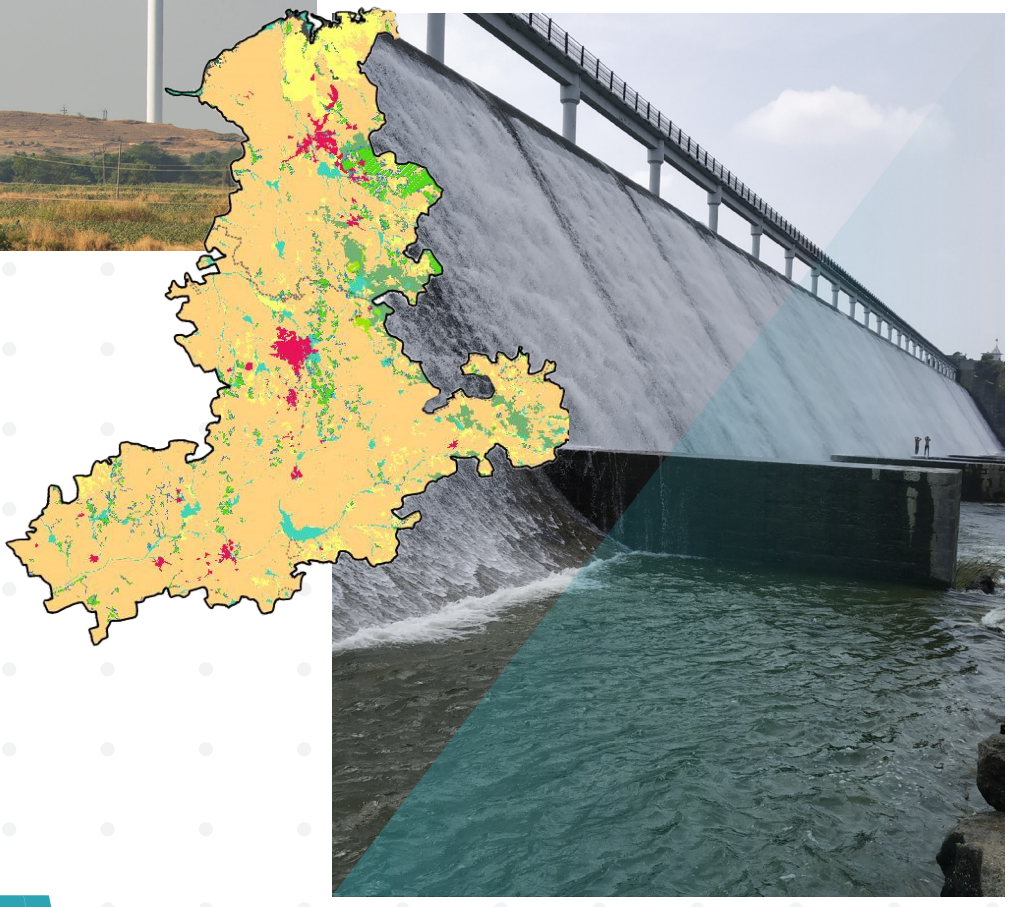
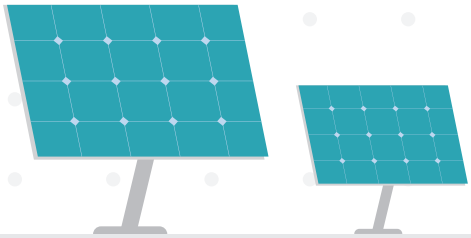
January, 2022

Climate Change and Environment Action Plan of

Rajkot District





Prepared By

VASUDHA FOUNDATION
Green ways for a good earth!

In Association with

Climate Change Department
Government of Gujarat

GEER FOUNDATION
Gujarat Ecological Education and Research Foundation

Supported By

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. For Rajkot, the plan was developed in collaboration with the Climate Change Department, Government of Gujarat and Gujarat Ecological Education and Research (GEER) Foundation, Forests and Environment Department, Government of Gujarat.

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 commitments to 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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Research leads: Rini Dutt, Shubhi Gupta

Research support: Manjusha Mukherjee, Shivika Solanki, Archit Batra, Monika Chakraborty, Rahul K.P.

GIS support: Akinchan Singhai, Amit Yadav

Guided by: Srinivas Krishnaswamy, Raman Mehta

Knowledge partner: Shri B. H. Talati, IAS, Joint Secretary and Shwetal Shah, Technical Advisor, Climate Change Department, GoG

Mr. R. D. Kamboj (former Director) and Dr. Sweta Rajpurohit, Manager, GEER Foundation, Forest and Environment Department, GoG

Copyediting: Swati Prasad

Design and layout: Priya Kalia (Vasudha Foundation), and Aspire Design, New Delhi

Photo credits: Shutterstock, iStock, various government departments websites

January, 2022
Rajkot, Gujarat

Cover page images

Top left image:
Wind mills on Rajkot-Amreli highway (sourced from shutterstock)

Bottom right:
Reservoir on Aji dam, Rajkot (sourced from istock)

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

Forest | Crop-land | Built-up Land | Mixed Forest | Shrubland
Fallow-land | Wasteland | Water bodies | Grassland

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Kiritsinh Rana

सत्यमेव जयते

No. M/F.&E.C.C.P.S./ 344 /2021

Minister,
Forest & Environment, Climate Change,
Printing & Stationery
GOVERNMENT OF GUJARAT
Swarnim Sankul-1, First Floor, Sardar Patel Bhavan,
New Sachivalaya, Gandhinagar-382 010.
Tel. : 079-232 50126 to 50128

Date : - 4 JAN 2022

Message

The state of Gujarat is a front-runner and significantly contributes to the national GDP through various sectors. In addition to this, Gujarat is working to combat climate change and take timely climate mitigation actions. The state currently ranks 1st in solar rooftop installed capacity and contributes to 25% of the total national solar rooftop installed capacity. Moreover, Gujarat also stands 3rd for total installed renewable power in India.

While state level policies and initiatives are being put in place, a first of its kind, Climate Change and Environment Action Plan for Rajkot districtprepared by Vasudha Foundation will aid the district to effectively contribute in state's climate planning. I would like to congratulate Vasudha Foundation and all its partners for formulating a comprehensive district Action Plan that provides doable short, medium and long-term recommendations for various sectors.

I would encourage the district administration and relevant in-line departments to adopt this Action Plan and take initiatives that are climate cognizant.

(Kiritsinh Rana)

Jagdish Vishwakarma (Panchal)

सत्यमेव जयते

No.Co-Op.C.I.S.I.P.(Ind.)I.F.E.C.C.P.S.(Sta.Mi.)/ 249 /2021

Minister of State,
Co-operation, Cottage Industries, Salt Industries, Protocol (Independent Charge), Industries, Forest, Environment and Climate Change, Printing and Stationery (State Minister)
GOVERNMENT OF GUJARAT
Swarnim Sankul-2, 1st Floor, Sachivalaya, Gandhinagar.
Phone No. : (O) : (079) 232 57012 to 15.
(Fax) : 232 57016

Date : 07.1.2022

MESSAGE

Climate change has emerged as a global threat, prompting nations to come together to tackle the challenge. Under the visionary leadership of the Hon'ble Prime Minister, Shri Narendra Modi, India announced its intention to achieve net zero emissions by 2070 at the 26th Conference of Parties (COP26) meet at Glasgow, in November, 2021. India has also vowed to reduce the total projected carbon emissions by one billion tonnes, from now onwards until 2030. To achieve these goals, it is imperative that appropriate actions are undertaken at the state level.

The state of Gujarat is a high performing state in terms of environment management besides leading in development and industrial output. The state ranked first in the Composite Water Management Index 2019 (NITI Aayog) for the third year in a row. The city of Rajkot, was in the top 10 'Cleanest Cities with more than a million population' in Swachh Survekshan, 2020. The SDG India Index and Dashboard 2020-21 by NITI Aayog, applauds Gujarat's performance in attaining the Sustainable Development Goals.

Gujarat was the first state in India and Asia, and globally the fourth to form an independent Department of Climate Change back in 2009. I take pride to say that Government of Gujarat believes in development that is sustainable in nature. I am thus delighted to see that a **Climate Change and Environment Action Plan has been developed for Rajkot district.** Developing a plan for the district that factors climate action is a crucial step in the bottom-up approach to meet the state and national climate targets. I am certain that this initiative would set the foundation for tangible actions towards climate conscious development.

I appreciate detailed study undertaken in consultation with various stakeholders to develop **the Climate Change and Environment Action Plan of Rajkot district.** I hope to see the implementation of this Action Plan soon.

Jagdish Vishwakarma (Panchal)

सत्यमेव जयते

Shri S. J. Haider, IAS
Principal Secretary
Climate Change Department
Government of Gujarat

Message

Climate Change Department, Government of Gujarat has been actively engaged for over a decade to effectively address climate change. The concerted actions initiated so far have helped bring forth several innovative initiatives for climate mitigation measures, like the installation of solar panels on Narmada branch canals that help generate clean power, while reducing water loss from evaporation. Gujarat is one of the front-runners in renewable energy growth. It ranks first by contributing 25% of the total national solar rooftop installed capacity. Moreover, the Department undertakes different studies from time to time as well as initiatives to enhance State's measures to combat climate change.

In one such endeavour, the 'Climate Change and Environment Action Plans' (CCEAPs) of Ahmedabad & Rajkot Districts have been developed by Vasudha Foundation in collaboration with the Climate Change Department and GEER Foundation. I appreciate the collective efforts put in, for accomplishing this task.

These district Action Plans recognize that there are no universal solutions for climate change. Therefore, regionally appropriate and district-specific Action Plans have been prepared for both the districts. They take into account the district-level baseline studies on: climate variability and projections, emissions profile and budgetary analysis to estimate climate expenditure, and other crucial aspects. They also bring forth a comprehensive set of recommendations for various climate-relevant sectors and environmental issues of the districts, along with case examples and estimated mitigation potential. These Action Plans, I hope, will be of use and relevance in the exercise of district-level planning to integrate climate action with development activities.

(S. J. Haider)

सत्यमेव जयते

GEER FOUNDATION
Gujarat Ecological Education and Research Foundation

U. D. Singh, ***IFS***
Director

Message

One of the most challenging threats today is climate change, which has caused regional level disturbances in rainfall, temperature, and extreme events. Countries across the world are realizing the danger posed by this threat and coming together to tackle it. In the most recent Conference of Parties held in Glasgow, India has made many ambitious commitments such as reducing the emissions intensity of its GDP by 45% by 2030 and meeting 50% of its energy requirements from renewable sources in the same timeframe. The most important of announcement was of India to achieve net zero target by 2070.

To meet these targets, particularly net zero by 2070, there is a need to understand the role that forestry sector can play not just as a sink of carbon emissions but also for its myriad ecosystem services for human well-being. The past few Forest Survey Reports have indicated that the recorded forest area in the state of Gujarat, currently standing at 11.03% of the geographical area, has been maintained. Further increase in forest cover, through strategic actions at local level, can reap multiple benefits for the state while combatting climate change in the long term.

In this context, I am pleased to see the efforts made by Vasudha Foundation, in association with the Climate Change Department and GEER Foundation towards developing the 'Climate Change and Environment Action Plan' (CCEAP) for the district of Rajkot. The CCEAP is a detailed study of the district and its priorities in alignment with state and national climate goals. The key takeaway from this action plan is a set of comprehensive recommendations, which can enable the district to mainstream climate action and contribute to India's climate goals. I hope the recommendations in the Action Plan are adopted and implemented by the respective departments.

Udsingh

(U.D. Singh)

GEER Foundation, Indroda Nature Park, PO Sector-7, Gandhinagar-382 007, Gujarat, INDIA
Phone: +91-79-23977300 **Fax:** +91-79-23977313
Email: dir-geer@gujarat.gov.in; geer.info@gmail.com **Website:** www.geerfoundation.gujarat.gov.in

Arun Mahesh Babu
I.A.S

Collector &
District Magistrate

सत्यमेव जयते

Collector Office, Jilla Seva Sadan,
Rajkot. - 360 002 (Gujarat)
Tel. : (O) 0281-2473900
Fax : 0281-2453621
E-mail : collector-raj@gujarat.gov.in

Date: 24-01-2022

MESSAGE

Climate related catastrophic events are on the rise across the world, prompting nations to come together to tackle climate change, which has emerged as a global threat in the past few decades. India has established itself as a world leader in climate action as it recently announced its intention to achieve net zero emissions by 2070 among other ambitious targets at COP26 at Glasgow in November, 2021. To achieve these goals, it is imperative that all the states commence their climate actions immediately and contribute towards the national targets.

In a federal country like India, each state plays an instrumental role in contributing towards national climate goals. Gujarat is one of the leading states in the country in terms of climate action and sustainable development, as seen through several initiatives such as the launch of the latest State Action Plan on Climate Change. The state government has taken a strong stance to reduce emissions from high emitters by announcing curtailment on new thermal power plants. The state also has an all-inclusive EV policy (Gujarat Electric Vehicle Policy, 2021) which focuses not only on a major shift in the automobile segment from fossil-fuel based to electric, but also on supporting infrastructure.

Rajkot is one among the nine cities awarded four-star rating under the Climate Smart Cities Assessment Framework, 2021 by the Ministry of Housing and Urban Affairs. Rajkot city's efforts to reduce carbon dioxide emissions and tackle climate change were recognized by World Wide Fund for Nature as it was awarded the prestigious title of 'National Capital of India 2019-20' for reducing its conventional energy consumption by 17.26 million kWh; the city has won the title three years in a row.

The growing developmental needs in cities, and its peripheries within the district calls for comprehensive sectoral level analyses followed by interventions to curb emissions. Further, adopting a bottom-up approach to climate planning and action can contribute towards achieving the larger goals set by the state and the country. In this light, the Climate Change and Environment Action Plan (CCEAP) of Rajkot district was developed by Vasudha Foundation, in collaboration with Climate Change Department and GEER Foundation. The Action Plan has been developed in consultation with District Administration of Rajkot, officials from relevant departments, academia, civil society organizations and other key stakeholders through multiple rounds of consultation.

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

(Arun Mahesh Babu)

ACKNOWLEDGEMENTS

We would like to thank S.J. Haider, IAS (Principal Secretary), Shwetal Shah (Technical Advisor) and other officials from the Climate Change Department, GoG, and U.D. Singh, IFS (Director), R.D. Kamboj, IFS (Retd.) (former Director), Dr. Sweta Rajpurohit (Manager), and Vibha Goswami (Deputy Director) from GEER Foundation, Forest Department, GoG, as their inputs and support have been vital in development of the Climate Change and Environment Action Plan for Rajkot district.

We are obliged to Arun Mahesh Babu, IAS (District Collector, Rajkot) as well as Remya Mohan, IAS (former District Collector, Rajkot) for their support and motivation to accomplish the completion of the action plan for Rajkot 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 – C.N. Pandey, IFS (former PCCF and HOFF, Forest Department, GoG), Dr. D.B. Vyas, IAS (MD, PGVCL), Kartikeya Sarabhai (Director, CEE), and Mahesh Pandya (Director, Paryavaran Mitra) for inputs and suggestions to refine the action plan.

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

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

We are also grateful to Swati Prasad for proofreading and giving the finishing touches to the manuscript, and 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
AMC	Amdavad Municipal Corporation
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
CAPEX	Capital expenditure
CAAQMS	Continuous ambient air quality monitoring system
CBWTF	Common bio-medical waste treatment and 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
DDUGJY	Deen Dayal Upadhyaya Gram Jyoti Yojana
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
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
GAIC	Gujarat Agro Industries Corporation Limited
GDP	Gross domestic product
GHG	Greenhouse gas
GHGPI	GHG Platform India
GIDB	Gujarat Infrastructure Development Board
GIDC	Gujarat Industrial Development Corporation
GIM	Green India Mission
GoG	Government of Gujarat
GoI	Government of India
GPCB	Gujarat Pollution Control Board
GUDC	Gujarat Urban Development Company Ltd.
GUVNL	Gujarat Urja Vikash Nigam Ltd
GW	Gigawatt
HW	Hazardous waste
ICAP	India Cooling Action Plan
ICE	Internal combustion engine
IEC	Information education and communication
IISS	Indian Institute of Soil Science
IMD	India Meteorological Department
IoT	Internet of things
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial processes and product use
IPT	Intermediate public transport
ISRO	Indian Space Research Organisation
ISWM	Integrated solid waste management
JFMC	Joint Forest Management Committee
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
MGNREGS	Mahatma Gandhi National Rural Employment Guarantee Scheme
MI	Micro irrigation
MLD	Million litres per day

MMM	Multi-model mean
MRF	Material recycling facility
MSME	Micro, small and medium enterprises
$MtCO_2e$	Million tonnes of carbon dioxide equivalent
MU	Million units
MW	Megawatt
NASA	National Aeronautics and Space Administration
NCAP	National Clean Air Programme
NDCs	Nationally determined contribution NEX-GDDP NASA Earth Exchange Global Daily Downscaled Projections
NPK	Nitrogen, phosphorus and potassium
NRSC	National Remote Sensing Centre
NTPC	National Thermal Power Corporation
RO	Reverse osmosis
RPO	Renewable purchase obligation
RTS	Rooftop solar
RUDA	Rajkot Urban Development Authority
RWA	Resident welfare association
RWHS	Rainwater harvesting system
SBR	Sequencing batch reactors
SDGs	Sustainable Development Goals
SEZ	Special economic zone
SKY	Suryashakti Kisan Yojana
SLNP	Streetlight National Programme
SMB	Solar municipal bonds
SMNP	Smart Meter National Programme
STP	Sewage treatment plant
SUP	Single-use plastic
SW	Solid waste
SWM	Solid waste management
T&D	Transmission and distribution
ORNL- DAAC	Oak Ridge National Laboratory Distributed Active Archive Center
TOE	Tonnes of oil equivalent
TOU	Time of use
PAT	Perform, achieve and trade
PCCP	Personal care and cosmetic products
PEG	Public electricity generation
PGVCL	Paschim Gujarat Vij Company Ltd.
PLF	Plant load factor
PM	Particulate matter
PMKSY	Pradhan Mantri Krishi Sinchayee Yojana
PRI	Panchayati Raj Institutions
PT	Public transport
PUC	Pollution under control
RCP	Representative concentration pathway
RE	Renewable energy
REC	Renewable energy certificate
RESCO	Renewable Energy Service Company
RGP	Residential general purpose
RMC	Rajkot Municipal Corporation
TPD	Tonnes per day
TPP	Thermal power plant
TSDF	(Hazardous waste) Treatment, storage and disposal facility
UDAY	Ujjwal DISCOM Assurance Yojana
UJALA	Unnat Jyoti by Affordable LEDs for All
ULB	Urban local body
W	Watt
W2E	Waste to energy
WEEE	Waste electrical and electronic equipment regulations
WSP	Waste stabilisation pond
WW	Wastewater
ZEV	Zero emission vehicle

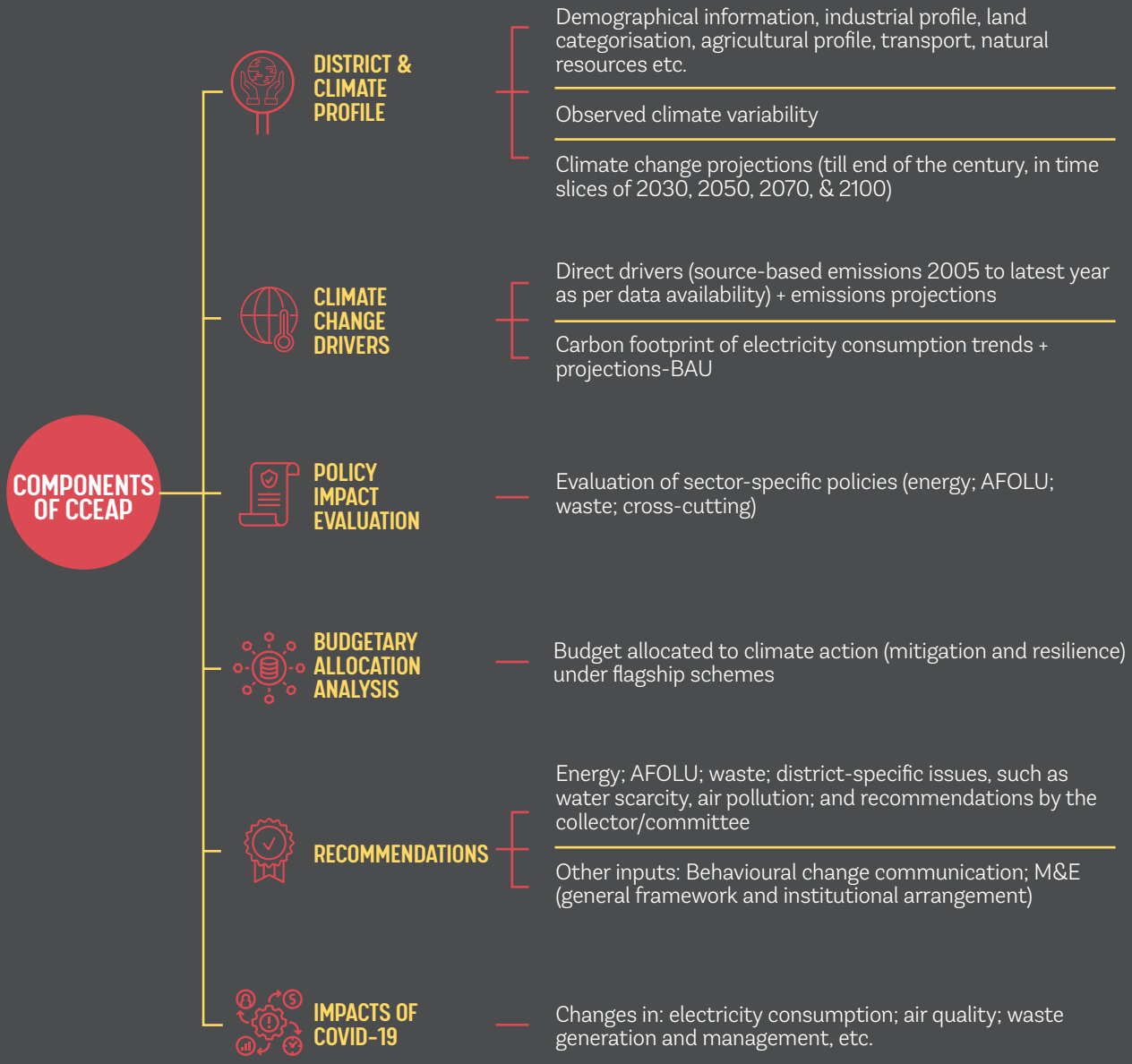
EXECUTIVE SUMMARY

This Climate Change and Environment Action Plan studies the past, present and the future of the district of Rajkot 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 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. Several 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 the waste sector emissions with the rise in covid-related waste incineration and increased disposal of single use plastic.

The 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 following chart:



CLIMATE PROFILE AND PROJECTIONS

In this section, historical data and projected changes in rainfall and temperature for Rajkot 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 temperatures in April and May show a significantly increasing trend, which has accelerated in the last two decades. The mean percentage of warm days has also increased by 10 percent in recent years. The winter minimum temperatures also show an upward trend with high variability in the percentage of cold days.
- **Rainy days show more variability:** The seasonal monsoon rainfall does not show any major trend. Variability in rainy days is more in July and August in the recent decade with a slightly decreasing trend observed during 1951 to 2018.
- **Warm days projected to go up by over 53 percent:** Projections indicate that the district will experience warming of 1°C to 2°C under RCP4.5 and 1°C to 4°C under RCP8.5 (between near term and far term/end of century). The percentage of warm days is projected to increase by more than 53 percent. The minimum temperature projects an increasing trend with a decreasing percentage of cold days in all epochs.
- **Rainfall projected to increase:** The seasonal rainfall is projected to increase by 10 to 21 percent under RCP4.5 and 17 to 46 percent under RCP8.5 emission scenarios (between near-term and far-term/end of century) respectively.[1] The number of rainy days is projected to increase during the monsoon season, particularly during July and August.

SECTORAL GREENHOUSE GAS EMISSIONS PROFILE: CLIMATE CHANGE DRIVERS

- **Greenhouse gas emissions have increased by 52 percent since 2005:** Between 2005 and 2019, the total emissions of Rajkot district increased by 52 percent (from 1.71 million tonnes CO_2e in 2005 to 2.61 million tonnes CO_2e in 2019) at a CAGR of 3.04 percent. For Rajkot, the overall increase in emissions is modest (in comparison to other districts) because the energy sector emissions (i.e., emissions from fuel consumption by different categories) for the recent years were lower than 2015. As a result, the CAGR of the economy-wide emissions between 2005 and 2018 was quite low.
- **Energy sector emissions have increased by 64 percent since 2005:** Energy sector (direct fuel combustion in transport, agriculture, residential, industries etc.) is the highest contributor with 59 percent of total emissions in Rajkot. This is followed by agriculture, forests, and other land use or AFOLU sector (33 percent) and waste sector (8 percent). Between 2005 and 2019, the emissions from energy sector in Rajkot have increased by 64 percent (from 0.94 Mt of CO_2e in 2005 to 1.54 Mt of CO_2e in 2019). Since Rajkot does not have any electricity generation of its own, the category of transport is the highest contributor to the energy emissions.
- **AFOLU emissions have risen by 39 percent since 2005:** The net emissions of agriculture, forests, and other land use (AFOLU) sector increased by only 39 percent (between 2005 and 2019). However, if the sink created by improvement in forest cover is not considered then the gross emissions of AFOLU sector increased by 77.89 percent. The category 'forest removals' was a source of emissions (till 2015) due to reduction in total forest area. However, the rate of loss of forest area kept decreasing from 2007 onwards. As a result, the emissions from this category kept decreasing as well. With substantial increase in forest area of Rajkot – from 141 sq km to 154 sq km between 2015 and 2017 – the 'forest removals' category became a sink.
- **Waste sector emissions have increased by 36.20 percent since 2005:** Waste sector has witnessed a slow growth (by a CAGR of 2.23 percent; between 2005 and 2019) and the total waste emissions have increased by only 36.20 percent (between 2005 and 2019).

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

ASSESSMENT OF POLICIES THROUGH THE LENS OF CLIMATE CHANGE

Around 40 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 13 policies/programmes were evaluated (UDAY and wind energy schemes are the biggest contributors to GHG mitigation)
  - Policies related to clean energy mitigated 17,96,180 tCO_2e emissions.
  - Policies related to energy-efficient buildings and processes helped avoid 55,65,448 tCO_2e.
  - Transportation interventions have led to an emission avoidance of 2,68,308 tCO_2e.
- **AFOLU and cross-cutting:** As many as 11 policies were assessed (nine for AFOLU and two for cross-cutting).
  - Forestry policies have helped mitigate 5,66,637 tCO_2e emissions.
  - Policies pertaining to livestock also proved to be beneficial for climate action, as they helped avoid 1,791 tCO_2e.
  - In agricultural sub-sector, impact of only one policy could be computed – the National Food Security Mission added 75,273 tCO_2e.
  - The cross-cutting sector policies mitigated approximately 2,87,427 tCO_2e emissions.
- **Waste:** In the waste sector, a total of 15 policies were assessed.
  - Policies pertaining to sanitation added 1,14,626 tCO_2e emissions.
  - Composting as a part of solid waste management practices has mitigated 4,160 tCO_2e.
  - Bio-medical waste incineration caused 135 tCO_2e emissions.
  - Domestic wastewater treatment interventions have led to 19,029 tCO_2e emissions.

BUDGETARY ANALYSIS TO ESTIMATE EXPENDITURE ON CLIMATE ACTION

This section analyses the district expenditure to estimate spending on climate action. However, the district budget for Rajkot was not available and the following flagship schemes were analysed for the same. 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, four schemes were selected for further analysis.

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

Scheme selected	Climate relevant activities	Year	Total allocation to district under scheme (₹ lakh)	Allocation to climate action (₹ lakh)	% of total scheme budget for climate action at district level
MGNREGS	Eleven out of 17 activities 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	476.63	109.62	23
		2019-20	917	220.08	24
PMKSY	Micro-irrigation activities	2016-17	940	648.60	*69
		2019-20	1,802	1,243.38	
AMRUT	Water supply, sewage and septage management, urban transport, drainage, green spaces	2015-16	4,617	2,760	*54.5
		2016-17	7,757	3,886	
		2017-20	4,363	2,145	
DDUGJY + Saubhagya	New and upgradation of substations, LT lines, feeder segregation, consumer metering, DTR metering etc	Up to April 2020	3,964	1,982	*50

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

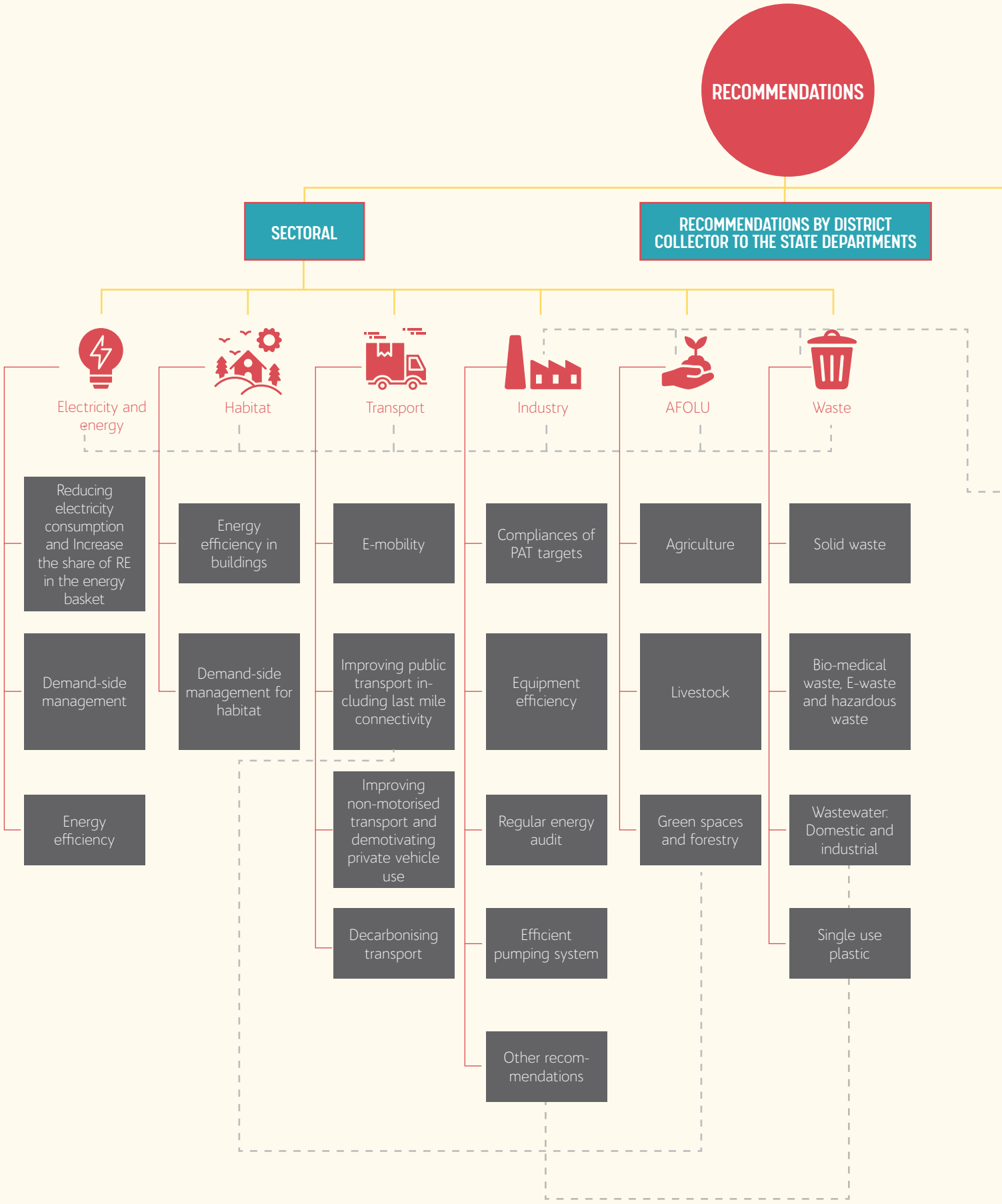
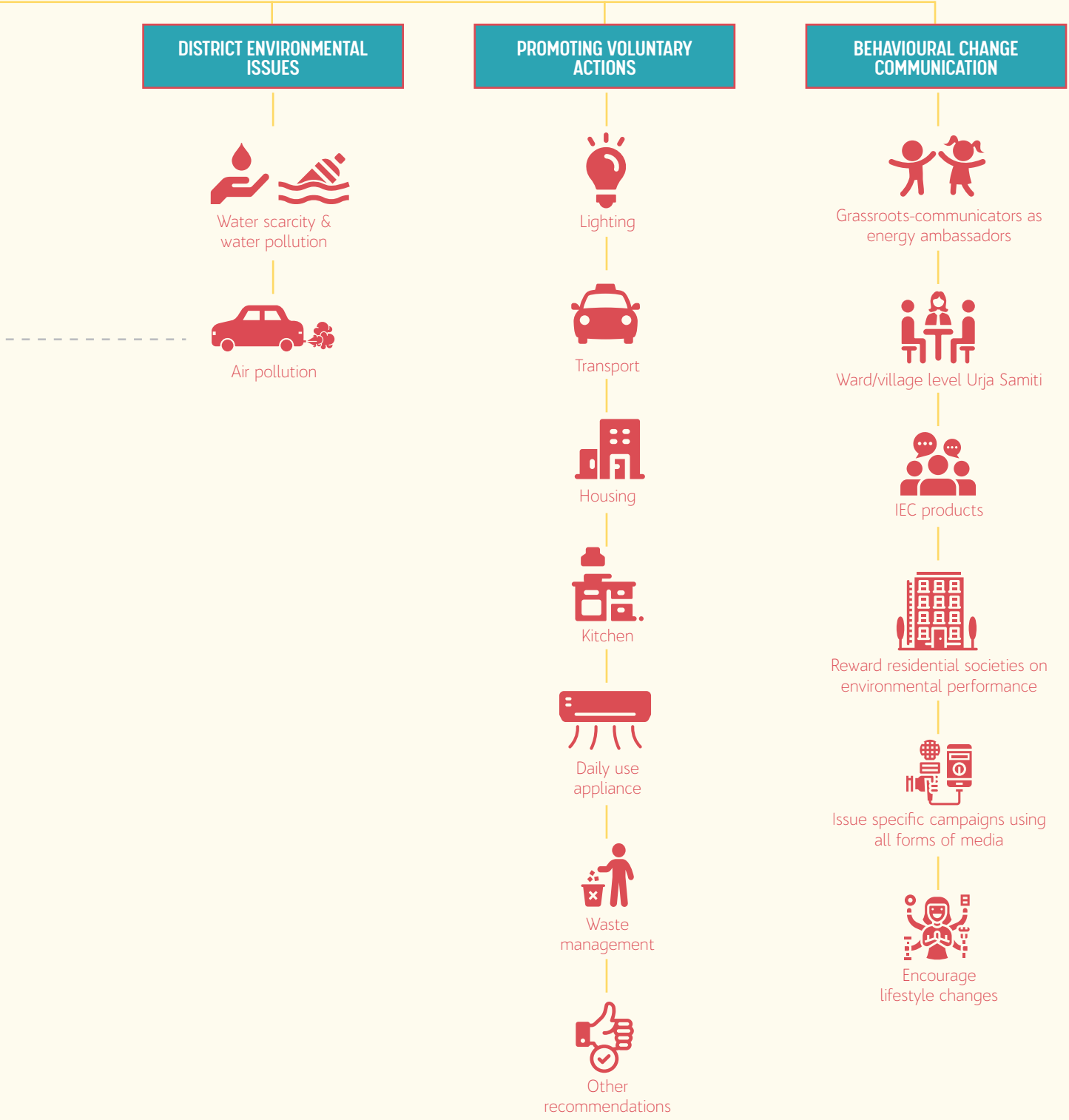


Figure 1: Recommendations for CCEAP Rajkot


DISTRICT ENVIRONMENTAL ISSUES
PROMOTING VOLUNTARY ACTIONS
BEHAVIOURAL CHANGE COMMUNICATION
Water scarcity & water pollution
Air pollution
Lighting
Transport
Housing
Kitchen
Daily use appliance
Waste management
Other recommendations
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)

RECOMMENDATIONS

The action plan provides comprehensive, sector-wise recommendations from a climate perspective. The aim is to align the district with India's climate 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.

Overall, the mitigation actions suggested in the recommendations can help mitigate 8.8 Mt CO_2e per annum. The sectoral breakdown of the same is as following:

Some in-brief, sector-wise recommendations are provided in figure 1.

GHG mitigation potential of CCEAP recommendations (tCO_2e)

Energy
25,12,744

AFOLU
62,94,009

Waste
33,534

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, 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, encouraging industries to follow the Gujarat Industrial Policy, 2020, etc.

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-motorised transport through dedicated cycle lanes; and (d) improving traffic flow.

AFOLU

For agriculture, forestry, and other land use (AFOLU) sector, it's important to promote climate conscious practices that do not have an adverse impact on the ecosystem, biodiversity and natural resource dependent communities. Our recommendations include: (a) promoting the use of organic fertilisers, solar pumps and practices such as micro-irrigation and alternative ways to manage crop-residue under agriculture; (b) having a good mix of high-yield, cross-breed cattle and indigenous cattle, and encouraging the use of good quality fodder to bring down enteric fermentation emissions; and (c) maintaining the forest area and the tree cover of Rajkot 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 waste sector being one of the biggest contributor of methane emissions globally, major recommendations revolve around reducing landfill disposal of waste and managing wastewater to reduce GHG emissions from them through measures such as: (a) reducing waste at source; (b) proper segregation, collection and channelisation of different categories of waste (including bio-medical waste and e-waste) for recycling and treatment; (c) 100 percent conversion of organic waste to compost and gas management of composting units; (d) recycling, recovery and reuse of 100 percent inert waste (plastic, construction waste, etc); and (e) setting up of centralised aerobic wastewater treatment plants with closed sewer networks and periodical sludge removal facility.

Given the unique environmental issues of the district, the action plan also recommends adopting a holistic approach to water conservation and wastewater management, including conservation techniques such as rainwater harvesting, net zero water infrastructure, minimising losses in water supply, installing water-efficient fittings, water metering and adoption of inclusive and sustainable water governance. Moreover, it recommends developing extensive infrastructure to monitor air pollution and suggestions on interventions for preventive measures.

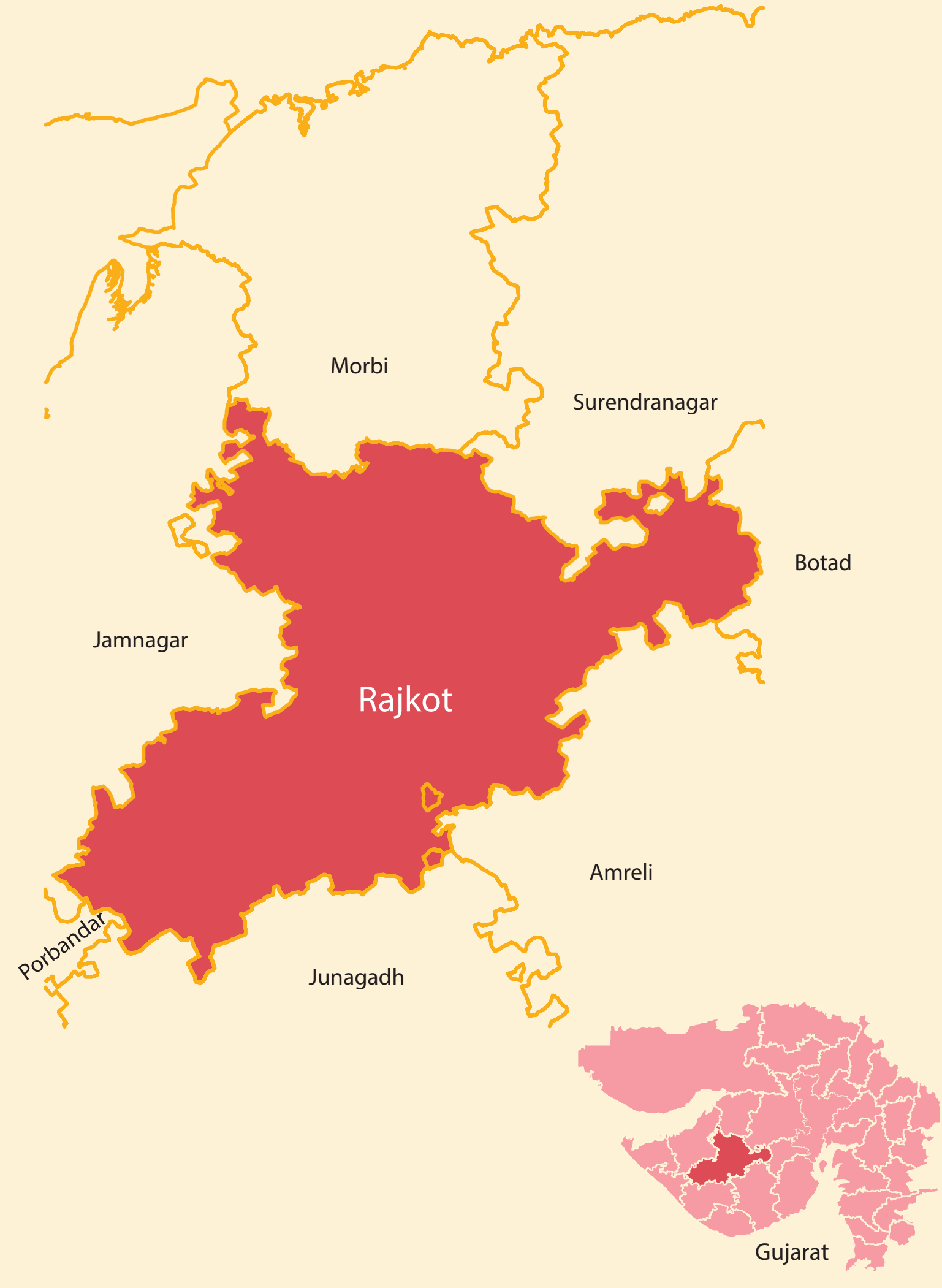
COVID-19 IMPACT

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

In agriculture, harvesting activities were interrupted due to the lockdown. Supply chain problems were also witnessed. However, the reverse migration proved beneficial for kharif season.

