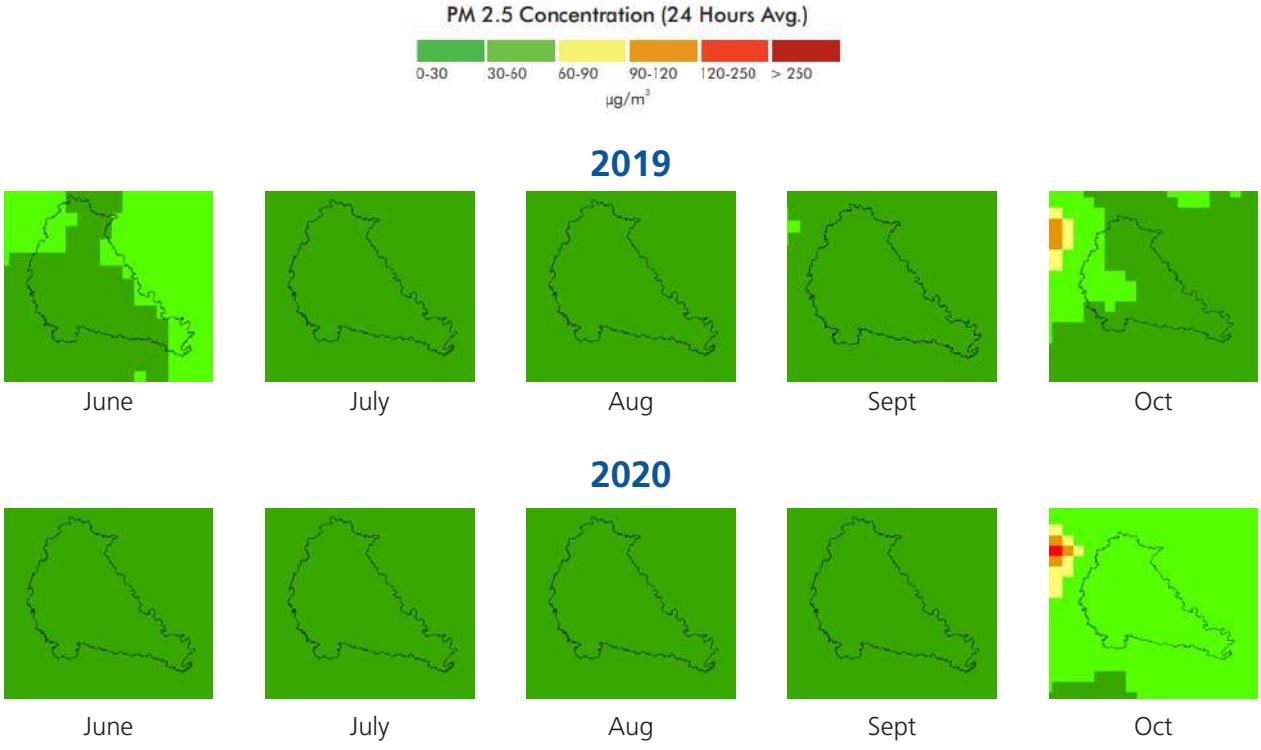


Figure 48: $PM_{2.5}$ concentration over Pune for June to October, 2019 vs 2020

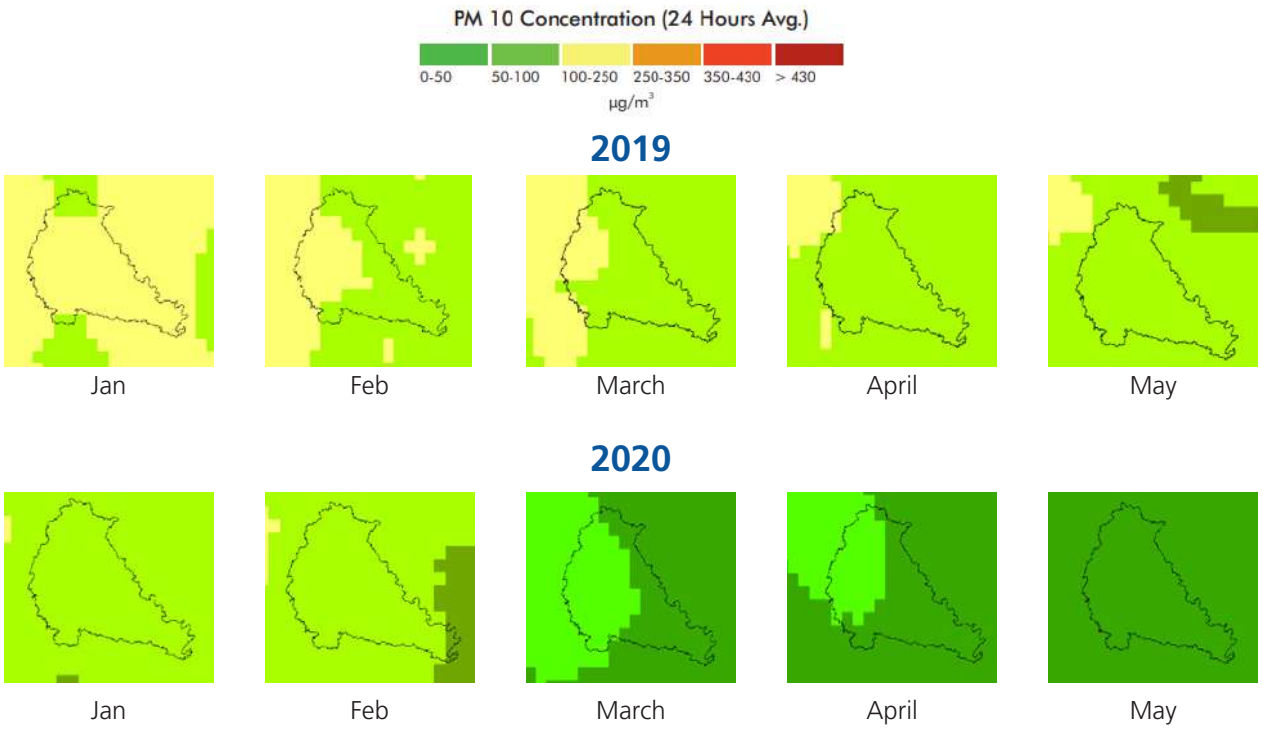


Figure 49: PM_{10} concentration over Pune District for the months January to May 2019 vs. 2020

