Climate Centre for Cities

GLOBAL COVENANT of MAYORS for CLIMATE & ENERGY SOUTHEAST ASIA

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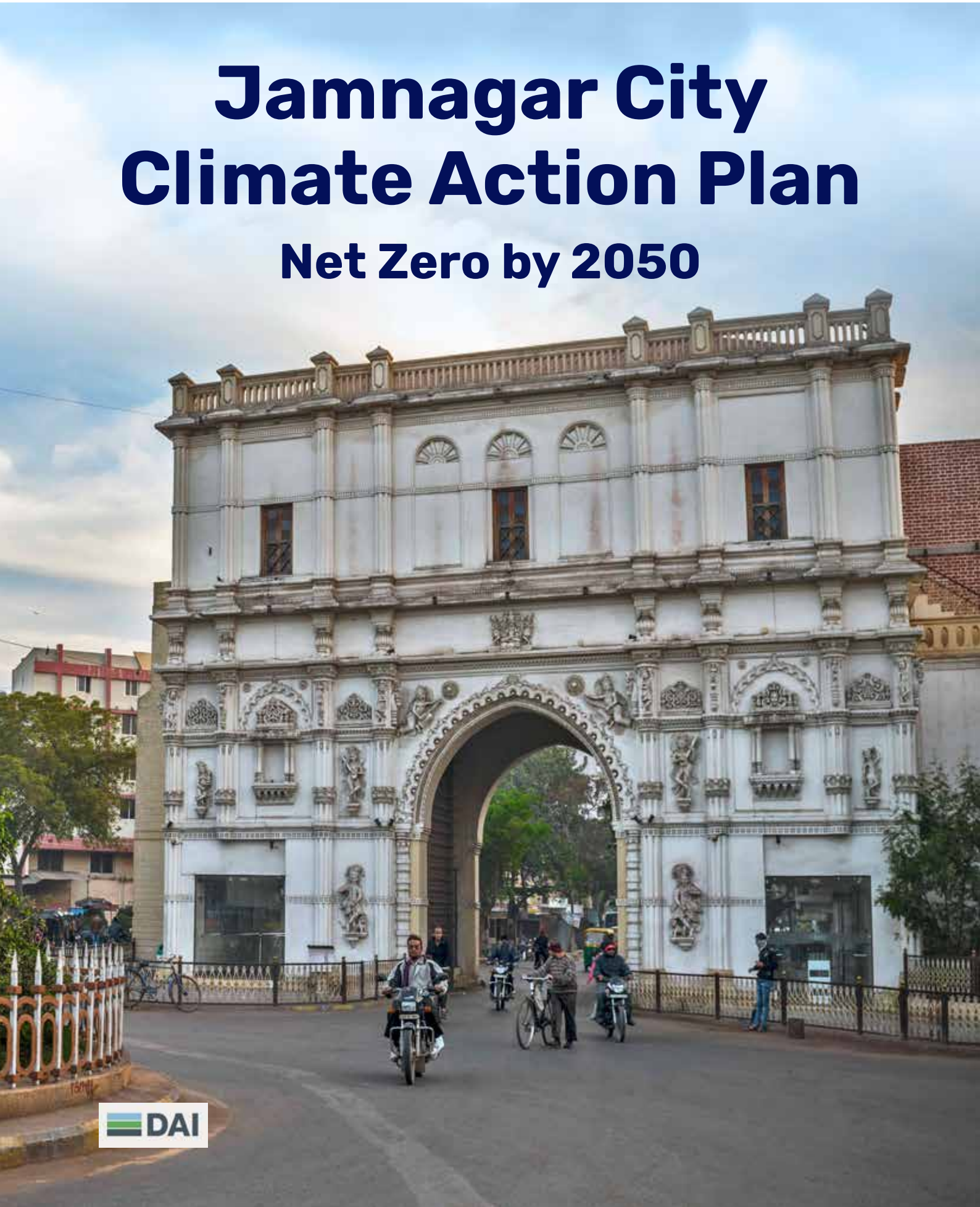
Jamnagar City Climate Action Plan

Net Zero by 2050



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Net Zero by 2050

Photo Credit: Sandip Maru

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Message

Dr. Debolina Kundu
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It is my pleasure to present the **City Climate Action Plan (CAP) for Jamnagar**, a comprehensive roadmap to a sustainable and climate-resilient future for this vibrant and historically significant city. Jamnagar, located along the coast of Gujarat, is known for its thriving industries and unique cultural heritage. However, like many urban areas, it faces increasing environmental challenges, including the effects of climate change. The CAP aims to provide a framework to address these challenges and steer Jamnagar towards a more resilient future. I would like to extend my heartfelt appreciation to the **Global Covenant of Mayors for Climate & Energy**, the **European Union** for their financial support, and the **Jamnagar Municipal Corporation** for their dedicated efforts. Additionally, I thank all the stakeholders for their invaluable contributions in shaping this action plan.