The pandemic has only underscored the need to increase focus on renewable energy and strengthen its integration into the grid. Rajkot 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 due to reduced transport and industrial activities during the lockdown and unlock periods. However, the most impacted sector was waste management with single-use plastic waste and bio-medical waste from both households and healthcare sector increasing manifold, leading to increased incineration, landfilling and single-use product consumption.


Morbi
Surendranagar
Botad
Jamnagar
Rajkot
Amreli
Porbandar
Junagadh
Gujarat

DISTRICT PROFILE

Aji dam and Rajkot city

1. DISTRICT PROFILE

Rajkot is centrally located in the Saurashtra region of Gujarat, India. Topographically, the district is sub-divided into the regions of Maliya coastal plain, Rajkot alluvial plain, Rajkot stony-waste land, Bhadar river plain and Vinchhiya upland. The three distinct geographical regions are eastern hill, alluvial plain of Bhadar on the west and south-west and northern plains, Rann of Kachchh and a swampy coastline.

Rajkot was the capital of Saurashtra from 1948 to 1956, before it merged with the state of Bombay in 1956. It was finally reincorporated into Gujarat in 1960. Rajkot city – the fourth largest in Gujarat and one of the prime industrial centres of the state – is also the administrative headquarter of the district. The city is spread over 170 square km area and located on the bank of Aji river and Nyari river. Apart from being an industrial hub, Rajkot district is the largest producer of cotton, second largest producer of oilseeds and spices in the state. Rich in minerals, Rajkot is also the largest producer of fireclay in the state leading to the development of ceramic-related industries in and around the district.

1.1 Key statistics

Table 2: District profile of Rajkot

General characteristics of the district			
Location	South-west Gujarat, western part of India		
Latitude	20°18' north	**Area**	11,198 sq km
Longitude	70°56' east	**Elevation**	128 m (420 ft)
Agro-climatic/ecological zone (NICRA-ICAR, 2016)			
Agro-ecological sub region (ICAR)	Western plain, Kachchh and part of Kathiawar peninsula, hot arid eco-region		
Agro-climatic zone (Planning Commission)	Gujarat plains and hills region		
Agro-climatic zone (NARP)	North Saurashtra		
Administrative units (Rajkot District Administration, 2020)			
Tehsil (block)	14	**ULB**	Municipal corporation: 1; municipality: 6
Constituency	8 (Assembly)	**Gram panchayat**	593 (villages: 598)
Demography (Census of India, 2011)[2]			
Population (total)	38,04,558	**Population density**	340 person/km^2
Population (urban)	22,14,050	**Household**	10,31,529
Population (rural)	15,90,508	**% urbanisation**	Population share: 58% household share: 60.5%
Population growth	20% (decadal)	**Women headed household**	53,414
Land-use classification 2017-18 (area: '00 hectare) (Directorate of Agriculture, 2018)			
Culturable wasteland	164	Other fallows	6
Land put to non-agricultural uses	794	Current fallow	136
Barren and unculturable land	473	Net area sown	5,363
Pasture and other grazing	557	Area sown more than once	1,182
Land under miscellaneous	0	Gross cropped area	6,545
Agriculture profile (Department of Agriculture, 2015; ICAR-NICRA, 2011; Directorate of Agriculture, 2020)			
Major crop season	Kharif (rainfed/irrigated) and rabi (rainfed/irrigated)		
Major agriculture produces	Foodgrain: Wheat, pulses (tur, mung, urad), cumin, pearl millet, bajra, jowar, maize Oilseeds: Groundnut, castor, sesamum Cash crop: Cotton		

2 In 2013, districts in Gujarat were rearranged and a few talukas of Rajkot district were merged to form a new district Morbi.

Soil type (GGRC & NABCONS, 2016)	Medium to shallow black (53%), shallow to medium black (12%), medium black and hilly soil (18%), medium black (7%), sandy black (7%), saline (2%), sandy soil (1%)		
Industrial profile (MSME, 2017)			
Registered industrial unit (MSME till 2015)	Micro enterprises: 28,065 Small enterprises: 4,113 Medium enterprises: 232	**No. of industrial areas (GIDC)**	16 (3,320 units; 800.85 ha area)
Dynamic groundwater resources (in MCM) (CGWB, 2013)			
Annual replenishable ground water resources	1,528.25	**Net ground water availability**	1,451.83
Annual ground water draft	948.65	**Projected demand for domestic and industrial uses up to 2025**	103.44
Stage of ground water development (%)	65.34		

Table 3: Rajkot vs Gujarat: A comparative profile (DoE&S, 2018)

Particular	Rajkot district	Gujarat	% contribution
Total population (2011)	38,04,558	6,04,39,692	6.3%
Urban population (2011)	22,14,050	2,57,45,083	8.6%
Percentage of urban population	58%	42.6%	Higher than the state
Geographical area (sq. km)	11,198	196,244	5.7%
Forest cover (sq km) (FSI, 2019)	154.32 (Very dense: 0; medium dense: 2.64; open forest: 151.68)	14,857 (Very dense: 377.9; medium dense: 5,092; open forest: 9,387.43)	1.03% (No dense forest in the district)
Per capita forest cover (ha/ person)	0.004	0.024	Six times less than that of the state
Total registered vehicles	20,20,470	2,32,86,418	8.67%
Total rice production (in '000 tonnes)	No rice production	1,692	0%
Installed capacity of electricity generation (Conventional, MW) *	No TPP	25,235.81	0%
Major types of industries (Industries Commissionerate, ND; MSME, 2017)	Engineering, electronics and auto ancillary, textiles, chemicals, ceramics, granites, jewelleries, watch parts, casting industry, foundry, dyeing and printing, agri and food processing, plastic industries	Pharmaceuticals, textiles, chemicals, gems and jewelleries, marine products, milk products, food processing, etc.	--
Total MSME units registered	32,410	4,89,617	6.6%

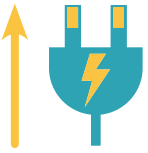
1.2 Power and energy sector

Rajkot district gets electricity from the state's west zone DISCOM – Paschim Gujarat Vij Company Limited (PGVCL), which in turn procures electricity from Gujarat Urja Vikas Nigam Limited (GUVNL). Industry is the predominant electricity consuming sector in the district, followed by commercial, residential, and agricultural sectors (Figure 2). The overall electricity consumption increased at a CAGR of 8.40 percent between 2011 and 2018, with the consumption mix remaining unchanged for that period (GERC, 2021).

Industries consume highest electricity amongst all categories, it has increased with

13%

CAGR



For FY 2019-20, GUVNL purchased 98,262 MUs of electricity, of which around 80 percent came from coal, followed by

renewable sources and gas-based generation, illustrated in Figure 3 (GERC, 2021) (Vasudha Power Info Hub, 2021). Out of the total RE purchased, wind power contributed around 52 percent (GERC, 2021) (Vasudha Power Info Hub, 2021)

Information on category-wise electricity consumption (EC) of Rajkot district is depicted in Figure 5.

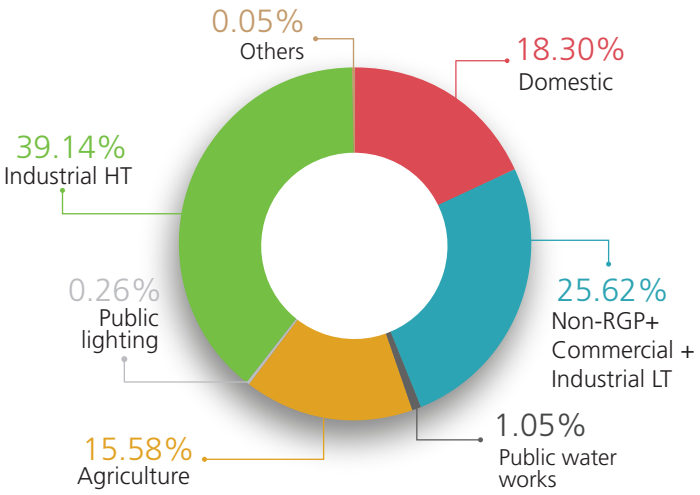


Figure 2: Consumer-wise electricity consumption in Rajkot (2019)

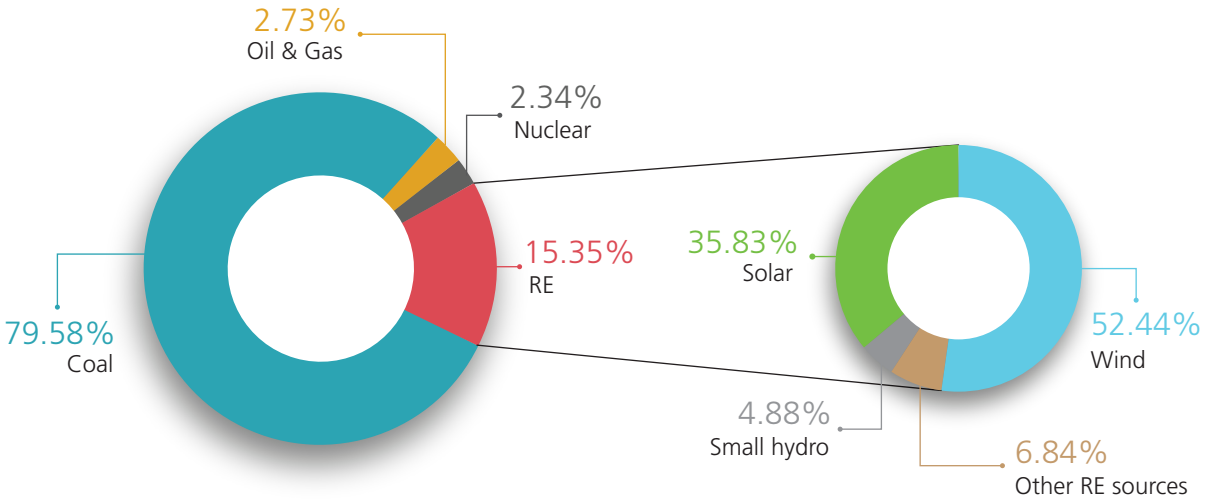
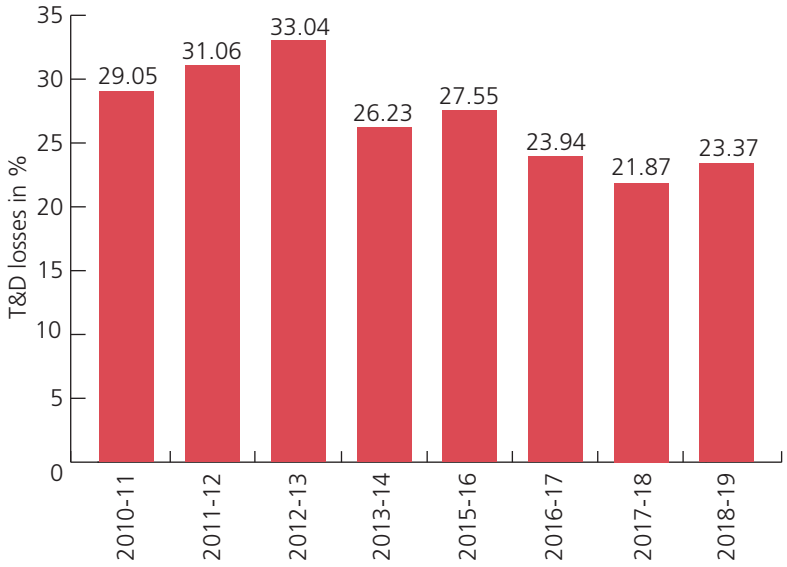


Figure 3: Electricity procurement mix of GUVNL (2019-20)

The transmission and distribution (T&D) losses for PGVCL were 23.37 percent during the FY 2018-19 (GERC, 2020). T&D losses for PGVCL are slightly higher than the national average of 21.42 percent (CEA , 2019). T&D losses of PGVCL over the years are depicted in Figure 4.



T&D losses for PGVCL is slightly higher than the national average and has scope to further reduce.

Figure 4: T&D losses (%) of PGVCL from 2010-11 to 2018-19

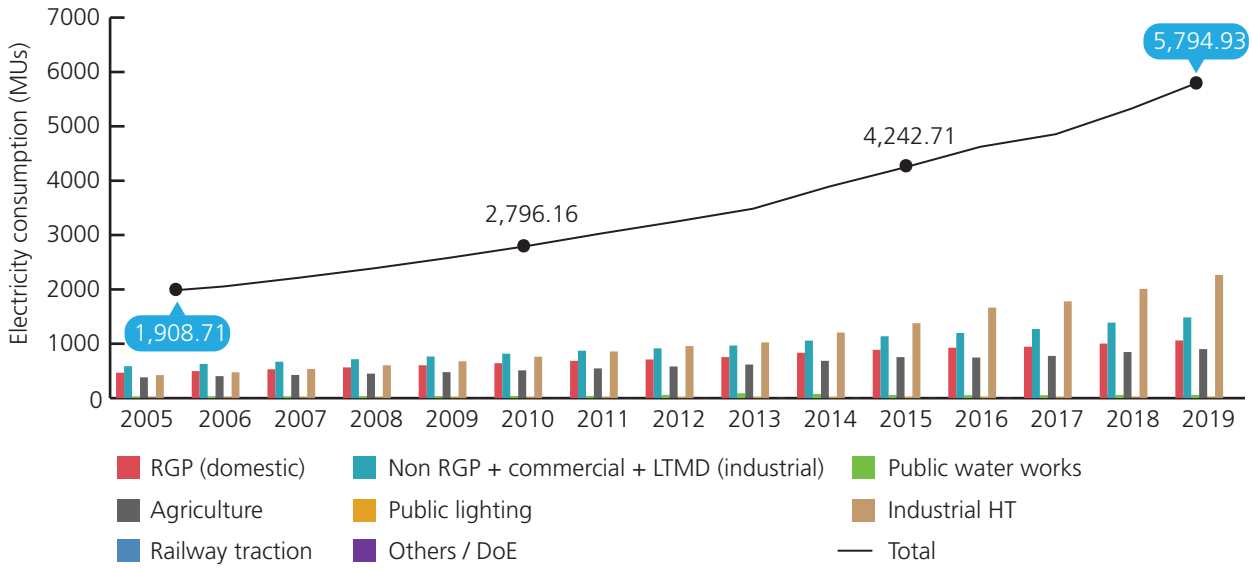


Figure 5: Category-wise electricity consumption in Rajkot over the years (MUs)

1.3 Transport and related infrastructure

Rajkot has two major public transport systems – the Rajkot Municipal Transport Service (RMTS), a bus service running on all roads, including the narrow ones; and the BRTS, operated by Rajkot Rajpath Ltd (RRL), which runs on the 150 feet Ring Road. Both RMTS and BRTS are wholly owned subsidiaries of the RMC.

Rajkot is becoming increasingly urbanised and is experiencing significant growth in private vehicle use. With increasing per capita incomes, more people are able to afford two-wheelers and many existing two-wheeler owners are upgrading to four-wheelers, leading to a dramatic increase in overall vehicular population. The number of people relying on auto-rickshaws has also increased. Such socio-economic changes are leading to traffic congestion and increasingly difficult conditions for public transport service operations, which in turn adversely impact the environment.

Table 4: Total registered motor vehicles in Rajkot (2015-16) (MoRTH, 2018)

Mode	Vehicle type	Number (FY 2015-16)
Public transport	Bus	7,806
	Electric bus	
	Midi bus	
IPT	Mini bus	NA
	Taxi/cab	7,138
	Auto-rickshaw	27,554
Private	Two-wheeler	14,14,853
	Four-wheeler	1,80,725

This growing metropolis presents many opportunities to upgrade and plan the road transport infrastructure in order to minimise greenhouse gas (GHG) and pollutant emissions.

1.4 Habitat (urban and rural)

Rajkot district is spread over 11,198 sq km. The Rajkot city area is about 170 sq km that falls under the Rajkot Municipal Corporation (RMC), while RUDA covers an area of 686.3 sq km. The district has 58.19 percent of its population residing in urban areas, higher than the state average of 42.60 percent (Census of India, 2011). Rajkot is the fourth most populous and third largest district (5.17 percent of the state area) of Gujarat with a population density of 340 per sq km, which lies in between the state (308 per sq km) and the national (380 per sq km) average. There are seven urban local bodies in the district, Rajkot (Municipal Corporation), Bhayavadar (municipality), Dhoraji (municipality), Gondal (municipality). Jasdan (municipality), Jetpur-Navagadh (municipality) and Upleta (municipality). The projected trajectory of developed area under RUDA is illustrated in Figure 6.

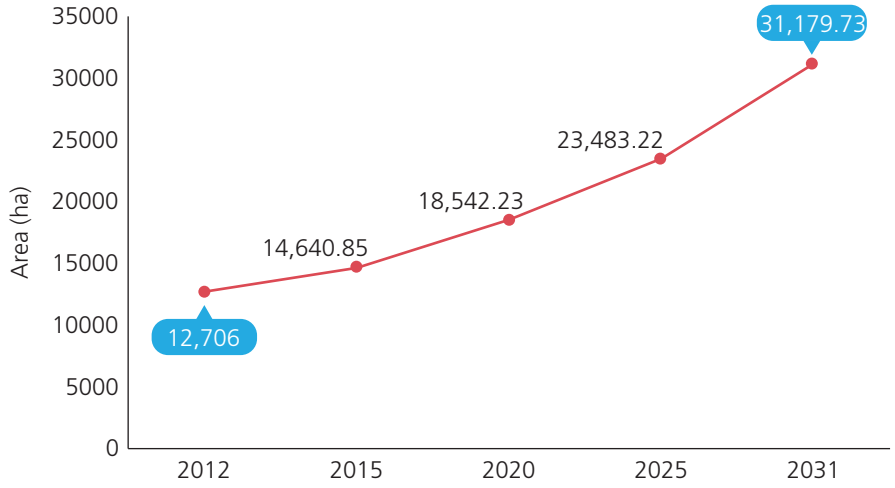
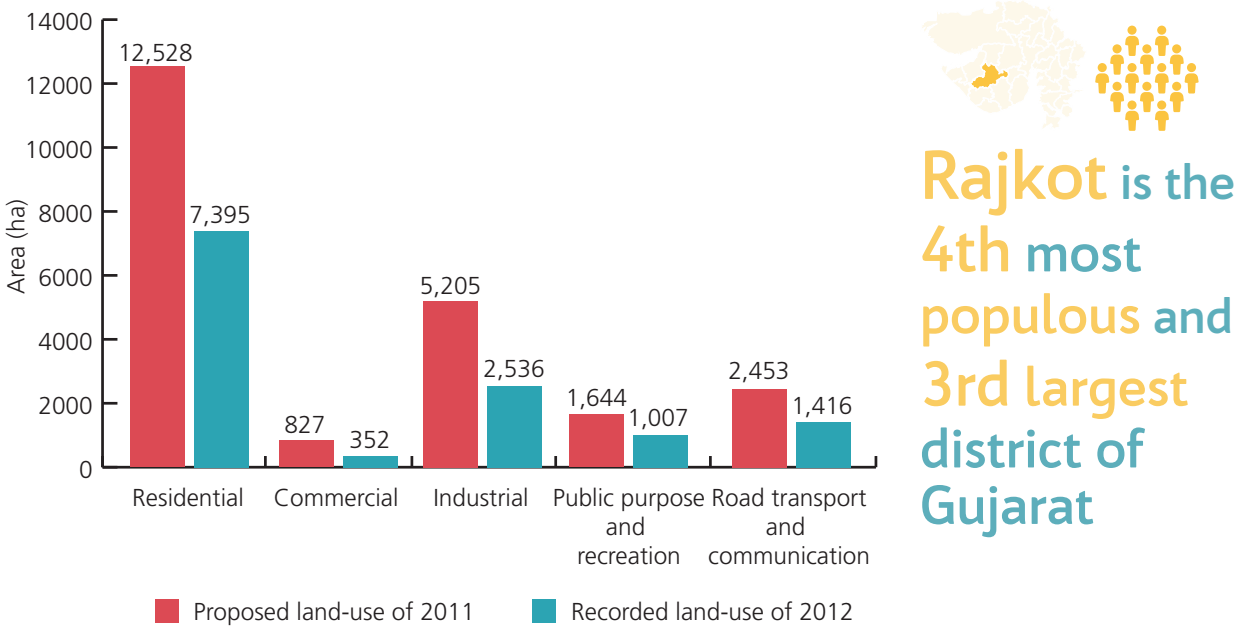


Figure 6: Projected trajectory of developed area under RUDA

Proposed and recorded land-use details of area under RUDA is presented is Figure 7.



Rajkot is the 4th most populous and 3rd largest district of Gujarat

Figure 7: Proposed and recorded land-use details of area under RUDA

1.5 Industrial profile

Rajkot has 16 industrial estates covering an area of 800 hectares across the district. Manufacturing activities in Rajkot district are concentrated in two main industrial estates – Aji and Bhaktinagar. Engineering and auto-ancillary sector growth is on the rise with diesel engine manufacturing being the leading business with around 105 manufacturing units operational in the district. Overall, the district is rich in natural resources and has well developed infrastructure and connectivity, which are conducive for the growth of industries in the region.

The district of Rajkot has 30 large scale industries and public sector undertakings, some of which contribute to the industrial processes and product use (IPPU) sector emissions as per IPCC classification. There are 32,410 MSME units in the district that have made investments to the tune of ₹ 15,950 crore between 2006 and 2015 and employ 2,28,412 workers (MSME, 2017). For further details please refer to Annexure 1.1.

1.6 Natural resources

Rajkot district lies in the North Saurashtra agro-climatic sub-region. The climatic conditions are mainly arid, making the district prone to droughts. The district has an overall cropping intensity of 139 percent, covering a net sown area of over 5,32,582 hectares (GGRC, 2016). Major crops produced in the district include cotton, groundnut, oilseeds, wheat, cumin, pulses, mango, tomato, brinjal among other fruits and vegetables. The net irrigated area in the district is 2,94,500 hectares and the rainfed area is 4,72,400 hectares.

The total livestock population of Rajkot as per the nineteenth Livestock Census is 14,78,136. The results of the census are detailed in Table 5.

The district's forest area is 15,432 hectares, comprising 1.38 percent of its total geographical area, and is much below the state average of 7.57 percent (FSI, 2019). However, there has been an increase of 13.32 percent in forest cover since the previous survey.

The important mineral resources found in Rajkot district are fireclay, limestone, perlite and quartz/sand.[3] Rajkot taluka is the largest producer of fireclay amounting to about 96,728 tonnes, which accounted for 57 percent of the total state production during 2014-15 (Indian Bureau of Mines, 2017). Firebricks and ceramic industries have come up in the district due to the abundance of fireclay. The only deposit of perlite in the district is in village Patanvav (Ministry of Mines, GoI, 2015). Perlite is used in horticulture and construction activities. In 2001-02, the sole mine for perlite in the country recorded production of 137 metric tonnes. Other minerals found in the district include brick sand, black trap, silica sand, calcite and red clay. Fireclay, limestone, sandstone (for building) and calcite are among the major minerals that are commercially mined in the district. The number of industrial establishments for mining and quarrying decreased from 52 (2009-10) to 42 (2010-11).[4]

Table 5: Livestock population of Rajkot (19th Livestock Census)

Livestock	Number
Cattle	6,06,296
Buffaloes	4,32,203
Camels	279
Sheep	1,96,169
Goats	1,72,477
Horses and ponies	1,438
Donkeys and mules	747
Dogs	68,175
Pigs	27
Others	325

The overall groundwater development in the district is 65.34 percent (CGWB, 2013). CGWB statistics indicate that in 2017, groundwater levels in the district were in the range of 0 to 2 metres (CGWB, 2019). As per the analysis based on IWRIS data, pre-monsoon groundwater level of 59 stations located in the 13 blocks indicates a significantly improved underground water level, especially in the lower and eastern part of the district. In contrast, the southern part of the district observed declining water level (Figure 8).[5] Post monsoon trend also indicates an improved groundwater level, especially in the central part of the district during the last 15 years (Figure 9).

3 https://ibm.gov.in/writereaddata/files/02202018152222Gujarat%20AdvanceRe2016.pdf

4 https://gujecostat.gujarat.gov.in/uploads/mediafiles/2409-PART-A-DCHB-RAJKOT.pdf

5 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).

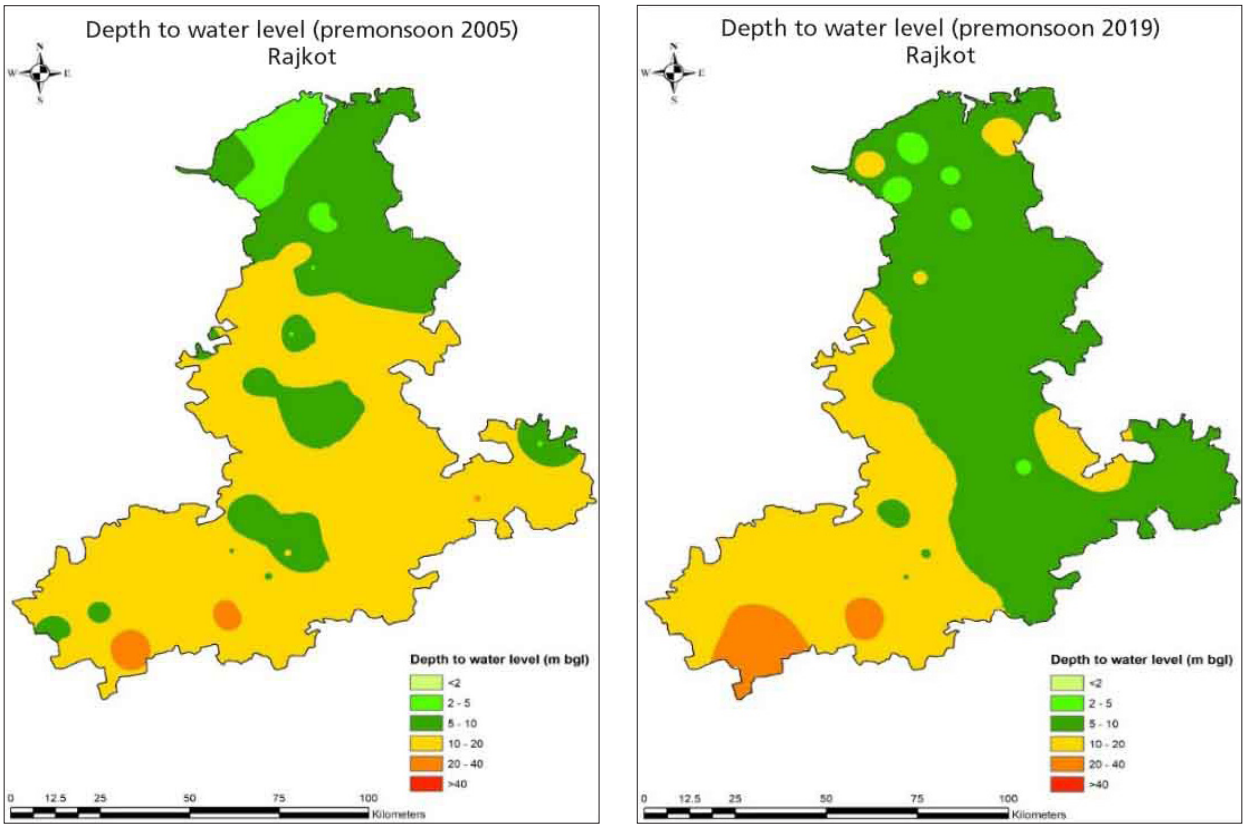


Figure 8: Pre-monsoon groundwater levels in Rajkot: a) 2005 and b) 2019

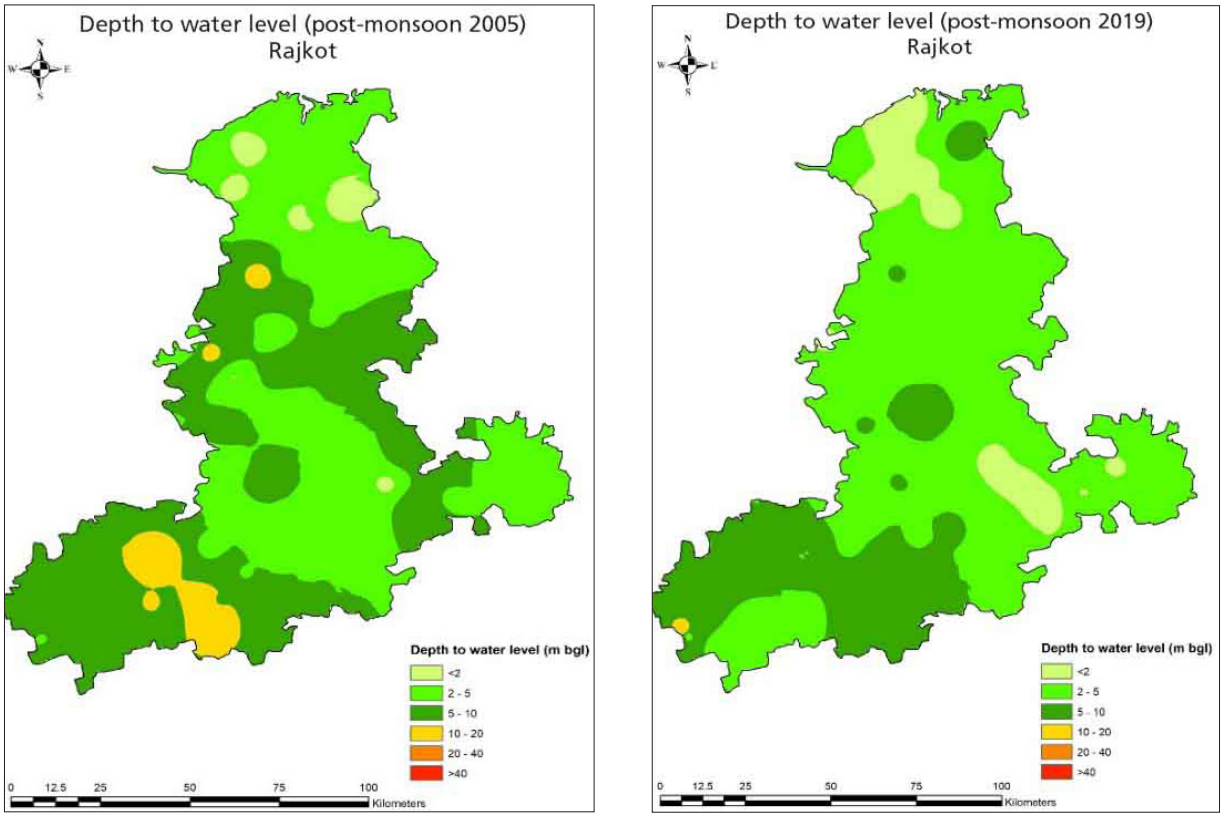


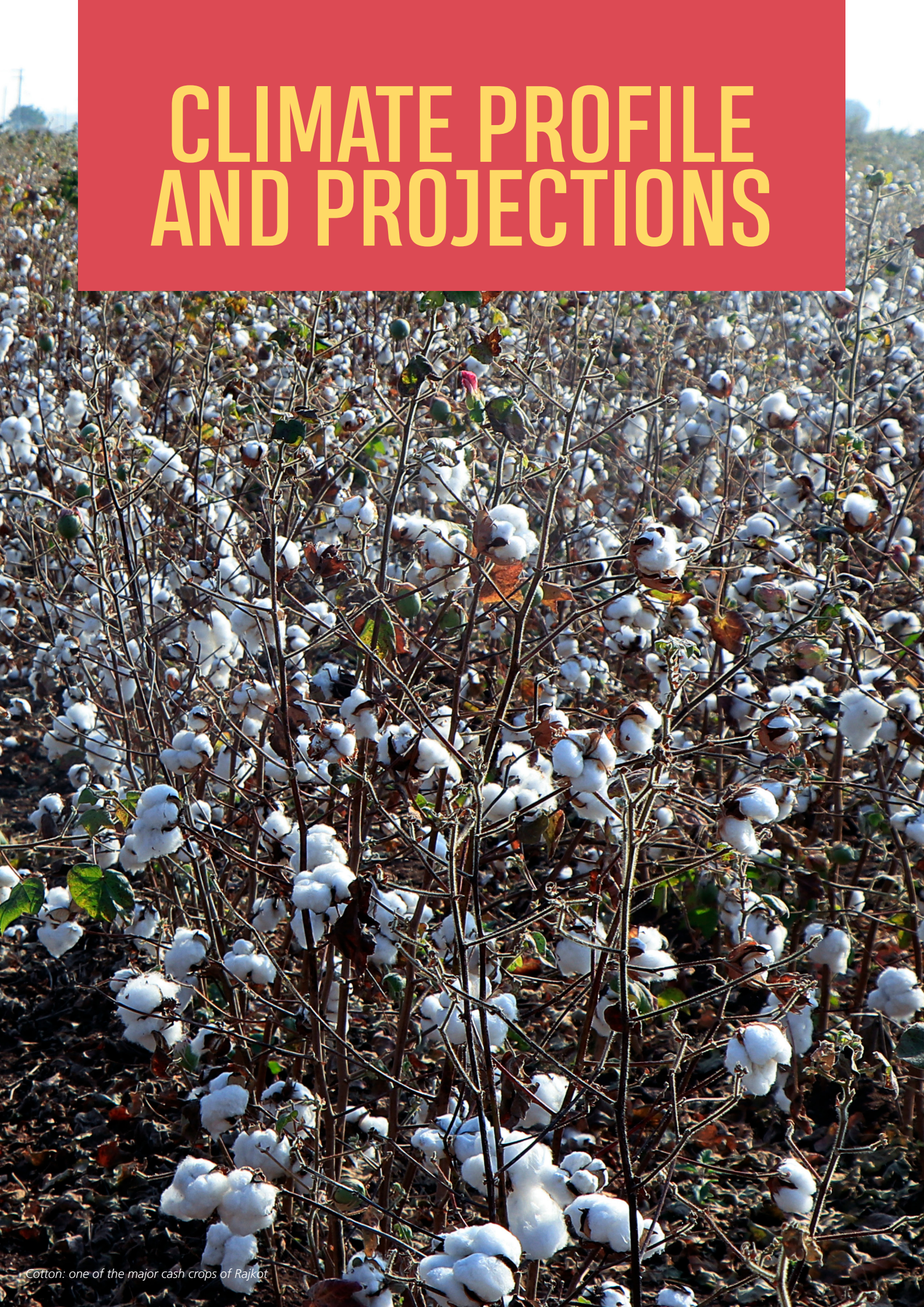
Figure 9: Post-monsoon groundwater levels in Rajkot: a)2005 and b)2019

1.7 Waste sector

Rajkot is ranked the sixth cleanest city (out of 47) with more than a million population in India by the Swachh Survekshan 2020 (cleanliness, hygiene and sanitation survey) (MoHUA, 2020). The city has upgraded its rank from ninth in 2019, indicating an improvement in the waste management sector. Gujarat has adopted the concept of common regional landfills for ULB clusters and vermi-compost treatment facilities at the ULB level. The Rajkot cluster has four ULBs – Chotila and Thangadh of Surendranagar district, Jasdan and Gondal of Rajkot district. The two landfill sites for Rajkot – Sokhada and Manda Dungar – located 12 km and 7 km from the city respectively, are about to reach their capacity. Another landfill site is proposed at Nakrawadi, 15 km from the city. (Rajkot Municipal Corporation, ND) (GPCB, 2021). The district is not fully covered by underground sewerage. Rajkot Municipal Corporation has an underground sewerage network coverage for 60 percent of its population, with two aerobic type STPs for domestic liquid waste treatment (CPCB, 2015). Though there are several industrial clusters in the district, industrial wastewater generation or treatment database is not in public domain apart from information on the common effluent treatment plant (CETP) (which also is not given industry category wise). Rajkot has four CETPs with a total of 40.12 MLD treatment capacity (GPCB, 2020).

*C&D: Construction and demolition; CBWTF: Common bio-medical waste treatment facility; TSDF: treatment, storage and disposal Facility

CLIMATE PROFILE AND PROJECTIONS



Cotton: one of the major cash crops of Rajkot

2. CLIMATE PROFILE AND PROJECTIONS[6]

2.1 Observed climate variability over Rajkot district

Climate variability refers to variations in the mean state (of temperature, monthly rainfall, etc.) and other statistics (such as standard deviations, statistics of extremes, etc.) of the climate 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 Rajkot district, based on the data for the past 68 years. Precipitation and temperature are used as the key climate variables in this analysis.

2.1.1 Precipitation variability

Rajkot district has a tropical dry, semi-arid climate with summer monsoon (June to September) being the main rainy season. The mean monsoon rainfall over the district is around 500 mm, with maximum rainfall being experienced during July and August. The number of rainy days (a day with rainfall of 2.5 mm or more) vary from five to 10 a month in July and August. The district receives more than 28 days of rainfall in the entire summer-monsoon season.

The year-to-year rainfall variability during monsoon months are shown in Figure 10. No significant trend is observed in rainfall. However, it is observed that the variability in rainy days is higher in July and August, reflecting a weak decreasing trend during the period 1951-2018 (Figure 11).