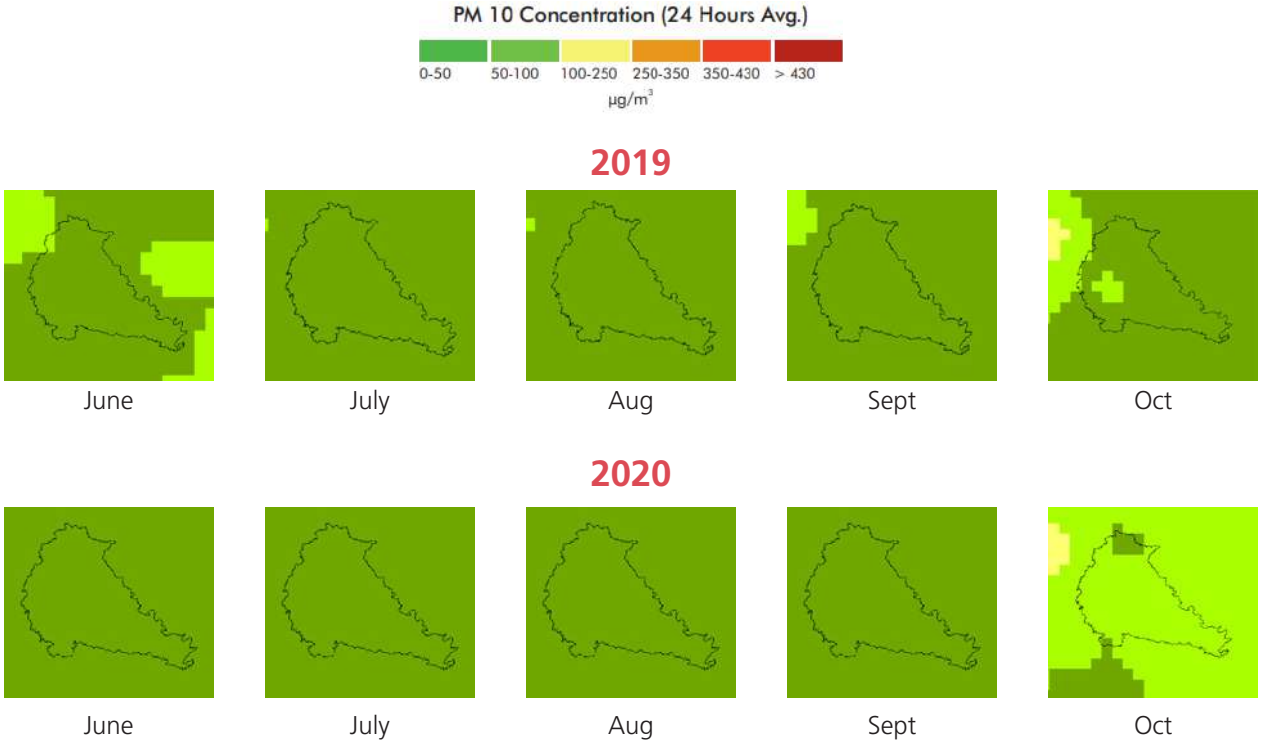


Figure 50: PM_{10} concentration over Pune District for the months June to October 2019 vs. 2020

During the lockdown, most anthropogenic activities were at a standstill or were limited. Therefore, the concentration of nitrogen dioxide over Pune city (upper region) reduced significantly in comparison to 2019, (especially from March to September). From a range of 172 to 200 µmole/m^2 in 2019, the concentration decreased to the range of 57 to 85 µmole/m^2 in 2020 (Figure 51 and 52).