The **Jamnagar CAP** is structured around a clear vision of achieving **Net Zero emissions by 2050** and promoting climate resilience. The plan identifies the city's key vulnerabilities, such as **increased frequency of extreme weather events**, **flood risks**, and the urgent need for **sustainable water management**. The CAP outlines both **mitigation** and **adaptation** strategies, including the promotion of **renewable energy**, the **rejuvenation of water bodies**, and the development of **green infrastructure**.

However, while this plan marks a crucial first step, its success will depend on its **implementation**. The **Jamnagar Municipal Corporation**, in collaboration with all key stakeholders, will need to take a proactive role in turning these strategies into tangible actions. The support of local communities, civil society, and businesses will be essential to ensure that the vision of this plan becomes a reality.

The plan aligns with the **ClimateSmart Cities Assessment Framework (CSCAF)**, introduced by the **Ministry of Housing and Urban Affairs (MoHUA)** under the **Smart Cities Mission** in 2019. This framework helps ensure that city-level actions are consistent with national priorities and contribute to the **Sustainable Development Goals (SDGs)**.

At the **National Institute of Urban Affairs (NIUA)**, we are committed to supporting Jamnagar and other cities across India as they navigate the complexities of climate action. Through our collaboration with national and international partners, including the **Global Covenant of Mayors**, we are working to scale up the development and implementation of **Climate Action Plans** across the country.

Furthermore, we are actively promoting the engagement of **young urban professionals** and **citizens** to ensure that climate action is not only government-led but also driven by the communities it seeks to protect. This grassroots approach will be key in fostering climate resilience and sustainability in our cities.

In conclusion, the **Jamnagar Climate Action Plan** represents a significant leap towards safeguarding the city's future. The journey ahead will require sustained effort, innovation, and collaboration, but with the collective determination of all stakeholders, we can achieve a climate-resilient and sustainable future for Jamnagar.

Message

D. N. Modi
Municipal Commissioner
Jamnagar Municipal Corporation

It is a great honor to present the **City Climate Action Plan (CAP)** for Jamnagar, a vital step in our ongoing efforts to combat the growing challenges posed by climate change. Jamnagar, known as the **"Jewel of Kathiawar,"** is a city rich in history and culture, and now, more than ever, it faces the need to secure a sustainable future for its residents. This Climate Action Plan provides a comprehensive framework for addressing the climate vulnerabilities and risks that threaten our city. I extend my sincere gratitude to the **Global Covenant of Mayors for Climate & Energy, the European Union** for their generous financial support, and the **National Institute of Urban Affairs (NIUA)** for their leadership and expertise in developing this plan. I also appreciate the commitment of all stakeholders who contributed to making this plan possible.

The **Jamnagar CAP** outlines the city's path to achieving **Net Zero by 2050** through a combination of **mitigation** and **adaptation strategies**. As a coastal city, Jamnagar faces unique risks, including **rising sea levels, tropical cyclones,** and **flooding**. The CAP presents a clear roadmap to address these challenges by enhancing **water management systems**, improving **energy efficiency**, and leveraging **renewable energy** resources. Additionally, the CAP highlights the importance of **rejuvenating natural water bodies** and enhancing **green cover,** which play a crucial role in mitigating the impacts of climate change.

However, while the development of this plan is a significant achievement, its success will depend on its effective implementation. The **Jamnagar Municipal Corporation** is committed to leading this charge, but we will need the active participation of our citizens, businesses, and civil society to make this vision a reality. The collaboration between government agencies, local communities, and stakeholders will be essential in achieving the ambitious targets set out in the CAP.

Jamnagar has immense potential in **renewable energy generation,** particularly **solar energy**, and this plan provides the framework to significantly expand our use of sustainable energy sources. By doing so, we can reduce our carbon footprint while contributing to the long-term resilience of our city.