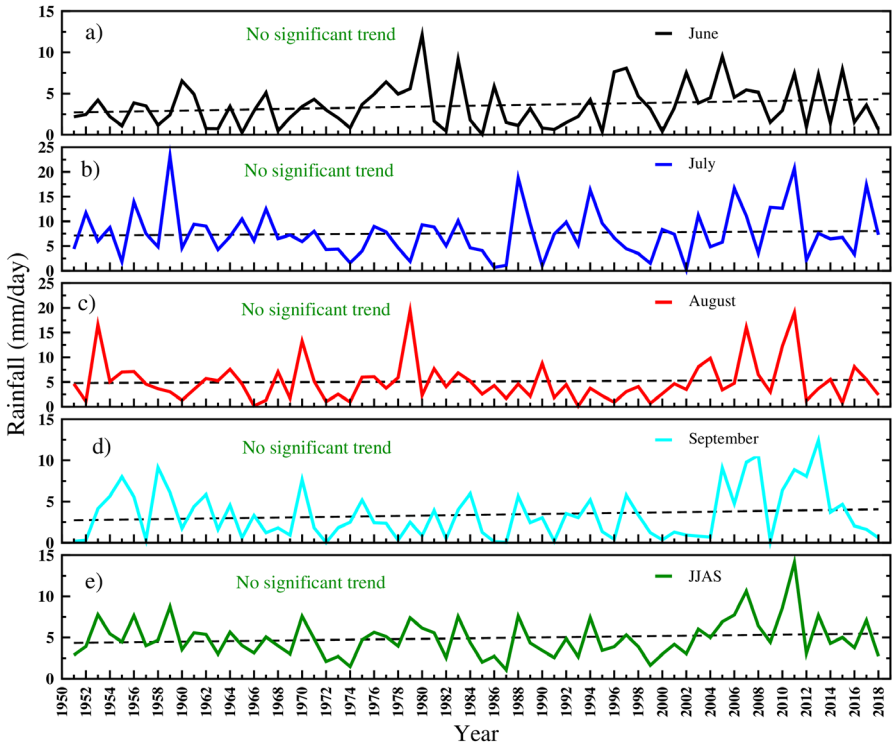


Figure 10: Inter annual variability of rainfall (mm/day) over Rajkot for 1951-2018

The semi-arid district of Rajkot receives around 500 mm of monsoon rainfall

6 Refer to Annexure 2.1 for background note of climate projections and 2.2 for data source & methodology.

Rainy days show higher variability in July and August with a weak decreasing trend during 1951-2018

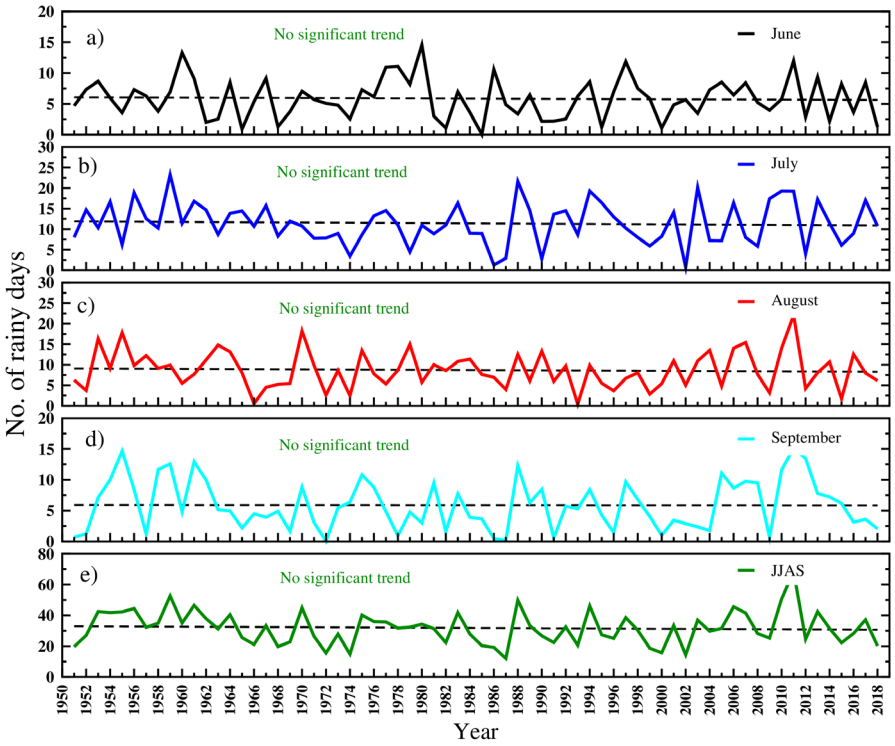


Figure 11: Inter annual variability of rainy days (number of days) over Rajkot for 1951-2018

2.1.2 Temperature variability

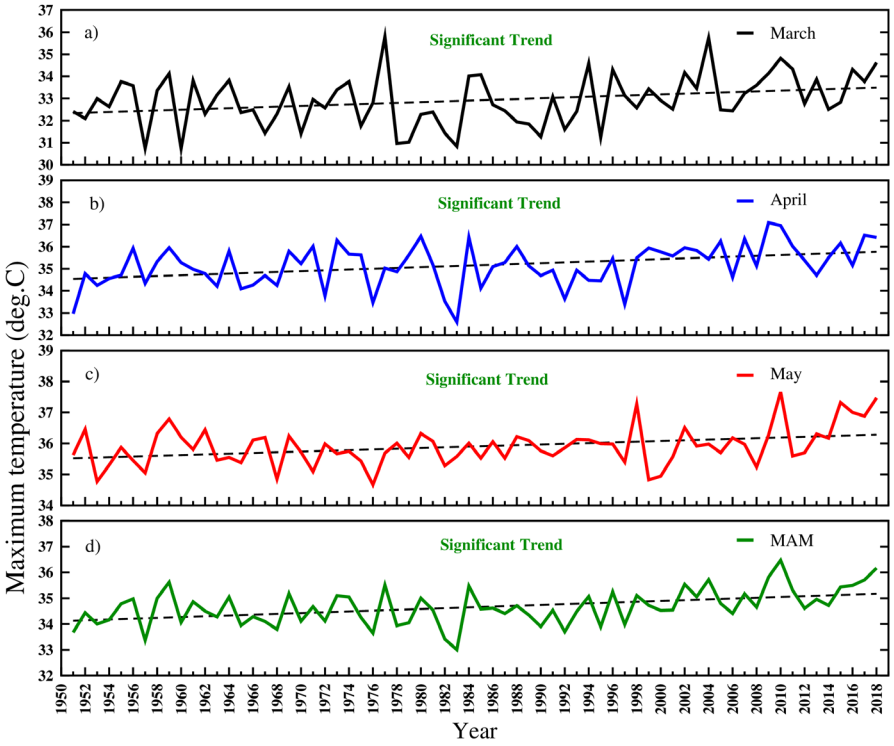
In Rajkot district, the mean maximum temperature varies from 32.9°C to 35.8°C during summer season (March, April and May). The daily maximum temperature in May goes up to 36°C. Summer is the driest period of the year. The maximum temperatures in April and May show a significantly increasing trend, getting accelerated 1990s onwards (Figure 12). The mean percentage of warm days has also increased by about 10 percent during 1986 to 2005 (Figure 13). [7]

There has been a steady increase in minimum temperatures during the winter season (December, January, and February) ranging from 13.5°C to 15°C. The year-to-year variability of minimum temperature (Figure 14) shows an increasing trend in all months, particularly significant during January. The cold days show large variability and also show a gradual decrease in their number since the last decade (Figure 15).[8]


Dry land

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

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



Maximum temperature during summer months shows a significantly increasing trend

Figure 12: Inter annual variability of maximum temperature (°C) over Rajkot for 1951-2018

Mean percentage of warm days has increased by about 10 percent

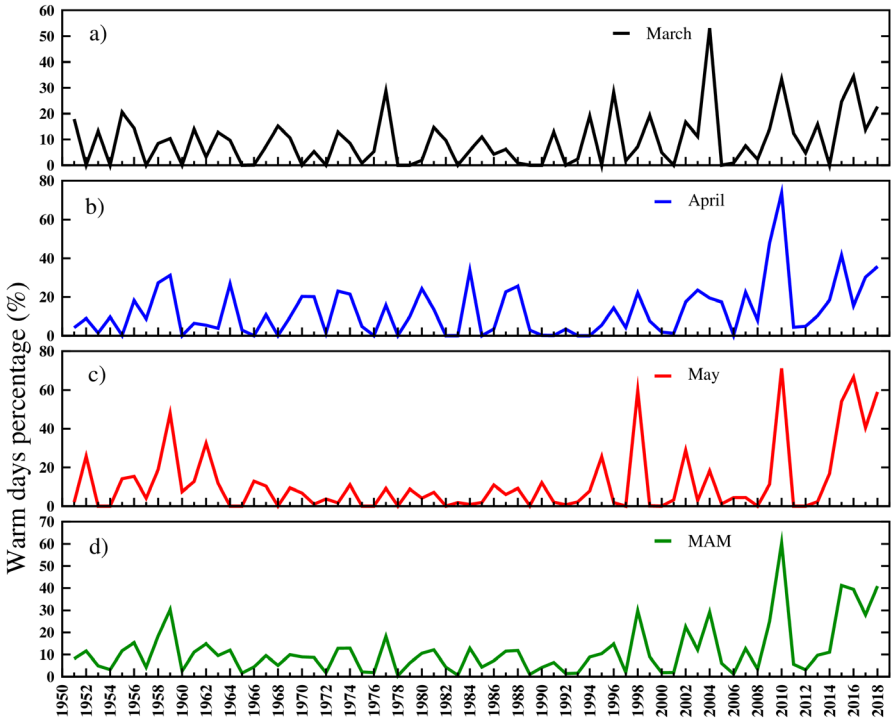


Figure 13: Inter annual variability of warm days (%) over Rajkot for 1951-2018

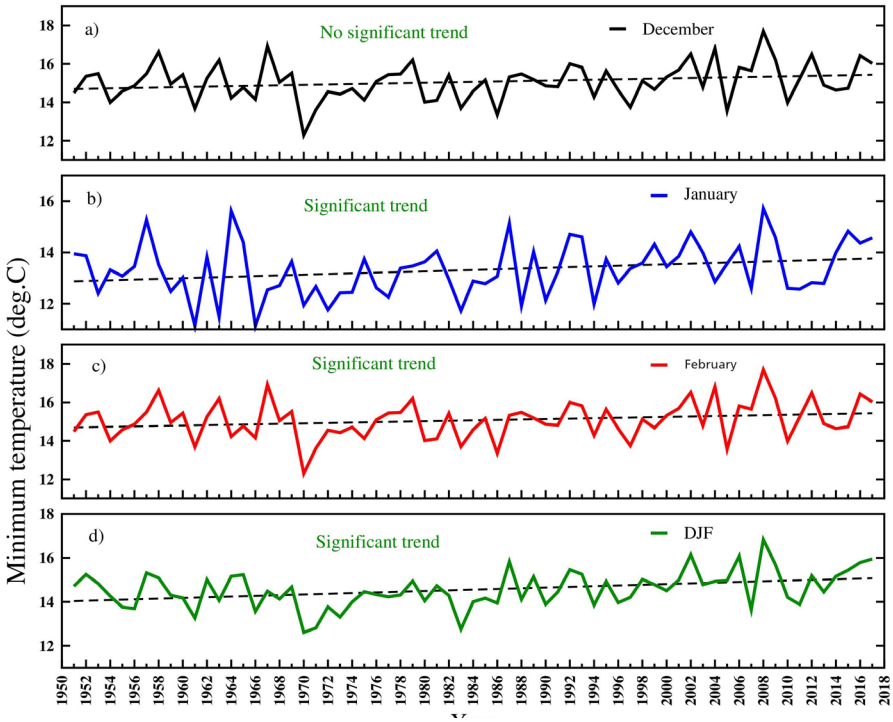


Figure 14: Inter annual variability of minimum temperature (°C) over Rajkot for 1951-2018

Mean minimum temperature has increased significantly during the last few decades

Cold days are observed to be decreasing in number in recent decades

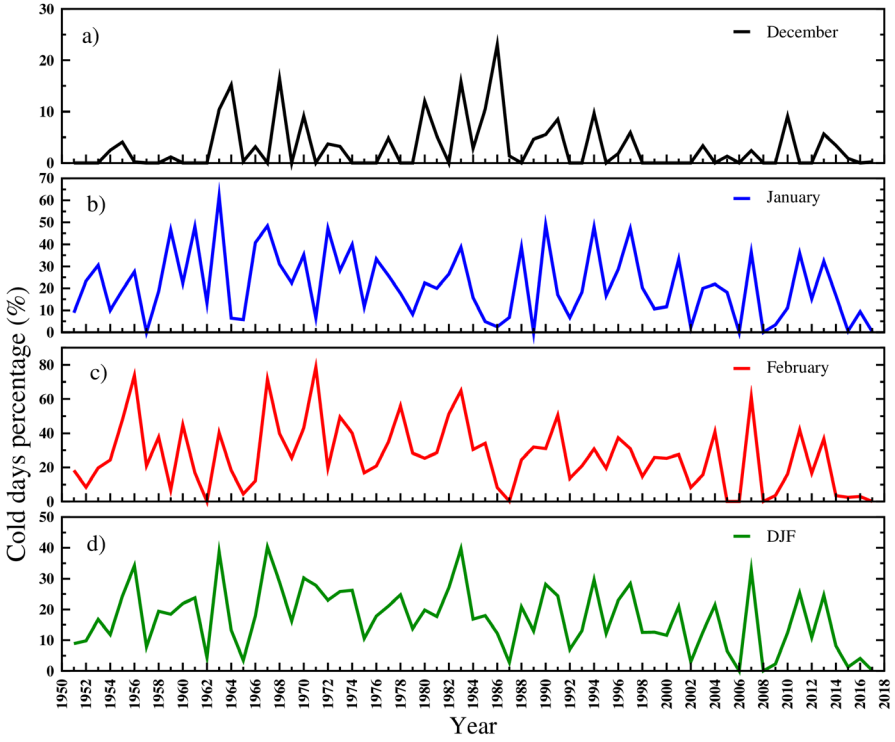


Figure 15: Inter annual variability of cold days (%) over Rajkot for 1951-2018

2.2 Future climate projections for Rajkot district

The precipitation and temperature over Rajkot district during 1986 to 2005 has been simulated using the multi model mean (MMM) ensemble. The district is projected to experience an increase in the mean rainfall in the monsoon months and the season as a whole in different epochs (2021-2040, 2041-2060, 2061-2080 and 2081-2100) under medium (RCP4.5) and high (RCP8.5) emission scenarios (Table 6). There may be an increase in seasonal mean rainfall of 10 to 21 percent under RCP4.5 and 17 to 46 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 (Table 7).

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

Rainfall (mm)	June	July	August	September	JJAS (total of June, July, Aug & Sept)
Observed	111	200	112	73	498
Simulated	81	188	142	80	494
RCP4.5					
2030s (2021-2040)	99	188	153	100	544
2050s (2041-2060)	87	191	162	111	554
2070s (2061-2080)	84	208	181	125	602
2090s (2081-2100)	90	204	188	114	599
RCP8.5					
2030s	98	197	180	99	578
2050s	86	204	190	122	605
2070s	93	225	195	123	640
2090s	103	228	238	150	723

Table 7: Observed (1986-2005), simulated (1986-2005) and projected (RCP4.5 and RCP8.5 emission scenarios) mean monthly and seasonal rainy days (a day with rainfall of 2.5 mm or more rainfall) for Rajkot district

Rainy days	June	July	August	September	JJAS (total of June, July, Aug & Sept)
Observed	5	10	7	5	28
Simulated	5	11	9	9	30
RCP4.5					
2030s (2021-2040)	6	11	9	5	31
2050s (2041-2060)	5	11	9	6	32
2070s (2061-2080)	5	11	10	6	33
2090s (2081-2100)	5	11	10	6	32
RCP8.5					
2030s	5	11	10	5	31
2050s	5	11	10	6	32
2070s	5	10	9	6	31
2090s	5	10	10	6	31

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°C to 4°C under RCP8.5, particularly during the month of May (Table 8). The percentage of warm days is also projected to increase, 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 climate conditions. The analysis shows there is a clear increase in temperature towards the end of the century.

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

Temp. max (°C)	March	April	May	MAM (average of March, April and May)
Observed	32.9	35.1	35.8	34.6
Simulated	33.8	36.7	38.1	36.2
RCP4.5				
2030s	35.0	37.9	39.1	37.3
2050s	35.6	38.4	39.6	37.9
2070s	35.9	38.9	40.0	38.2
2090s	36.3	39.1	40.1	38.5
RCP8.5				
2030s	35.2	40.0	39.3	37.5
2050s	36.1	38.9	40.0	38.3
2070s	37.3	39.9	40.9	39.4
2090s	38.2	40.9	41.8	40.3

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

Warm days (%)	March	April	May	MAM (average of March, April and May)
Observed	9	10	10	10
Simulated	9	10	9	9
RCP4.5				
2030s	37	45	49	44
2050s	54	63	70	63
2070s	61	75	79	73
2090s	71	79	84	78
RCP8.5				
2030s	44	50	61	53
2050s	65	75	83	75
2070s	86	92	95	91
2090s	93	97	98	95

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

Temp. min (°C)	Dec	Jan	Feb	DJF (average of Dec, Jan and Feb)
Observed	15.0	13.5	15.0	14.7
Simulated	13.6	12.9	13.8	13.1
RCP4.5				
2030s	14.9	13.3	15.0	14.3
2050s	15.5	14.1	15.6	15.0
2070s	16.1	14.5	16.2	15.6
2090s	18.2	14.7	16.4	15.8
RCP8.5				
2030s	15.2	13.4	15.3	14.6
2050s	16.1	14.6	16.2	15.6
2070s	17.6	15.9	17.6	17.0
2090s	18.9	17.2	18.7	18.2

Table 11: Observed (1986-2005), simulated (1986-2005) and projected (RCP4.5 and RCP8.5 emission scenarios) mean monthly and seasonal cold days (%) with respect to baseline for Rajkot district

Cold days (%)	Dec	Jan	Feb	DJF (average of Dec, Jan and Feb)
Observed	3	21	23	16
Simulated	4	16	36	18
RCP4.5				
2030s	1	4	16	7
2050s	0	2	9	4
2070s	0	1	6	2
2090s	0	1	4	1
RCP8.5				
2030s	0	4	13	6
2050s	0	1	6	2
2070s	0	0	2	1
2090s	0	0	0	0

2.3 Sectoral impacts of climate change

2.3.1 Agriculture and allied sectors

The trends of change in rainfall and temperature across Rajkot indicate greater adverse impacts during *kharif* season as compared to *rabi* season. It is predicted that climate change would severely affect the yields of wheat crop, followed by maize, paddy and groundnut during *kharif* season (Pandey, et al., 2015).

A study on the impact of climate change on *kharif* pearl millet crop in Rajkot district reported that the impacts of climate change on the flowering and maturity of grain will also affect the grain and biomass yields by 14 and 12.6 percent, respectively (Yadav, et al., 2013).

According to a Gujarat Institute of Desert Ecology (GUIDE) study (2019), extended monsoon, unseasonal rain, hailstorms and cyclonic storms, will become more intense and frequent along the coasts of Gujarat, which will compel the farmers to change their cropping patterns and timings. Additionally, decrease in biomass production will negatively impact livestock rearing. The projected heat stress will decrease cattle productivity and yield, particularly affecting the dairy sector. Impact will also be seen in reproduction of these animals along with heat-stress related health issues.

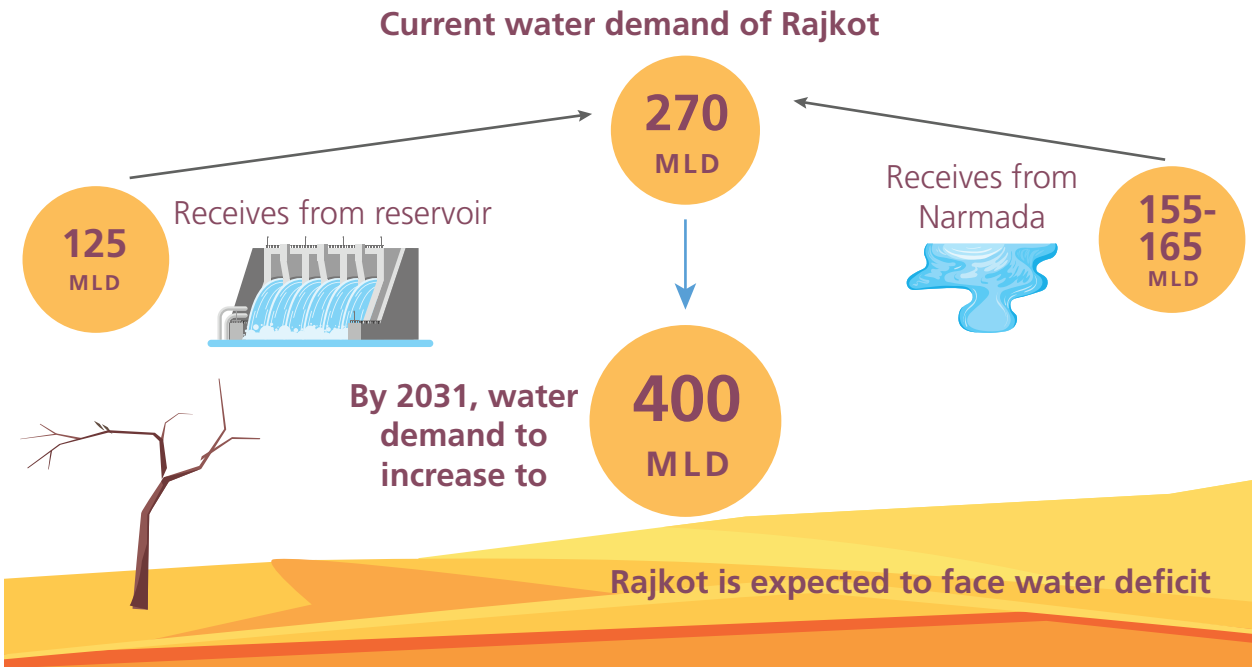
2.3.2 Water resources

In Gujarat, agricultural activities consume 80 percent of the available water resources, of which irrigation consumes a major part. Various scientific assessments show that climate change will have a significant impact on Gujarat's freshwater resources. The river basins of Aji, Mahi, Pennar, Sabarmati and Tapi are likely to experience water scarcities and shortage as well as increase in flooding events based on the current observed trends (Climate Change Dept, 2014).

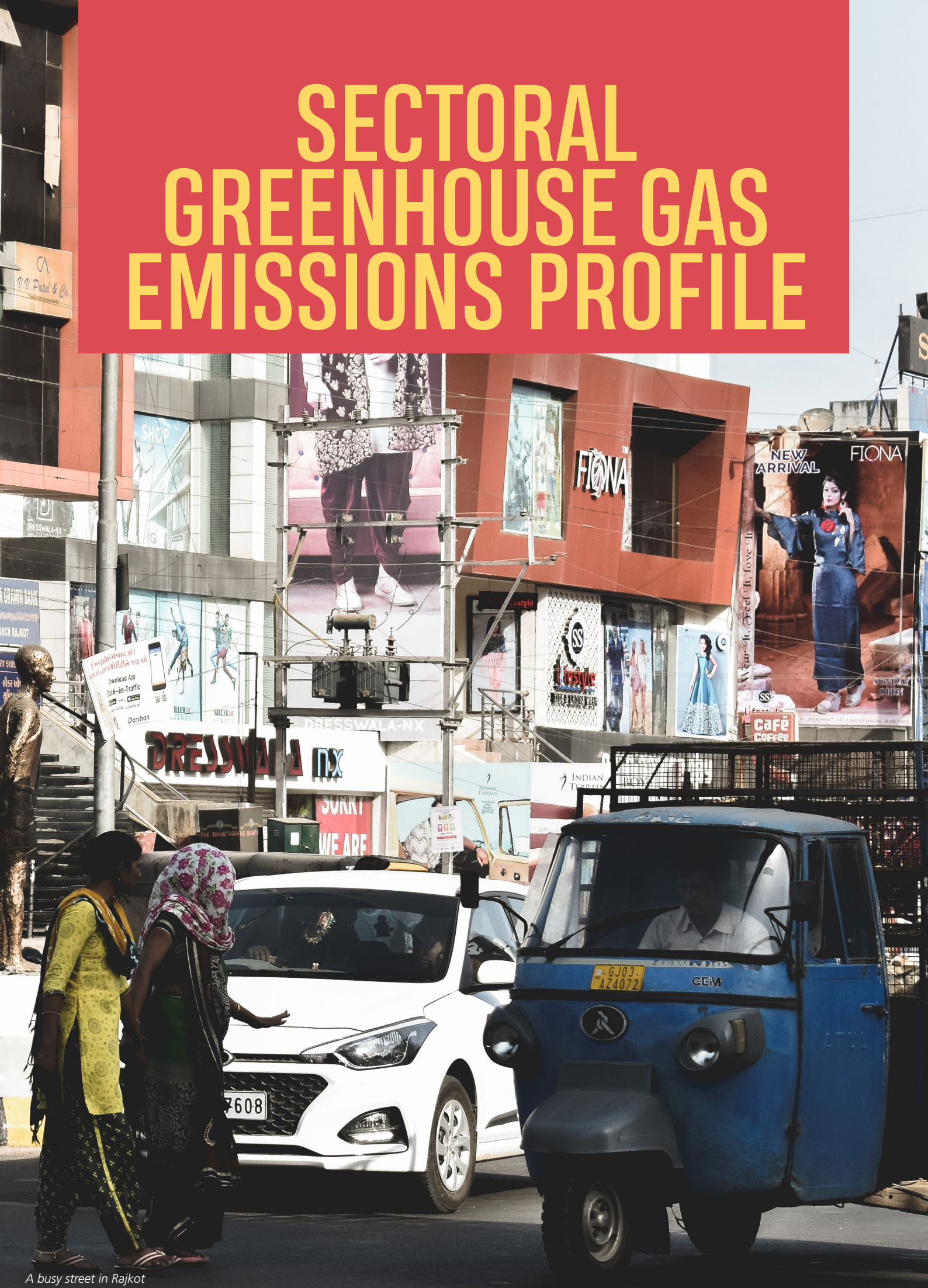
The ongoing development of the Aji riverfront will have further impacts on the water quality and cooling capabilities of the river in the coming years.

In Gujarat, droughts have occurred with unfailing regularity. Longer periods of drought affect the ground water and river flows. The frequency of extreme drought has been higher for the entire Saurashtra agroclimatic zone, which includes the Rajkot district. Almost every year the region experiences drought of different magnitudes and time scales. According to future projections, while droughts might occur less frequently, they will have longer durations (Shete & Patel, 2013).

Rajkot currently needs about 270 million litres of water every day. Of this, it gets about 125 million litres from local reservoirs, and it draws about 155 to 165 million litres from the Narmada. By 2031, the town's water demand will increase to 400 million litres a day (Rajshekhar, 2017). Thus, the current annual deficit is expected to grow in the coming years with growth in urbanisation, migration and population.



SECTORAL GREENHOUSE GAS EMISSIONS PROFILE



A busy street in Rajkot

3. SECTORAL GREENHOUSE GAS EMISSIONS PROFILE: CLIMATE CHANGE DRIVERS

This section estimates greenhouse gas (GHG) emissions for Rajkot district using the guidelines laid down by the Intergovernmental Panel on Climate Change (IPCC).[9] Estimates have been provided for 12 categories covering three major sectors – energy; agriculture, forestry and other land use (AFOLU); and waste for the period 2005 to 2019.[10] Though Rajkot has some industrial units that fall under the industrial processes and product use (IPPU) sector, emissions from the sector could not be taken into account due to unavailability of activity data (industry-wise production details). However, energy used in industries and the corresponding emissions are reported in the energy sector.

The activity data was sourced from government-approved datasets for all the sectors and wherever possible, country-specific emission factors were used in place of default emission factors.[11]

3.1 Direct emission estimates

3.1.1 Economy-wide emission

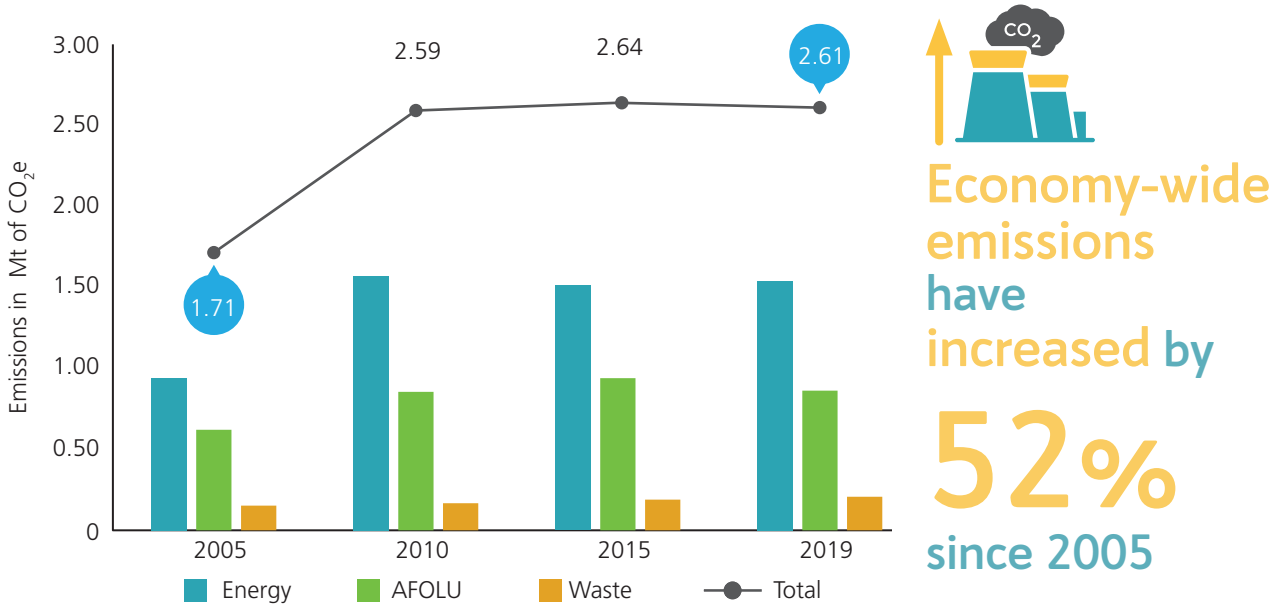


Figure 16: Economy-wide emissions of Rajkot district (million tonnes of CO_2e)

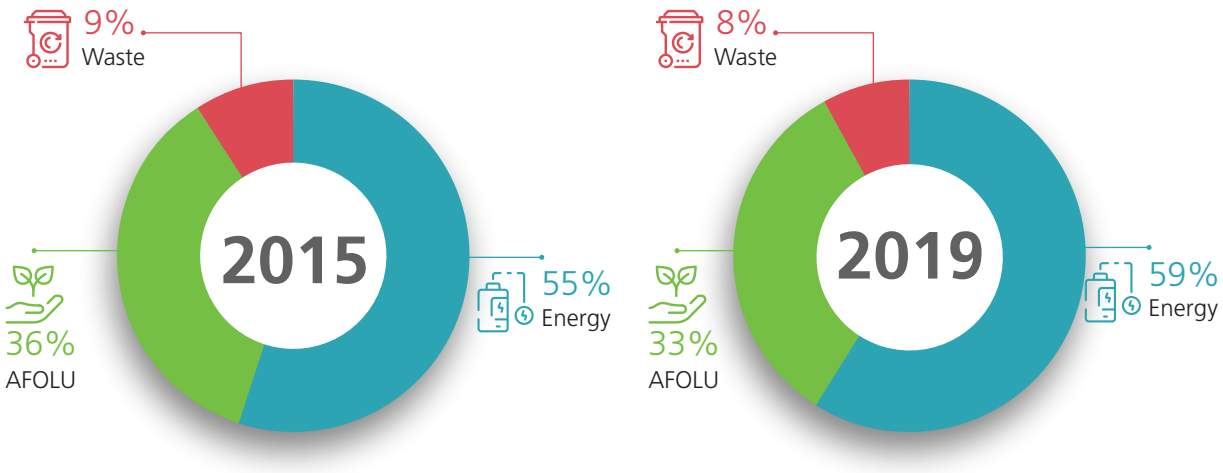


Figure 17: Percentage share of sectors in total emissions (2005 and 2019)

9 The 2006 IPCC guidelines were followed to the extent possible. For very few categories, the 1996 IPCC guidelines were referred to. Background on GHG inventorisation and its significance is given in Annexure 3.1

10 Estimates for 2017, 2018 and 2019 were arrived at by applying CAGR on the latest possible GHG calculations for each category (based on availability of activity data)

11 Category-wise activity data sources for emissions are provided in Annexure 3.2.

Table 12: Sectoral contribution and growth in emissions

Sector	Growth in emissions CAGR (2005-19)	% share in total emissions (2019)
Energy	3.57%	59.01%
AFOLU	2.38%	33.07%
Waste	2.23%	7.92%
Total emissions	3.04%	100%

Energy sector is the highest contributor with

59%

of total emissions.

- Between 2005 and 2019, the total emissions of Rajkot district increased by 52 percent (from 1.71 million tonnes CO_2e in 2005 to 2.61 million tonnes CO_2e in 2019).
- For Rajkot, the overall increase in emissions is modest (in comparison to other districts) because energy sector emissions (i.e., emissions from fuel consumption by different categories) for the recent years have been lower than the corresponding emissions in 2015. As a result, the CAGR between 2005 and 2018 was quite low. The activity data for these categories is sourced from the Petroleum Planning and Analysis Cell (PPAC), Ministry of Petroleum & Natural Gas, GoI.
- Net emissions for 2015, 2016, 2017, 2018 and 2019 were 2.66, 2.51, 2.60, 2.53, and 2.62 Mt of CO_2e respectively.
- In 2016, net emissions were 5.5 percent lower than that of 2015.
- Energy sector (direct fuel combustion in transport, agriculture, residential etc.) is the highest contributor with 59 percent of total emissions in Rajkot. This is followed by AFOLU sector (33 percent) and waste sector (8 percent).
- During 2005 to 2019 – the timeframe considered for emissions profile – AFOLU emissions peaked in 2015. Substantial enhancement in Rajkot's forest cover has helped turn 'forest removals' category into a sink post 2015. This reduction in AFOLU emissions helped bring down the economy-wide net emissions of Rajkot.

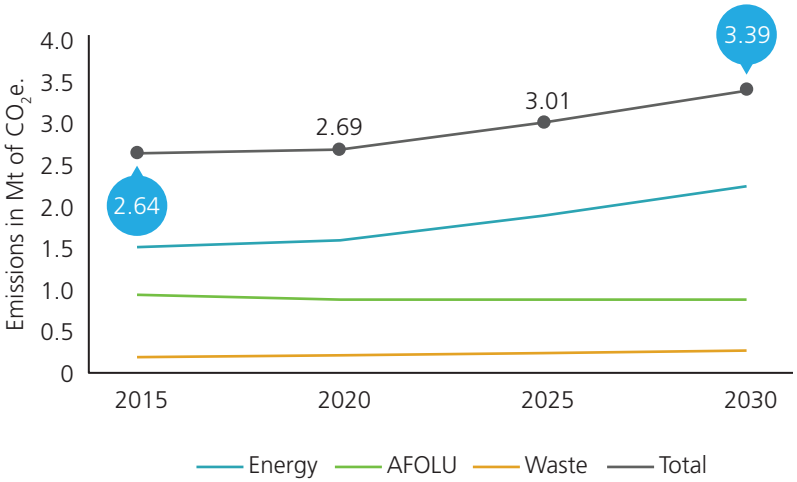


Figure 18: Projections of economywide emissions (BAU) for Rajkot district (Mt of CO_2e.)

Economy-wide emissions to rise by ~

29%

in BAU scenario

- In business-as-usual scenario (i.e., no actions/policies are put in place to mitigate the emissions), total emissions of Rajkot are likely to grow by ~29 percent until 2030, with respect to 2015.
- It is assumed that the forest area of Rajkot will continue to enhance (as seen in recent years). If this trend is not maintained, rise in emissions will be much higher.
- During the same period (2015 to 2030), emissions of Gujarat are likely to increase by 157 percent with a CAGR of 6.5 percent.

3.1.2 Per capita emissions

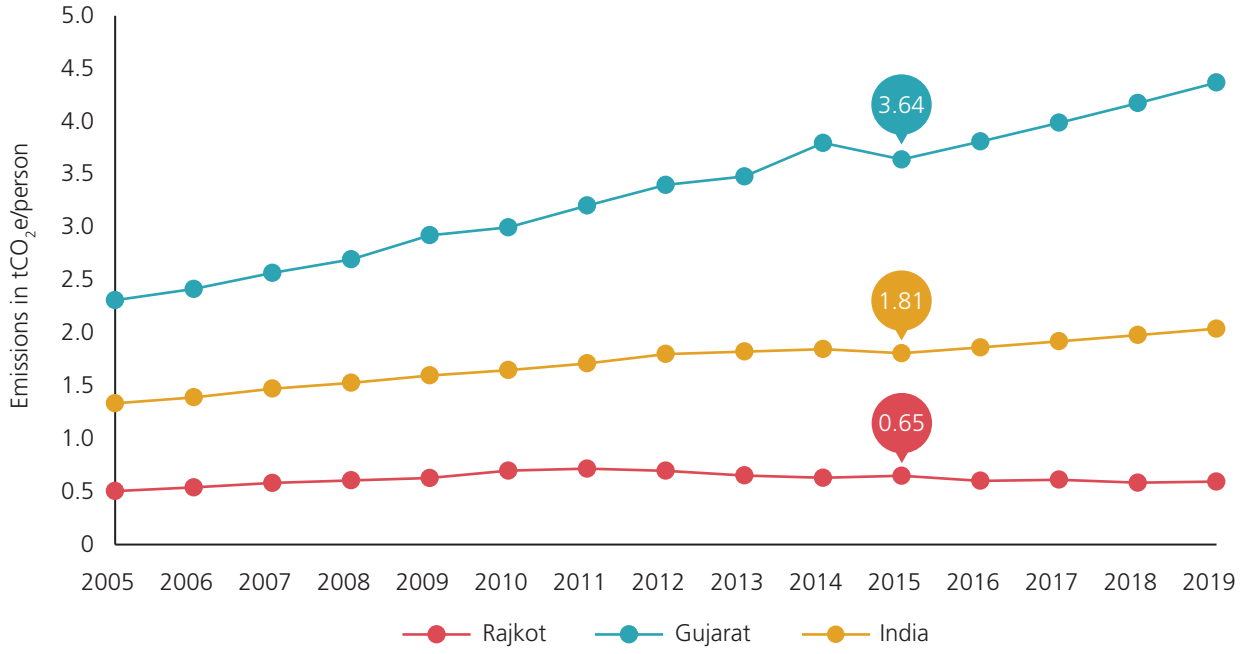
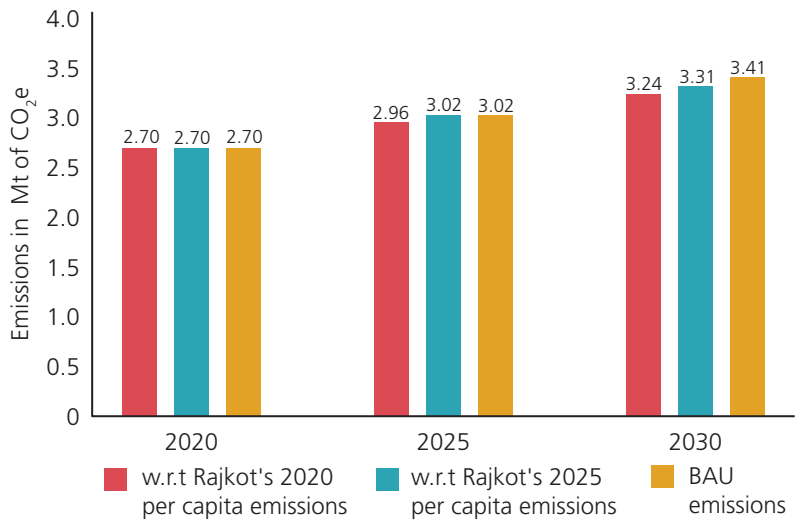


Figure 19: Per capita emissions (tCO_2e/person) – a comparison

- Per capita emissions were computed using the district's total emissions that were estimated in this analysis (therefore, it does not include emissions from IPPU).
- Absence of thermal power plants in the district is also a key reason for overall low emissions of Rajkot with respect to state emissions.
- As per this analysis, the per capita emissions of Rajkot district peaked in 2011 (around 0.7 tonne of CO_2e per person)
- Rajkot's per capita emissions are much lower than the national average per capita emissions and that of Gujarat as well. However, it may be noted that Rajkot estimates do not include emissions from IPPU sector and that from CNG and PNG consumption.



- Business-as-usual projections of per capita emissions show an increase in total emissions by 21 percent (between 2020 and 2030, as shown in economy-wide section as well).
- However, total emissions can be 5.2 percent lesser if 2020 per capita emissions level is maintained and 2.87 percent lesser if 2025 per capita emissions level is maintained.

Figure 20: Projected total emissions (million tonnes CO_2e) with different per capita emission scenarios

3.1.3 Sectoral analysis and projections

Energy sector

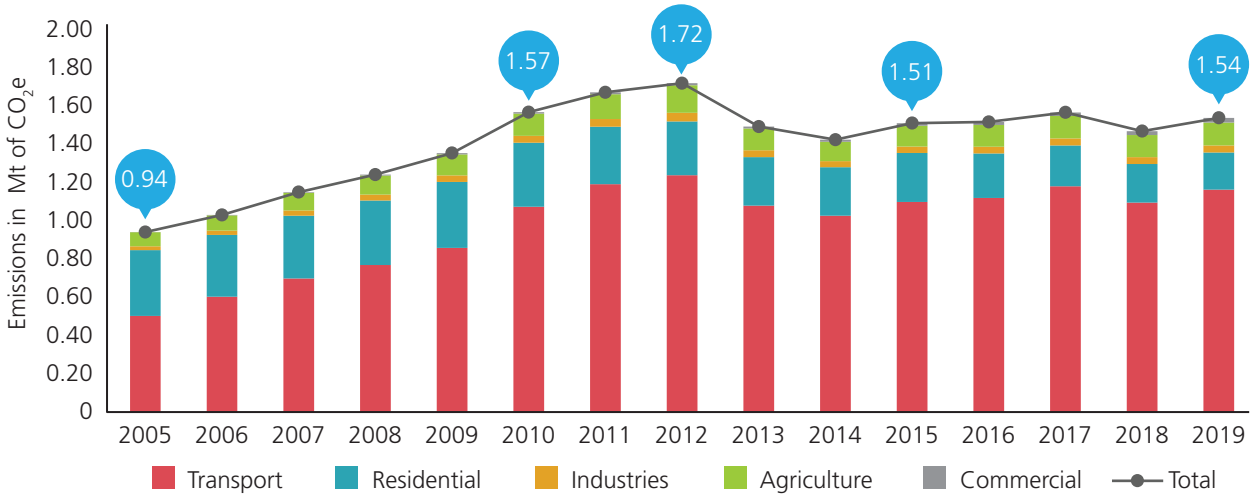
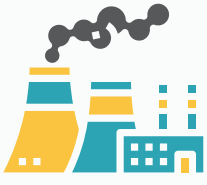


Figure 21: Energy sector emissions of Rajkot district (million tonnes of CO_2e.)

The energy sector emissions increased by **64%** since 2005.



- This sector estimates emissions from direct fuel consumption by various categories.
- Between 2005 and 2019, emissions from energy sector in Rajkot increased by 64 percent (from 0.94 Mt of CO_2e in 2005 to 1.54 Mt of CO_2e in 2019).
- Since Rajkot does not have electricity generation capacity of its own, the category of transport is the highest contributor to energy emissions. This is followed by residential, agriculture, commercial and industries.
- However, it may be noted that emissions from the residential category have decreased over time (w.r.t the PPAC data that has been analysed). Rajkot city has seen an immense rise in PNG connections (replacing LPG). However, due to unavailability of PNG data, emissions from consumption of PNG could not be computed. As a result, residential emissions are seen reducing over the years.

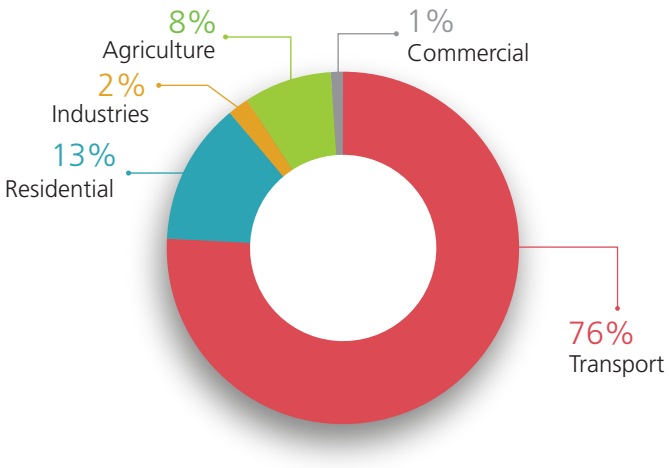
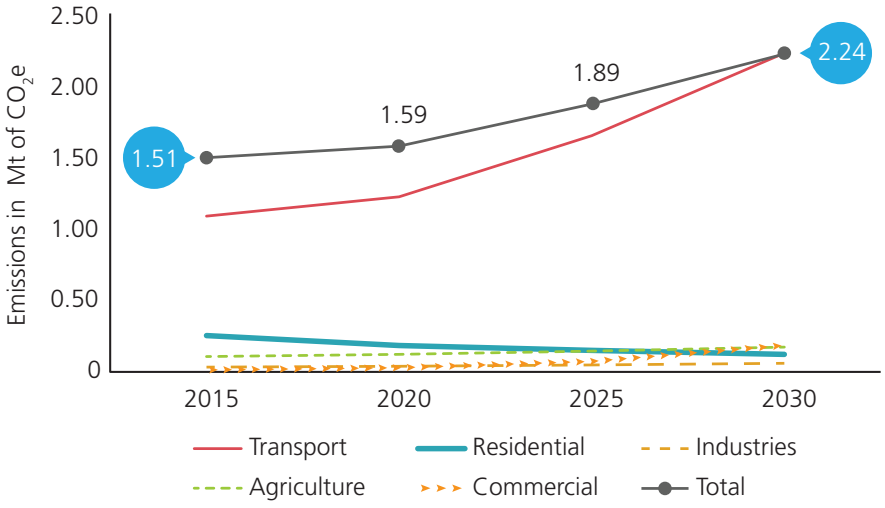


Figure 22: Percentage share in total energy emissions (2019)

Table 13: Growth in energy sector emissions and % share

Category	Sub-category[12]	CAGR (2005-18)	% share of energy emissions (2019)	
Transport (CAGR: 7.63% Share: 43.01%)	Road (88.3% transport emission)	5.75%	71.59%	Total share of transport is 75.60%
	Aviation (5.94%)	18.31%	1.39%	
	Railway (3%)	5.84%	1.58%	
Residential		- 4.01%	12.61%	
Agriculture		3.53%	7.76%	
Industries		4.47%	2.44%	



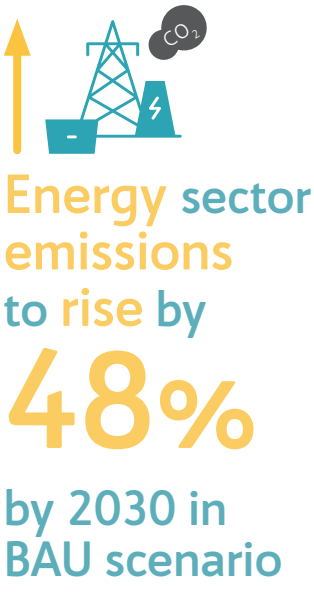


Figure 23: Projected emissions of energy sector (BAU) of Rajkot district in Mt of CO_2e.