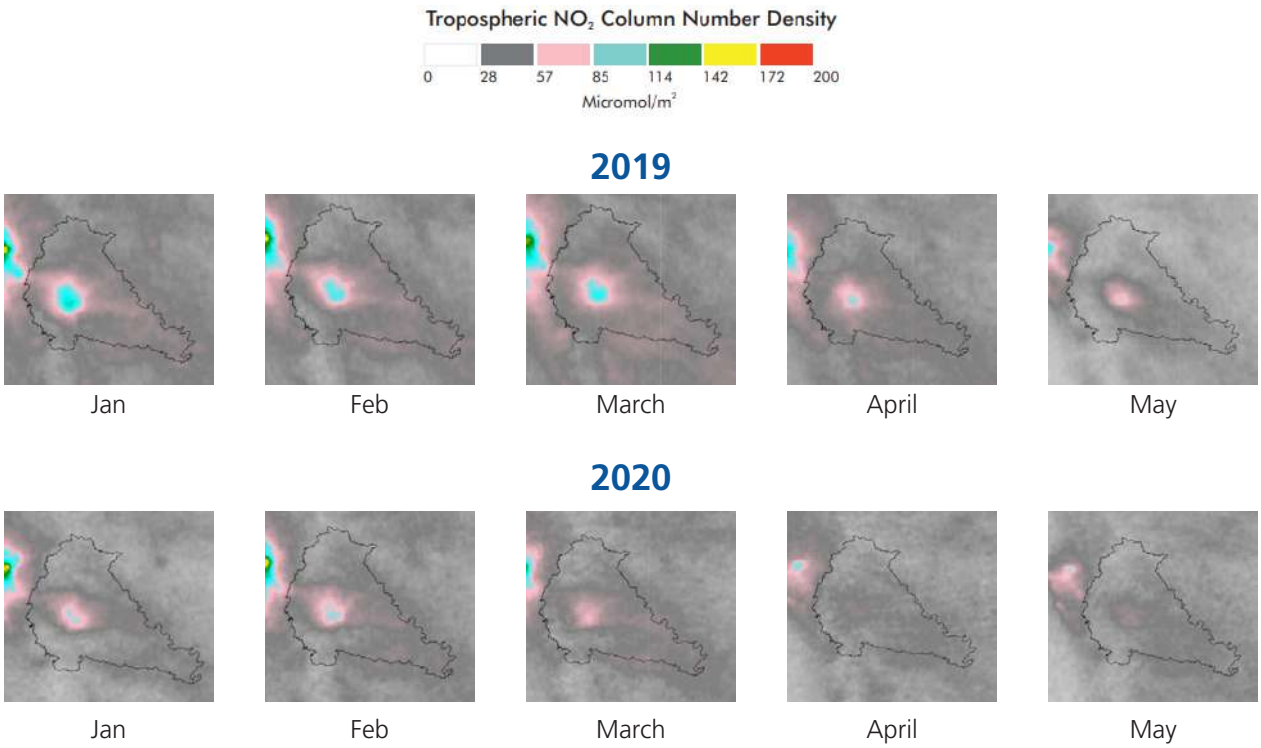


Figure 51: NO_2 concentration over Pune for January to May 2019 vs. 2020

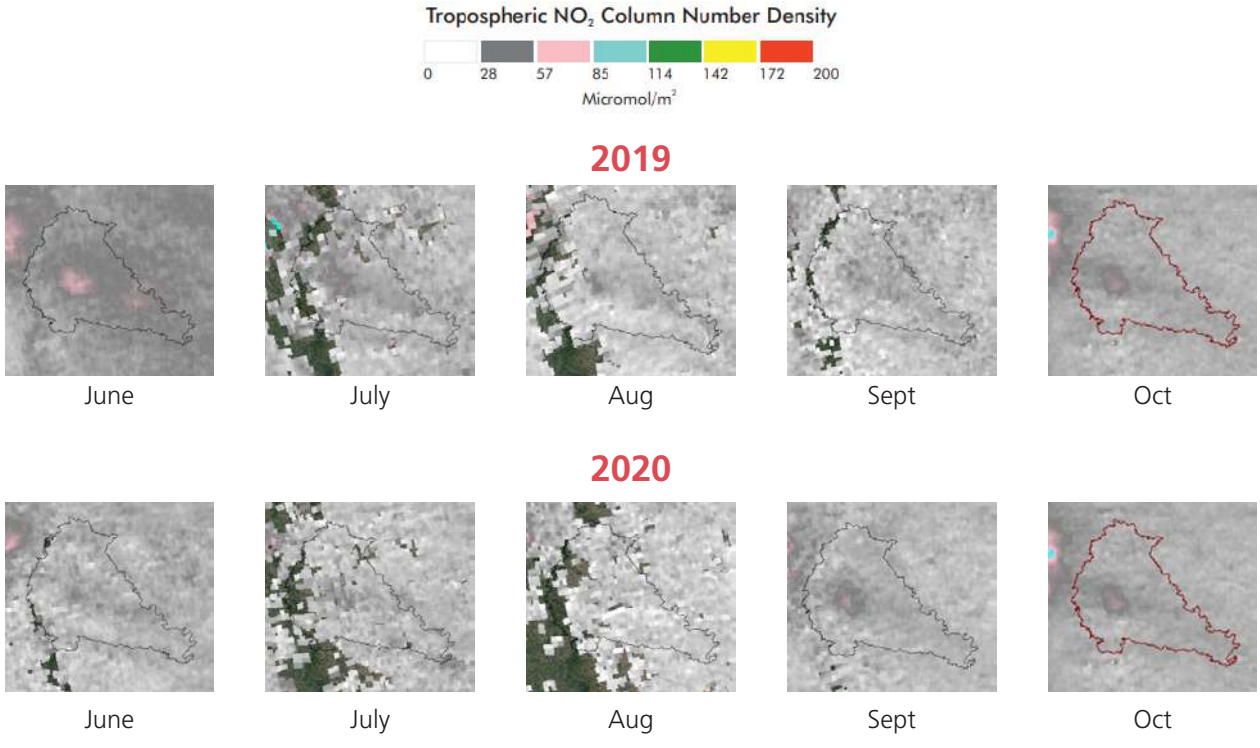


Figure 52: NO_2 concentration over Pune for June to October 2019 vs. 2020

Similar effect was observed on the SO_2 concentration over Pune with a sharp decline in April and May 2020 from its usual high 500 to 420 µmole/m² to 0 to 140 µmole/m². Patches of SO_2 were observed over the entire district and were particularly dense near urban agglomerations (Figures 53 and 54).