In closing, I would like to thank all the individuals and organizations that have been involved in the preparation of this Climate Action Plan. Your dedication and contributions have been invaluable, and together, we can ensure a **sustainable** and **climate-resilient future** for Jamnagar.

Message

Piero Roberto Remitti
Co-managing Director
Global Secretariat, Global Covenant of Mayors

It is with great pleasure that I introduce the Climate Action Plan for Jamnagar. Known as the 'Oil City of India,' Jamnagar's transformative journey to combat climate change remains aligned with its industrial significance.

The city's commitment to reducing greenhouse gas emissions and enhancing resilience against climate impacts showcases an innovative approach to sustainable urban development. This plan reflects Jamnagar's resolve to be part of a greener, more resilient future while maintaining its economic growth.

I am confident that this pioneering effort will inspire other industrial cities to follow suit in integrating sustainability into their urban growth strategies.

Message

Victor R. Shinde
Head, Climate Centre for Cities
National Institute of Urban Affairs (NIUA)

With great satisfaction, I present the City Climate Action Plan for Junagadh, a critical step in building the city's resilience against climate change. This plan not only identifies the key climate vulnerabilities such as flood risks and water scarcity but also outlines effective mitigation and adaptation strategies to address these challenges. I would like to extend my gratitude to the Global Covenant of Mayors, the European Union, and all local stakeholders for their invaluable contributions to this effort. As we move forward, the successful implementation of this plan will require the continued collaboration of all sectors, ensuring that Junagadh becomes a model for sustainable urban development.

Executive Summary

Jamnagar, the "Jewel of Kathiawar," is a coastal city situated in the Gujarat's Saurashtra region. It serves as the district's administrative headquarter, with 0.6 million population (as per 2011 census) and covering an area of 128.4 km2. Historically known for pearl fishing, Jamnagar has transformed into a centre for traditional textile crafts like tie-dye and Bandhani techniques. Also a major industrial hub, housing the world's largest oil refinery complex, petrochemical industries and a strong presence of brassware production, the city population is expected to increase to 1.6 million by 2050.

The city experiences a hot semi-arid climate with distinct seasons, this report looks at the two main climate risks that Jamnagar is likely to face: Urban Floods and Storm Surge Hazard Risk. Jamnagar's flood risk is high due to its low elevation (20m MSL) and unpredictable rainfall. The city experiences an average of 527 mm of rain annually, almost 95% concentrated in the monsoon months (June-September). Composite flood risk mapping identifies 9% high risk, 18% moderate risk and 73% low risk in the city with Ward 1, 4, 10, 11, 12, 15, 16 requiring immediate attention for settlements in the floodplain. Further, storm surge will put infrastructure and freshwater resources at risk.

This climate action plan looks at Jamnagar, a historically significant city with a diverse ecosystem and less than a million population, facing growing environmental challenges. Rising temperatures, a decline in natural green spaces, and increasingly frequent extreme weather events, including floods, pose significant risks to the city's freshwater supply, economy and well-being. Additionally, the recent rise in coastal tropical cyclones and projected sea level rise over the next 30 years necessitate proactive measures.

Baseline

Jamnagar's baseline emission inventory for 2021-22 shows total emissions of 8,61,532 MTCO2e, with a per capita rate of 1.1 MTCO2e. Stationary energy accounts for over 67%, transportation for nearly 27%, and waste for only 6% of emissions. Projections indicate a 4.1 times increase in emissions by 2050, with stationary energy's contribution rising to 76% and transportation and waste sectors decreasing to 20% and 4%, respectively.