- In business-as-usual scenario, the total energy emissions of Rajkot district are likely to grow at a CAGR of 3.57 percent and the overall emissions will witness an increase of 48 percent by 2030 (with respect to 2015).
- As can be seen in Table 13, emissions from road transport contribute 88.3 percent of total transport emissions. Reducing emissions from road transport (i.e., reducing direct fuel consumption) will significantly mitigate transport emissions. Modal shift to public transport, transition to e-vehicles (powered by RE) can help attain this. Detailed recommendations are given in Chapter 6.

12 Data gap: CNG & PNG data was not available for Rajkot district

Agriculture, forestry, and other land use (AFOLU) sector

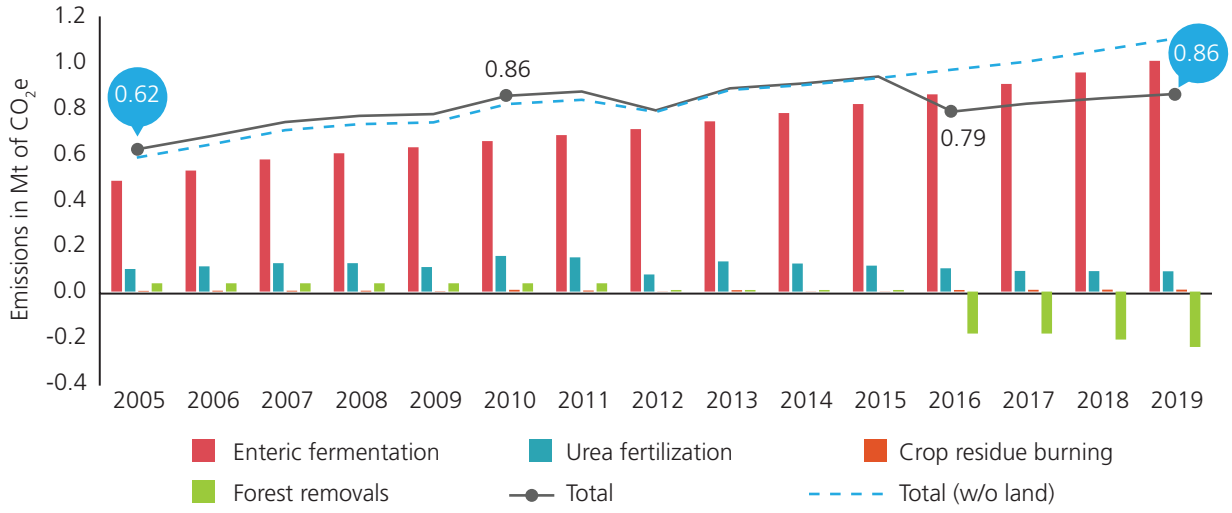


Figure 24: AFOLU sector emissions of Rajkot district (Mt of CO_2e.)

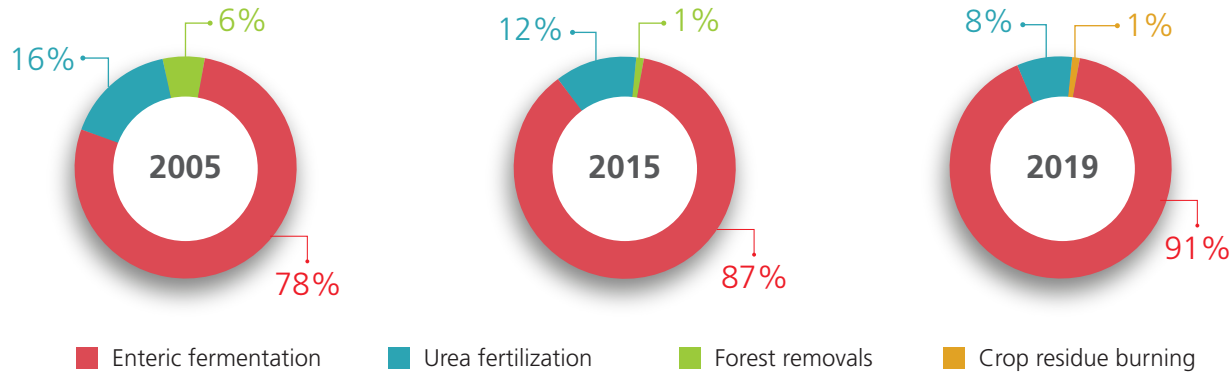
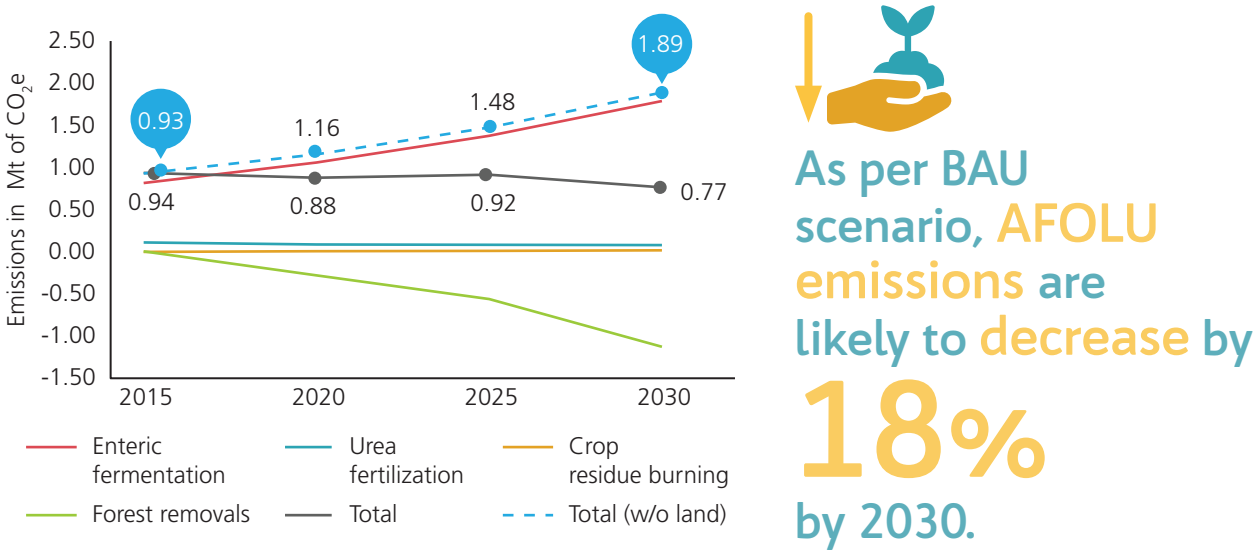


Figure 25: Percentage share of categories in total AFOLU emissions

Table 14: Growth in AFOLU emissions (2005-17) and % share

Category	CAGR (2005-17)	% share in AFOLU emissions		
		2005	2015	2019
Enteric fermentation	5.37%	78%	87%	91%
Forest removals	-15.27% (between positive values 2005 & 15)	6%	1%	Became a sink
Urea fertilisation	-0.74%	16%	12%	8%
Crop residue burning	7.76%	0.5%	0.06%	1%
Total emissions	4.60%	NA	NA	NA

- Net emissions from AFOLU sector increased by only 39 percent (between 2005 and 2019). However, if the sink created by improvement in the forest cover is not considered, gross emissions from AFOLU sector increased by 77.89 percent.
- 'Forest removals' was a source of emissions (till 2015) due to reduction in total forest area. However, the rate of loss of forest area kept decreasing 2007 onwards. As a result, emissions from this category kept decreasing as well.
- With substantial increase in forest area of Rajkot – from 141 sq km to 154 sq km between 2015 and 2017 – the 'forest removals' category became a sink.
- Use of urea in agriculture has also shown a negative trend, although the district's crop production has increased over the years.
- Emissions from enteric fermentation of livestock is the key source of emissions from AFOLU; its share in total economy-wide emissions have increased from 28 percent to 38 percent from 2005 to 2018.



As per BAU scenario, AFOLU emissions are likely to decrease by **18%** by 2030.

Figure 26: Projections of AFOLU sector emissions (BAU)

- In business-as-usual scenario, AFOLU sector net emissions are likely to decrease by 18 percent by 2030 (with respect to 2015 levels).
- However, if the sequestration of GHG emissions (through increase in forest area) is not considered, AFOLU emissions will increase by 102 percent between 2015 and 2030.

Waste sector

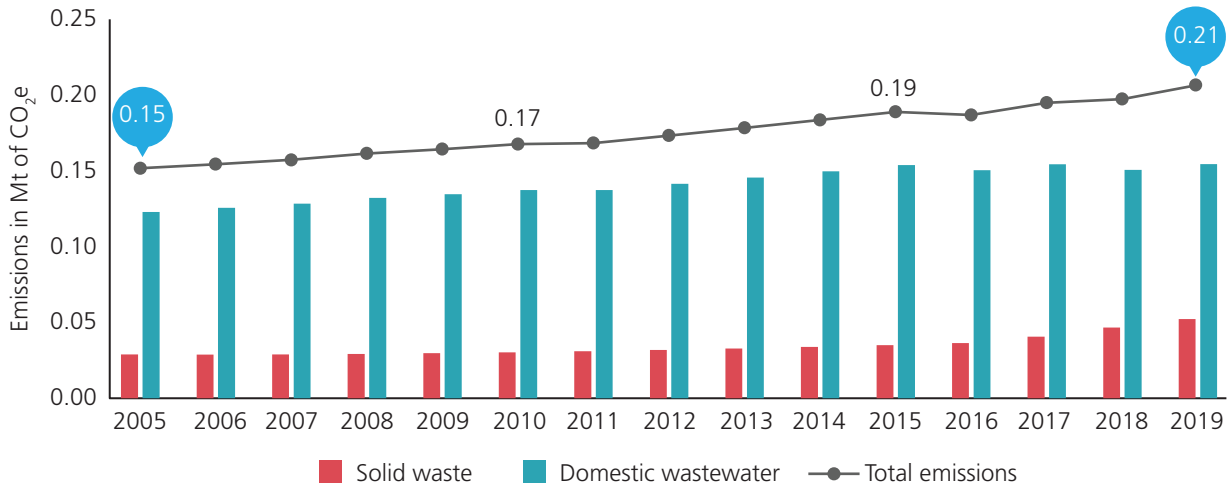


Figure 27: Waste sector emissions of Rajkot district (in Mt of CO_2e.)

Waste sector emissions have increased by **36%** since 2005.

- Waste sector contributes the least to economy-wide emissions (8 percent in 2019).
- This sector has witnessed a slow growth (by a CAGR of 2.23 percent; between 2005 and 2019).
- Total waste emissions have increased by 36.20 percent (2005-19).
- If emissions from solid waste are not mitigated, they are likely to double by 2030 (w.r.t. 2015 levels).

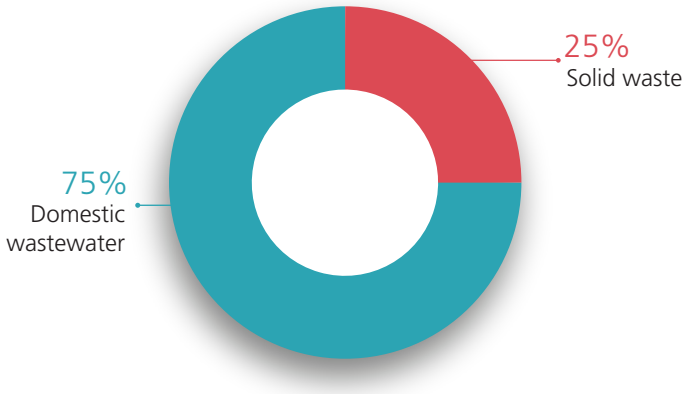
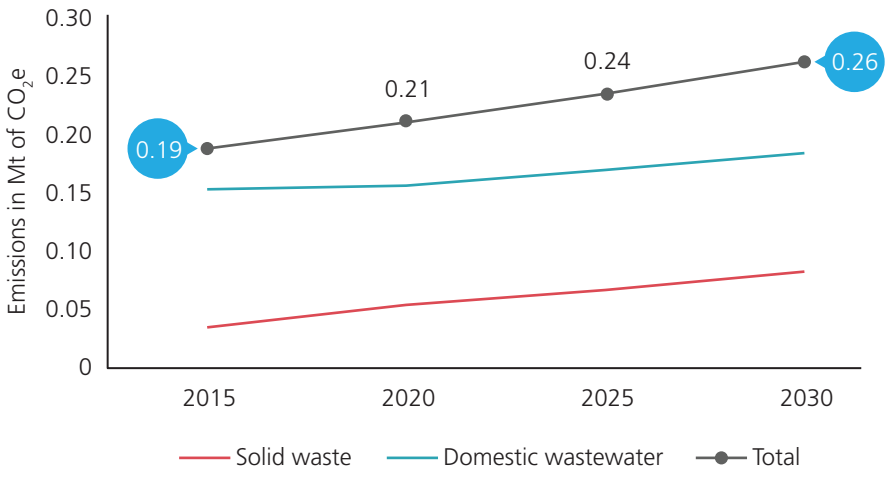


Figure 28: Percentage share of categories in total waste emissions (2019)

Growth in emissions (2005-19) and % share		
Category	**CAGR**	**% share in waste emissions (2019)**
Solid waste	4.31%	25%
Domestic wastewater	1.65%	75%



Waste sector emissions to rise by **37%** in BAU scenario

Figure 29: Projections for waste sector emissions (BAU)

3.2 Carbon footprint of electricity consumption

- Rajkot district receives electricity from Paschim Gujarat Vij Company Ltd. (PGVCL) – a Government of Gujarat DISCOM.
- Projections on electricity consumption have been made by applying CAGR (between 2011 to 2018) on total electricity supplied by PGVCL (CAGR of 8.40 percent).
- For PGVCL, contribution of coal and gas in electricity generation is taken from FY 2019-20 (as per data availability).
- Based on this, carbon footprint (basically CO_2 emissions) from electricity consumption in Rajkot district is ascertained.
- However, it is important to note that emissions (from electricity consumption) are not added to the district emission profile (showcased in sections above). The IPCC methodology adopted to build the emission profile of the district clearly mentions that only emissions occurring at the source of production/generation need to be included, and not those at the consumption site.

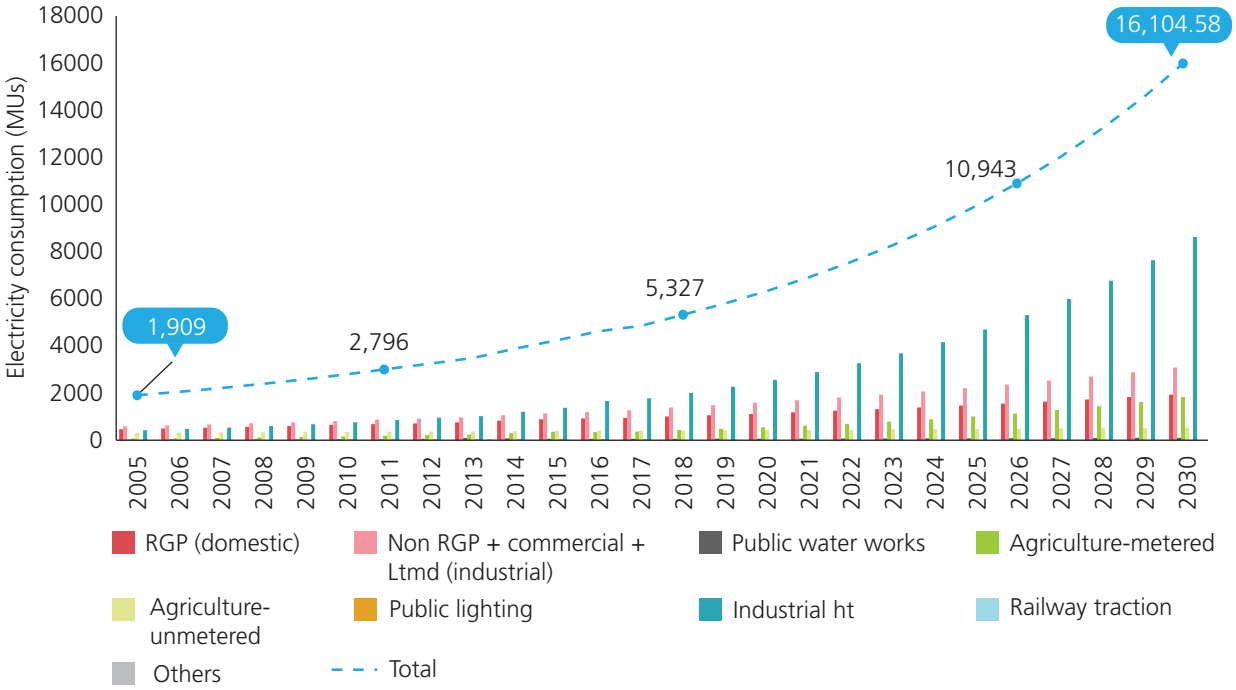


Figure 30: Electricity consumption (2005 to 2020) and its projections (till 2030) in Rajkot district across categories

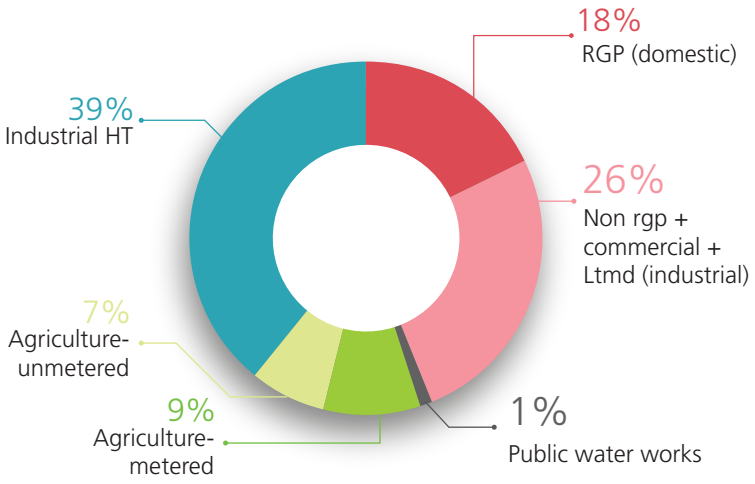


Figure 31: Sector wise share in electricity consumption of Rajkot district (2019)

Table 15: Estimation of carbon footprint (emissions) from electricity consumption in Rajkot district

Carbon footprint calculations for electricity consumption in Rajkot district[13]							
	Units	2005	2010	2015	2020	2025	2030
Total electricity supplied to Rajkot district	MUs	1,909	2,796	4,243	6,331.45	9,960.33	16,115.78
Coal-based electricity	MUs	1,626.03	2,382.05	3,614.36	5,393.77	8,485.20	13,729.03
Gas-based electricity	MUs	19.09	27.96	42.43	63.31	99.60	161.16
Emissions from coal-based electricity	$MtCO_2e$.	1.40	2.05	3.11	4.64	7.30	11.81
Emissions from gas-based electricity	$MtCO_2e$.	0.01	0.01	0.02	0.03	0.04	0.07
Total emissions from PGVCL electricity supply	$MtCO_2e$.	1.41	2.06	3.13	4.67	7.34	11.87

Table 16: Per capita electricity consumption in India and its cities[14]

City/region	kWh/person
Rajkot	1,316
Ahmedabad	1,564
Gujarat	2,378
India	1,181
MP	1,084
Bhopal	588
Indore	724
New Delhi	1,548
Mumbai	1,121
Chennai	1,366
Bengaluru	1,074

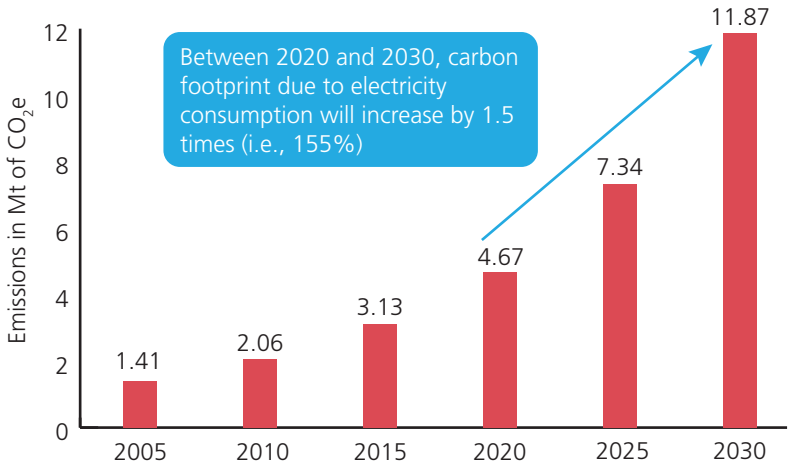


Figure 32: Carbon footprint of electricity consumption of Rajkot district

3.3 Vehicular growth trends

The data trend below confirms to vehicular registrations at RTO Rajkot (Parivahan Sewa, 2021) (Table 17 and Figure 33). In August 2013, districts in Gujarat state were re-arranged, and a few talukas from Rajkot district were separated to form Morbi district, diverting the vehicular registrations from RTO Rajkot to RTO Morbi, hence the decline in numbers post 2014 can be observed. Dips in registrations can also be observed in 2019 and 2020, due to recession in automobile sector and COVID-19 pandemic, respectively. Hence, projections were made for vehicle numbers for Rajkot RTO for 2025 and 2030 based on the CAGR estimated from 2016 to 2018 to depict a fair trend of projections (Table 18 and Figure 34).

13 Grid emissions factor for electricity generated through Coal = 0.86 kg CO_2/kWh; and through Gas = 0.42 kg CO_2/kWh

14 Per capita electricity consumption for states is sourced from the following government website: https://pib.gov.in/PressReleseDetailm.aspx?PRID=1592833 and for cities it is calculated on the basis of total electricity consumption.

Table 17: Trend of vehicular registrations over the years in Rajkot (2012 to 2020)

Vehicle category	2012	2013	2014	2015	2016	2017	2018	2019	2020
Heavy goods vehicle	922	798	622	947	1,009	717	783	940	387
Heavy motor vehicle	69	67	32	26	64	27	13	21	15
Heavy passenger vehicle	302	164	94	182	131	56	121	54	33
Light goods vehicle	3,009	2,638	2,265	2,829	2,630	2,107	2,298	2,532	1,704
Light motor vehicle	19,154	15,383	19,553	20,114	18,398	20,710	21,460	18,834	16,794
Light passenger vehicle	416	247	226	299	224	274	278	371	190
Medium goods vehicle	305	224	206	207	223	188	233	195	82
Medium motor vehicle	17	12	12	14	15	17	20	21	40
Medium passenger Vehicle	91	98	102	64	100	78	70	65	37
Three-wheeler(T)	4,080	2,715	3,165	3,267	2,541	2,348	3,309	3,249	1,325
Two-wheeler	88,331	80,987	97,658	85,819	75,200	80,963	82,982	68,052	43,865
Other	311	221	250	226	207	202	354	400	286
Total	1,17,007	1,03,554	1,24,185	1,13,994	1,00,742	1,07,687	1,11,921	94,734	64,758

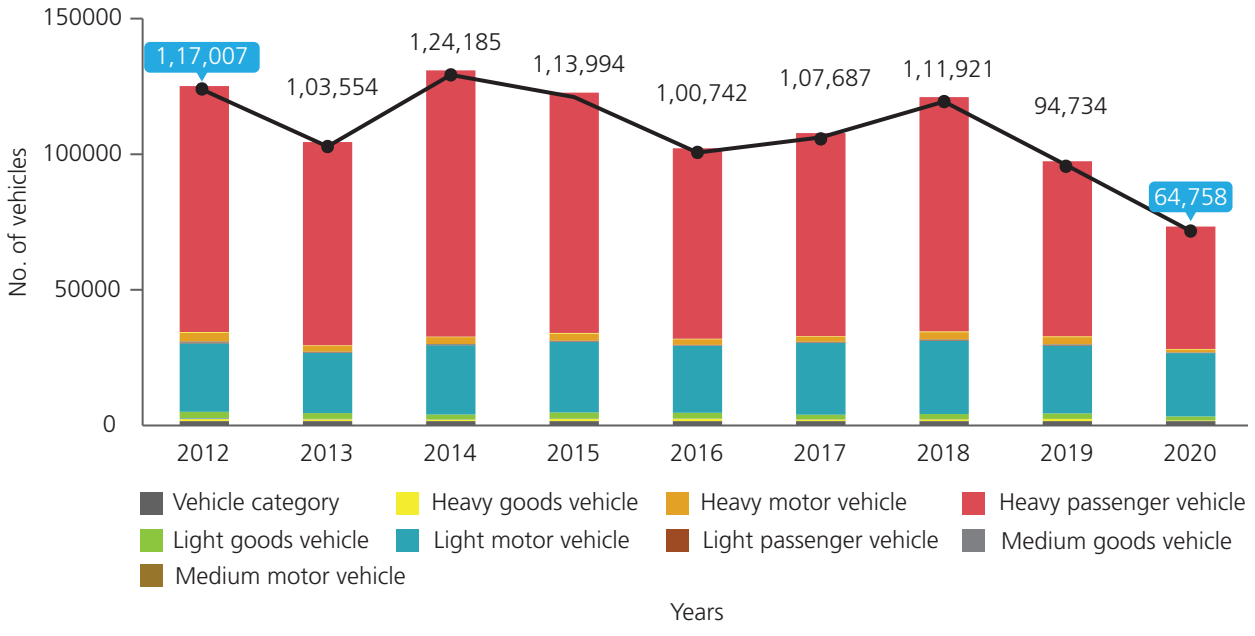


Figure 32a Trend for vehicular registrations in Rajkot over the years

Table 18: Projections for vehicle numbers (vehicle category wise) for Rajkot RTO (CAGR 2016-18)

Vehicle category	2012	2015	2018	2020	2025	2030
Heavy goods vehicle	922	947	783	387	205	109
Heavy motor vehicle	69	26	13	15	0	0
Heavy passenger vehicle	302	182	121	33	27	22
Light goods vehicle	3,009	2,829	2,298	1,704	1,216	868
Light motor vehicle	19,154	20,114	21,460	16,794	24,678	36,262
Light passenger vehicle	416	299	278	190	326	559
Medium goods vehicle	305	207	233	82	92	102
Medium motor vehicle	17	14	20	40	82	169
Medium passenger vehicle	91	64	70	37	15	6
Three-wheeler	4,080	3,267	3,309	1,325	2,564	4,962
Two-wheeler	88,331	85,819	82,982	43,865	56,109	71,771
Others	311	226	354	286	1,094	4,183
Total	1,17,007	1,13,994	1,11,921	64,758	86,408	1,19,013

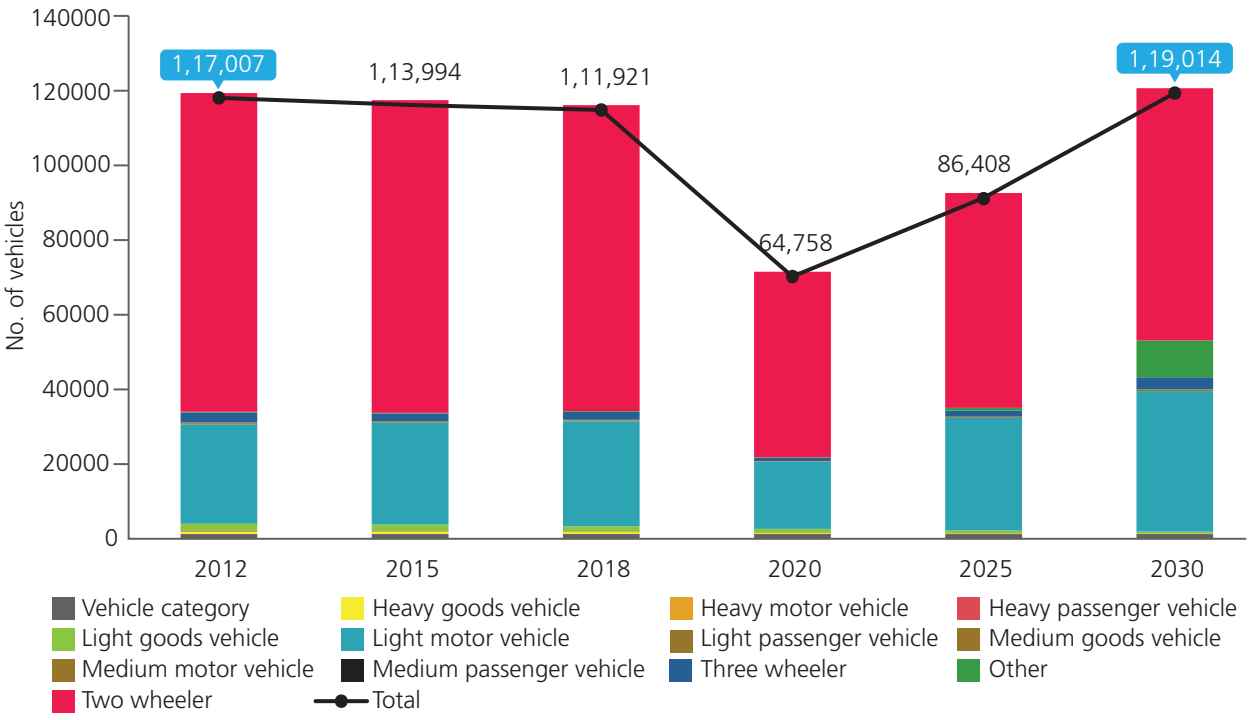
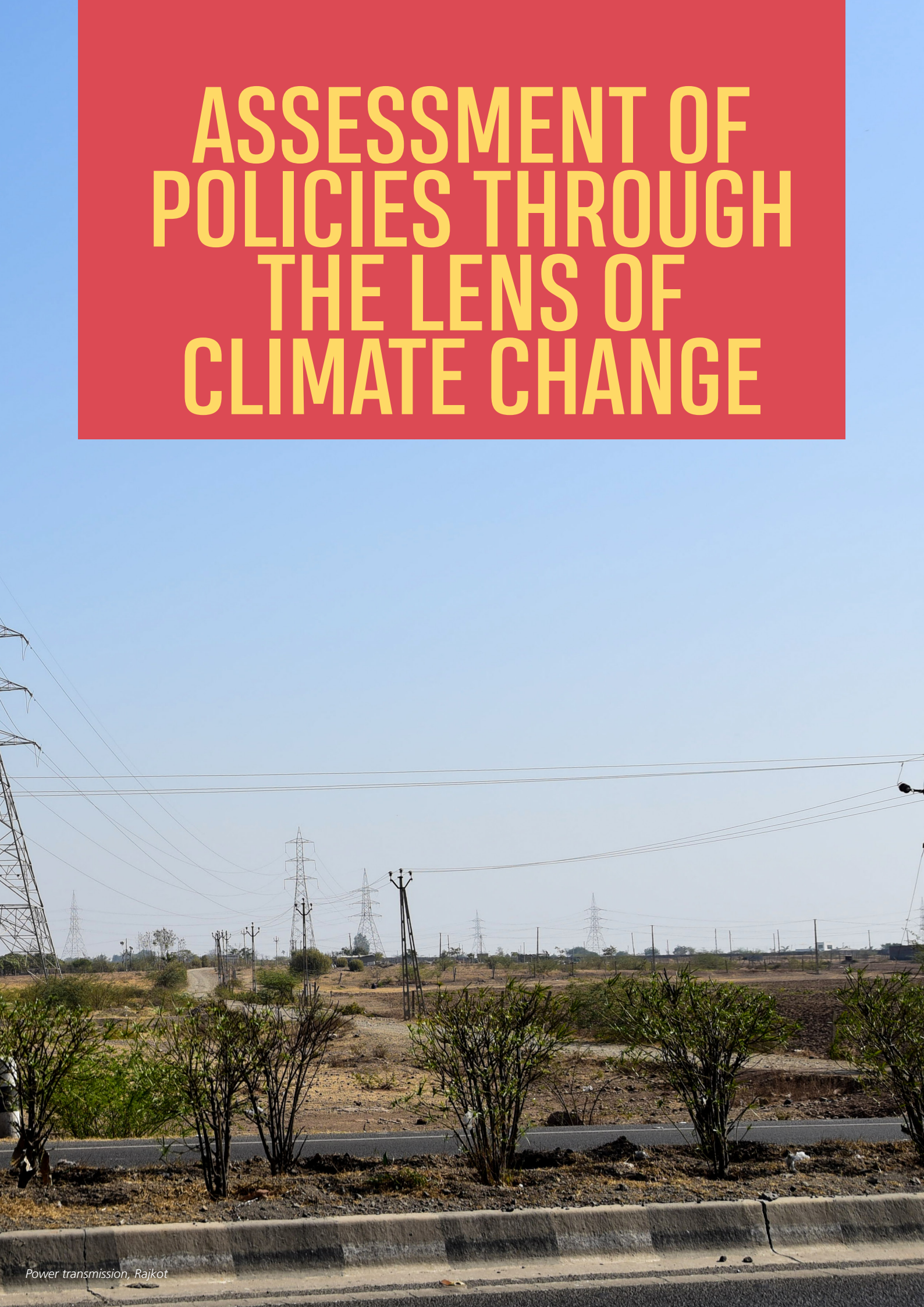


Figure 32b Projections for vehicle numbers (vehicle category wise) for Rajkot RTO (CAGR 2016-18)

ASSESSMENT OF POLICIES THROUGH THE LENS OF CLIMATE CHANGE



Power transmission, Rajkot

4. ASSESSMENT OF POLICIES THROUGH THE LENS OF CLIMATE CHANGE

This section uses a climate change mitigation perspective to evaluate the impact of national and state level policies and programmes that are implemented in Rajkot district. A total of 40 policies have been evaluated for the sectors of energy, AFOLU and waste.

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

4.1 Sector-wise policy impact analysis

4.1.1 Power and energy sector[15]

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

List of policies evaluated

Clean Energy

1) Gujarat Solar Policy, 2021; 2) Surya Rooftop Yojana; 3) Solar Power Policy, 2015; 4) Policy for Development of Small-Scale Distributed Solar Projects, 2019; 5) Gujarat Wind Power Policy, 2016; 6) Gujarat Wind Solar Hybrid Power Policy 2018-19

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) PAT (Perform, Achieve and Trade) Scheme

Transport

1) BRTS Rajkot

Emissions evaluation

Amongst the policies evaluated

- Clean energy-related policies and programmes resulted in avoidance of 17,96,180 tonnes of CO_2e emissions (policies on solar energy avoided: 40,695 tCO_2e whereas, wind energy avoided: 17,55,485 tCO_2e).
- Policies and programmes related to enhancing energy efficiency in buildings and processes have avoided 55,65,448 tonnes of CO_2e. emissions (UJALA Scheme: 2,98,517 tCO_2e.; SLNP: 46,178 tCO_2e.; IPDS, R-APDRP, UDAY: 49,27,630 tCO_2e; PAT Scheme: 2,93,123 tCO_2e.).
- Interventions in transport resulted in avoidance 2,68,308 tonnes of CO_2e emissions.

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

Information gaps

1 Policies pertaining to renewable energy: a) Year-on-year data is not available for Rajkot, since inception (for the policies considered here); b) Generation data of the solar and wind plants is not available;

2 Energy efficiency: Year-on-year data on number of the UJALA LEDs distributed and the number of LED streetlamps installed in the district, is not available;

3 Transport: Annual utilisation factor of vehicles is required for the district; for the current analysis, national values have been used.

4.1.2 Agriculture, forestry and other land use (AFOLU) and cross-cutting[16]

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

List of policies evaluated

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

Agriculture

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

Livestock

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

Forestry

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

Cross-cutting (agriculture and energy)

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

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

Emissions evaluation

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

- Forestry policies helped to avoid 5,66,637 tonnes of CO_2e emissions.
- Policies pertaining to livestock proved to be beneficial for climate action by avoiding 1,791 tonnes of CO_2e.
- In the agricultural sub-sector, impact of only one policy could be computed – the National Food Security Mission added 75,273 tonnes of CO_2e.
- Under the cross-cutting sector, the National Mission on Micro Irrigation resulted in avoidance of 1,033 tonnes of CO_2e emissions (from reduction in use of fertiliser). Additionally, the Pradhan Mantri Ujjwala Yojana has helped mitigate 2,86,393 tonnes of CO_2e./year.

Information gaps

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

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

4.1.3 Waste management[17]

Waste sector policies implemented in the district were categorised into sanitation, waste management (solid, BMW & 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; 7) Integrated Urban Sanitation Programme (IUSP)

Waste management

1) Solid Waste Management Rules, 2016 & Amendment 2018; 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) Atal Mission for Rejuvenation and Urban Transformation (AMRUT); 4) Common effluent treatment plant (CETP) for medium and small-scale industries; 5) Online Monitoring of Industrial Emission & Effluent (OCEMS)

17 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 emissions from incineration of bio-medical waste and hazardous waste. The policy activities have led to an annual average:

- Emission of 39,806 tCO_2e from individual household latrines (IHHL: two pit latrine) and 74,820 tCO_2e from community latrines (septic tank) constructed under sanitation programmes/policies;
- Emission mitigation of 4,160 tCO_2e from biological treatment (composting) of MSW, emission of 135 tCO_2e from incineration of bio-medical waste;
- Emission of 19,029 tCO_2e from STPs constructed under sewerage connection programmes. It must be noted that the implementation of these activities has avoided an annual average emission (w.r.t baseline) of 30,610 tCO_2e and 2,484 tCO_2e by sanitation and liquid waste management policy initiatives respectively in the district.

Information gaps

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

Gaps in policy and implementation

Power and energy sector

Gujarat ranks #4 in total solar installed capacity, and #1 in solar rooftop installed capacity at national level. The current total solar installed capacity of Gujarat stands at 4.05 GW (as on Jan 31, 2021), 77.3 percent of which is ground-mounted, and 22.7 percent is solar rooftop (MNRE). It is noteworthy that GoG has lifted the capacity ceiling for setting up solar plants and has a subsidy provision of ₹ 10,000/kW for domestic consumers and up to 40 percent of the installation cost for government, commercial, and industrial 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 around 4 GW of the state target of 8 GW installed solar capacity by 2022. This indicates that the state needs to enhance its endeavours in implementing the solar projects to cover this lag in due time. The completion of the proposed hybrid RE power plant in Kachchh, with the proposed capacity of 30GW by 2022, would help the state in achieving its target. Rajkot, being a industrialised and moderately urbanised district, also has a huge potential for solar rooftop installations.

Current total solar installed capacity of Gujarat is 4.05 GW, of which 77.3% ground mounted & 22.7% solar rooftop.

Through the Surya Shakti Krishi Yojana (SKY), the Government of Gujarat hopes to benefit 12,400 farmers across 33 districts, by helping them generate solar energy for captive consumption and sell the surplus to the grid. However, the progress report for this scheme is not available. In addition, the Solar Pump Scheme in tandem with PM KUSUM Yojana was launched to provide solar pumps to farmers to reduce grid dependence for irrigation. However, no solar plant or stand-alone solar pumps have been installed in the state under PM

KUSUM Yojana (GUVNL).[18] Enhanced endeavours of the state in implementing and capturing mass attention towards SKY and PM-KUSUM Yojana would help the state strengthen its RE infrastructure.

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 Gujarat.

Transport sector policies:

- The current modal share of public transport is low – around 14 percent – indicating a weak public transport network. Policy interventions are needed to overhaul the existing public transport system and increase its popularity and usability.
- Policy-level interventions are needed to improve the BRTS and other public transport modes in terms of robustness, reliability, frequency, and reach in the district.
- There is also a need for policies or programmes to green the transport sector in the district.

AFOLU and cross-cutting

- Although the forest cover of Rajkot district has improved in recent years, the district (an important urban agglomeration in the Saurashtra region) is susceptible to losing its already very low forest cover (only 1.38 percent of its geographical area) due to rapid urbanisation and development. Stringent policy measures are needed to ensure that Rajkot's forest cover is not only maintained, but also enhanced. This will ensure several benefits, such as: (a) the green cover will act as a sink for the district's GHG emissions; (b) the urban heat-island effect will get reduced; (c) groundwater sources will increase.
- Increase in cattle count of low productivity is a key contributor to AFOLU sector emissions due to enteric fermentation. Currently, there are a few policies in place that can be enhanced to curtail emissions arising from enteric fermentation in livestock. Sectoral experts can suggest relevant changes (with climate mitigation perspective) in 'Feed and Fodder Development Programme' and 'Cattle and Buffalo Development Programme' to bring quantifiable reduction in emissions from the livestock category.
- The nexus between power and agriculture sector has a lacuna in policy level interventions. Agriculture activities, such as non-judicious irrigation practices, lead to high electricity consumption patterns and over withdrawal of groundwater. Policies pertaining to electricity pricing, subsidies, and collection of tariffs need to be revised.