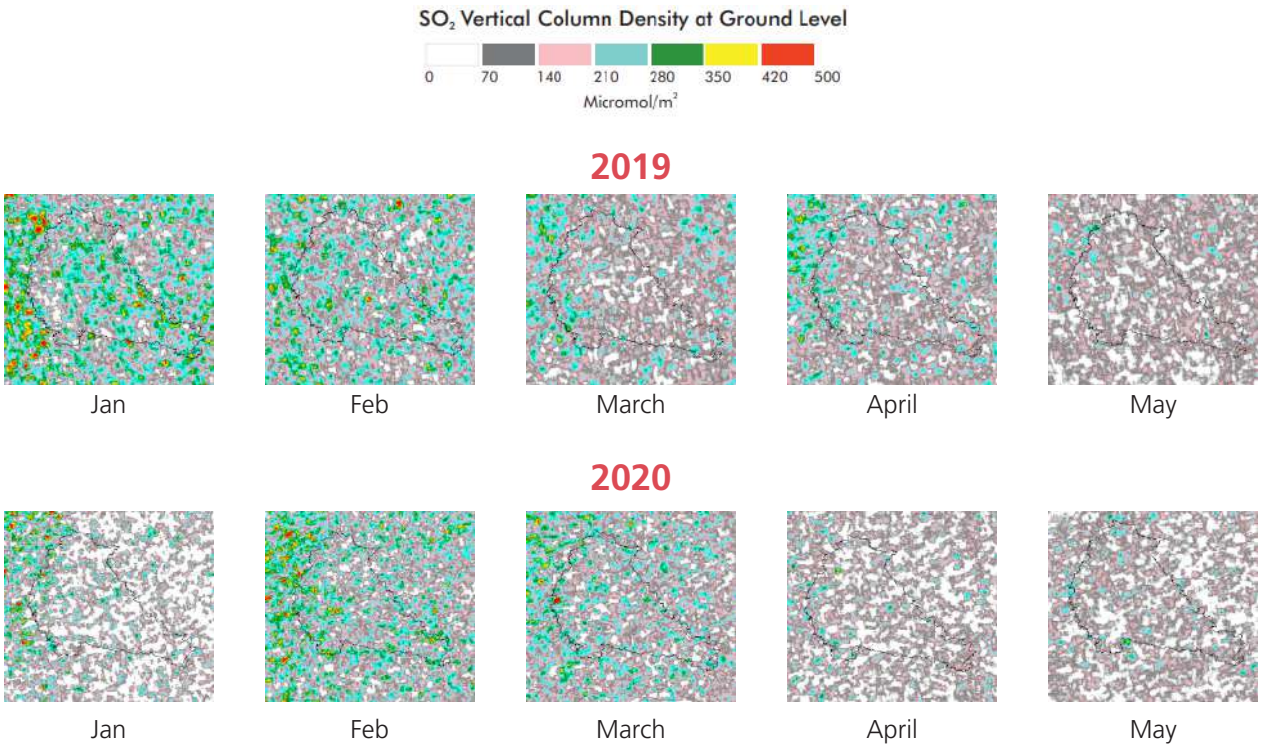


Figure 53: SO_2 concentration over Pune for January to Mayr, 2019 vs 2020

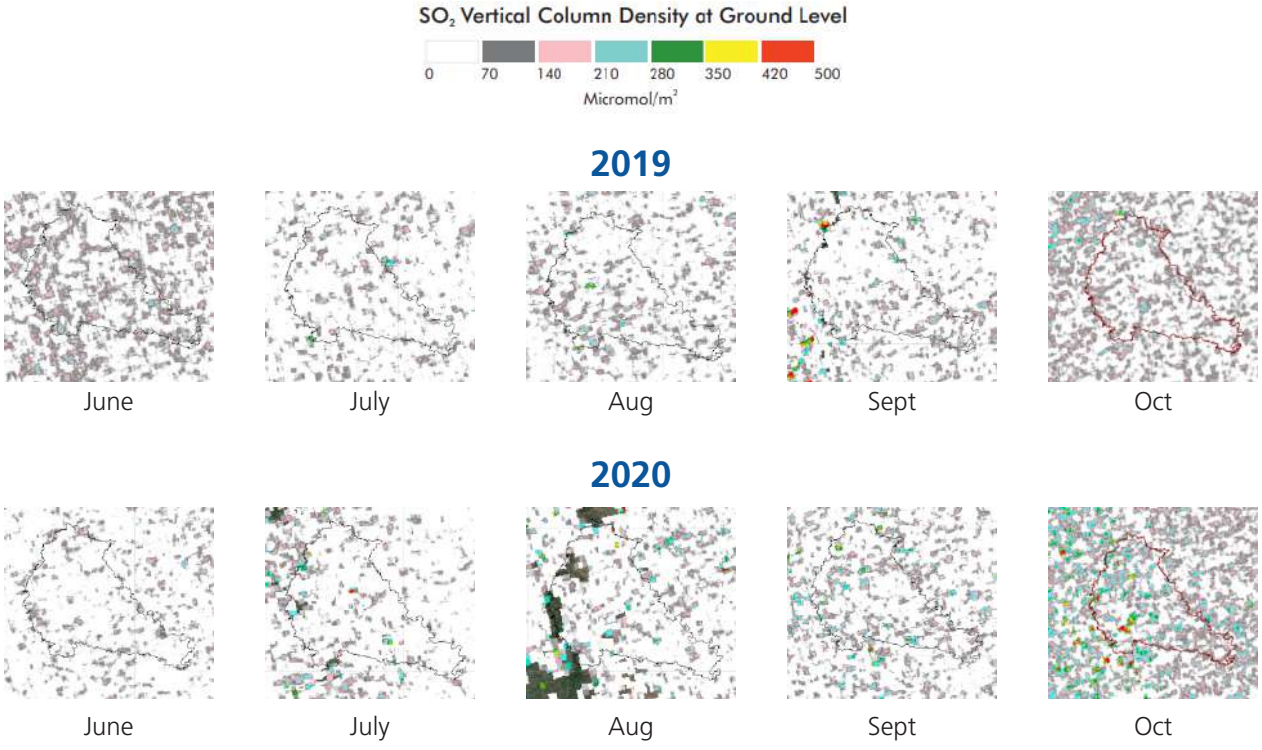


Figure 54: SO_2 concentration over Pune for June to October, 2019 vs 2020

Outlook for Pune

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 Pune 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

Solar tree in Pune

9. THE WAY FORWARD

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

As a state, Maharashtra is one of the forerunners in bringing several mitigation-oriented policies and initiatives that aim for sustainable transport and energy consumption, such as the State Energy Conservation Policy 2017, State Renewable Energy Policy 2020, Maharashtra EV Policy, 2018, Majhi Vasundhara initiative.