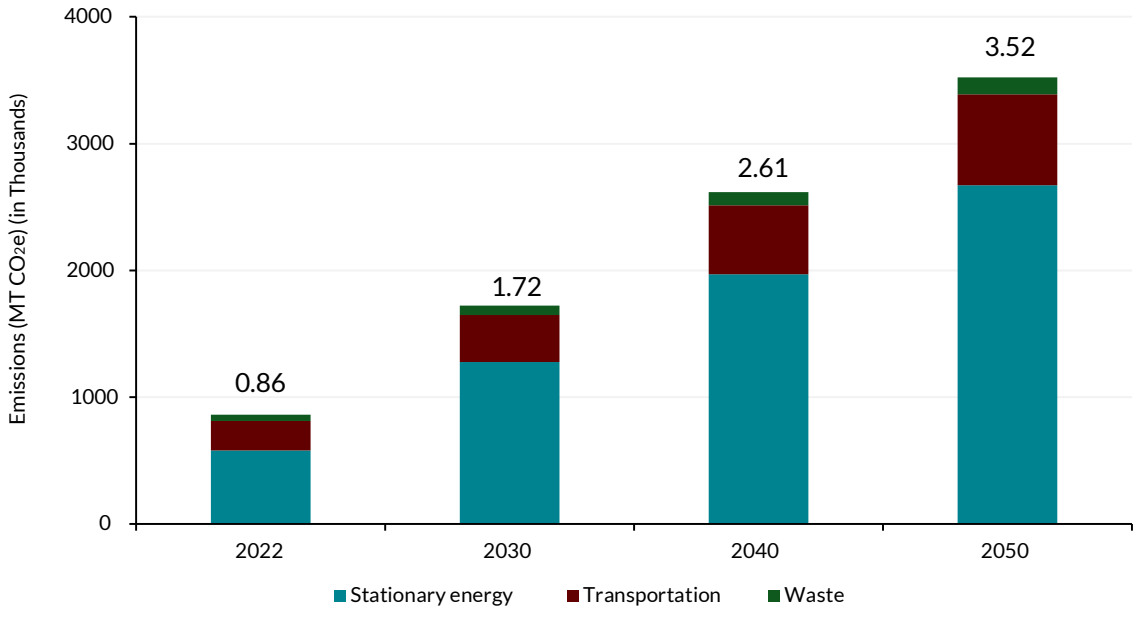

Figure 1: Projected GHG emissions growth in Jamnagar

Recommendations

The climate action plan lays down strategies and targets with a vision towards a 'Net Zero' & 'Climate Resilient' Jamnagar by 2050. It comprises two key objectives, directly addressing the twin pillars of climate action: Mitigation and Adaptation. This ambitious vision has been set in consultation with the public representatives and the administration. This vision also underscores the region's commitment to cultivating environmental responsibility and resilience within its long-term growth strategy. By embracing this forward-looking vision, Jamnagar seeks to preserve its natural splendour and build a balanced, sustainable future for future generations.

The mitigation actions for Jamnagar are divided into three groups: Existing & Planned Actions , Ambitious Actions and Extended Scenario. These aim to reduce 35,21,755 MTCO2e by 2050. Existing & Planned Actions includes national, state and local actions which are underway. Ambitious Actions focuses on realistic set of actions informed by key stake-holders and consultations with all relevant departments. Implementing all strategies under the Ambitious Scenario can lead to substantial emission reductions. However, these efforts alone are insufficient to reach the net zero emissions goal by 2050. Therefore, Jamnagar must identify additional strategies to address the remaining emissions. The "Extended Scenario" encompasses these necessary strategies, which are currently unfeasible due to significant political, institutional, technological, or financial challenges.

To determine the mitigation pathways and targets that Jamnagar needs to adopt to achieve City's Climate Vision, following four scenarios are modelled:

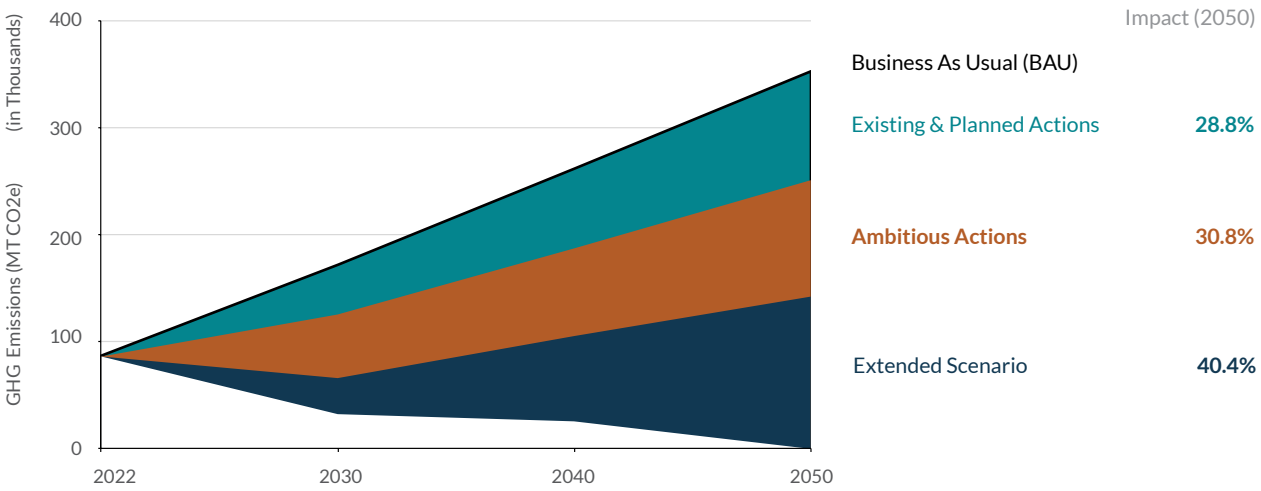

Figure 2: Comparison of Jamnagar Mitigation Scenarios

Jamnagar's climate action plan outlines a comprehensive adaptation strategy to address water security and flooding challenges through a network of interconnected solutions. The cornerstone of the plan will be the "sponge city" approach. Collaboration across city, district, and state government levels will ensure success in coastal management, construction of check dams on key rivers to control water runoff, and the implementation of rainwater harvesting initiatives.

Addressing rising temperatures and air pollution, the plan prioritizes climate-resilient urban planning. Recognizing the importance of environmental health and biodiversity for climate resilience, the plan fosters initiatives like tree cover expansion to 2.5 trees per capita and wetland protection that will enhance the city's environmental health.

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List of Abbreviations

AT&C: Aggregate Technical & Commercial losses

BAU: Business As usual

BEE: Bureau of Energy Efficiency

BLDC: Brushless Direct Current

BMC: Biodiversity Management Committee

BOD: Biochemical Oxygen Demand

C-Cube: Climate Centre for Cities

C&D: Construction and Demolition

CAP: Climate Action Plan

CCAP: City Climate Action Plan

CH4: Methane

CNG: Compressed Natural gas

CO2: Carbon Dioxide

COD: Chemical Oxygen Demand

COP: Conference Of Parties

CPHEEO: Central Public Health and Environmental Engineering Organisation

CR: Critically Endangered

CSCAF: ClimateSmart Cities Assessment Framework

DDMP: District Disaster Management Plan

DPR: Detailed Project Report

ECBC: Energy Conservation Building Code

ECSBC: Energy Conservation Sustainable Building Code

EN: Endangered

ENS: Eco Niwas Samhita

ESR: Elevated Surface Reservoirs

EV: Electric Vehicle

EWS: Early Warning System

FOD: First Order of Decay

GBH: Girth at Breast Height

GDCR: General Development Control Regulations

GCoM: Global Covenant of Mayors

GDP: Gross Domestic Product

GEDA: Gujarat Energy Development Agency

GHG: Green House Gases

GIDC: Gujarat Industrial Development Corporation

GPCB: Gujarat Pollution Control Board

GSAPCC: Gujarat State Action Plan on Climate Change

GSR: Ground Service Reservoirs

GSRTC: Gujarat State Road Transport Corporation

HPCL: Hindustan Petroleum Corporation Limited

HT: High Tension

HVRA: Hazard, Vulnerability and Risk Assessment

IEC: Information, Education and Communication

IMD: Indian Metrological Department

IOCL: Indian Oil Corporation Limited

IPCC: Intergovernmental Panel on Climate Change

IPT: Intermediate Public Transport

JADA: Jamnagar Area Development Authority

JMC: Jamnagar Municipal Corporation

Km: Kilometre

LBSAP: Local Biodiversity Strategy and Action Plan

LED: Light Emitting Diode

LEZ: Low Emission Zone

LiFE: Lifestyle for Environment

LPCD: Litres Per Person Per Day

LPG: Liquified Petroleum Gas

LT: Low Tension

MBBL: Model Building Bye-Laws

MLD: Million Litres per day

MoHUA: Ministry of Housing and Urban Affairs

MSMEs: Micro, Small, and Medium Enterprises

MTPD: Metric Tonnes per day

MW: Mega Watt

N2O: Nitrous Oxide

NAPCC: National Action Plan on Climate Change

NDC: Nationally Determined Contribution

NGO: Non-government Organization

NIUA: National Institute of Urban Affairs

NMSH: National Mission on Sustainable Habitat

NMT: Non-motorized Transport

NRCG: National Research Centre for Groundnut

NRW: Non-Revenue Water

PAT: Perform, Achieve and Trade

PBR: People's Biodiversity Register

PGVCL: Paschim Gujarat Vij Company Ltd.