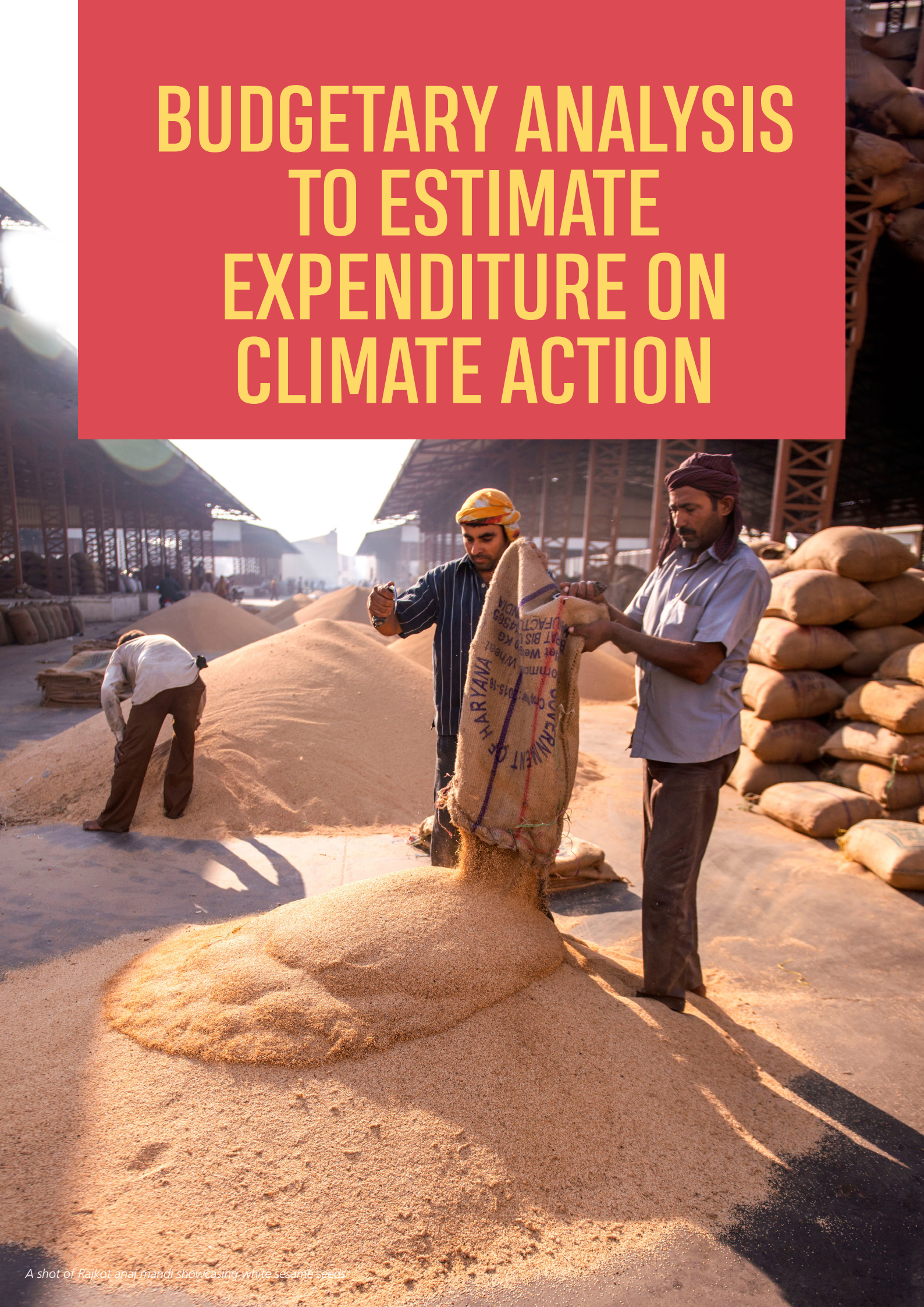
Waste management

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

- State-level reporting of waste generation and treatment data is mandatory. However, district-wise and waste treatment type-wise data maintenance and reporting is not a policy requirement for any waste sector categories, except for biomedical waste (BMW). Even for BMW, this data is not being recorded and maintained in the 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 management policies do not suggest gas management/capture facilities for composting and incineration units to dispose waste.
- Waste transportation emission reduction is not addressed in the waste management policies.
- The Solid Waste Management Rules, 2016 suggest producer take back mechanisms for disposables in municipal solid waste. However, there is a lack of guidelines for monitoring and reporting framework for the same.
- E-waste Management Rules, 2016 recommends states to have an e-waste inventory. Though Gujarat Environment Management Institute (GEMI) has taken up inventorisation of e-waste, it does not reflect the total waste electrical and electronic equipment (WEEE) generation quantity from the district, as it does not consider all categories of electricals and electronics and the consumer generation of e-waste.

18 https://pmkusum.guvnl.com/achive.html

BUDGETARY ANALYSIS TO ESTIMATE EXPENDITURE ON CLIMATE ACTION



A shot of Rajkot anaj mandi showcasing white sesame seeds

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 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 select flagship schemes at the district level has 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, four schemes for Rajkot were selected for further analysis.

Annexure 5.1 and 5.2 detail the rationale and steps undertaken to conduct district-level analysis.

5.2 Analysis and findings of flagship schemes

5.2.1 Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS)

2018-19

- District annual budgetary expenditure: ₹ 476.63 lakh
- Allocation to climate action: 23%
- Majority of climate action works: Renovation of traditional water bodies, drought proofing

2019-20

- District annual budgetary expenditure: ₹ 917 lakh
- Allocation to climate action: 24%
- Majority of climate action works: Renovation of traditional water bodies, drought proofing

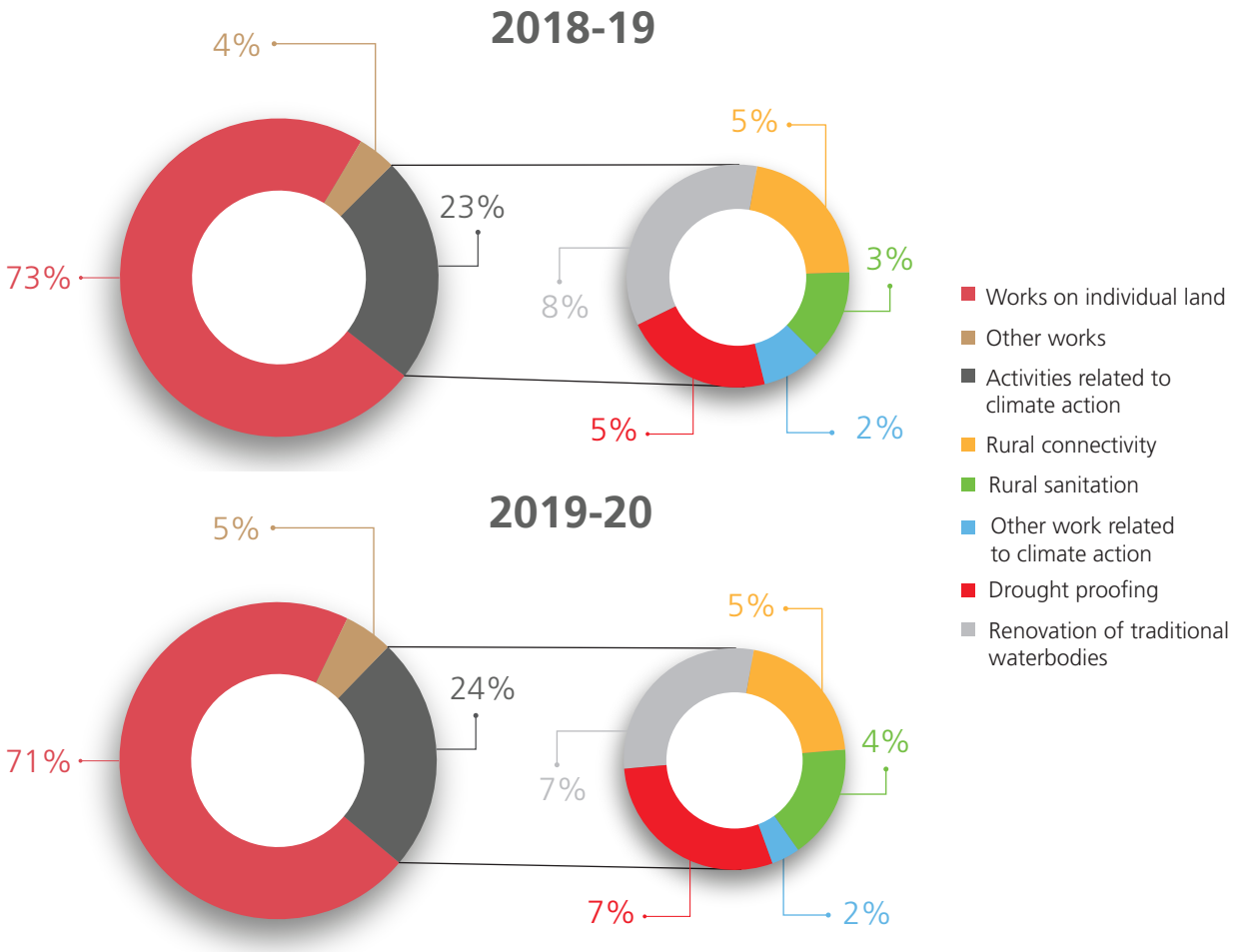


Figure 33: MGNREGS expenditure in Rajkot district for 2018-19 and 2019-20

Total budget allocated under MGNREGS in Rajkot between 2018-2019 and 2019-20 (₹ lakh)

	Drought proofing	Renovation of traditional water bodies	Rural connectivity	Rural sanitation	Other works related to climate action
2018-19	22.57	36.89	22.67	14.08	10.68
2019-20	61.83	64.91	47.37	40.91	12

Figure 34: Comparing annual expenditures (in ₹ lakh) under MGNREGS in Rajkot between 2018-19 and 2019-20

5.2.2 Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)

The micro-irrigation techniques employed in the district under this scheme are: 1) Drip irrigation technique and 2) Sprinkler irrigation technique. Other works include building of community ponds, tanks, check dams, and earth dams. See annexure 5.3 for methodology.

Budget allocation	2016-17	2019-20
Budgetary spending on micro-irrigation activities (₹ lakh)	940	1,802
Budget attributed to climate action (₹ lakh)	649	1,244
State budget for PMKSY micro-irrigation (₹ lakh)	25,000	24,000
% attributed to climate action (micro-irrigation budget under PMKSY) given to district w.r.t state budget	2.59	5.18

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

Until April 30, 2020, an amount of ₹ 3,964 lakh had been released to carry out activities under the Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY) and the Saubhagya Scheme. Hence, an amount of ₹ 1,982 lakh can be attributed towards climate action for Rajkot district. See Annexure 5.2 and 5.3 for methodology and assumptions.

5.2.4 Atal Mission for Rejuvenation and Urban Transformation (AMRUT)

Based on the methodology and assumptions detailed in Annexure 5.2, amounts of ₹ 2,760 lakh, ₹ 3,886 lakh, and ₹ 2,145 lakh can be attributed to climate action for Rajkot district in FY 2015-16, FY 2016-17, and FY 2017-20, respectively (see figure 35 for distribution) under AMRUT. Further, figure 36 gives a comparison of budgetary allocations between years 2015 and 2020 in Rajkot district, with the total allocation in this period being ₹ 16,737 lakh.

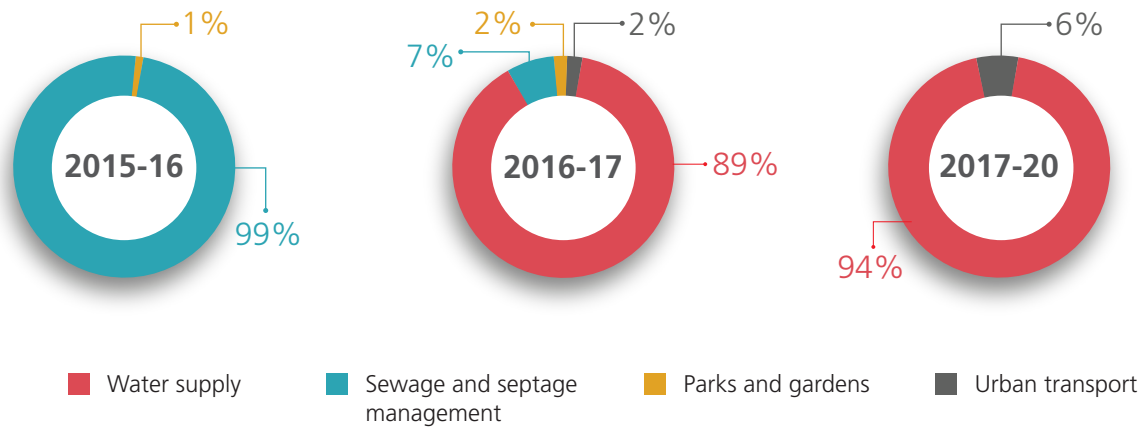


Figure 35: Distribution of climate relevant budgetary expenditure on activities under AMRUT scheme in Rajkot for 2015-16, 2016-17 and 2017-20

Total budget allocated under AMRUT (₹ crore)

	Water supply	Sewage and septage management	Parks and gardens	Urban transport
2015-16	0	27.45	0.15	0
2016-17	34.31	3.40	0.52	0.62
2017-20	20.61	0	0	0.84

Figure 36: Comparison of budgetary expenditure on climate related activities under AMRUT scheme in Rajkot district

RECOMMENDATIONS

Rajkot BRTS bus near Gondal Chowkdi

6. RECOMMENDATIONS

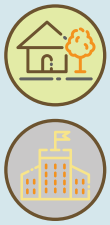
This section provides a comprehensive basket of sector-wise recommendations from a climate perspective, with an aim to complement India's 2030 NDC commitments through a district-level alignment in the form of this District Climate Change and Environment Plan. The salient features of these recommendations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

- Recommendations are grouped under four broad categories -- energy, agriculture, forestry and other land use (AFOLU), waste, and district-specific environmental issues.
- 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.
- Recommendations are based on district-specific ground realities and situations.
- The state and district vision documents were factored in while developing the recommendations.
- 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 mentioned recommendations in this action plan.
- GHG mitigation potential that can be achieved through these recommendations are:
  - Energy: 25,12,744 tCO_2e
  - AFOLU: 62,94,009.23 tCO_2e
  - Waste: 33,534 tCO_2e
- 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

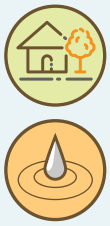
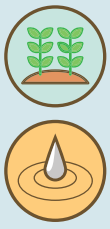
6.1 Sector-specific recommendations

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) Creating awareness in residential sector	India has a target of 40 GW for solar rooftop (2022) and as of February 28, 2021, the achievement is only 4.32GW. Gujarat has only 0.94GW solar rooftop capacity (as of February 2021). If equipped with solar rooftops, government schools in the district can generate 81.5 MUs electricity, thereby avoiding 71,000 tCO_2e., annually. The large commercial buildings (institutions and complexes) in Rajkot have a solar rooftop potential of 390 MW. If installed, solar equipment could help avoid 4,10,736 tCO_2e annually. Further, if 50% households are equipped with solar rooftops, total potential installed capacity would be 2,789 MW, which can help avoid 1.93 Mt CO_2e emissions annually. Meeting the solar rooftop targets can be fast-paced by making it mandatory for hospitality industry/new construction (having built-up area above 20,000 sq ft) / private healthcare infrastructure (above certain bed-capacity). Ground mounted solar: The current ground mounted solar installed capacity of Gujarat stands at 3.11 GW (as of February 2021). Rajkot district has a huge potential for solar power generation (rooftop and ground mounted). For Rajkot city, solar rooftop installation can be promoted. For the remaining district, ground mounted solar installations can be a more viable option.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Aggressively promote battery storage for RE.		Short to medium-term	Additional financial support can be created	Case example: Maharashtra Energy Development Agency has installed 650 Ah (Ampere hour) batteries for a few solar projects and has proposed hybrid inverters for RE projects across Maharashtra. Hybrid inverters take power from RE/battery installation up to a particular load, and on increased demand, they switch to the grid supply. Similar initiatives can be taken up in the district by GEDA.
Encourage captive use of renewable energy, particularly in rural areas for small industries and local entrepreneurs.		Short to medium-term	Policy framework exists. (section 6.1.1.1) Generate awareness	By 2030, the electricity demand for Rajkot district is expected to be approximately 16,000 MUs, annually. If this electricity demand is to be met from coal, it would cause annual emissions of around 14 $MtCO_2e$. Decentralised renewable energy (DRE) setups can power/boost small/cottage industries. This 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 across the district can be powered through DRE setups. Such set-ups could be especially useful for reliable storage of vaccines, farm produce, and rural non-farm productive use appliances.
Energy demand side management (DSM) and energy efficiency				
Encourage faster penetration of Street Lighting National Programme (SLNP). This will ensure all street and public lighting fixtures are replaced with energy-efficient LED bulbs, (by 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 SLNP had a national target of replacing 1.34 crore conventional street lamps with LED lamps by March 2020. However, till date only 1.18 crore LED lamps have been installed.[19] Replacement of the existing 52,000 sodium vapor street lamps in Rajkot district with LED lamps under SLNP can potentially avoid about 26,000 tCO_2e emissions annually.

19 International Energy Agency. 2021. Empowering Cities for a Net Zero Future: Unlocking resilient, smart, sustainable urban energy systems. Available at https://iea.blob.core.windows.net/assets/4d5c939d-9c37-490b-bb53-2c0d23f2cf3d/G20EmpoweringCitiesforaNetZeroFuture.pdf

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 GUVNL to develop advanced metering infrastructure (AMI). Install smart meters, along with accompanying IT infrastructure. This will help the DISCOM obtain real time energy consumption data of each consumer for subsequent analysis and will pave the way for initiating various smart measures like: (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 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) Generate awareness among consumer segment	Implemented by EESL (BEE), Smart Meter National Programme aims to replace 250 million conventional meters across the country with smart meters. However, under this programme no smart meter has been installed in Gujarat as of now. Smart meters are being installed under PGVCL's pilot project, Smart Village Distributed Renewable Energy generation with Smart Grid Concept, at village Nana Kajliyara and Shapur of Junagadh circle in Gujarat. As of now, a 480-kW grid-connected solar PV plant, two off-grid solar water pumping stations, an energy management centre and a weather station have been commissioned. The work of providing smart meters to the consumers of both the villages is on hand. PGVCL can consider implementing a similar project in Rajkot district as well.
Replace/upgrade existing inefficient pumping infrastructure by energy-efficient pumps/solar pumps (where possible) for supply of piped drinking water in both rural and urban pockets of Rajkot district.		Short to medium-term	Relevant schemes and programmes can help achieve this (section 6.1.1.1) Inter-departmental collaboration is required	GUDC has been designated as the nodal agency for the Municipal Energy Efficiency Programme (MEEP). This programme aims to improve the energy efficiency of pumping stations in 139 municipalities across Gujarat through detailed energy auditing.
In agriculture sector, promote energy efficient water pumps (provided by EESL), and solar pumps, wherever possible (through PM-KUSUM and SKY).		Short to medium-term	Policy framework exists (section 6.1.1.1)	According to BEE, 30 to 40% energy savings is possible in agriculture by adoption of energy-efficient star labelled pump sets. Conversion of 50% of the existing electricity/diesel operated tube-wells in Rajkot to solar can potentially save 5,008 tCO_2e emissions annually.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
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 the Collector's office to the State departments)		Medium-term	Additional financial support can be created Generate awareness through dedicated IEC and long-running campaigns	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 power consumption. 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. PGVCL can implement a similar scheme in its area of supply, with a pilot in Rajkot district. The unutilised funds from the District Mineral Foundation (DMF) can render much needed financial support (by providing subsidies to mining affected communities) to implement the scheme.

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

Sub-sectors	Policies and programmes that can push forward the recommendation	Primary departments/ agencies	Associated departments/agencies
Increase RE share in electricity generation	1) Gujarat Solar Power Policy, 2021 2) Surya Rooftop Yojana 3) Policy for Development of Small-scale distributed solar projects, 2019 4) Waste to Energy Policy, 2016 5) National Solar Mission 6) i-SMART Project 7) PM KUSUM 8) Surya-Shakti Krishi Yojana (SKY)	1) GEDA, GoG 2) Energy and Petrochemicals Department, GoG	1) ALL ULBs 2) Gujarat Electricity Regulatory Commission. 3) Rural Development Department, GoG (reporting and monitoring) 4) Urban Development Department, GoG 5) Climate Change Department, GoG (monitoring and reporting) 6) Commissionerate of Cottage and Rural Industries. 7) GUVNL-PGVCL, GoG 8) Department of Agriculture, GoG 9) Proposed District level Committee on Climate Change and Environment

Sub-sectors	Policies and programmes that can push forward the recommendation	Primary departments/ agencies	Associated departments/agencies
Energy demand side management (DSM) and energy efficiency	1) Smart Meter National Programme (SMNP) 2) National Smart Grid Mission 3) Streetlight National Programme (SLNP), 2015 4) UJALA Scheme, 2015 5) Standards and Labelling Programme 6) Sustainable Habitat Mission 7) Smart Cities Mission 8) National Mission for Enhanced Energy Efficiency 9) Municipal Energy Efficiency Programme (MEEP) 10) PM KUSUM 11) Surya-Shakti Krishi Yojana (SKY) 12) Gujarat Solar Power Policy, 2021 13) Policy for Development of Small-scale distributed solar projects, 2019	1) GEDA, GoG 2) All ULBs 3) Panchayati Raj Institutions (PRIs) 4) BEE (EESL) 5) Energy and Petrochemicals Department, GoG	1) Climate Change Department, GoG 2) Department of Agriculture, GoG 3) District Mineral Foundation (DMF) 4) RUDA 5) Rajkot Smart City Development Limited (RSCDL) 6) Proposed District level Committee on Climate Change and Environment

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
		Timeframe for the action to be accomplished	Framework for implementation	
Energy-efficiency in buildings				
Energy Conservation Building Code (ECBC) to be incorporated in the building byelaws and green building rating programmes. For instance, the Indian Green Building Council (IGBC) rating programme can be encouraged by giving incentives. This will create a pathway for having 'net zero energy' consumption buildings.		Medium to long-term	Policy framework exists (section 6.1.2.1) Inter-departmental collaboration required Capital incentives/ relevant exemptions over and above the existing provisions from the district administration	Residential and commercial sectors in Rajkot contribute around 30% of the total electricity consumption in the district. GEDA is working with the Urban Development Department and the Climate Change Department to incorporate ECBC into building compliance systems.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
District administration, in collaboration with the ULBs, can implement the India Cooling Action Plan (ICAP) and achieve its objectives, in tandem with the District Heat Action Plan. 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 can 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 that 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; and (v) train and certify 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 EWS and LIG houses; (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. The district cooling system in the Gujarat International Finance Tech-City (GiFT City) in Gandhinagar provides reliable cooling to residential, commercial and industrial buildings. The system regulated by advanced metering and supervisory control and data acquisition (SCADA) systems, is expected to consume 60% to 85% of the energy used in conventional air conditioning.
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 >20,000 sq ft.		Short to medium-term (government buildings) Medium to long-term (privately owned, commercial, institutional, and others)	Policy intervention is required Proper policy backup can mitigate GHG emissions and align India with Paris targets Needs inter-departmental collaboration	In Rajkot district, 88 entities use DG sets as power backup. If 50% of the DG sets alone are replaced with solar powered backup, 23,000 tCO_2e. emissions can be averted annually.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
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 generating data that will provide important investment information to the energy market. Deploying public funding schemes like feed-in tariffs; leverage national and international funds; and providing digital upskilling opportunities to citizens can help promoting the initiative.		Medium-term	Can be pushed forward by aligning with existing policy framework	
Upgrade public transport infrastructure such as bus depots, bus stops, railway stations etc. 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 needs to be mandated by building byelaws	Rajkot district can adopt and implement initiatives, similar to the initiative listed below, to green its transport-related infrastructure: In Lucknow, the municipal corporation has announced setting up of 200 solar powered bus stops.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Encourage fast penetration of UJALA scheme in every household of Rajkot district.		Short to medium-term	Schemes and programmes are available (section 6.1.2.1)	The UJALA scheme provides an LED bulb at a nominal price for replacement of incandescent lamps /conventional bulbs. A projected estimated number of LED bulbs to be used in the households of Rajkot district through implementation of UJALA scheme by 2030 can potentially avoid emission of about 47,000 tCO_2e. annually. The Gram Ujala programme was recently launched by Convergence Energy Services Limited (CESL). Under the programme, 7-watt and 12-watt LED bulbs with three years of warranty will be given to rural consumers on submission of working incandescent bulbs, at a price of ₹ 10/LED bulb. Consumers can exchange a maximum of five incandescent bulbs with LED bulbs. In the first phase of this programme, 15 million LED bulbs will be distributed across villages of Aarah (Bihar), Varanasi (Uttar Pradesh), Vijaywada (Andhra Pradesh), Nagpur (Maharashtra), and villages in western Gujarat. The programme will be financed entirely through carbon credits and will be the first such programme in India.
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 agricultural land and open space and makes the transport mechanism much more efficient.
Enhance public awareness for switching to energy-efficient BEE star-labelled home appliances.		Short-term and continuous	Needs collaborations and awareness.	

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Demand-side management				
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) Awareness generation required	Under Comprehensive General Development Control Regulation (2016) of RUDA, rainwater harvesting is mandatory for all buildings with ground coverage of 80 sq mt and above.
Implement individual water metering in residential sector to reduce water wastage and introduce other energy efficient measures for drinking water and wastewater plants (thereby reducing energy consumption).		Medium-term	Policy intervention is required Need to create awareness	In many cities, drinking water and wastewater plants are municipally owned and are among the largest municipal energy consumers, often accounting for 30% to 40% of total municipal energy consumption. By incorporating energy efficiency measures into their water and wastewater plants, municipalities can save 15% to 30% of their municipal budgets. During the FY 2016-17, RMC commenced the water metering project in Chandreshnagar water supply zone, targeting 12,000 subscribers in the area. Case example: 16 apartments in Mantri Residency, Bengaluru, installed with water meters, are consuming 25% to 30% less water every year.
Encourage residential societies to adopt 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 a part of green buildings	As a rule, for multi-storey residential buildings up to 12 storeys, community solar water heating systems on the roof (assuming utilisation of 60% of the roof area) can meet around 70% of the annual electricity requirement for heating water (BEE).
Promote installation of automatic/smart water pumps to control overflowing of tanks.		Short-term	Need to generate awareness.	
Water cess/pricing by municipal corporation to be revised and gradually increased.		Medium-term	Policy framework to be revised	

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
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, Rajkot can counteract on heat islands through tree plantations that provide shade and reduce the power demand for cooling in buildings.

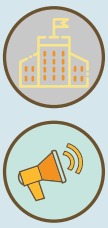
6.1.2.1 Habitat: Policy framework and concerned departments/agencies

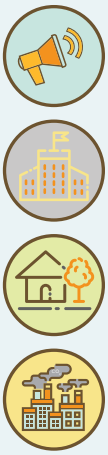
Sub-sectors	Policies and programmes that can push forward the recommendation	Primary departments/ agencies	Supporting departments/ agencies
Energy efficiency in buildings	1) ECBC, 2017 2) India Cooling Action Plan, 2018 3) UJALA Scheme, 2015 4) Gujarat Solar Power Policy, 2021 5) Surya Rooftop Yojana 6) Policy for Development of Small-scale distributed solar projects, 2019 7) Smart Cities Mission 8) Sustainable Habitat Mission 9) Gram Ujala Programme, 2021	1) Urban Development and Urban Housing Department, GoG 2) All ULBs 3) Rajkot Smart City Development Limited (RSCDL) 4) Panchayati Raj Institutions (PRIs)	1) GEDA, GoG 2) BEE (EESL) 3) Rural Development Department 4) Road and Building Department 5) Ports and Transport Department/GSRTC 6) Proposed District level Committee on Climate Change and Environment
Demand-side management	1) Gujarat Domestic Water Supply Protection Bill, 2019 2) ECBC 3) Building byelaws 4) Comprehensive General Development Control Regulations- Urban Development and Urban Housing Development, GoG	1) Urban Development and Urban Housing Department, GoG 2) All ULBs 3) Rural Development Department 4) Panchayati Raj Institutions (PRIs)	1) RUDA 2) Gujarat Water Supply and Sewerage Board. 3) Rajkot Smart City Development Limited (RSCDL) 4) Proposed District level Committee on Climate Change and Environment

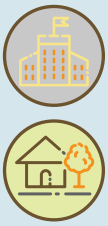
6.1.3 Transport: Recommendations, cross-cutting sectors, qualifying priority, and district scenario

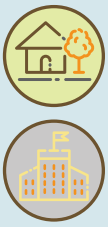
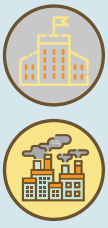
Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Promote e-mobility				
Generate awareness and information dissipation to encourage adoption of electric vehicles.		Short-term and continuous	Inter-departmental collaboration and dedicated long-running campaigns required	The Gujarat EV Policy, 2021 plans for transition of the transport regime of Gujarat to electric mobility in a phased manner. Planned awareness campaigns can encourage widespread acceptance of EV in the district.
Increase the 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) Budgetary provisions required	In January 2020, the Gujarat government announced it will be installing charging stations at multi-level parking lots and public places across the state. This will be a crucial step in transitioning to electric mobility in the state as well as the district.
Make all public transport (PT) modes low carbon intensive, such as shifting current fossil fuel-based vehicles to electric or hybrid vehicles.		Medium and long-term	Policy framework (section 6.1.3.1) and budgetary provisions exist	Under FAME II, Rajkot Municipal Corporation has approved 50 e-buses in 2019. These will be procured for both RMTS and BRTS services. In 2019, Gujarat CM had announced the procurement of 500 electric buses across the state.
Initiate transition of intermediate public transport (IPT) vehicles to electric by incentivising IPT operators through: a) subsidies, b) separate lanes, c) dedicated parking spaces, d) replacement of lead acid battery-powered electric IPT vehicles with more sustainable Li-ion battery e-vehicles in a phased manner.		Medium-term	Policy framework exists (section 6.1.3.1)	Currently, Gujarat provides subsidies of ₹ 10,000 for Li-ion battery-operated rickshaw, bringing their cost down to approximately ₹ 40,000. There is no subsidy for lead-acid battery-based vehicles. However, they are still cheaper, costing around ₹ 30,000.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
District administration, ULBs (for office use and solid waste transport activities) and all district-level government offices can adopt e-vehicle fleets. Additionally, all these offices need to install charging infrastructure at the earliest.		Short-term	Proper policy backing required.	The Gujarat EV Policy, 2021 has recommended all government office building parking areas to install charging infrastructure for both employees and visitors. The district can take advantage of this provision and build on the same to encourage government departments to transition their fleets to EV-based vehicles.
Develop robust and widespread charging infrastructure through: a) Installations at strategic locations – commercial hubs, public parking, airports and railway stations etc. b) Adoption of relevant policies: Amendments in Model Building Bye-Laws (MBBL - 2016) give guidelines for setting up charging infrastructure for e-vehicles. c) Prioritising land acquisition for setting up charging infrastructure. d) Introduction of dedicated parking spaces for EVs with charging facilities. e) Incentivising restaurants, fuel pumps and commercial spaces on highways for installation of EV charging infrastructures to make long journeys with e-vehicles hassle-free. f) Preference to development of RE-powered charging facilities. g) As a cost effective solution to reduce street clutter and to open access (particularly for those without garages), integrated EV charging points into lampposts can be evaluated as a trial solution for further implementation possibilities.		Medium-term	Policy framework exists (section 6.1.3.1) Inter-departmental collaboration required	RMC can consider collaboration with Energy Efficiency Services Limited (EESL) to establish wide-spread charging structure across the district. Example: In Ahmedabad, EESL has partnered with Ahmedabad Municipal Corporation (AMC) to establish infrastructure for electric vehicles (EV) in the urban area over a 10-year period to establish 100 charging stations and promoting electric vehicles on rental and purchase basis in AMC areas. Each EV is expected to avoid 4.46 tonnes of CO_2 emissions per year.
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) exemption on road tax, b) exclusive parking for EVs, c) additional subsidy scheme for women and students.		Short-term	Policy framework needs to be enhanced	Government of Gujarat is already providing subsidies up to ₹ 12,000 to students and women for purchase of electric two-wheeler. Also, a subsidy of ₹ 42,000 is provided for e-autos.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Promote fast registration of EVs at RTO and create awareness to popularise EVs.		Short-term	Existing policy framework can be enhanced Need for inter-departmental coordination	Can be modelled after Delhi's EV Policy that fast-tracks the integration of EV into the transport mix of the city and allows for fast tracked registration of EVs.
Encourage development of local network of rental e-vehicles, including cars and bikes as well as a battery rental network for faster adoption of EVs. Further, this can be integrated with smart cards.		Medium-term	Needs policy backing	Rajkot city may replicate the bicycle and electric two-wheeler renting models which are in practice in Ahmedabad. In December 2019, AMC made 1,000 bicycles and 500 electric scooters available for rent in various parts of the city.
Encourage and promote adoption of EVs for all delivery operations within the district.		Short to medium-term	Policy framework is required Need for inter-departmental coordination	Currently, most delivery partners for food, courier and other 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.
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 to ensure the popularity of EV by allowing the EV 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. Promoting smart lampposts using efficient LEDs, powered with electricity from the grid or can be equipped with PV modules to harvest and store solar energy during the day to power lighting at night. They may also be equipped 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
		Timeframe 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) Integrating smart mobility applications with real-time service updates across modes, including car hire, public transit and shared micromobility schemes. c) Increasing fleet strength. d) Increasing frequency of PT. e) Adding more stops. f) Enhanced reach to low or non-serviced areas, such as peri-urban and rural areas. g) Developing dedicated parking spaces for IPT.		Medium to long-term	Policy framework required Inter-departmental collaboration required	Rajkot is the second city in Gujarat to launch BRTS – Rajkot Rajpath Ltd (RRL) RMTS network covers 223 km stretch, 46 routes, 342 stops and 99 buses. BRTS network covers 10.7 km stretch, one route, 18 stops and 11 buses. Further network coverage of 63.5 km is planned. Rajkot can adopt the smart card initiative similar to the one introduced by AMC. Example: AMC has introduced Janmitra Card for BRTS, AMTS, some tourist site entries, parking, property tax payments, among others. This initiative (if implemented in Rajkot) can be expanded to other modes of transport for seamless connectivity. Currently, there is only 21% network coverage of PT in RUDA areas, which includes peri-urban areas of the district. These generally rely on hired autos and other IPT modes. At present, the IPT sector is not completely formalised, and connectivity is limited to certain routes (largely in and around popular commercial and residential areas). Residents in outskirts/ peri-urban areas still rely on private vehicles or walking for majority of their commute.
District administration can collaborate with ULBs to develop fiscal measures to discourage the use of personal vehicles, through measures such as variable parking charges for peak hours.		Short-term and continuous	Proper policy backing, based on research and inter-departmental cooperation is required	Rajkot can adopt recommendations from Delhi Master Plan 2021, which provides a parking district management plan. The action plan suggests that the transport department, municipal corporations, traffic police and other agencies need to collaborate to develop and maintain parking areas. The plan also suggests that variable and time-based parking prices should be introduced.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Implement policy measures to discourage use of private vehicles: a) Parking policy for vehicle ownership. b) No car days on certain roads. c) Parking allowed only in dedicated areas.		Short to medium-term	Proper policy backing, based on research and inter-departmental cooperation is required	Example: Sikkim Parking Policy, 2010 mandates that only houses with parking slots can procure vehicles.
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, needs stricter implementation.	
Awareness campaigns to popularise PT and IPT modes.		Short-term and continuous	Dedicated awareness campaigns required	
Augment non-motorised transport (NMT)				
Improve infrastructure to enhance modal share of NMT transport options, through measures such as introducing segregated cycle lanes.		Medium-term	Proper policy backing, based on research and inter-departmental cooperation is required	Current modal split in Rajkot indicates that the share of NMT is approximately 40%. However, it is decreasing over the years. Efforts are needed to make NMT a preferred and viable option.
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.		Starting short-term and continuing throughout	Policy framework exists, timely inter-departmental cooperation is required	
Introduce cycle hire service in key locations across the district.		Short-term	Requires proper policy backing and strategic awareness drives Further, PPP models can be explored for successful implementation	Case example that can be adopted in Rajkot: 'Amdabike' is SCADL's flagship public bike share project for Ahmedabad city. The services are planned for all BRTS bus stops in the western part of the city and are to connect various colleges, offices and residential complexes, malls, lakes, gardens, etc. Currently, there are 30 hubs and a fleet of 500 bicycles with a plan of 500 additional bicycles and 30 more hubs.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
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	Proper policy backing based on research, and multi-stakeholder and inter-departmental cooperation required	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. Similar shift is also being planned in Bengaluru. Rajkot too can adopt these best practices to minimise congestion at peak hours.
a) Create additional dedicated parking zones for vehicles to deter encroachment of road space and pavements. b) Direct business/corporate centres to have mandatory private parking with sufficient parking slots, so as to avoid parking on roads, service lanes and other public spaces.		a) Medium-term b) Short-term and continuous	While the policy framework exists, implementation is poor Requires multi stakeholder and inter-departmental cooperation	Example: Ahmedabad has multi-level parking spaces available. However, since awareness is low, utilisation is poor. The municipal corporations and district authorities can work towards building awareness and encouraging use of parking. Similar structures can be developed at strategic locations in Rajkot district with special emphasis on popularising parking spaces for public use.
Develop dedicated areas for street vendors in order to deter encroachment of pavement and avoid traffic congestion on roadsides.		Short to medium-term	Policy framework exists; implementation is irregular and for short timeframes Requires multi-stakeholder and inter-departmental cooperation	There are regular drives by the RMC and the city police to clear encroachments. However, such measures can affect the livelihoods of the street vendors.
Regular maintenance of roads to ensure smooth flow of traffic as it can help reduce GHG emissions while extending the life of the road.		Short to medium-term and continuous	While the policy framework exists, implementation is lacking in some areas. Multi stakeholder and inter-departmental cooperation is required.	

6.1.3.1 Transport: Policy framework and concerned departments/agencies

Sub-sectors	Policies and programmes that can push forward the recommendation	Primary departments/ agencies	Supporting departments/agencies
Promoting E-mobility	1) FAME II 2) Gujarat EV Policy, 2021 3) JNNURM 4) National Electric Mobility Mission Plan 5) Smart Cities Mission 6) AMRUT 7) Proposed e-vehicle Policy (as per 2021-22 Union Budget) 8) National Urban Transport Policy, 2006	1) All ULBs 2) RTOs 3) EESL	1) Urban Development & Urban Housing Department, GoG 2) GEDA 3) Transport Department, GoG 4) Roads and Buildings Department, GoG (of infrastructure for public transport) 5) Climate Change Department, GoG 6) Rural Development Department 7) RUDA 8) Other ULBs 9) Smart City Rajkot Development Limited 10) Airport authority 11) Western Railways - Rajkot Division
Public transport and intermediate public transport	1) BRTS 2) JNNURM 3) ECBC 4) Smart Cities Mission 5) AMRUT 6) National Urban Transport Policy, 2006	1) All ULBs 2) Rajkot Smart City Development Limited 3) GSRTC 4) GMRC	1) Urban Development & Urban Housing Department, GoG 2) Transport Department, GoG 3) RTOs 4) Roads and Buildings Department, GoG 5) Climate Change Department, GoG 6) Rural Development Department, GoG 7) GEDA 8) RUDA 9) Other ULBs
Augment non-motorised transport	1) Smart Cities Mission 2) AMRUT 3) National Urban Transport Policy, 2006	1) All ULBs 2) RUDA 3) Smart City Rajkot Development Limited	1) Urban Development & Urban Housing Department, GoG 2) Roads and Buildings Department, GoG 3) Climate Change Department, GoG 4) Rural Development Department, GoG 5) GEDA 6) Police Department, GoG

Sub-sectors	Policies and programmes that can push forward the recommendation	Primary departments/ agencies	Supporting departments/agencies
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) RUDA 3) Other ULBs 4) Smart City Rajkot Development Limited 5) RTOs	1) Urban Development & Urban Housing Department, GoG 2) Roads and Buildings Department, GoG 3) Gujarat Infrastructure Development Board (GIDB) 4) Climate Change Department, GoG 5) Rural Development Department, GoG 6) Police Department, GoG 7) Department of Industries, GoG 8) GIDC

6.1.4 Industry: 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	
The district can develop an incentive system, similar to a 'cap and trade' system for enhancing energy efficiency of MSMEs, in coordination with the state energy department.		Medium-term	Requires formulation of policy framework 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 Further awareness 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
		Timeframe for the action to be accomplished	Framework for implementation	
Optimise equipment efficiency. Equipment that are not usually turned off during downtime, 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)	Gujarat Industrial Policy 2020 focusses on: a) Strengthening the regulation and environmental compliance b) Implementation of cleaner production technology in place of existing processes, such as substitution and optimisation of raw material, reduction in water consumption or energy consumption or waste generation, at 35% of cost of plant and machinery to MSMEs, and 10% of cost of plant and machinery to large enterprises, with a maximum support of up to ₹ 35 lakh. Similarly, purchase of new equipment/ system related to safety, occupational health or for environment compliances for common use of industries located in cluster also get assistance of up to 35% of cost of equipment, up to a maximum of ₹ 35 lakh. c) Encouraging green practices and environmental audit of MSMEs by exempting up to 75% of fees of audit services (up to a maximum of ₹ 50,000). d) Industrial buildings with green rating under Indian Green Building Council to be exempt by up to 50% of consulting charges, up to a maximum of ₹ 2.5 lakh. e) Encouraging existing industries to shift the unit outside the urban agglomerations.
Invest in green projects – such as plantation drives and afforestation activities – within and around industrial areas in the district.		Short-term	Policy framework exists. Improved monitoring and evaluation will give the 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 required for successful implementation	
Encourage industries to use recycled water from their plants, rather than freshwater.		Short-term	Policy framework exists. However, it can be upgraded in collaboration with the responsible agencies and departments.	