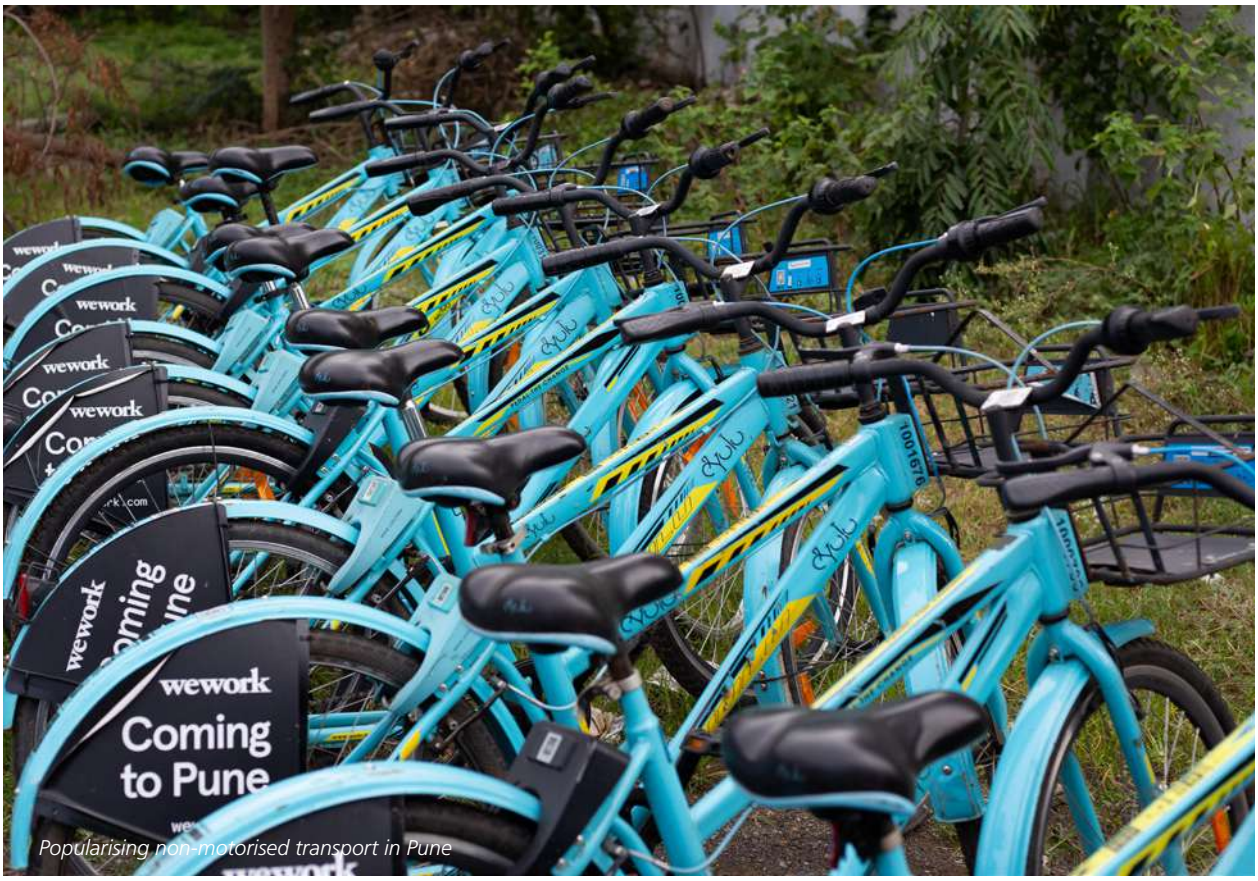
The district of Pune has also taken several steps towards sustainability, and mitigating climate change. Pune city has already launched 125 electric vehicles with only 10 percent of public vehicle fleet operating in diesel, and has also installed 90,000 LED streetlights. PMC provides five percent tax rebate for an operational rainwater harvesting system, and five percent for societies having solar energy and vermicompost. Pimpri Chinchwad has mandated rainwater harvesting for all new residential and commercial buildings with area >20,000 m^2. PMC also encourages voluntary compliance with ECBC/IGBC/GRIHA rating system in all new buildings.

Pune city has 100 percent waste collection and 74 percent waste treatment efficiency. Treatment facilities include composting, material recycling facility, refuse derived fuel, bio-mining, etc. Both PMC and PCMC have proposed waste to energy plants. Pune is also one of the few cities to have conducted a geo-tagged tree census survey.

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

A detailed budgetary analysis with respect to climate action carried out for Pune district shows an expenditure of around 25 percent, 29 percent and 27 percent of the total district budget respectively during 2016-17, 2017-18 and 2019-20 on climate relevant actions, for three years.

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



Popularising non-motorised transport in Pune

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

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

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

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