PM: Particulate Matter

PPP: Public Private Partnership

RL: River Length

RTO: Regional Transport Office

RTS: Rooftop Solar

SA: Surface Area

SCADA: Supervisory Control And Data Acquisition

SCM: Smart Cities Mission

SDGs: Sustainable Development Goals

STP: Sewage Treatment Plan

SWM: Solid Waste Management

$MTCO_2$: Metric Tonnes of Carbon Dioxide

TCPO: Town and Country Planning Organisation

TPD: Tonnes per day

UNFCCC: United Nations Framework Convention on Climate Change

VU: Vulnerable

WSS: Waste Segregation at Source

₹: Indian Rupee (INR)

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01 Introduction

Project Background
Need for City Climate Action Plan
India's Climate Journey
CSCAF


MBBS

1.1 Project Background

The anthropogenic impacts of climate change affect 80% of the land area where more than 85% of the world's population currently reside. Almost 3.6 billion (~44%) live in areas highly susceptible to climate change. Cities, which house more than 4.2 billion people, are particularly vulnerable to these impacts where urban form and socio-economic activities can amplify vulnerabilities. Cities face intensified challenges, grappling with the urban heat island effect, increased vulnerability to floods and storms, and strained resources. The impact extends beyond physical infrastructure, affecting health, economies, and emergency response capabilities. Mitigation and adaptation measures are crucial to enhancing urban resilience and addressing the complex interplay between climate change and city life. Parallelly, cities consume 60-80% of all energy and contribute 75% of the planet's carbon emissions.

India, as per the Intergovernmental Panel on Climate Change's (IPCC) Sixth Assessment Report (IPCC, 2021), is on the brink of experiencing severe impacts of climate change. These include increased flood damage to infrastructure, heat-related human mortality, and exacerbated drought-related food and water scarcity. The country ranks second to Puerto Rico in terms of extreme weather deaths (2736 deaths) and severe economic losses (USD 13.8 billion). It is also ranked 6th among the ten most affected countries in the world as per the Global Climate Risk Index, 2016. Urban centres, which house a third of India's population and contribute to 63% of the nation's GDP, are particularly vulnerable to these climate disasters. These disasters are projected to put at least 4.5% of the GDP at risk by 2030, while extreme heat stress alone is projected to kill 15 lakh more Indians annually by 2100. Indian cities also disproportionately contribute to Greenhouse Gas (GHG) emissions. While the national average per capita emissions is around 1.8 $MTCO_2e$ per year, the average in urban areas can be as high as 4.79 $MTCO_2e$.

In collaboration with the National Institute of Urban Affairs, the Ministry of Housing and Urban Affairs (MoHUA), the Government of India, has established the Climate Centre for Cities (C-Cube). Since its inception, C-Cube has been instrumental in coordinating an ecosystem development process to create synergy across all climate actions (both mitigation and adaptation) being undertaken by various stakeholders in Indian cities. As part of this, C-Cube, in partnership with the Global Covenant of Mayors and the European Union, is leading the development of City Climate Action Plans. These plans aim to streamline climate actions undertaken by cities and align them with national and international targets and commitments.

1.2 Need for City Climate Action Plan

While India has set national-level priorities and targets to address climate change, it is crucial to translate these into actionable interventions at the local level. A city climate action plan serves this purpose by defining the city's climate visions and developing pathways for implementing mitigation and adaptation actions (policies, plans and projects) that the city can take to reduce its GHG emissions and increase climate resilience. The plan develops emission inventories and conducts climate vulnerability assessments to identify and prioritise the actions that will need to be taken by the city.

1.3 India's Climate Journey

India's climate journey which began in 2008 has been turbo charged since 2016 when India became a signatory to the Paris climate agreement. Since then, India has taken various actions to fulfil its commitments under the NDCs. The details of these actions are below:

2008

8 Missions NAPCC

The Prime Minister's Council on Climate Change, GoI, launched the National Action Plan on Climate Change in 2008 with 8 sub-missions representing the multi-pronged, long-term, and integrated strategies to mitigate and adapt to the adverse impacts of climate change. The plan aims at fulfilling India's developmental objectives with a focus on reducing the emission intensity of its economy. Eight missions under NAPCC are as follows:

- National Solar Mission
- National Mission for Enhanced Energy Efficiency
- National Mission on Sustainable Habitat
- National Water Mission
- National Mission for Sustaining the Himalayan Ecosystem
- National Mission for Green India
- National Mission for Sustainable Agriculture
- National Mission for Strategic Knowledge for Climate Change