6.1.4.1 Industry: Policy framework and concerned departments/agencies

Sectors	Policies and programmes that can push forward the recommendation	Primary departments/ agencies	Supporting departments/agencies
Industry	1) Gujarat Industrial Policy, 2020 2) Gujarat Solar Policy, 2021 3) National Mission on Enhanced Energy Efficiency 4) Reuse of Treated Waste Water Policy, 2018 (GoG)	1) Industries and Mines Department, GoG	1) Industries Commissionerate, GoG 2) Gujarat Industrial Development Corporation 3) Gujarat Industrial Investment Corporation 4) Energy & Petro-Chemicals Department, GoG 5) District Industries Centre 6) GIDC 7) BEE 8) GEDA 9) GUVNL-PGVCL 10) Proposed District level Committee on Climate Change and Environment

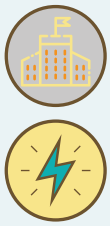
6.1.5 Agriculture, forestry and other land use (AFOLU): Recommendations, cross-cutting sectors, qualifying priority and district scenario

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
AFOLU: Agriculture				
Promote sustainable farming through practices and programmes, such as the use of non-chemical fertilisers and by adopting zero budget natural farming.		Short to medium-term	Policy framework exists (section 6.1.5.1) Budgetary provisions are available	In 2017-18, Rajkot used approximately 1.2 lakh tonnes of urea in agriculture. Replacement just 10% of this urea with non-chemical fertilisers can help avoid 9,000 tCO_2e emissions/annum. This initiative will also contribute towards: a) cutting down of compostable solid waste from landfilling/dumping and converting it to organic waste that can further be used to make organic fertilisers (thereby, reducing emission from waste sector), b) lessening of 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 to have easy access to markets/industries that would take crop residue/ stubble This also helps meet the following targets of SDG #8 (Decent Work and Economic Growth): 8.2 and SDG#12 (Responsible Consumption and Production): 12.5, 12. a	Improved harvesting practices, such as the use of Happy Seeder, has the capacity to eliminate 78% of the GHG emission (from crop residue burning). It has the potential to increase farmers' profits by at least 10%. Feasibility studies may be undertaken for a cost-benefit analysis to support farmers with such improved harvesting machines and practices. Direct sowing of rice reduces soil disturbance, enabling it to retain more nutrients, moisture, and organic content. It also removes the need to burn rice stubble, thereby reducing air pollution. Other feasibility studies or projects can be initiated. Such as the development of biofuel pellets from crop residue.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Farmers should be encouraged to follow the recommendation given in Soil Health Cards.		Short to medium-term	Can be implemented by generating awareness	According to Soil Health Card Portal progress report, so far 16,84,207 samples have been tested in Cycle- II in Gujarat. In Rajkot, soil nitrogen status has been found to be very low for all the samples tested across the district, and 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.
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	Currently, Gujarat holds 12% of the total area under micro irrigation in India[20] All farmers, irrespective of social group status, landholding, crops, and geographical location, are entitled to get subsidy of 50% of capital cost of MI or ₹ 60,000/ha, whichever is lower, of which, 40% is provided by the national government, and the state government bears the remaining 10%. In addition to this, more subsidy is provided to dark zone blocks and tribal blocks (talukas) as well as to SC/ST farmers. In March 2015, additional subsidy was announced for small and marginal farmers. However, it varies for non-dark zone and dark zone blocks.[21] As per PMKSY District Irrigation Plan (2019-20) for Rajkot, the proposed area under MI is 8,084 ha. By attaining this target of irrigating the proposed area through MI, Rajkot should have avoided approximately 6834.12 tonnes of CO_2 emissions (due to savings in electricity consumption).

20 A. Suresh and Manoj P. Samuel, Micro-irrigation development in India: challenges and strategies, Current Science

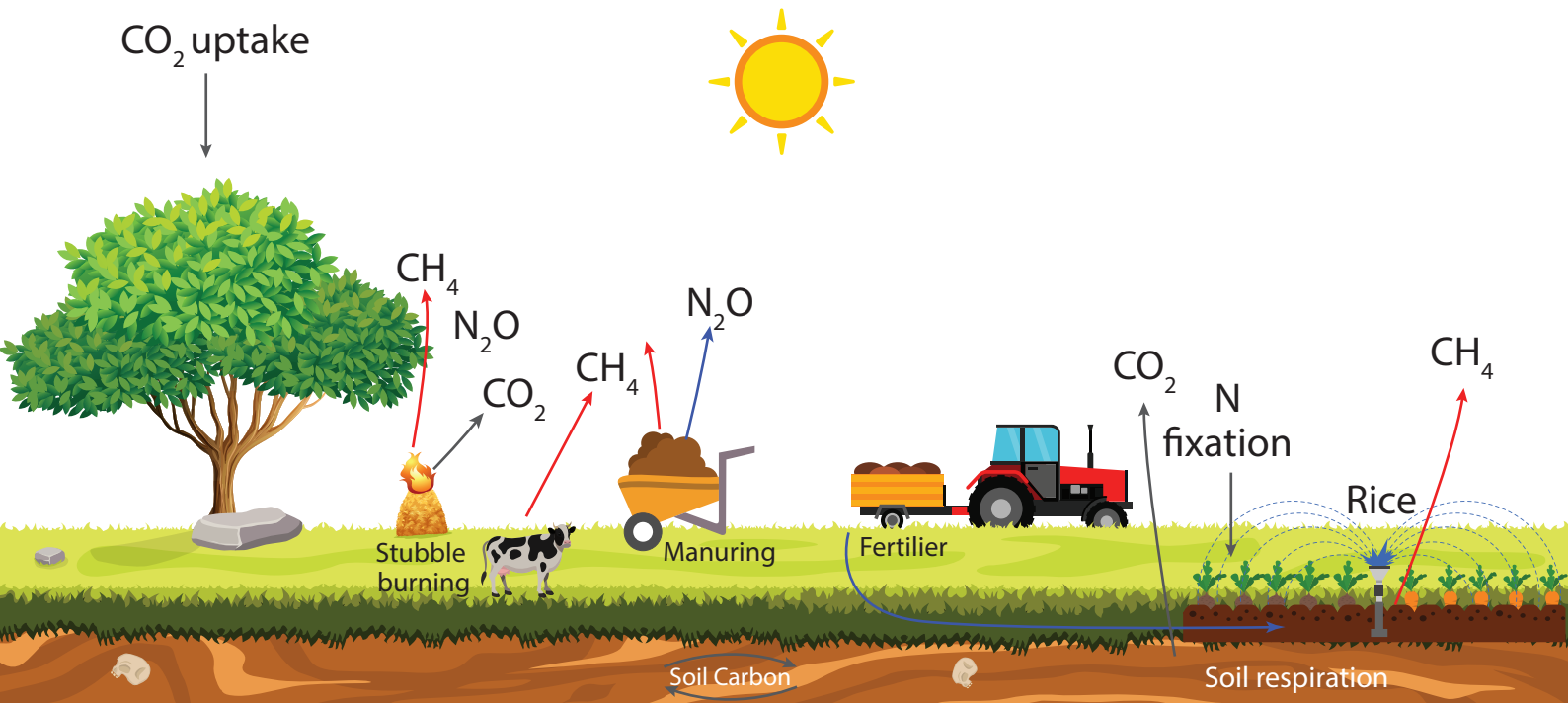
21 Chandra Sekhar Bahinipati and P.K. Viswanathan, Adoption and Diffusion of Micro-irrigation Technologies in Gujarat, Western India: Do Institutions and Policies Matter?

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Encourage adoption of latest technologies, such as: a) Solar pumps (under PM KUSUM Yojana and SKY) 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 2018, Gujarat government launched Suryashakti Kisan Yojana (SKY) with an objective of doubling the farmers' income by generating their own power and selling the surplus back to the state. 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 lifecycle of solar pumps, which can potentially save ₹ 840 crore of diesel subsidy and 2.53 million tonnes of CO_2 emissions. These initiatives will increase farmers' income, provide reliable source for irrigation and reduce dependence on diesel/grid in the farm sector.
Enhance the efficiency/ network of cold storage systems and initiate a gradual shift to renewable energy powered cold storages.		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	Under PMKSY, 969 cold storage facilities with a capacity of 38,22,112 tonnes are proposed for Gujarat, to avoid post-harvest losses. These new cold storages can be solar powered.
AFOLU: Livestock				
Promote grasslands and cultivation of cattle feedstock for good quality forage and to manage fodder scarcity.		Short to medium-term	Policy framework exists (section 6.1.5.1) Research inputs required Collaboration between different communities (farming and pastoral) is needed	Intensive cultivation of *Sesbania grandiflora* which produces about 7.8 kg/tree/year or 93.6 MT/year/ha when fed to lactating crossbred cows leads to an increase in milk yield by 11.97%.[22] 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 and a 30% reduction in emission is estimated. 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 Rajkot at the district level.[23]

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

23 http://nianp.res.in/harit-dhara-tamarin-plus

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Promote cattle breeds with higher productivity. Productivity of indigenous cattle should also be improved (e.g.: through provision of Nand Ghars). However, the balance between resilience and productivity should be maintained. 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 biodiversity of the region is not impacted) 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 five years, the loss in milk production will be 36 lakh litres and 2,27,100 tonnes of CO_2e emission will be avoided. To compensate for this loss in milk production, a total of 2,29,248 new crossbreed cattle would be needed, which will lead to 2,07,000 tonnes CO_2e emissions. The net emissions avoided per year would be approximately 4,009.23 tonnes CO_2e.
Promote use of waste from livestock and poultry as an important source of organic manure for various crops, such as sugarcane and potato, for enhancing crop production.		Short to medium-term	Collaboration between different communities (farming and pastoral) is needed Policy framework is available (section 6.1.5.1)	Poultry manure fertiliser is rich in nitrogen and contains all the 13 essentials nutrients required for crop production. In comparison to cow manure, it is two to three times richer in inorganic fertiliser content.
AFOLU: Forestry and green spaces				
Ensure minimum diversion of forest land for any activity or project and promote compensatory afforestation (of the same species) from the funds given by the user agency. Funds for continuous tree improvement and tree breeding programmes can be ensured through CAMPA.		Short to medium-term	Policy framework and budget provisions exist (section 6.1.5.1) Policy implementation required Stringent monitoring and evaluation needed	In 2019, Gujarat received ₹ 1,484.60 crore from the Compensatory Afforestation Fund Management and Planning Authority (CAMPA), which aims to promote afforestation and regeneration activities as a way of compensating for forest land diverted to non-forest uses.



Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Measures to increase trees outside forest area and green spaces in Rajkot. a) Setting up of urban parks. b) Adoption of Miyawaki Urban Forestry method. c) Transplanting trees with the help of tree transplanting machines. d) Setting up of floating gardens, butterfly gardens etc. e) Initiate afforestation activities on wastelands and fallow lands. f) Plantations along village roads can be taken up under MGNREGS. g) Tree census should be conducted periodically. h) Development of green belt along the major terrain roads and surrounding the industrial areas.		Medium to long-term	Policy framework is available (section 6.1.5.1) Capital investment, research collaboration and inter-departmental cooperation is required	As per the FSI report 2019, Gujarat has 11,984 sq km of 'trees outside forest' which includes both forest cover outside the recorded forest area/green wash and tree cover. Currently, the forest area in Rajkot district is only 1.38%. If 7% of geographical area of Rajkot (equivalent to state average forest cover) is converted to forest and tree cover, over a period of 10 years, 12.21 million tonnes of CO_2e emissions can be avoided. Miyawaki urban forestry method has reported 15% faster growth rate per year, compared to other reforestation methods. (Example: Oxygen Park has been developed by adopting Miyawaki method in the Science City on Ahmedabad-Gandhinagar highway) A similar pilot projects can be adopted in Rajkot as well. Green belts help mitigate air pollution, increase urban green cover, thereby leading to carbon sequestration.
Enhance forest cover by promoting agro-forestry and social forestry to increase forest biomass and soil moisture along with adoption of the following measures. a) Control illegal timber trade. b) Carry out mapping of agroforestry area to monitor the coverage. c) Create provisions of financial instruments/ relaxation in other taxes (over and above the existing schemes) to encourage 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. to aid increase of tree density.		Medium to long-term	Policy framework and budget is available, implementation is required Stringent monitoring and evaluation are necessary	According to the 2019 Forest Survey of India Report, there is an increase in forest cover by 13.32 sq km in Rajkot from 2017, which is a positive sign. Moreover, tree density in the district has significantly increased from 7.87 trees/ha (2003) to 10.45 trees/ha in 2013.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Ensure ULBs regularly monitor survival of trees, post plantation. a) A thorough study needs to be done on suitability of the site and survival ratio of species (mainly native species) before initiating any plantation drive. b) Prepare an audit every year on the number of saplings surviving 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	
Promote regeneration of degraded and open forest areas by developing awareness among locals regarding the importance of green spaces.		Long-term	Strengthen the existing policy framework. Collaboration among different stakeholders required	
Various aspects of joint forest management (JFM) need to be promoted. a) Capacity building and skill development of 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 information, education, and communication (IEC) material to be developed and used Provisions of monetary support	Total area covered under JFM in Rajkot is 5,976 ha with about 57 JFM committees in the district.

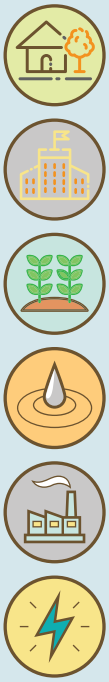
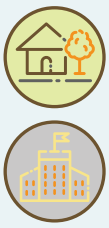
Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Prevent invasion of non-indigenous species a) Develop a database and update information on invasive species and their management. b) Raise awareness at regional levels. c) Strengthen and maintain institutions to coordinate invasive species programmes.		Medium to long-term	Research studies on flora specific to the region Provisions of monetary support Exclusive communication strategy and IEC material to be developed and used Monitoring and evaluation required Collaboration among different stakeholders required	*Prosopis juliflora, Lantana camara, Parthenium hysterophorus* are some major invasive species in Gujarat. 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. [24]
Develop participatory forest fire management strategies such as: a) Collecting baseline forest fire data with respect to perceptions, beliefs, expectations, and behaviour of local people (pertaining to forest fires). b) Training local communities to tackle forest fires. c) Organising awareness programmes in local schools. d) Building capacity for an early warning system.		Medium to long-term	Provisions of monetary support Exclusive communication strategy and IEC material to be developed and used Monitoring and evaluation required Collaboration among different stakeholders required	According for Technical Information Series Volume-I, FSI (2019), 0.25%, 8.43% and 85.18% of the total forest cover area of Gujarat is extreme fire prone, moderately fire prone and least fire prone, respectively.

24 Solanki H.A., 2018, Checklist of invasive plants of Gujarat and some most insidious plants of Gujarat, their hazards, its management and public perspective

6.1.5.1 AFOLU: Policy framework and concerned departments/agencies

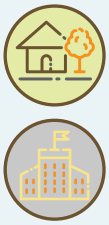
Sectors	Policies and programmes that can push forward the recommendation	Primary departments/ agencies	Supporting departments/agencies
Agriculture	1) Rashtriya Krishi Vikas Yojana: Remunerative Approaches for Agriculture and Allied Sector Rejuvenation (RAFTAAR) 2) National Mission for Sustainable Agriculture 3) Pradhan Mantri Krishi Sinchayee Yojana 4) PM KUSUM Yojana 5) Soil Health Card 6) National Mission on Food Security 7) National Mission on Micro-irrigation 8) Price Support Scheme 9) AGR 2 (farm mechanisation) scheme of farmers other than SC/ ST 10) National Policy for Crop Residue Management 11) Suryashakti Kisan Yojana/Supply of Solar Agricultural Pumpsets-Gujarat Urja Vikas Nigam 12) Dinkar Yojana	1) Agriculture, Farmers' Welfare and Co-operation Department, GoG	1) Gujarat Green Revolution Company (GGRC) 2) Rural Development Department, GoG 3) Irrigation Department, GoG 4) Energy and Petrochemicals Department, GoG 5) GEDA 6) Animal Husbandry Co-operation 7) Gujarat Water Resource Development Corporation (GWRDC) 8) Climate Change Department (for reporting), GoG 9) Forests and Environment Department, GoG 10) GNFC, GSFC 11) Commissionerate for Cottage and Rural Industries 12) Gujarat Agro Industries Corporation (GAIC) 13) Junagadh Agriculture University and other Agriculture Universities of Gujarat 14) APMCs 15) Proposed District-level Committee on Climate Change and Environment
Livestock	1) National Livestock Mission 2) Rashtriya 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) National Mission on Food Security 9) Rashtriya Krishi Vikash Yojana	1) Animal Husbandry Department, GoG	1) Forests and Environment Department, GoG 2) Agriculture, Farmers' Welfare and Co-operation Department, GoG 3) Climate Change Department, GoG
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	1) Gujarat Forest & Environment Department, GoG	1) Agriculture, Farmers' Welfare and Co-operation Department, GoG 2) Climate Change Department, GoG 3) All ULBs (RMC + other Municipalities) 4) RUDA, GoG 5) Industries & Mines Department, GoG 6) UDD & RDD 7) All PRIs

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

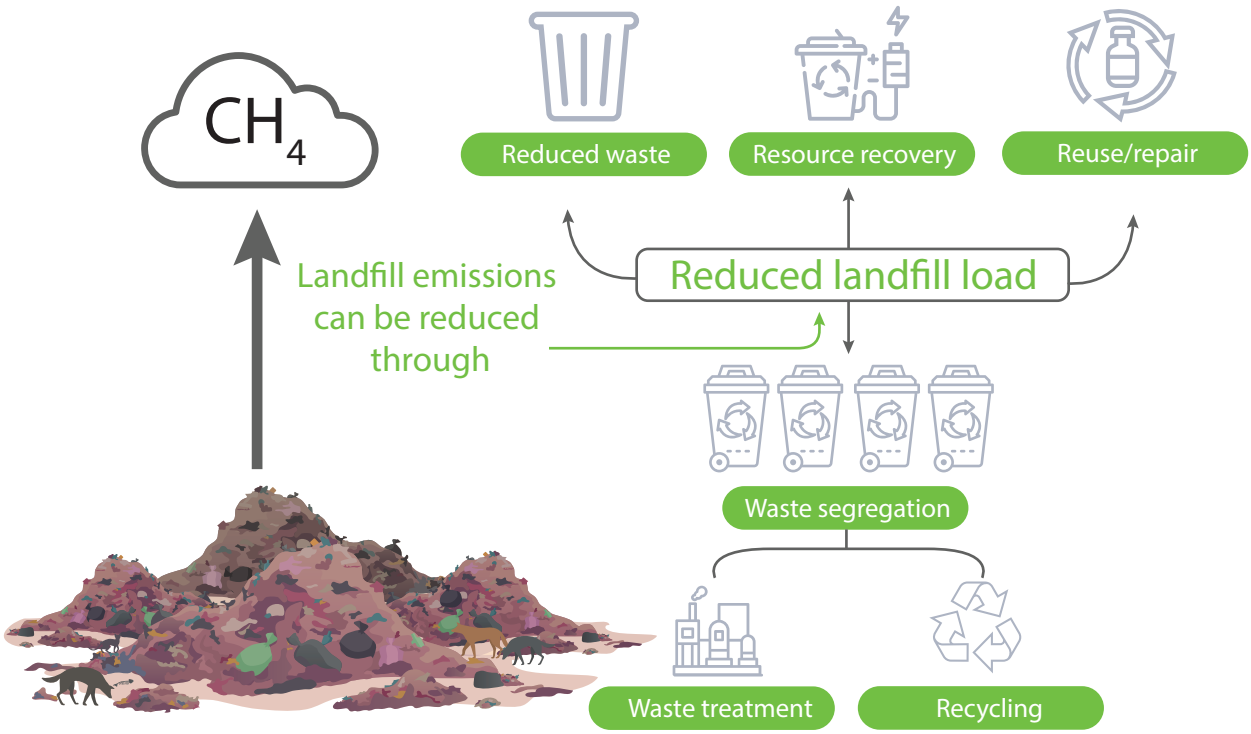
Recommendations	Cross-cutting with	Qualifying priority		District scenario/ case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Solid waste				
Waste prevention: Reducing landfilling				
Minimising landfill waste disposal by: a) Promoting 'at source reduction of waste' through product reuse, extending lifetime (maximum use of resources) and right to repair. b) Ensuring efficient and 100% segregated waste collection from across the district (both urban and rural) by distributing colour coded bins, monitoring waste collected from household and penalising households not practicing segregation. c) Ensuring and maximising recycling, recovery, optimum resources 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) Need policy intervention, awareness generation 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 drafted by NITI Aayog; not implemented as of now)	Landfills are one of the largest anthropogenic source of methane emissions, contributing 11% of all global CH_4 emissions. Hence, reducing landfill load and emissions are critical in achieving India's NDCs. Following are the initiatives towards the same adopted in Rajkot (mostly the city area) which will reduce the emission from landfill eventually and can be planned for the district as well: Rajkot has one of the 29 regional landfill clusters of Gujarat for the ULBs of Chotila, Thangadh, Jasdan and Gondal. RMC has its own landfill sites at Sokhada (11 acres; 12 km from the city) and at Manda Dungar (2.5 acres; 7 km from the city). Both are operating at maximum capacity. There is a proposed landfill site at Nakarwadi (40 acres; 15 km from the city) Primary and secondary waste collection and transport have been privatised for 12 out of 23 wards of RMC, with 80% coverage of door-to-door collection. Rajkot has one W2E plant with a capacity of processing 850 tons of solid waste and reduces GHG emissions by 1,474.38 tonnes CO_2e per day. It replaces fossil fuels and stops waste from going to landfill.
Minimising single use plastics (SUPs): Detailed information and recommendations on SUPs is given in section 6.1.6.2		Short to medium-term	Already on national priority. Policy framework exists (section 6.1.6.2). Can be accelerated with district-level interventions / implementation.	Disposable SW take-back (a policy mandate already) needs to be implemented through the producers/ brand owners.

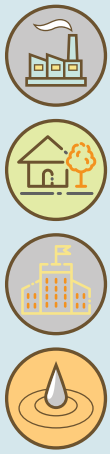
Recommendations	Cross-cutting with	Qualifying priority		District scenario/ case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Implementing producers' (manufacturers, brand owners, etc.) take-back mechanism (SWM Rules, 2016) either through financial assistance by the producers or a defined collection system facilitated by the producers for disposables, such as tin, glass, plastics packaging, sanitary napkins, and diapers, for efficient management of these waste materials, thereby reducing landfill inert waste load.		Short to medium-term	Mandated by the SWM Rules (2016); needs district-level policy formulation and interventions	45% of the total waste generated in Rajkot is inert waste and 5% is paper waste, much of which can be treated/ recycled, which will lead to huge landfill waste reduction. There is no SUP ban in the state as of now. The new 2021 Plastic Waste Management Amendment Rules need to be implemented. Rajkot has submitted a Plastic Control Action Plan.
Ensure 100% recycling of recyclables at landfill through measures such as a material recycling facility (MRF), refuse derived fuel (RDF), waste to energy (W2E), etc. Encourage use of LDPE and HDPE plastic waste in road construction.[25]		Short to medium-term	Requires capacity enhancement of existing facilities	
Management of construction and demolition (C&D) waste: a) Ensure segregation, collection, transportation and proper management. b) Facilitate processing and recycling facilities. 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) Implementation and enforcement required Capital investment in infrastructure required	
Increasing consumer awareness and access to recycling facilities and repair options.		Short to medium term	Dedicated awareness campaign required	
Education and awareness drives for 100% at source segregation of biodegradable, non-biodegradable, domestic hazardous and household biomedical wastes.		Short-term	Dedicated awareness campaign required	Segregation of domestic hazardous waste and household waste is not practiced in the district.

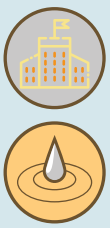
25 Guidelines given by Indian Roads Congress in this regard can be followed. https://pib.gov.in/PressReleasePage.aspx?PRID=1736774

Recommendations	Cross-cutting with	Qualifying priority		District scenario/ case examples
		Timeframe for the action to be accomplished	Framework for implementation	
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	About 10% to 15% of global GHG emissions could 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.
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 the waste generated. For example, conducting weekly workshops at all public schools for waste reduction and recovery. These workshops can also address issues, such as, energy efficiency, water conservation etc.		Short-term and continuous	Needs sustained campaign for the target groups	
Consumer awareness for demand-side management of product choices with a) sustainable packaging, b) displayed higher product lifespan, c) displayed recycling/ resource recovery efforts and information.		Short-term and continuous	Dedicated awareness campaign required	
Conduct waste audits at household level, corporate offices, institutes, etc. to identify scope of waste minimisation and promote the same as an evidence-based practice.		Short to medium-term	Needs research collaboration	
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, CPCB guidelines exist. Capital investment in infrastructure development (for treatment) is required, which can be obtained from the producers.	Sanitary waste segregation and treatment is currently not practiced in the district and has been going to the landfill.

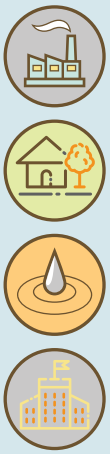
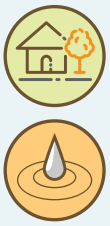
Recommendations	Cross-cutting with	Qualifying priority		District scenario/ case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Transitioning the district to a 'green market' approach by: a) promoting local circular business models, b) mainstreaming of alternative sustainable business models for the consumers to have a basket of choices.		Medium-term and continuous	Needs alternative business models, collaborations, and awareness	
Reduce emissions from waste transportation: a) Encourage shift 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 (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	Solid waste is transported over long distance for common landfill disposal of ULB clusters under ISWM. Petrol or diesel-driven trucks and smaller vehicles are being used for primary and secondary transport of SW with significant transport emission potential, which could be avoided by switching to ZEVs. Garbage transfer stations are constructed to transfer garbage from smaller primary collection vehicles to bigger secondary collection vehicles, thereby reducing the number of vehicles transporting waste. Although, several specifications for CBWTF vehicles already exist (that ensure efficient management and monitoring of BMW), they do not consider reducing emissions from transport.



Recommendations	Cross-cutting with	Qualifying priority		District scenario/ case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Waste treatment – composting				
Full conversion of organic waste to biological waste processing (composting, biogas, etc).		Short to medium-term	Policy framework exists (section 6.1.6.1); needs awareness and infrastructure	Organic treatment of compostable waste though initially leads to emissions, reduces GHG emissions drastically over the long run, when compared to landfill emissions. It takes at least three decades of landfill emissions to balance with those from aerobic composting. Several best practices and technologies are available for reducing GHG emissions from composting. Even in the absence of a gas management system, composting is a more environmentally sustainable practice as opposed to methane capturing from landfilling of organic waste. Composting also avoids multi-layered pollution potentials and reduces landfill loads. 45% of solid waste generated in Rajkot is biodegradable, of which 10% is sent for composting. Composting emission potential (@ current 10% processing of the total waste generated): 812 tons CO_2e/year. Currently, there are no gas management systems at composting units. Composting with gas management of the entire organic waste going to landfill can reduce emission by 12,021 tonnes CO_2e/year in Rajkot.
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 emission.		Medium-term	Needs land and infrastructural investment at ULB level	
a) Equip new composting units and upgrade/convert existing composting units with gas management systems for gas capture after conducting feasibility studies. b) Biomethane produced from wastewater and solid waste processing can be used as a fuel for industrial production, to provide energy services in buildings or as a transport fuel. A benefit of biomethane is that 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 Needs district-level capital investment and research collaboration	

Recommendations	Cross-cutting with	Qualifying priority		District scenario/ case examples
		Timeframe 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 and industrial wastewater is important for accurate city or district-level emission estimations from the waste sector.		Short-term	Needs research collaboration	
Ensure better compliance of 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 frameworks exist in most cases (section 6.1.6.1)	
Bio-medical waste and hazardous waste				
a) Promote installation of modern incinerators with energy-recovery facilities (such as use of recovered heat for pre-heating of waste to be burnt or use of incinerator steam to generate electricity) for new common bio-medical waste treatment facility (CBWTFs) 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	Incineration is not recommended due to its emission potential. However, to prevent manual scavenging and further contamination from certain kinds of infectious waste (particularly the anatomical, contaminated waste, discarded medicines and chemical waste), incineration is the recommended practice in India. At present, BMW incineration emission in Rajkot district stands at 135 tCO_2e/year. The 2016 BMW Management Rules mandate the formation of a district biomedical waste monitoring committee for strict monitoring of adherence to rules by both healthcare facilities and CBWTFs. There are no TSDFs within the Rajkot district. However, hazardous waste from the district gets incinerated elsewhere.
Strict monitoring of adherence to recommended incineration technologies 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
		Timeframe 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. Ensuring inclusion of lighting infrastructures, particularly, fluorescent and mercury containing lamps (as per the provisions of the rules) in the inventory and their proper treatment is critical as this waste mostly goes to landfills at present, due to the absence of separate collection and treatment infrastructures.		Short to medium-term	Mandated by the rules (section 6.1.6.1) Needs research collaborations	About 95% of the e-waste in India is processed informally (including rudimentary operations like open burning, acid wash, open smelting, etc). City-based studies show that efficient management and recycling of WEEE can significantly contribute to emission reduction. The e-waste inventory by GEMI estimates WEEE generation by only bulk consumers for the city (not the district). The estimates also do not consider all WEEE categories. According to the inventory, 2,674.75 MT of annual WEEE is projected to be generated from bulk consumers by 2025 in Rajkot city. Most of the current e-waste is routed informally. No information on e-waste inventory or WEEE generation and treatment is available. Rajkot has one formal e-waste recycling industry, which can be effectively used in the city's e-waste collection and formal disposal.
Ensure stringent policy implementation: Trace informal routing, ensure proper collection, restrict informal processing of e-waste (open burning, metal smelting, etc.), ensure proper disposal of electrical waste (lighting infrastructure including mercury containing lamps) and strict monitoring to stop landfilling of the same.		Short term and continuous	Mandated by the rules (section 6.1.6.1) Needs monitoring, manufacturer collaboration and consumer awareness	
Tapping into the informal e-waste collection network and formalisation of the same to channelise e-waste disposal to the formal sector.		Short to medium-term	Can be achieved through the producers/ recyclers/PROs	
Improve consumer awareness on responsible e-waste disposal and make information available on e-waste collection points, recyclers, producers (manufacturer), producer responsibility organisations (PROs) or 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 through collaborating with producers	

Recommendations	Cross-cutting with	Qualifying priority		District scenario/ case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Formulation of district level e-waste policy with district level action and implementation plans.		Short to medium-term	Needs state and district-level collaboration	
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 district. b) Complete shifting of domestic wastewater treatment plants (STP) to aerobic set ups by having only aerobic STPs for new constructions. Transition old anaerobic STPs to aerobic set ups. c) Operation and regular maintenance of periodical 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. Open sewers being stagnant and subject to heating cause anaerobic conditions to emit CH_4. Closed underground sewers are an insignificant source of CH_4. Rajkot has aerobic STPs of 95.5 MLD capacity in operation (at Madhapar and Raiya). 58% sewerage coverage with 60 sq km covered area and 1500 km network out of 104.86 sq km city limit of RMC. STPs of 48.8 MLD combined capacity under installation in Jetpur, Jasdan and Gondal.
Development of rural wastewater disposal and treatment plan for the district.		Medium to long term	Requires capital investment and inter-departmental collaboration.	16 MLD of combined capacity STPs in Dhoraji and Bhayavandar, 150 km collection network planned under RUDA covering 3000 ha of land.

Recommendations	Cross-cutting with	Qualifying priority		District scenario/ case examples
		Timeframe for the action to be accomplished	Framework for implementation	
Create appropriate connecting infrastructure for the industries to utilise treated industrial and domestic wastewater. Provide subsidy/tax rebate to smart recycled water investments for industries, healthcare, hospitality sectors.	 	Medium to long-term	Policy implementation required Needs capital investment in infrastructure and technology upgradation	No information is available on rural sewerage coverage and treatment. 100% closed and underground sewer connection and centralised aerobic well-managed STPs can potentially reduce 21,513 tCO_2e emission from STPs to negligible or almost non-existent in Rajkot. AMC 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 Rajkot district.
Implement and operationalise the guidelines and regulations of the National Policy on Faecal Sludge and Septage Management, 2017 to reduce emissions from faecal sludge. Regular collection and appropriate disposal of sludge shall also be ensured.	 	Medium to long-term	Needs ULB level implementation and capital investment in infrastructure	
Develop a policy mandate for data transparency and availability of waste and wastewater generation, treatment, and discharge information for the 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	Data transparency on wastewater by industries is key to reducing water pollution, which can be achieved through rating of industries based on their emission and effluent discharge and treatment. For example, under its Star Rating Programme, the Odisha State Pollution Control Board gives star rating to industries and highlights 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 that can push forward the recommendation	Primary departments/ agencies	Supporting departments/ agencies
Solid waste	1) Solid Waste Management Rules, 2016 & Amendment 2018 2) Plastic Waste Management Rules, 2016 and Amendment Rules, 2021 3) Construction & Demolition Waste Management Rules, 2016 4) Integrated Solid Waste Management Project 5) Swachh Bharat Mission – urban and rural 6) Comprehensive District Urban Development Plan 2031 of Rajkot 7) Rajkot Smart Cities Mission 8) National Resource Efficiency Policy (draft) 9) Guidelines on Environmental Management of C&D Waste Management in India, CPCB 10) GPCB Annual Report	1) Urban Development and Urban Housing Department, GoG 2) All ULBs 3) Panchayats, Rural Housing & Rural Development Department, GoG 4) All Gram Panchayats 5) Gujarat Pollution Control Board (GPCB)	1) Rajkot District Administration and the proposed District Level Climate Change & Environment Committee 2) Gujarat Urban Development Company Ltd (GUDC) 3) Climate Change Department, GoG (research) 4) Forest and Environment Department, GoG (research) 5) Rajkot Urban Development Agency (RUDA) 6) District Rural Development Agency (DRDA) – Rajkot 7) 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) GPCB 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 the Department of Forest and Environment, GoG, Climate Change Department, GoG, GPCB, etc.[26]	1) GPCB 2) Rajkot District Administration and 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, CPCB	Only implementation monitoring and research needs resources, which can be obtained from the Department of Forest and Environment, GoG, Climate Change Department, GoG, GPCB, etc.[27]	1) GPCB 2) Rajkot District Administration and the proposed District Level Climate Change & Environment Committee 3) Electronic and electrical producers/ manufacturers/ brand owners/PROs

26 Bio-medical and hazardous waste management is profitable and not funded by govt except for providing the land, which usually belongs to the Industrial Development Corporation

27 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 that can push forward the recommendation	Primary departments/ agencies	Supporting departments/ agencies
Wastewater: Domestic	1) Atal Mission for Rejuvenation and Urban Transformation (AMRUT) 2) Jawaharlal Nehru National Urban Renewal Mission on Urban Infrastructure and Governance (JNNURM) 3) National River Conservation Plan 4) Integrated Urban Sanitation Programme 5) Swachh Bharat Mission (Urban) – Gujarat 6) Swachh Bharat Mission (Rural) – Gujarat 7) Rajkot Smart City Mission 8) Comprehensive District Urban Development Plan, 2031 of Rajkot	1) Urban Development and Urban Housing Department, GoG 2) All ULBs 3) Panchayats, Rural Housing & Rural Development Department, GoG 4) Gujarat Water Supply & Sewerage Board	1) RUDA 2) Commissionerate of Rural Development 3) District Rural Development Agency (DRDA) 4) GUDC 5) Rajkot Smart City Development Corporation 6) All gram panchayats
Wastewater: Industrial	1) Common effluent treatment plant system 2) Online Continuous Emission Monitoring System 3) GPCB Annual Report	1) Gujarat Pollution Control Board (GPCB) 2) Gujarat Industrial Development Corporation (GIDC)	1) Industries and Mines Department, GoG

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 ingested by aquatic animals; b) stay in the environment for forever leading to microplastic pollution; and c) block waterways and intensify natural disaster.
- They have high carbon footprint and high cost for collection, transport, and treatment/recycling.
- 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
Polythene bags	Low density polyethylene (LDPE)	Fast moving consumer goods (FMCG)	Cotton bags, jute bags, bioplastics	**Cloth (cotton)** • Pros: Natural fibre, durable, reusable, biodegradable, profitable and non-food crop • Cons: High consumption of chemical fertilisers and pesticides in cotton farming, high cost, water intensive crop, not moisture resistant, needs to be reused many times to offset high degradation/recycling carbon footprint **Jute** • Pros: Natural fibre, durable, reusable and biodegradable, high carbon assimilation rate • Cons: Expensive, water intensive crop, highly dependent on rainfall, product not moisture resistant **Bioplastics** • Pros: Bio-degradable, moisture resistant, inexpensive, light weight • Cons: Most contain 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/ PET + foil + LDPE, etc. d) LDPE	FMCG (food and beverages), hospitality, e-commerce	Bioplastics, 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 & other drink bottle	Polyethylene Terephthalate (PET)	Hospitality, FMCG (food & beverages)	Glass, metal, ceramics, bulk vending	
Plastic cutlery, plates, cups, & 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 pack, bottling & bulk vending	
Face shields	Polycarbonate and polyester (PET)	Healthcare	Compostable/ bio-degradable face shield	
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, nondegradable and made of plastic. European Commission defines them as consisting of 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 industry; 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 all the sources, intentionally added microbeads in cosmetics and personal care products are 'designed to drain' single use plastics. Though replacement of microbeads in PCCPs come under central regulation, at a district level, consumer awareness can make a change through shifting of demand to sustainable alternatives.

Regulatory provisions in India for SUPs

- 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 – such as 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) Extended producer responsibility of the producers to collect plastic waste involving State Urban Development Department either individually through their own distribution channel or collectively with the concerned local body; b) Primary responsibility for collection of used multi-layered plastic sachet or pouches or packaging is of producers, importers and brand owners who introduce the products in the market; c) Manufacture and use of multi-layered plastic which is non-recyclable or non-energy recoverable or with no alternate use of plastic if any should be phased out in two years.
- Solid Waste Management Rules, 2016: a) Extended producer responsibility for manufacturers or brand owners of disposable products including plastic packaging and sanitary napkins and diapers to provide financial assistance to local authorities for waste management system and to set up a collection/take back system for packaging waste.
- Different policy frameworks for SUP ban or restrictions (of different kind) exist in at least 23 states and five union territories of India. Gujarat does not have any policy directive at the state level as of now.

Recommendations[28]

- Implement the ban (as specified by the Plastic Waste Management Amendment Rules, 2021) on manufacture, import, stocking, distribution, sale and use of the single use plastic.
- Formulate policies with provisions to: a) mandate producer responsibility for awareness, labelling requirement on disposal, clean-up, collection and treatment of SUP products/packaging; b) mandate collection target (can be a differential target for different products) for SUP producers as part of extended producer responsibility (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 (giving the transition time) of other selected categories of SUP products; can be achieved by sensitising the key producers for voluntary action.
- Promote eco-friendly alternatives to SUPs through: a) identifying alternative sustainable products; b) identifying micro-enterprise 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, such as no resin or plastic powder mixed product in the name of alternative.

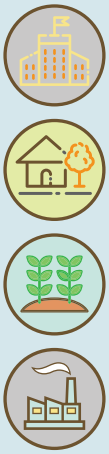
28 Note: A sustainable solution to SUP products needs both state and district level collaborations at all levels including policy formulations and implementations
UNEP. 2018. Single use plastics: a roadmap for sustainability. Available at http://www.indiaenvironmentportal.org.in/files/file/singleUsePlastic_sustainability.pdf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

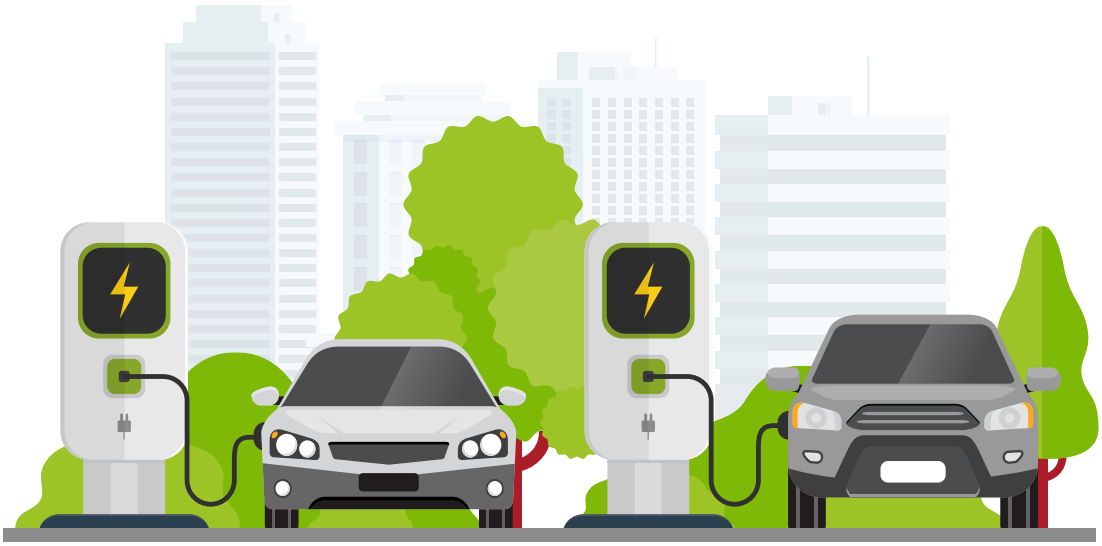
- Promote extended lifespan and reuse of products, even for the sustainable alternatives through continued and lasting campaign for 'no single use' to ensure public participation. Replacing the concept of 'single use' is critical as biodegradability or recyclability have 'time' and 'conditions' (energy & water footprint, transport requirement, etc.) attached to them.
- Introduce economic incentives/support: a) Invest into R&D of alternatives to different SUP products; b) Support technology incubation and stimulate creation of micro-enterprises to drive job creation; c) Introduce livelihood support schemes or have 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.

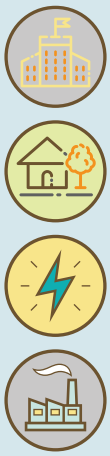
6.2 Innovative financing

Recommendations	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe 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	For example: In 2017, Rajkot Municipal Corporation had planned to issue municipal bonds worth ₹ 200 crore, in order to raise money for installing smart meters in the city and ensuring round-the-clock water supply in the city.
Voluntary carbon market mechanism can be developed for the district of Rajkot 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 for the same	For example: In 2020, Smart City Indore collected carbon credit of around ₹ 50 lakh through the city's two bio-methanisation plants. The smart city has avoided emissions of 1,70,000 tCO_2e since 2019 and generated these credits. Gas generated from these plants is used in the city buses – City Bus and iBus.