2016

Paris Agreement and India's NDC

As a signatory to the Paris Agreement, India is bound by the terms of the landmark international treaty on climate change, adopted by 196 nations at the Conference of Parties (COP) 21 in Paris. The Agreement's overarching objective is to curb global warming to well below 2°C, ideally 1.5°C, compared to pre-industrial levels. To achieve this, India submitted its intended Nationally Determined Constributions (NDC) to the UNFCCC which included eight goals, aiming at increased non-fossil fuel capacity, reducing emissions intensity, and creating additional carbon sinks by 2030

2019

ClimateSmart Cities Assessment Framework

The Ministry of Housing and Urban Affairs (MoHUA) launched CSCAF as a city-level framework to promote climate-resilient and low-carbon development across urban India under the Smart Cities Mission (SCM). The first round of the assessment evaluates 96 cities.

2020

Climate Centre for Cities

MoHUA and NIUA launched C-Cube to institutionalise climate actions in Indian cities, focusing on an ecosystem development process for synergising all climate initiatives nationwide.

2020

CSCAF 2.0

The second round of the assessment expanded the evaluation to 126 cities and included cities that were not part of the Smart Cities Mission.

2021

COP26 (Net Zero 2070)

At COP26 in Glasgow, India reaffirmed its commitment to intensify climate action by presenting five key elements, referred to as 'Panchamrit'. It includes increasing non-fossil fuel capacity by 500GW, achieving 50% of energy requirements from renewable sources, reducing total projected carbon emissions by one billion tonnes, lowering the carbon intensity of the economy by 45%- all by 2030. It was an update to its climate targets through which India declared a long-term goal of achieving net-zero emissions by 2070, crucial to the environmental challenges it faces as a developing country

2022

CSCAF 3.0

The current round of CSCAF expands the assessment to 226 cities across India.

2022

National Mission on Sustainable Habitat (NMSH)

India's GHG emissions surged by 144%, from 1,311.29 $MTCO_2e$ in 1994 to 3,202 $MTCO_2e$ in 2014 (WRI CAIT). Effectively managing carbon footprint of urban habitats and ensuring their resilience to climate change poses a challenge for India, especially with its growing urban population and an amplified demand for land. To mainstream climate change mitigation and adaptation measures into urban planning and policy frameworks, the Government of India launched NMSH in 2010 under the NAPCC. It outlines strategies for mitigating GHG emissions and building resilience in infrastructure assets and communities.

2022

LT LEDS

India launched its long-term low-emission strategy for development in COP 28. This strategy, in line with the commitments under the Paris Agreement, focused on, among other strategies, long-term sustainable urbanism by integrating climate action, mitigation strategies and climate risk adaptation within planning processes.

Mission LiFE

The government of India introduced Mission Life in COP26 to encourage and mainstream environmentally responsible behaviours in everyday life. Intending to conserve natural resources, the mission focused on channelling the efforts of individuals and communities into a global mass movement of living in harmony with nature. The mission had seven main focus areas - Saving energy, Saving water, Stopping single-use plastics, Sustainable food systems, Reducing waste, healthy lifestyles, and Reducing e-waste.

1.4 ClimateSmart Cities Assessment Framework (CSCAF)

In February 2019, the Ministry of Housing and Urban Affairs (MoHUA) launched the ClimateSmart Cities Assessment Framework (CSCAF) under the Smart Cities Mission (SCM). This pioneering city-level framework, encompassing climate-relevant parameters, including those outlined in the National Clean Air Programme, aims to promote climate-resilient and low-carbon development across urban India, aligning with the Sustainable Development Goals (SDGs) and India's Nationally Determined Contributions (NDCs) towards mitigating global climate change. CSCAF as a city-level framework encompasses five climate-relevant thematic areas and 28 progressive indicators offering a comprehensive monitoring and evaluation tool for cities to annually assess their performance.

Comprising 28 progressive indicators across five thematic areas (Figure 3), the ClimateSmart Cities Assessment Framework (CSCAF) offers a comprehensive monitoring framework for evaluating the progress made in alignment with the National Mission for Sustainable Habitat (NMSH) guidelines. CSCAF functions as a tool for cities to annually assess their performance and provides an incremental roadmap for adopting and implementing relevant climate actions. The outcomes of CSCAF are utilized to monitor progress and inform NMSH. Additionally, the framework facilitates the dissemination of context-specific best practices implemented by Indian cities and assesses the necessary skills and resources for scaling up these practices through its Secretariat at the Climate Centre for Cities (C-Cube) at the National Institute of Urban Affairs (NIUA).