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
		Timeframe to attain the recommendation	Ease of implementation	
Water scarcity (decline in groundwater) and pollution				
Conduct assessment and mapping of zone-wise water challenges in the district.		Short-term	Stakeholder and research collaboration required	Gujarat has provided Aquifer Vulnerability Index (AVI) information to Central Ground Water Board and identified areas for mapping.
Prepare a comprehensive district action plan for integrated water resource management with a bottom-up approach. Establish sustainable and inclusive water governance in the district to develop, implement, evaluate as well as share information on programmes for water resource management in a transparent and inclusive manner with mandatory stakeholder engagement and public participation.		Short to medium-term	Policy intervention required Stakeholder and research collaboration required	GoG through Water and Sanitation Management Organisation (WASMO) has presence in all the villages of the state and involves community for in-village water supply network. Their programmes instill community ownership. This initiative can be scaled for urban areas, and it can be tapped for capacity building of the beneficiaries on efficient water management and conservation.



Recommendations	Cross-cutting with	Qualifying priority		District scenario / case examples
		Timeframe to attain the recommendation	Ease of implementation	
Implement recommendations given in different heat action plans for heat alert days, particularly: a) suspension of non-essential use of water; b) provision of water for cooling, public and institutional distribution; c) promotion of sprinkler irrigation; d) release water in canals during summer; e) ensuring efficient portable water supply; f) provision of water in reserved/ protected forests, zoos for wildlife and human habitations.		Short-term and ongoing	Action plans and studies exist Policy level interventions required	The Report 'Climate Adaptive Heat Action Plans to Manage Heat Stress in Rajkot City' by IRADe in collaboration with IIPH gives insights and recommendations for managing heat stress in Rajkot.
Promote net zero water construction and infrastructure upgradation in urban areas, in alignment with ECBC norms.		Medium-term	Policy level interventions required	
Promote rainwater conservation through: a) renovation of existing rainwater harvesting structures, b) ensuring rainwater harvesting 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	As per the Comprehensive Development Control Regulations, 2017, UD & UHD, GoG, rainwater harvesting is mandatory for all buildings with ground coverage of 80 sqm and above. According to the Gujarat Development Control Regulations, for buildings with area between 500 and 1,500 sq mt, the owner or developer shall have to undertake rainwater harvesting as per the specifications. For buildings with area between 1,500 to 4,000 sq mt, the owner or developer has to provide percolation wells with rainwater harvesting system with one percolating well for every 4,000 sq mt or part thereof of building unit.

Recommendations	Cross-cutting with	Qualifying priority		District scenario / case examples
		Timeframe to attain the recommendation	Ease of implementation	
Ensure minimum non-revenue water (NRW), i.e., technical loss due to leakage, seepage or unauthorised use (theft).		Medium-term	Research collaboration needed	The average NRW across all classes of ULBs in Gujarat ranges between 26% and 34%, indicating that nearly one-third of the water is lost in distribution.
Water billing based on water metering rather than fixed charges.		Medium to long-term	Awareness generation and collaboration	Under a pilot project, water meters were installed in Chandernagar water supply zone by the RMC with the objective of reducing water wastage.
Promote dual-flush systems to reduce water consumption, energy consumption, and wastewater generation.		Short to medium-term	Aligns with the existing policies Could be implemented as part of 'green buildings'	As a step towards this direction, UDD has recently implemented an amendment (through issuing a notification dated March 31, 2018) in the Comprehensive General Development Control Regulation (CGDCR). The inclusion states that "in every water closet or toilet it shall be mandatory to provide double button cistern (dual flush tank)". For now, it is mandatory for all new constructions to install dual-flush systems. The initiative can be scaled up by retrofitting in old buildings (starting with government and public buildings).
Prevent dumping of untreated effluent from industries, commercial and residential sector into open water bodies or groundwater.		Short to medium-term	Policy framework exists Strict monitoring and reporting required	Re-use of Treated Wastewater Policy, 2018 mandates that all power plants and large industries within 50 km of a sewage treatment plant must use recycled wastewater to relieve the burden on groundwater and surface water.

Recommendations	Cross-cutting with	Qualifying priority		District scenario / case examples
		Timeframe to attain the recommendation	Ease of implementation	
Managing air pollution				
Facilitate source apportionment studies to identify the sources and take specific containment measures.		Short to medium-term	Support to enhance the ongoing study (by GEMI)	Rajkot has two manual air quality monitoring stations (not continuous) that do not give a fair idea on the district's air quality status. The manual stations' reports – run under the National Air Quality Monitoring Programme (NAMP) by CPCB in Rajkot – show: a) Annual average PM_{10} concentrations have been exceeding the standard every year since 2004, b) The maximum 24-hourly average $PM_{2.5}$ concentration exceeds the standards in recent years. But Rajkot is not listed as a non-attainment city by CPCB. According to an emission inventory of Rajkot city, the particulate matter emission sources as per their share of contribution are as follows: industrial emissions, transport, road re-suspension and construction, open waste burning, residential emissions and diesel generator sets.
Increase the number of Continuous Ambient Air Quality Monitoring Stations (CAAQMS) to statistically, spatially, and temporally, represent the mix of sources and range of pollution in the city. Also, increase the number of air quality display facilities in public places.		Short to medium-term	Policy framework and budgetary provisions exist	
Increase the modal share of public and non-motorised transportation. Further, promote e-vehicles (detailed recommendation under Transport Sector).		Medium to long-term	Policy framework available Need to raise awareness Capital investment required Needs inter-departmental coordination	
Better traffic management, re-direction of traffic movement, development of multi-layered parking and ban on-street parking within specific perimeters of the multi-layered parking to ensure parking inside the facility.		Short to medium-term	Feasibility studies needed Requires implementation of existing rules/ policies Needs capital investment	
Increase/create green cover or green buffers along the major traffic corridors, roundabouts, and industrial areas.		Medium to long-term	Inter-departmental co-operation required Needs efficient maintenance and monitoring of plantation sites	
Enforce environmental standards for stack emissions in industrial sector.		Short-term and continuous	Requires robust M&E	

Recommendations	Cross-cutting with	Qualifying priority		District scenario / case examples
		Timeframe to attain the recommendation	Ease of implementation	
Sprinkling of water (preferably recycled grey water) for road dust suspension during peak pollution episodes		Short-term and continuous	Needs inter-departmental co-operation	Major industrial clusters in Rajkot are the foundries. They are also contributing most to the city's air pollution problem. Public transport services in Rajkot are already inadequate and challenged by limited last mile connectivity. This is leading to an increased use of private vehicles, which in turn are increasing air pollution. Union Budget 2020-21 (Fifteenth FC Report for 2021-2026) allocated ₹ 2,217 crore for 42 urban agglomerations with million-plus populations for air pollution; to be provided as performance-based grants to ULBs.
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 the action plan for construction and demolition waste (as per the CPCB guidelines)		Short to medium-term	Needs implementation of existing rules/ regulations	
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 required Robust M&E required	

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

Sectors	Policies and programmes that can push forward the recommendation	Primary departments/ agencies	Supporting departments/ agencies
Water scarcity (decline of groundwater) and water pollution	1) Model Bill for the Conservation, Protection, Regulation, Management of Ground Water, 2016 2) Reuse of Treated Waste Water Policy, 2018 3) Gujarat Domestic Water Supply (Protection) Act, 2019 4) Comprehensive State Water Policy, 2015 5) National Water Mission 6) Water Prevention and Control of Pollution Act, 1974	1) Water Resources Department, GoG 2) Water Supply Department 3) GPCB	1) District administration and the proposed District Level Climate Change & Environment Committee 2) WASMO (Ahmedabad DWSU) 3) All ULBs 4) RUDA 5) Urban Development Department, GoG 6) Rural Development Department, GoG 7) Commerce and Industries Department 8) GIDC 9) GAIC 10) CGWB
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 and Demolition Waste Management Rules, 2016	1) GPCB 2) System of Air Quality and Weather Forecasting and Research (SAFAR), IMD 3) All ULBs	1) District administration and the proposed District Level Climate Change & Environment Committee 2) Department of Climate Change, GoG 3) Commissionerate of Transport, GoG 4) Energy & Petro-chemicals Department, GoG 5) RTO 6) All ULBs

6.4 Actions district authorities can recommend to state departments: Recommendations, cross-cutting sectors, qualifying priority and district scenario

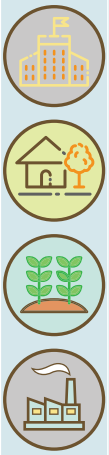
Recommendations that could be pursued by the district collector/committee at the state level	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
POWER SECTOR: Upgrade DISCOM infrastructure and their supply 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). With optimum push, this initiative can help India align with the Paris Agreement targets.	For FY 18-19, AT&C losses of PGVCL were 20.17%, well over the international standard range of 6% to 8%. PGVCL can work towards reducing the AT&C losses. Under PGVCL's pilot project, smart meters are being installed under Smart Village Distributed Renewable Energy generation with Smart Grid Concept at village Nana Kajliyara and Shapur of Junagadh Circle. PGVCL can consider implementing a similar project in Rajkot district.

Recommendations that could be pursued by the district collector/committee at the state level	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
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). Gujarat Tourism Policy 2021-25 offers reimbursement of 50% of certification fee, with a maximum limit of ₹ 10 lakh, to hotels / wellness resorts obtaining green rating from Indian Green Building Council (IGBC).
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) Equipping electric traction rolling stock with regenerative capability and feedback 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.
TRANSPORT: Use fiscal means to discourage the use of personal vehicles, such as: a) Increasing charges on registration of internal combustion engines (ICE) vehicles, b) Levy congestion charges and other green taxes. c) Phasing out of older, more polluting vehicles.	 	Short-term and continuous	Proper policy backing based on research and inter-departmental cooperation is needed	In January 2021, the Ministry of Road Transport and Highways announced additional taxes on old vehicles that were unfit for roads, terming them as 'green taxes'.
TRANSPORT: Identification and planned shift of key commercial / business centres from all the ULBs to outside city limits to reduce traffic load.	 	Long-term	Policy backing based on research and inter-departmental cooperation is needed	Requires development of areas outside RMC limits through RUDA.
District authorities while gradually rolling out EV infrastructure, can advocate to state and national governments for standardised EV cables and infrastructures for easier integration and interoperability for implementation of smart charging on a large scale.		Medium to long-term	Needs policy intervention	

Recommendations that could be pursued by the district collector/committee at the state level	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
INDUSTRY: a) Ensure regular PAT compliance of DISCOMs and other designated consumers (DCs) in the district; b) Increase the number of DCs for PAT scheme and ensure the compliance of targets.		a) Short-term and continuous b) Medium to long-term	Policy framework exists (section 6.4.1), but targets need to be revised gradually Ensure M&E Collaboration required	Until PAT Cycle VI (2020-21), only two DCs had volunteered under the scheme in Rajkot district. Over the years, various DCs from Rajkot district have helped avoid around 2,93,123 tCO_2e by improving their systemic energy efficiency under the PAT scheme.
INDUSTRY/ENERGY: Ensure compliance to renewable purchase obligations (RPOs) and increase the RPO targets gradually.		Medium to long-term	Policy framework exists (section 6.4.1)	Currently, the RPO target in Gujarat for industries is 15.65%.
AGRICULTURE: Encourage millet cultivation (it requires little 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 Rajkot, jowar and bajra production has continuously decreased (jowar from 2,300 MT in 2010-11 to 830 MT in 2018-19; and bajra from 11,300 MT in 2010-11 to 1,602 MT in 2018-19).
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): Targets 2.1, 2.3, 2.4, 2.a	Cotton and groundnut are two major crops of the district. Production of cotton decreased in Gujarat. In Rajkot alone, it reduced from 16.57 lakh MT in 2010-11 to 5.7 lakh MT in 2018-19. The area under cotton cultivation also decreased (from 3,56,900 ha in 2010-11 to 2,60,249 ha in 2018-19), thereby, resulting in 52.06% lower yield. Wide variation is observed in groundnut production throughout the years and overall, it decreased from 6.5 lakh MT (2010-11) to 2.52 lakh MT (2018-19). Low rainfall can be one of the key reasons for the reduced yield. Annual rainfall for Rajkot has significantly reduced from 853mm (2011) to 365mm (2018) as per district-wise rainfall data published in Gujarat Forest Statistics 2018-19.

Recommendations that could be pursued by the district collector/committee at the state level	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 can be reduced in a phased manner.		Medium to long-term	Policy intervention needed Requires awareness and collaboration with the farming communities	Power tariffs are as per different consumption slabs as well as the horsepower of pump being used. Currently, the tariff for farmers is at 60 to 80 paise/unit in Gujarat. Electricity tariff policies, in conjunction with large subsidies for agricultural power, have caused rapid groundwater depletion in many regions, along with massive financial losses to power utilities and governments (both central and state). Flat tariffs lead to more equitable distribution of water between high-income and marginal consumers but fail to encourage conservation. Metered tariffs have the potential to promote water conservation but are difficult to manage and are expensive for low-income farmers. Western states like Gujarat, with rapidly depleting aquifers, should promote tariffs to enhance water conservation. [29]
FORESTRY/GREEN SPACES: Promote regeneration of degraded and open forest areas through corporate social responsibility (CSR) or similar mandates and encourage corporates to dedicate some percent of their profits towards greening the spaces around their units/factories.		Long-term	Needs strengthening of the existing policy framework Needs different stakeholder collaboration	Green belts help mitigate air pollution, increase urban green cover, leading to carbon sequestration
E-WASTE: Adoption of 'green marketing' approach: Promoting green products by displaying product lifespan on the label on e-products to influence purchase decisions, thereby, using the labels as behavioural intervention.		Medium to long-term	Needs policy intervention, collaborations, and awareness	

29 Sindhu B.S. et. al., Power tariffs for groundwater irrigation in India: A comparative analysis of the environmental, equity, and economic trade-offs

Recommendations that could be pursued by the district collector/committee at the state level	Cross-cutting with	Qualifying priority		District scenario/case examples
		Timeframe for the action to be accomplished	Framework for implementation	
WATER SCARCITY & POLLUTION: Enactment of the 'Model Bill for the Conservation, Protection, Regulation, Management of Ground Water, 2016' as an act in the state and ensuring strict regulation of private groundwater abstraction.		Short-term	Requires policy implementation	Gujarat is the best performing state in the Composite Water Management Index (CWMI), 2018 by Niti Aayog. Gujarat has a comprehensive State Water Policy which has set up institutions, such as the state regulatory authority, state policy council and implementation committee, river basin organisations, water research and training institutes, integrated water data centre, etc. However, establishing a regulatory framework can help the state boost water levels in more wells than the present achievement of a rise in 33% of wells.

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

Sub-sectors	Policies and programmes that can push forward the recommendation	Primary departments/ agencies	Supporting departments/ agencies
Power sector	1) National Smart Grid Mission 2) Smart Metering National Programme 3) Integrated Power Development Scheme (IPDS) 4) Restructured Accelerated Power Development and Reforms Programme (R-APDRP) 5) UDAY Scheme, 2015 6) National Mission on energy Efficiency specifically PAT (Perform, Achieve and Trade) Scheme 7) Gujarat Solar Power Policy, 2021 8) Policy for Development of Small-scale distributed solar projects, 2019 9) Standards and Labelling Programme	1) GUVNL-PGVCL, GoG 2) MNRE, GoI 3) GEDA, GoG 4) BEE (EESL)	1) Proposed District Level Climate Change and Environment Committee 2) Climate Change Department, GoG 3) Western Railways – Rajkot Division
Habitat	1) ECBC, 2017	1) Urban Development and Urban Housing Department, GoG 2) All ULBs 3) Rajkot Smart City Development Limited (RSCDL)	1) Proposed District Level Climate Change and Environment Committee 2) RUDA 3) GEDA
Transport	1) ECBC 2) JNNURM 3) Smart Cities Mission and AMRUT	1) Ports and Transport Department 2) All RTOs 3) ALL ULBs	1) GSRTC 2) GEDA 3) Rajkot Smart City Development Limited 4) Western Railways - Rajkot Division

Sub-sectors	Policies and programmes that can push forward the recommendation	Primary departments/ agencies	Supporting departments/ agencies
Industry	1) PAT Scheme 2) Gujarat Industrial Policy, 2020	1) Industries and Mines Department, GoG	1) Industries Commissionerate 2) District Industries Centre 3) 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	1) Agriculture, Farmers' Welfare and Co-operation Department, GoG 2) Gujarat Forest & Environment Department, GoG	1) Proposed District level Committee on Climate Change and Environment 2) Gujarat Agro Industries Corporation (GAIC) 3) Junagadh Agriculture University and other Agriculture Universities of Gujarat 4) APMCs 5) Energy and Petrochemicals Department, GoG 6) GIDC
Waste	1) E-waste Management Rules, 2016	1) Science and Technology Department, GoG	1) Proposed District Level Climate Change and Environment Committee

6.5 Sustainable Development Goals being addressed

SDGs	Targets	Being addressed through recommendation given in sector (sub-sectors)
SDG 1: No Poverty	Target 1.4: Ensure that all men and women, in particular the poor and the vulnerable, have access to basic services	Waste water
SDG 2: Zero Hunger	Target 2.1: End hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round	AFOLU (agriculture)
	Target 2.3: Double Agricultural Productivity	AFOLU (agriculture)
	Target 2.4: Implement resilient agricultural practices that increase productivity and production	AFOLU (agriculture)
	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 & Well-being	Target 3.3: End the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases	Water pollution; co-benefits from waste
	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; water scarcity and pollution; air pollution

SDGs	Targets	Being addressed through recommendation given in sector (sub-sectors)
SDG 6: Clean Water & Sanitation	Target 6.1: Achieve universal and equitable access to drinking water	Water scarcity and water pollution
	Target 6.3: Improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally	Waste; energy (industry); water pollution
	Targe 6.4: Substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals	Energy (habitat -- demand side management, industry); AFOLU (agriculture and green spaces); water scarcity
	Target 6.5: Implement integrated water resources management at all levels	AFOLU (agriculture and green spaces/ forestry); water scarcity and pollution
	Target 6.8: Support and strengthen the participation of local communities	Waste; AFOLU (all three); 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
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 buildings 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 and energy)
	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 and energy); AFOLU
SDG 8: Decent Work & Economic Growth	All targets	AFOLU (agriculture and livestock)
	Target 8.2: Achieve higher levels of economic production through diversification, upgradation and innovation	Energy; AFOLU (agriculture and livestock)
	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	Agriculture (forestry/green spaces)
SDG 9: Industry, Innovation & Infrastructure	Target 9.1: Develop quality, reliable, sustainable and resilient infrastructure	Energy (habitat -- energy-efficiency in building, transport); waste
	Target 9.2: Promote inclusive and sustainable industrialization	Energy (industry)
	Target 9.3: Improving access and connectivity to industries/other enterprises	Energy (transport)

SDGs	Targets	Being addressed through recommendation given in sector (sub-sectors)
SDG 9: Industry, Innovation & Infrastructure	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-cold chains/water pumps etc.); waste; energy (industry); water scarcity
	Target 9.5: Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending	Energy (power); waste
	Target 9.b: Research and innovation in developing countries, including by ensuring a conducive policy environment	Waste; energy (power and energy, industry)
SDG 11: Sustainable Cities & Communities	Target 11.1: Ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums	Waste; habitat; water
	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 and energy, habitat -- energy efficient buildings): all district-specific sectors
	Target 11.4: Strengthen efforts to protect and safeguard the world's cultural and natural heritage	AFOLU (forestry); water scarcity
	Target 11.6: Reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management	Waste; energy (power and energy, transport, habitat, industry); air pollution
	Target 11.7: Provide universal access to safe, inclusive and accessible, green and public spaces	AFOLU (green spaces); habitat; air pollution
	Target 11.a: Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening regional development planning	Energy (transport -- improving traffic flow)
	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 & 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 and water 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 and water pollution

SDGs	Targets	Being addressed through recommendation given in sector (sub-sectors)
SDG 12: Responsible Consumption & Production	Target 12.5: Substantially reduce waste generation through prevention, reduction, recycling and reuse	Waste; 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; 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 and sub-sectors
SDG 14: Life under Water	Target 14.1: Prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution.	Waste (single use plastic)
SDG 15: Life on Land	Target 15.1: Ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements	AFOLU; waste; water pollution
	Target 15.2: Promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation	AFOLU (forestry/green spaces)
	Target 15.3: Combat desertification, restore degraded land and soil	AFOLU (forestry/green spaces)
	Target 15.5: Take urgent and significant action to reduce degradation of natural habitats, halt loss of biodiversity	AFOLU (forestry)
	Target 15.9: Integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies	AFOLU (all three) and water scarcity
	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 (all three) and water scarcity
SDG 17: Partnerships for the Goals	Target 17.7: Promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries	Energy; AFOLU; waste; individual action and behavioural change communication
	Target 17.16: Enhance the global partnership for sustainable development, complemented by multi-stakeholder partnerships that mobilize and share knowledge, expertise, technology and financial resources, to support the achievement of the sustainable development goals in all countries, in particular developing countries	Energy; AFOLU; waste

6.6 Promoting voluntary individual climate actions

Waste management

1. Practice source segregation and handover segregated waste: biodegradable, non-biodegradable, domestic hazardous and household clinical waste
2. Go for sustainable tourism/eco-tourism or tourism efforts for lowered waste footprint
3. Ensure formal recycling of your electronic products by going through the collection points information on the same are provided in electronic brand websites.
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.
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

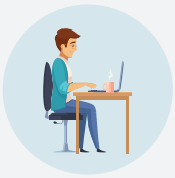
1. When cooking on gas stove, use moderate flame setting to conserve LPG
2. Prefer the use of pressure cookers
3. Keep the burner clean
4. Use lids to cover the pan while cooking
5. Use flat bottomed pan on electric stove
6. Turn off electric stove several minutes before the specified cooking time

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 water bottle, 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 then opt for work from home options for a few days in a week

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

Choose standard shipping when ordering online

Buy locally available produces especially food/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

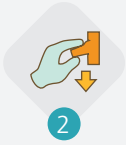
Include more meat-free meals and limit food wastage

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

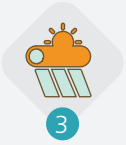
Opt for water saving fittings and fix any leakages in the house

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)

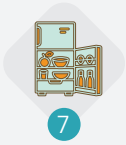


3. Replace electric water heater with a solar water heater, if feasible

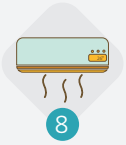
4. Unplug idle devices/appliances.

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

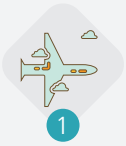


7. Do not overload the refrigerator



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

Transport

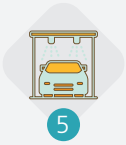


1. Choose direct flights to reduce carbon footprint

2. Travel light to reduce carbon emissions

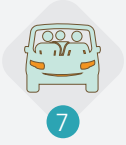
3. Strictly abide by pollution norms

4. Put on your shoes for short trips



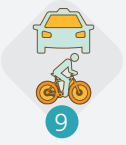
5. Ensure regular maintenance of vehicles

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

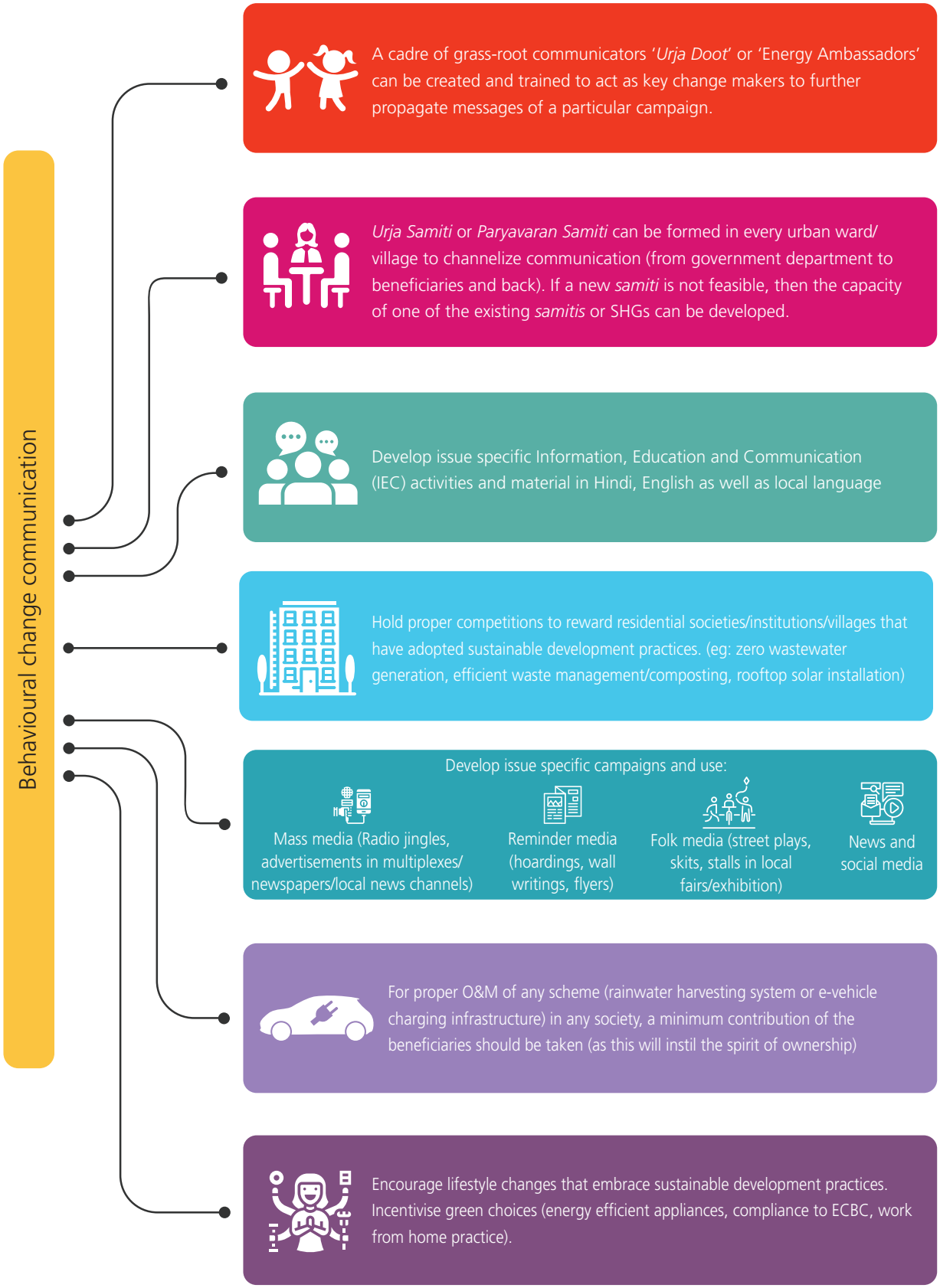
8. Shift to clean, non-petroleum fuels such as electricity to power vehicles



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



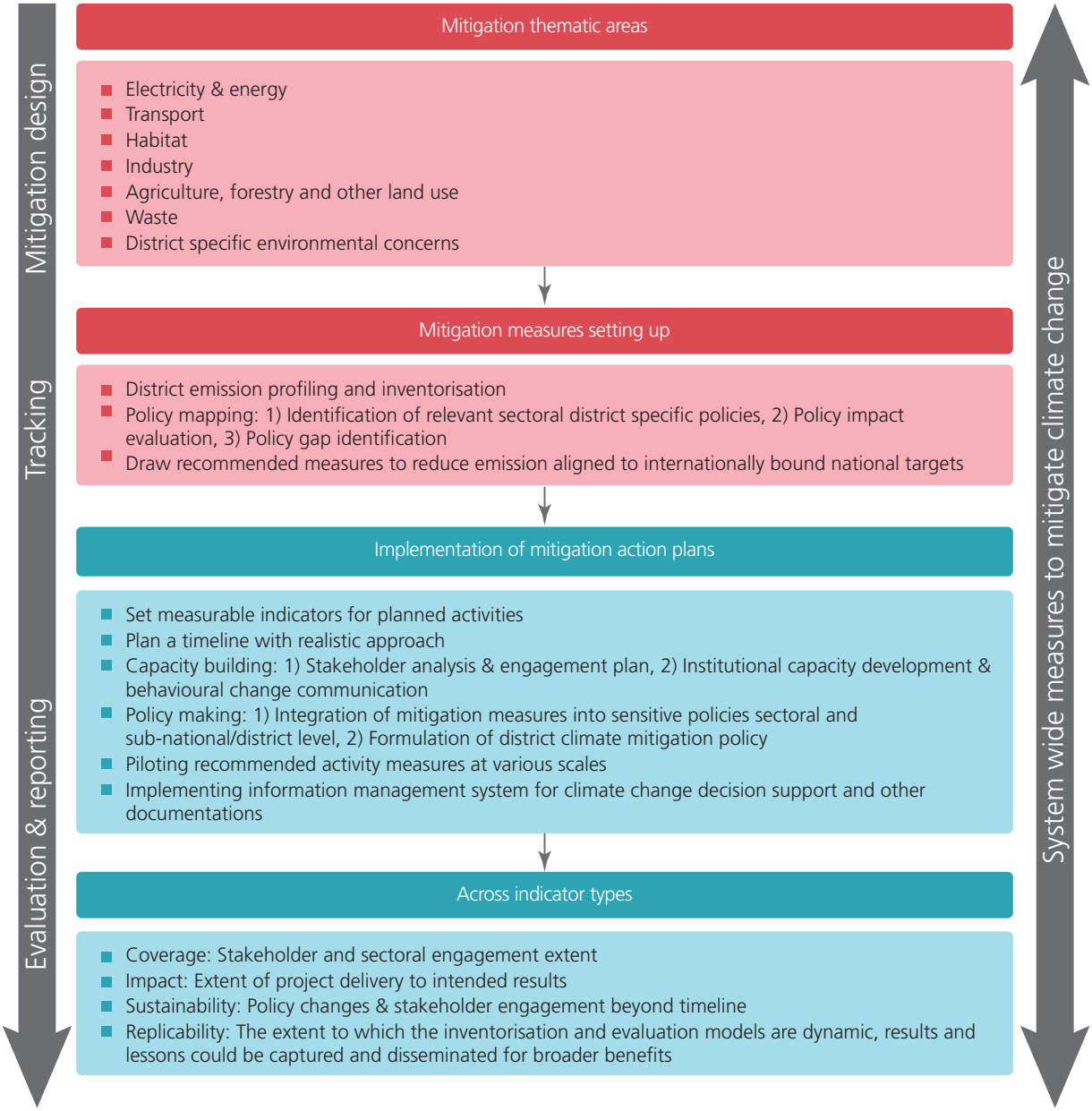
MONITORING AND EVALUATION PLAN

Stakeholder consultation for CCEAP Rajkot chaired by the collector, Shri Arun Mahesh Babu MS, IAS

7. MONITORING AND EVALUATION PLAN

7.1. Framework for monitoring and evaluation of climate change mitigation in Rajkot

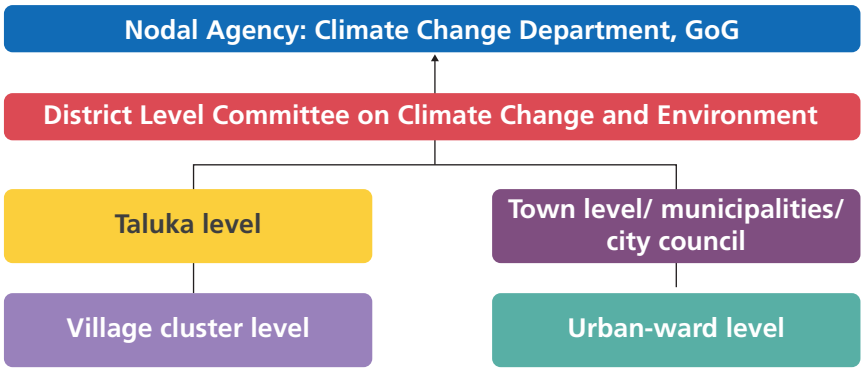
This section describes the planning for monitoring and evaluation (M&E) of the climate change mitigation measures that the district may adopt for the sectors identified in the report. M&E is crucial to realise the achievement and track the effectiveness of results envisaged in order to compliment the 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.[30]



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

7.2 Proposed institutional set-up

As a central authority or body to steer the wheels of climate mitigation, it is recommended to formulate a district climate cell/committee or include the perspective of climate change in the existing District Environment Committee.[31] The committee shall assign tasks according to stakeholder analysis and engagement as outlined in the model giving below. 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 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), 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, Rural Development Department (RDD), Health Care Department, Regional Transport Office (RTO) etc

Taluka level

Chairman: Mamlatdar/Taluka Development Officer

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

Town level/municipalities

Chairman: Head of Municipality/Nagarpalika

Members: Town level representatives of the departments mentioned above

Village cluster level

Chairman: Deputy Mamlatdar

Members: Sarpanch and other PRI members, Self-help group members, head of women committee, Village Water and Sanitation Committee (VWSC), grassroot communicators

Urban-ward level

Chairman: Ward Representatives

Members: President of RWAs, grassroot communicators, civil societies, members of samittee

31 As per the Hon'ble NGT order in O.A. No. 710-713/2017 dated 15.07.2019


NATIONAL HEALTH MISSION
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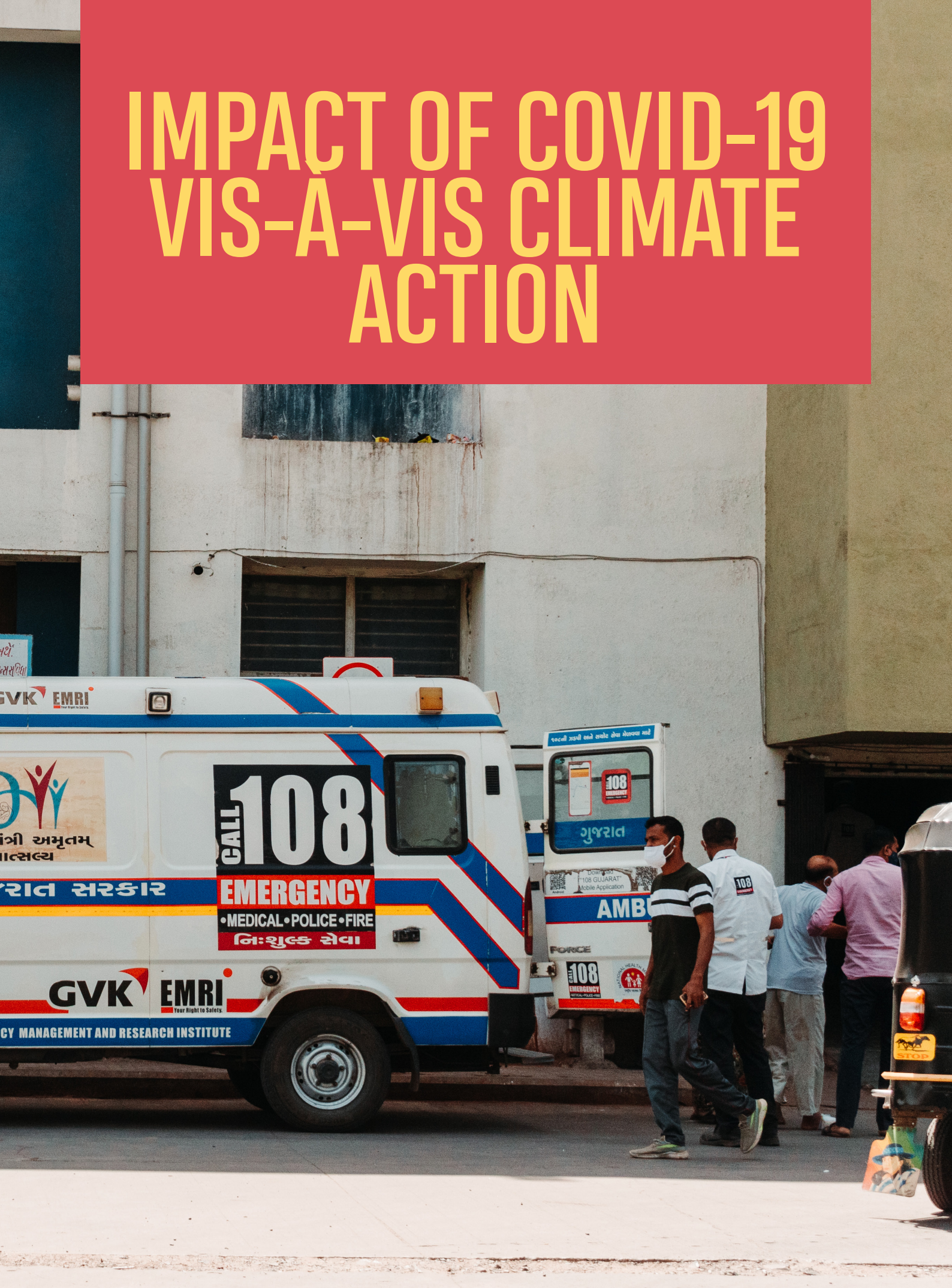
IMPACT OF COVID-19 VIS-À-VIS CLIMATE ACTION



Ambulance and people with mask at PDU Rajkot, a Covid-19 hospital

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

8.1 Introduction

The ongoing COVID-19 pandemic has gravely affected the country. Rajkot district reported 57,954 cases (as of September 30, 2021), and was in the top five districts of the state accounting for 7.02 percent of total cases in Gujarat (Covid19India, 2021). This has affected the management of the climate crisis.

Positive impacts: Lockdowns have had several positive impacts on the environment. For the first time in nearly four decades, India has seen reduction in CO_2 emissions by 30 million tonnes CO_2 (1.4 percent) in FY2019-20 due to economic slowdown and restricted activities (Lauri & Dahiya, 2020) during COVID lockdown. In April 2020, aerosol levels were at a 20-year low for that time of the year in North India, one of the most polluted regions in the world (NASA, 2020). Temporal air pollutant records from different zones of Gujarat suggest significant reduction in air pollution with respect to $PM_{2.5}$, PM_{10}, SO_2, NO_2 and CO_2, and AQI values (reduction in AQI: 60 to 75 percent) in the Rajkot and Jamnagar zones due to reduced industrial activities and vehicular movements compared to the same period of the previous year (Selvam, et al., 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 Rajkot.

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 and increased by 14.16 percent in May with relaxations in lockdown norms (The Economic Times, 2020). At the national level, while the fuel consumption took a dip of around 70 percent as compared with pre-COVID levels, electricity demand fell by 20 to 25 percent during the strict lockdown.

India's electricity demand is projected to be seven to 17 percent lower by 2025 due to the downward revision of its GDP growth partly due COVID-19 economic shock (Spencer, 2020).[32]

Outlook for Rajkot

Some states have reduced coal power generation to compensate for the reduced demand. Contribution of coal in total power generation reduced from an average of 72.5 percent in March 2020 to 65.6 percent in April 2020 in the country. 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 presents an opportunity to increase focus on renewable energy production and strengthen its integration into the grid. Rajkot district can contribute to Gujarat's RE generation capacity by encouraging projects such as solar rooftops, biogas and solar pumps for agriculture.

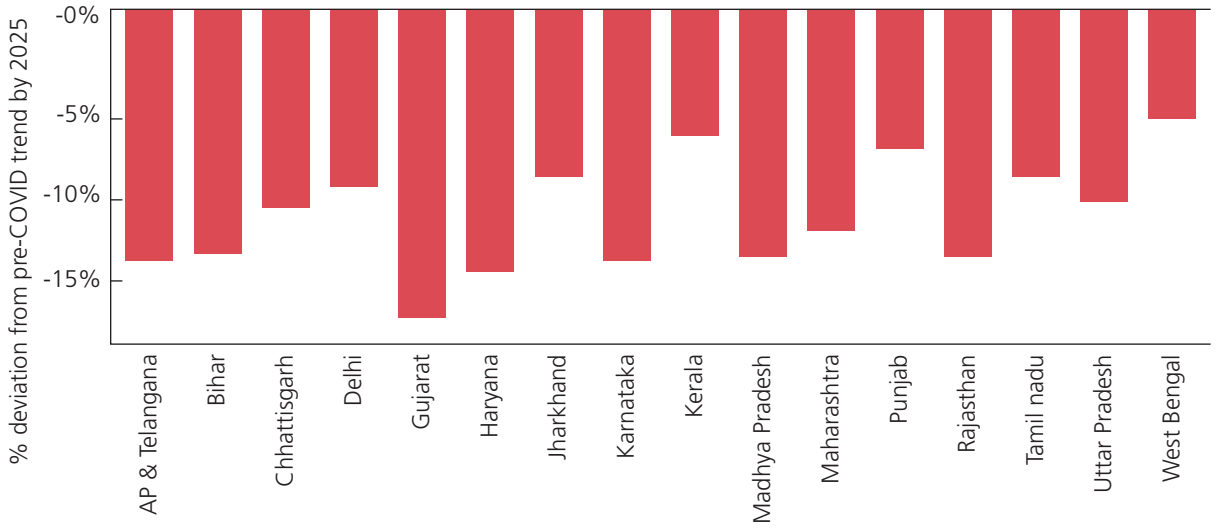


Figure 37: 2025 deviation of electricity demand from pre-COVID trends projected from major Indian states

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

8.2.2 Fuel consumption

India's fuel consumption fell 45.8 percent to 9.93 million tonnes in April, down from 18.32 million tonnes fuel consumed in the same month a year back (Business Standard, 2020). The only fuel that showed growth was LPG as the government dole of free cooking gas cylinders to poor households fired up consumption by 12.2 percent to 2.13 million tonnes in April, 2020. With gradual unlocking, moderately progressing economic recovery, restricted movement and industries mostly operating at 70 to 80 percent capacity due to subdued demand and restrictions, the overall demand for fuel has also reduced.

Outlook for Rajkot

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

8.3 Agriculture

COVID-19 caused disruptions to agriculture and its supply chains. Inability to hire harvesters and other machinery interrupted harvesting activities for wheat and pulses (during *rabi* season). There were disruptions in supply chains because of the lockdown. 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 milk and milk products supply chain. Meanwhile, poultry farmers were badly hit due to misinformation on social media.

While lockdown impacted 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 against 570.86 lakh ha area during the corresponding period of last year, an increase of 21.20 percent. (WBCSD, 2020) (PIB, 2020).

Overall, sowing in Gujarat went up by 35 percent for summer crop 2020 (State Agricultural Department) – highest since 2016 with an increased crop sowing area of 8.91 lakh hectare from 6.62 lakh hectare last year. The Saurashtra region, of which Rajkot is the central and major district, reported the highest spike (165 percent) in sowing (The Times of India, 2020). A likely impact of COVID-19 was seen on agricultural transactions in Gujarat. Between March and May 2020, 16.35 lakh farmers across Gujarat sold produce worth ₹ 5,400 crore to the Agriculture Produce Market Committees, which is significantly lower than the corresponding period in 2019 (The Indian Express, 2020).

Outlook for Rajkot

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 waste footprint. In Gujarat, 6.72 lakh workers exited the major urban centres by special trains and many travelled by road and on foot (The Indian Express, 2020).

Outlook for Rajkot

Employing 6 percent of the state's total migrant workers, Rajkot faced an exodus of a minimum of one lakh workers during COVID-19 lockdown, compelling the district to rely more on local labour (The Times of India, 2020). With unlocking and renewed opportunities of employment, some migrants may return to the city. The district administrator must understand the migration pattern in Rajkot and plan allocation and management of resources accordingly. Agriculture sector schemes, MGNREGS and state employment guarantee programmes can be used to fast-track incorporation of these migrants into the state roll 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 management

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

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

8.6 Air pollution[33]

Comparisons of 24-hour average of $PM_{2.5}$ over Rajkot district between Jan to May for 2019 and 2020 shows that $PM_{2.5}$ concentration reduced significantly in 2020 during the lockdown months (Figure 38 and 39), i.e., it remained within the range of 0 to 30 µg/m^3, implying good air quality by Indian standards.[34]

33 The $PM_{2.5}$ and PM_{10} modal forecast data obtained from European Centre for Medium-Range Weather Forecasts (ECMWF) and analysed at GIS platform for mapping of monthly mean values.
The data can be accessed from https://apps.ecmwf.int/datasets/data/cams-nrealtime/levtype=sfc/
For the mapping of NO_2 and SO_2 the data were obtained from following URLs.
https://developers google.com/earth-engine/datasets/catalog/COPERNICUS_S5P_OFFL_L3_NO2
https://developers google.com/earth-engine/datasets/catalog/COPERNICUS_S5P_OFFL_L3_SO_2

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

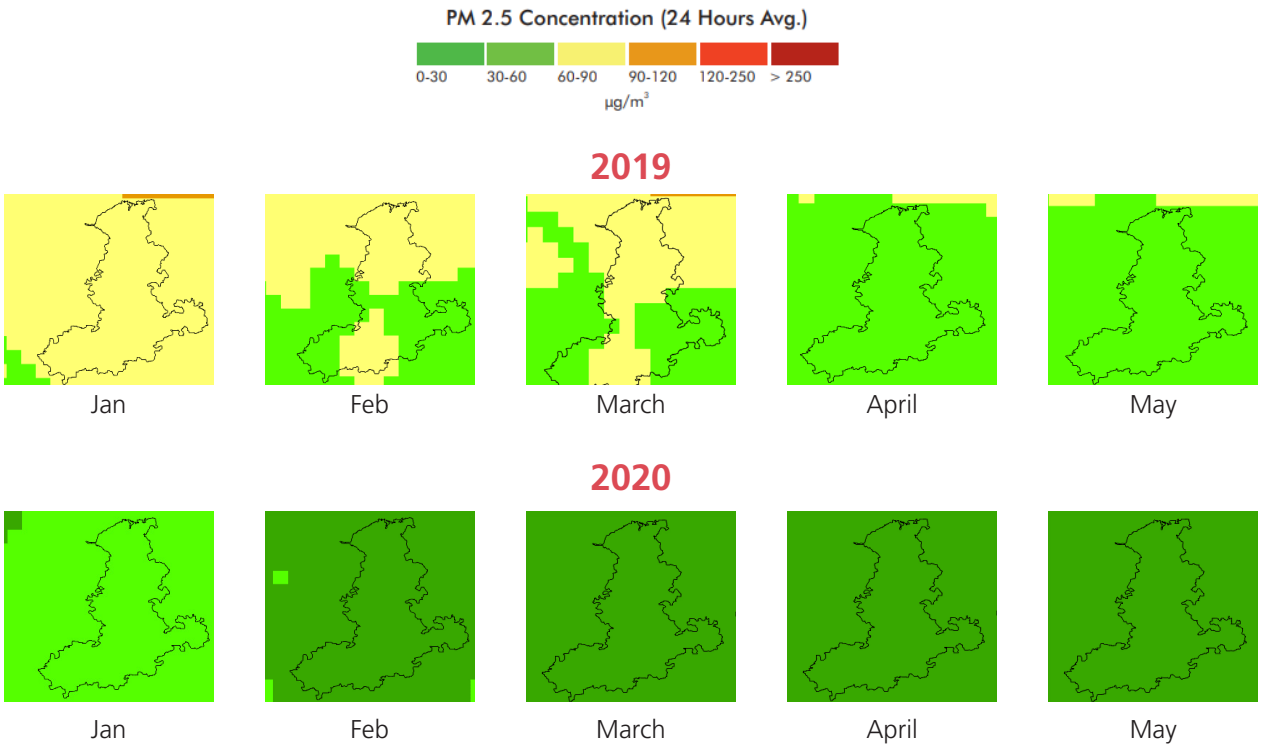


Figure 38 $PM_{2.5}$ concentration in Rajkot during January-May, 2019 vs. 2020

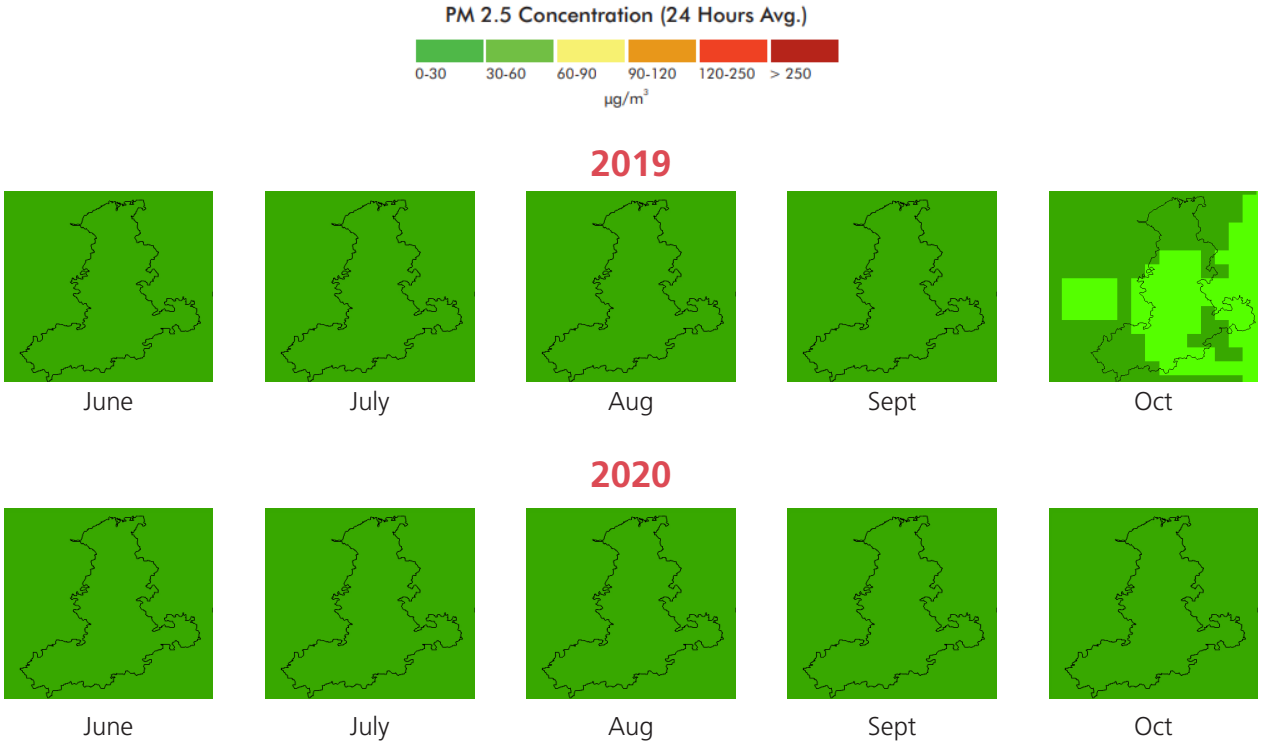


Figure 39 $PM_{2.5}$ concentration in Rajkot during June-October, 2019 vs. 2020

As in the case of $PM_{2.5}$, a significant reduction in PM_{10} concentration was observed during January to May 2020, with respect to the corresponding months of 2019 (Figure 40 and 41). In 2020, PM_{10} concentration was found to be mostly in the range of 50 to 100 µg/m³.

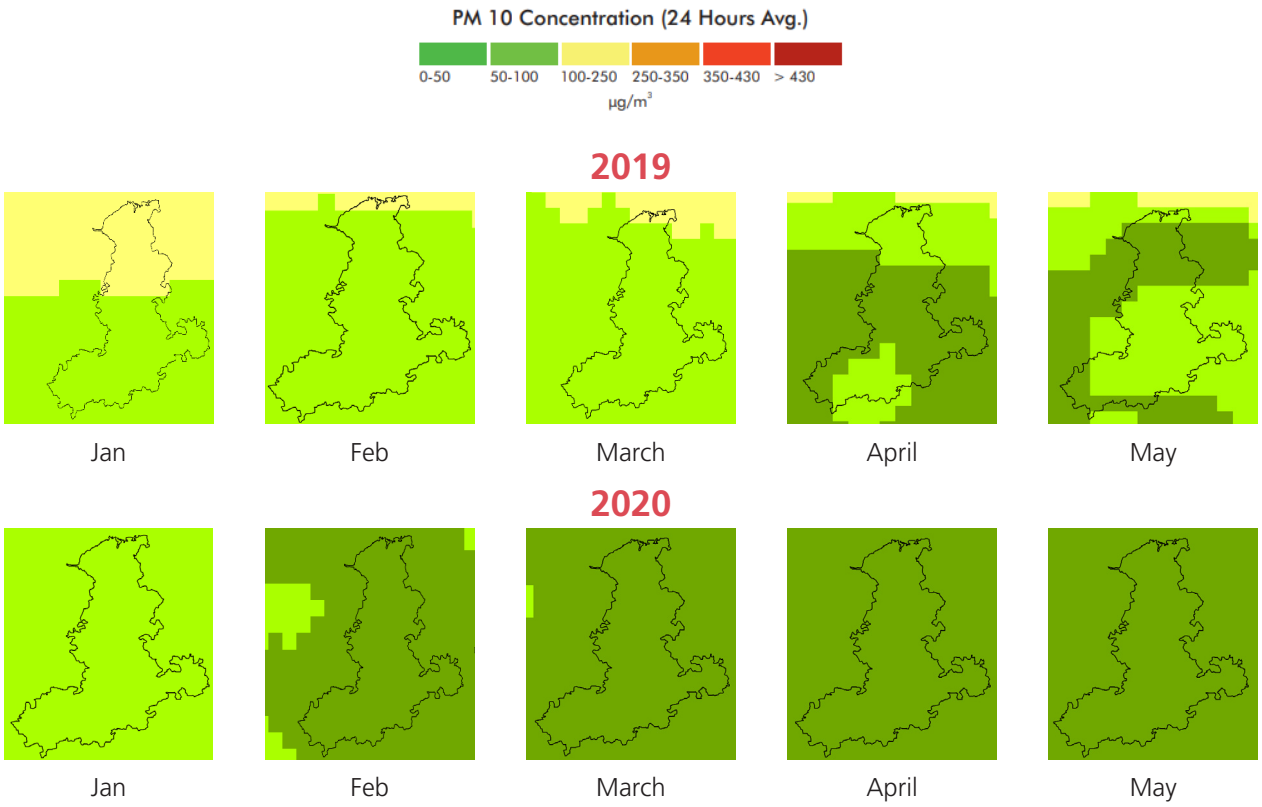


Figure 40 PM_{10} concentration in Rajkot during January-May, 2019 vs. 2020

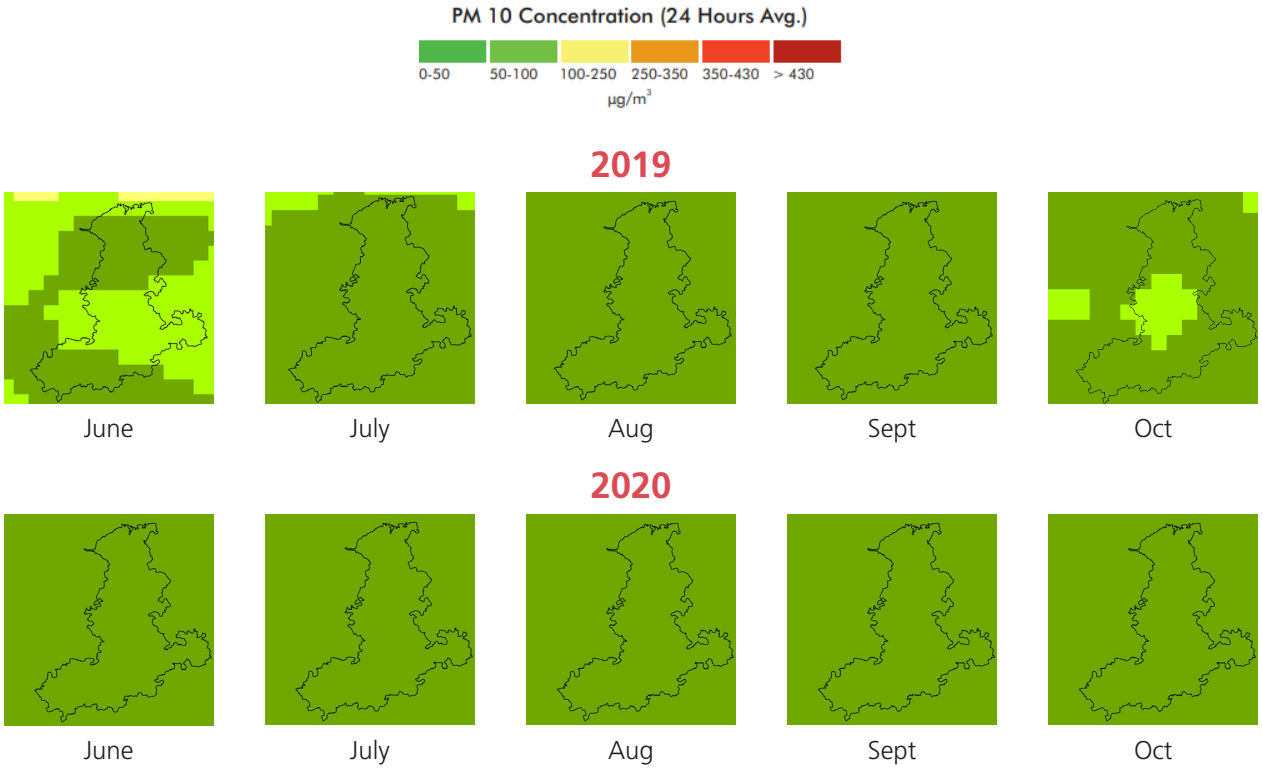


Figure 41 PM_{10} concentration in Rajkot during June-October, 2019 vs. 2020

During the lockdown, most anthropogenic activities were at a standstill or were limited. Therefore, the concentration of nitrogen dioxide over Rajkot city (upper region) reduced significantly in comparison to 2019, (especially from March to September). However, the NO_2 emission started rising again in October as soon as the lockdown was lifted completely. From the range of 114-142 µmole/m^2, the concentration values declined to 28-57 µmole/m^2 during the post lockdown period (Figure 42 and 43).

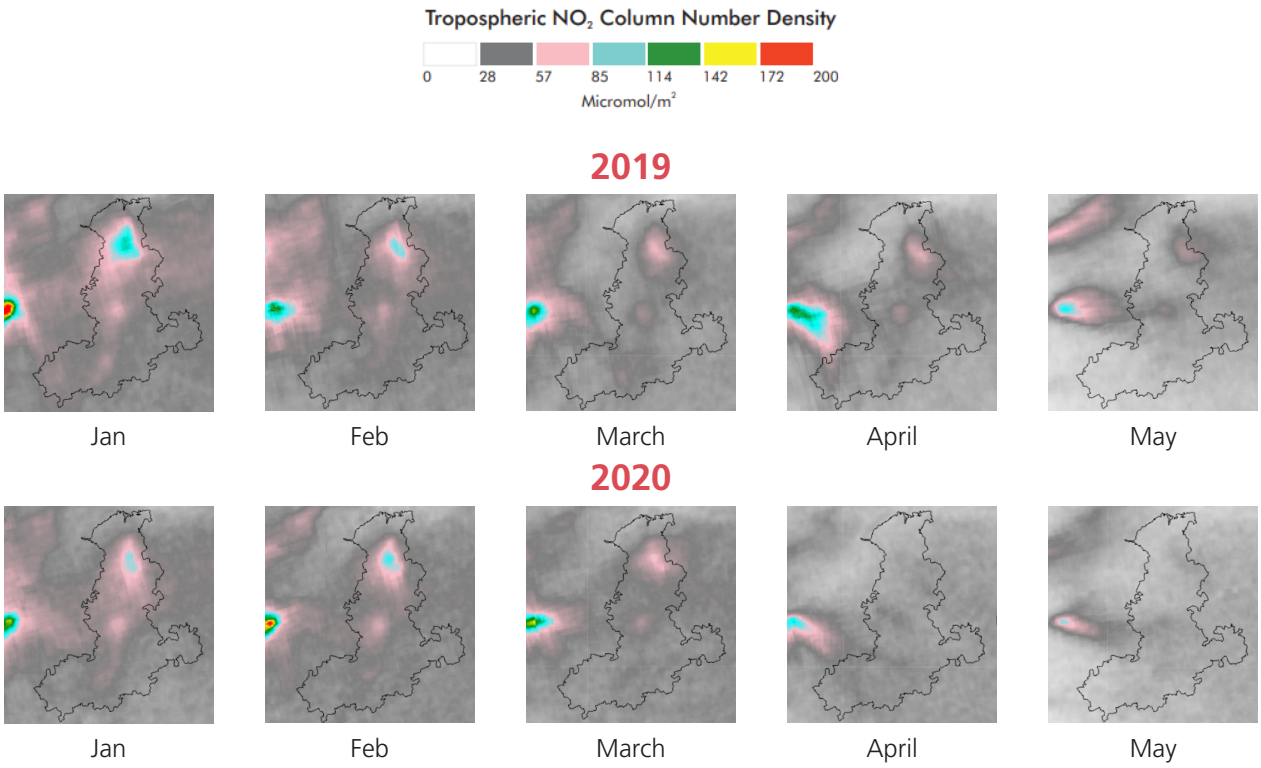


Figure 42 NO_2 concentration in Rajkot during January-May, 2019 vs. 2020

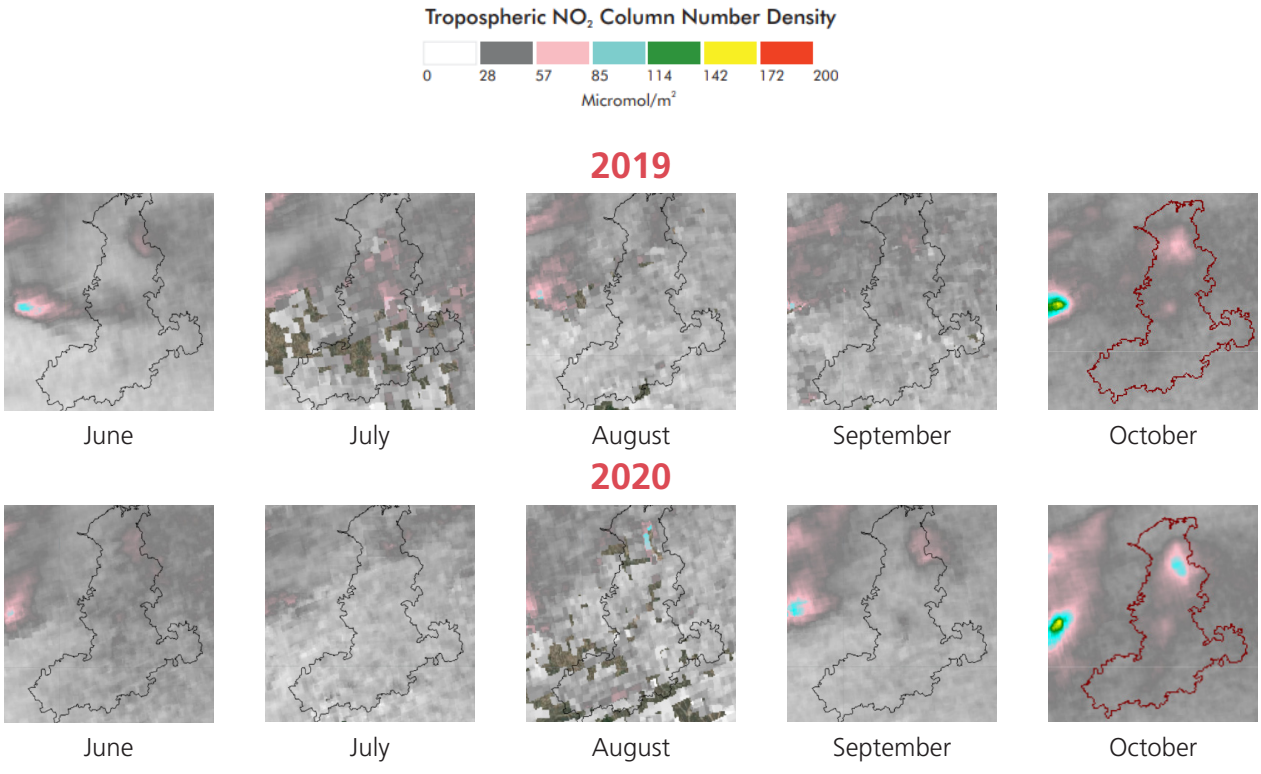


Figure 43 NO_2 concentration in Rajkot during June-October, 2019 vs. 2020

Most SO_2 emissions are anthropogenic, and adversely affect human health and air quality, besides impacting the climate through radiative forcing. It is usually concentrated as scattered patches near large urban agglomerations. The lockdown reduced SO_2 concentration over the city in comparison to the same period of 2019, especially during April and May when SO_2 concentration reduced from 350 to 420 µmole/m² to 0 to 280 µmole/m² range (Figure 44 and 45).

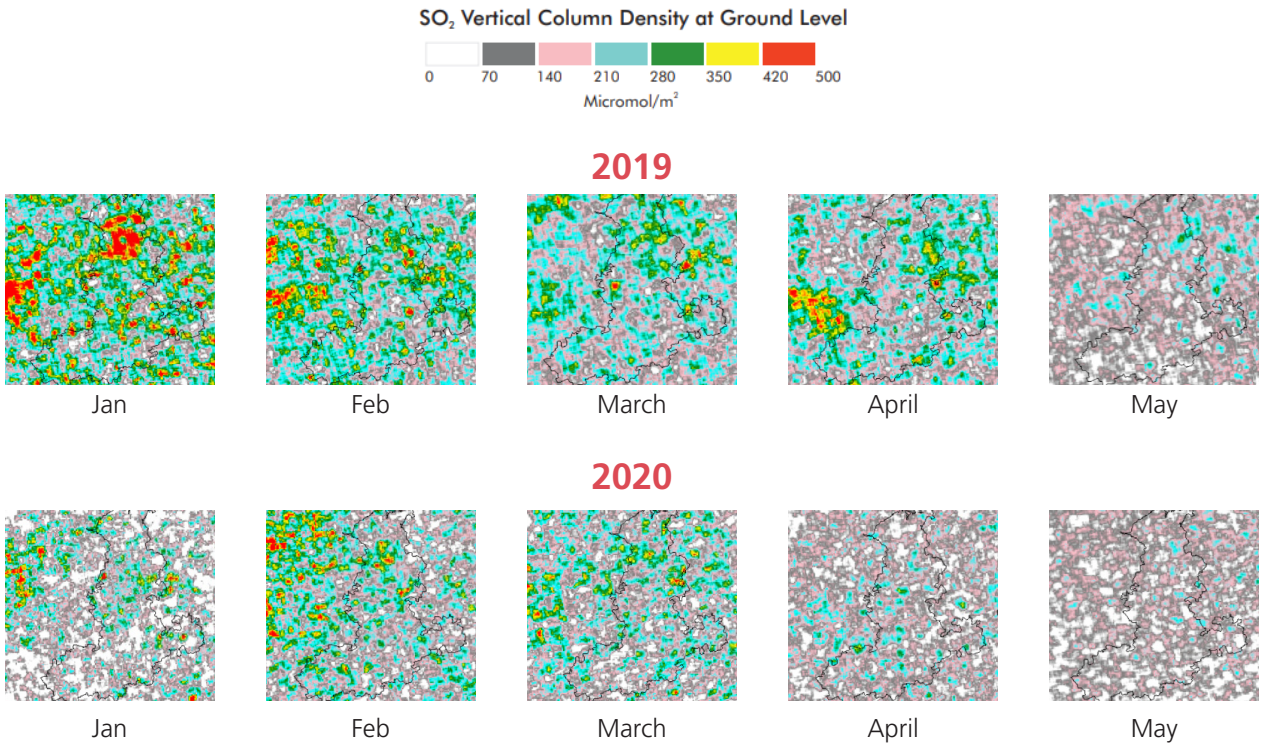


Figure 44 SO_2 concentration in Rajkot during January-May, 2019 vs. 2020

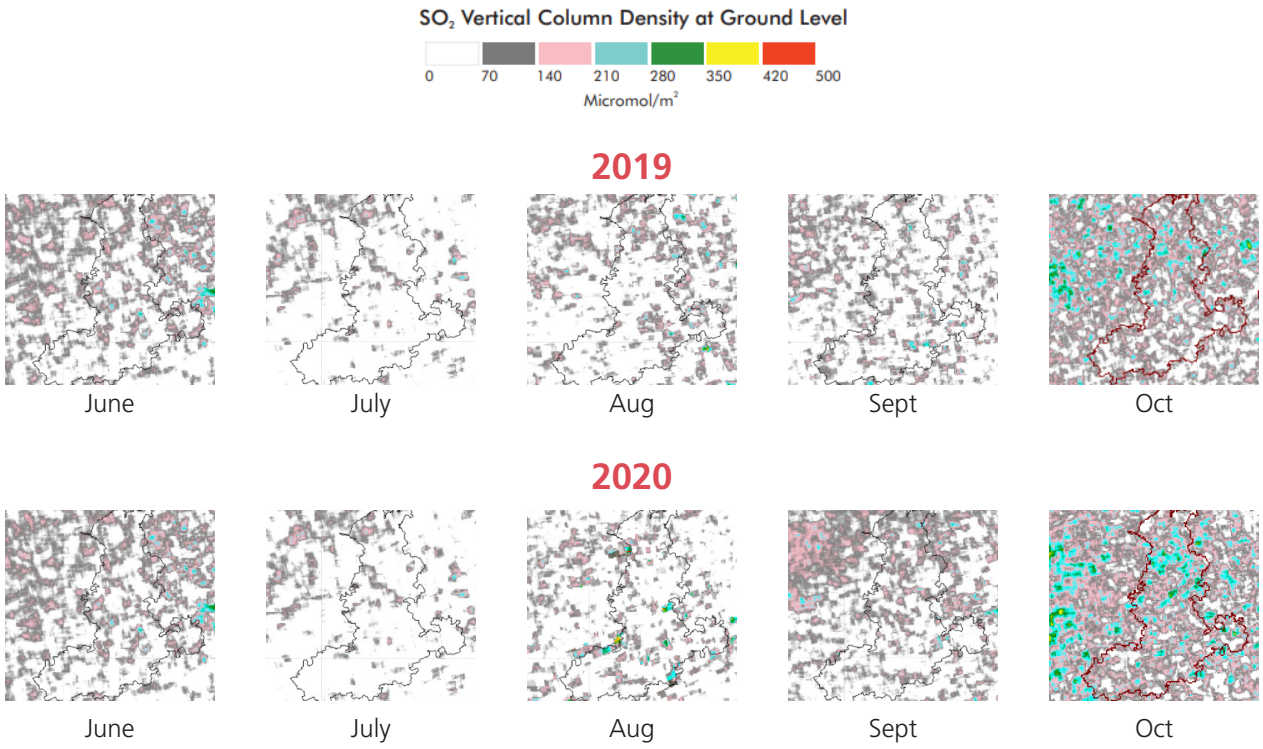


Figure 45 SO_2 concentration in Rajkot during June-October, 2019 vs. 2020

Outlook for Rajkot

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 when normal life resumed. Source apportionment studies can help identify air pollution hotspots in the district. Authorities in Rajkot 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

Aerial view of Rajkot with several rooftop solar panels

THE WAY FORWARD

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

Rajkot holds a lot of potential for making significant contributions towards meeting India's climate targets. It is one of the few districts in Gujarat with good potential for tapping wind energy. Rajkot district has the third-largest installed capacity for wind-energy in Gujarat (after Jamnagar and Kachchh) with an existing installation of more than 700 MW of wind power.

When it comes to public transportation, the district has already taken some significant steps. For instance, Rajkot Municipal Corporation (RMC) has initiated procurement of electric buses under FAME II for both RMTS and BRTS. Rajkot was the second city in Gujarat to launch BRTS. In waste collection, RMC has 80 percent door-to-door efficiency and has also set up a waste-to-energy (W2E) plant.

The district has a very wide and strong network of industrial and commercial associations. Being at the centre of Saurashtra, Rajkot can take the lead by setting examples of climate action that the other, smaller districts of the region can emulate.

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.

With the availability of a district-level policy and scheme-wise budgetary allocation, a detailed budgetary analysis with respect to climate action can be carried out for Rajkot as an add-on to this action plan. 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.

Wind mill

REFERENCES

Aruga, K., Islam, M. M., & Jannat, A. (2020). Effects of COVID-19 on Indian energy consumption. Sustainability. Retrieved from https://www.mdpi.com/2071-1050/12/14/5616/pdf

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

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

Census of India. (2011). District Census Handbook: Rajkot. Retrieved 07 16, 2021, from https://censusindia.gov.in/2011census/dchb/DCHB_A/24/2409_PART_A_DCHB_RAJKOT.pdf

CGWB. (2013). District groundwater brochure: Rajkot district, Gujarat. Ministry of Water Resources, Central Groundwater Board. Govt. of India. Retrieved from http://cgwb.gov.in/District_Profile/Gujarat/Rajkot.pdf

CGWB. (2013). Groundwater Brochure: Rajkot District, Gujarat. Retrieved from http://cgwb.gov.in/District_Profile/Gujarat/Rajkot.pdf

CGWB. (2019). Ground Water Year Book 2017-18: Gujarat State and UT of Daman and Diu. Retrieved from http://cgwb.gov.in/Regions/WCR/Reports/GW_Year_Book_2017-18_ahm.pdf

Climate Change Dept. (2014). Gujarat State Action Plan on Climate Change. Climate Change Department. Government of Gujarat. Retrieved from http://gujenvis.nic.in/PDF/Gujarat-SAPCC.pdf

Covid19India. (2020). Covid 19 Gujarat. Covid19India.org. Retrieved from https://www.covid19india.org/state/GJ

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

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

Dept of Agriculture. (2015). Report on Task Force to derive suggestions to increase agriculture development in Gujarat. Govt of Gujarat, Department of Agriculture & Cooperation. Retrieved from https://niti.gov.in/writereaddata/files/Gujarat.pdf

Directorate of Agriculture. (2018). Season and Crop Report 2017-2018. Government of Gujarat, Directorate of Agriculture. Retrieved from https://dag.gujarat.gov.in/images/directorofagriculture/pdf/Provisional-SCR-Yr-2017-18.pdf

Directorate of Agriculture. (2020). District-wise Area, Production & Yield of Important Food & Non-food crops in Gujarat State: 2016-17, 2017-18 & 2018-19. Govt of Gujarat, Directorate of Agriculture. Retrieved from https://dag.gujarat.gov.in/images/directorofagriculture/pdf/APY-2016-17-2017-18-2018-19-for-website.pdf

DoE&S. (2018). Statistical abstract of Gujarat State, 2018. Directorate of Economics & Statistics, Govt. of Gujarat. Retrieved from https://www.gsfc.gujarat.gov.in/gujecostat.gujarat.gov.in/html/sites/default/files/STATISTICAL-ABSTRACT-2018_19122019.pdf

FSI. (2019). India State of Forest Report 2019: Gujarat Vol 2. Forest Survey of India, Ministry of Environment, Forest & Climate Change, Govt. of India. Retrieved from https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-gujarat.pdf

FSI. (2019). State of Forests Report, Gujarat State. Forest Survey of India. Retrieved from https://fsi.nic.in/isfr19/vol2/isfr-2019-vol-ii-gujarat.pdf

GERC. (2020). Tariff Order Truing up for FY 2018-19 and Determination of Tariff for FY 2020-21 for PGVCL. Retrieved from Gujarat Electricity Regulatory Commission: https://gercin.org/wp-content/uploads/2020/03/PGVCL-True-Up-FY-2018-19-Final-Order.pdf

GERC. (2021). Tariff order. Retrieved from Gujarat Electricity Regulatory Commission: https://gercin.org/

GERC. (2021). Truing up for FY 2019-20, Determination of ARR and Tariff for FY 2021-22. Retrieved from https://gercin.org/wp-content/uploads/2021/04/PGVCL-1914-2020-True-up-FY-2019-20-Order-31.03.2021.pdf

GGRC & NABCONS. (2016). Pradhan Mantri Krishi Sinchayee Yojana (PMKSY): District Irrigation Plan (2016-2020) Rajkot, Gujarat. NABCONS. Gujarat Green Revolution Company Limited (GGRC). Retrieved from http://www.pmksy.gov.in/mis/Uploads/2016/20160816051209369-1.pdf

GGRC. (2016). PMKSY - District Irrigation Plan (2016-2020). Gujarat Green REvolution Company Limited.

GPCB. (2020). Performance status of CETP: April 2020. Gujarat Pollution Control Board, Govt. of Gujarat. Retrieved from https://gpcb.gujarat.gov.in/uploads/Perfomance_Status_CETP_April_2020.pdf

GPCB. (2021). GPCB Annual Report 2019-20. Govt of Gujarat, Gujarat Pollution Control Board. Retrieved from https://gpcb.gujarat.gov.in/uploads/English_Annual_Report_201920.pdf

Hindustan Times. (2020, 08 24). 12.7S% dip in diesel demand in July. Retrieved 09 15, 2020, from https://www.hindustantimes.com/india-news/12-7-dip-in-diesel-demand-in-july/story-A785vDisice69yD3KCz9QJ.html

ICAR-NICRA. (2011). Agriculture Contingency Plan: Rajkot. National Innovations in Climate Resilient Agriculture. Indian Council of Agricultural Research. Retrieved 07 16, 2021, from https://krishi.icar.gov.in/jspui/bitstream/123456789/30866/1/GUJ%2020-Rajkot%2031.05.2011.pdf

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

Indian Bureau of Mines. (2017). Indian Minerals Yearbook 2015 (Part III: Mineral Reveiws). Ministry of Mines, Govt of India. doi:15.03.2021

Industries Commissionerate. (ND). Rajkot District Profile. Govt of India, Industries Commissionerate. Retrieved from https://fdocuments.in/reader/full/rajkot-district-profile

Lauri, M., & Dahiya, S. (2020). Analysis: India's CO_2 emissions fall for first time in four decades amid coronavirus. CarbonBrief. Retrieved from https://www.carbonbrief.org/analysis-indias-co$_2$-emissions-fall-for-first-time-in-four-decades-amid-coronavirus

Ministry of Mines, GoI. (2015). Indian Minerals Yearbook 2013. https://ibm.gov.in/writereaddata/files/01192015115143IMYB_2013_Vol%20III_Perlite%202013.pdf: Indian Bureau of Mines, Ministry of Mines, GoI.

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

MoRTH. (2018). Road Transport Yearbook (2015-16). Ministry of Road Transport & Highways. Retrieved from https://morth.nic.in/sites/default/files/Road_Transport_Year_Book_2015_16_reduce.pdf

MSME. (2017). District Industrial Potential Survey REport of Rajkot District. Ministry of Small and Medium Enterprises, Govt of India. Retrieved from http://dcmsme.gov.in/dips/2016-17/24.%20Rajkot%202016-17.pdf

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

NICRA-ICAR. (2016). Agriculture Contingency PLan for district: Rajkot. National Innovations in Climate Resilient Agriculture (NICRA). Hyderabad: Central Research Institute for Dryland Agriculture. Retrieved from http://www.nicra-icar.in/nicrarevised/images/statewiseplans/Gujarat%20(Pdf)/JAU,Junagadh/GUJ%2023-Rajkot%2031.05.2011.pdf

Pandey, V., Patel, H. R., Lungaria, M. M., Karande, B., Yadav, S. B., Shah, A. V., & Sood, V. K. (2015, December). Climate change and its impact on major crops in Gujarat. Journal of Agrometeorology, 190-193. Retrieved from https://www.researchgate.net/publication/284725930_Climate_change_and_its_impact_on_major_crops_in_Gujarat/citations

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

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

Rajkot District Administration. (2020). About district: administrative set up. Retrieved from Rajkot District: rajkot.nic.in

Rajkot Municipal Corporation. (ND). Infrastrucsture: existing infrastructure. Retrieved from Rajkot Municipal Corporation: http://www.rmc.gov.in/rmcwebsite/infrastructure.aspx

Rajshekhar, M. (2017). Gujarat is battered by heat waves, floods, drought. How are its cities coping? Scroll.in. Retrieved from https://scroll.in/article/859203/gujarat-is-battered-by-heat-waves-floods-drought-how-are-its-cities-coping#:~:text=Rajkot%20currently%20needs%20about%20270,said%20senior%20municipal%20corporation%20official.

RUDA. (2020). Retrieved from http://www.auda.org.in/uploads/Assets/rdp/Basemap-36X36.jpg

Selvam, S., Muthukumar, P., Venkatramanan, S., Roy, P., Bharath, M. K., & Jesuraja, K. (2020). SARS-CoV-2 pandemic lockdown: effects on air quality in the industrialized Gujarat state of India. Sci Total Environ. doi:10.1016/j.scitotenv.2020.140391

Shete, D., & Patel, N. (2013). Climate Change IMpacts on Drought in North Gujarat Agroclimatic Zone: Special Reference to Ahmedabad District. Retrieved from https://www.researchgate.net/publication/263619586_1_Climate_Change_Impact_on_Crop_Water_Requirements_in_South_Saurashtra_Region_of_Gujarat_State_2_Climate_Change_Analysis_for_the_Coastal_Belt_Area_of_Saurashtra_3_26_Climate_Change_Impact_on_Rainfall_

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

Suresh, A., & Samuel, a. M. (2020). Micro-irrigation development in India: challenges and strategies. Current Science.

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

The Economic Times. (2020, 05 04). Lockdown pulls down power consumption by 22.75% to 85.05 BU. The Economic Times. Retrieved 07 16, 2021, from https://economictimes.indiatimes.com/industry/energy/power/lockdown-pulls-down-power-consumption-by-22-75-pc-to-85-05-bu-in-apr/articleshow/75533685.cms

The Indian Express. (2020, 05 21). Gujarat CM Vijay Rupani: 'My govt enabled migrants to reach home with dignity, care. Retrieved from https://indianexpress.com/article/india/gujarat-cm-vijay-rupani-my-govt-enabled-migrants-to-reach-home-with-dignity-care-coronavirus-lockdown-6418273/

The Times of Idia. (2020). Gujarat: 15 lakh migrant workers left during lockdown, says study. Retrieved 07 19, 2020, from https://timesofindia.indiatimes.com/city/ahmedabad/15l-migrant-workers-left-during-lockdown-study/articleshow/77044207.cms

The Times of India. (2020, September 04). Gujarat: Fuel sales at 70% of pre-Covid levels. Retrieved from https://timesofindia.indiatimes.com/city/ahmedabad/gujarat-fuel-sales-at-70-of-pre-covid-levels/articleshow/77922520.cms

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

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

Yadav, S. B., Patel, H. R., Lungaria, M. M., Parmar, P. K., Chaudhari, N. J., Karande, B. I., & Pandey, V. (2013). Impact Assessment of Projected Climate Change on PEarl Millet in Gujarat. Proceedings of National Seminar on Climate Chang eIMpacts on Water REsources Systems. Retrieved from https://www.researchgate.net/publication/263619586_1_Climate_Change_Impact_on_Crop_Water_Requirements_in_South_Saurashtra_Region_of_Gujarat_State_2_Climate_Change_Analysis_for_the_Coastal_Belt_Area_of_Saurashtra_3_26_Climate_Change_Impact_on_Rainfall_

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'.

The Climate Change Department, established in 2009, acts as a bridge within the Government, and between the Government and the Society to address Climate Change. Gujarat is the first and only State in India, the first in Asia and fourth in the world to form an independent department for Climate Change. 'Enabling a low carbon pathway for Gujarat's economic growth that would meet people's aspirations with equity and inclusiveness' is among the department's key objectives. The Department works to address the concerns of Climate Change at State Level by following a multi-pronged strategy, while suitably factoring in National Action Plan on Climate Change (NAPCC), Nationally Determined Contributions (NDCs), Sustainable Development Goals (SDGs), State Action Plan on Climate Change (SAPCC).

Gujarat Ecological Education and Research (GEER) Foundation is an autonomous organization set up in 1982 by the Forests and Environment Department, Government of Gujarat. The Foundation undertakes scientific research and studies on various aspects of ecology and nature conservation, including - wildlife, forests, biodiversity and climate change, together with ecological education and extension. The ecological studies and research carried out by the Foundation have created an important source of scientific information and decision making for the Government and other stakeholders. GEER Foundation is also the designated State Center on Climate Change of Gujarat under the aegis of the DST, MoST, GoI.

Vasudha Foundation

CISRS House, 14 Jangpura B, Mathura Road,
New Delhi, Delhi 110014
Phone: 011 2437 3680 | www.vasudha-foundation.org