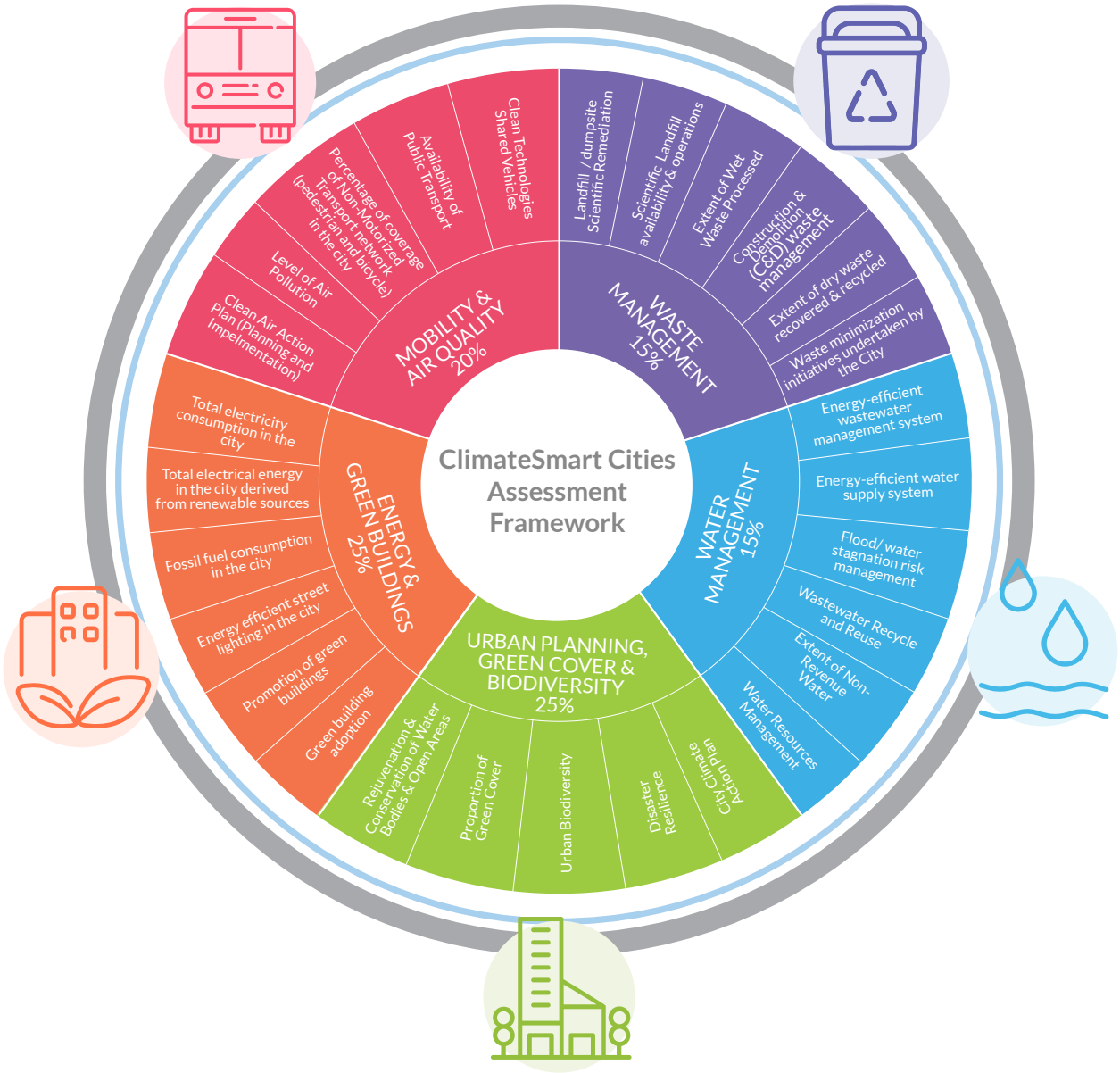


Figure 3: ClimateSmart Cities Assessment Framework

3500+

Brass Industries in the city, heavily contributing to GHG emissions

67%

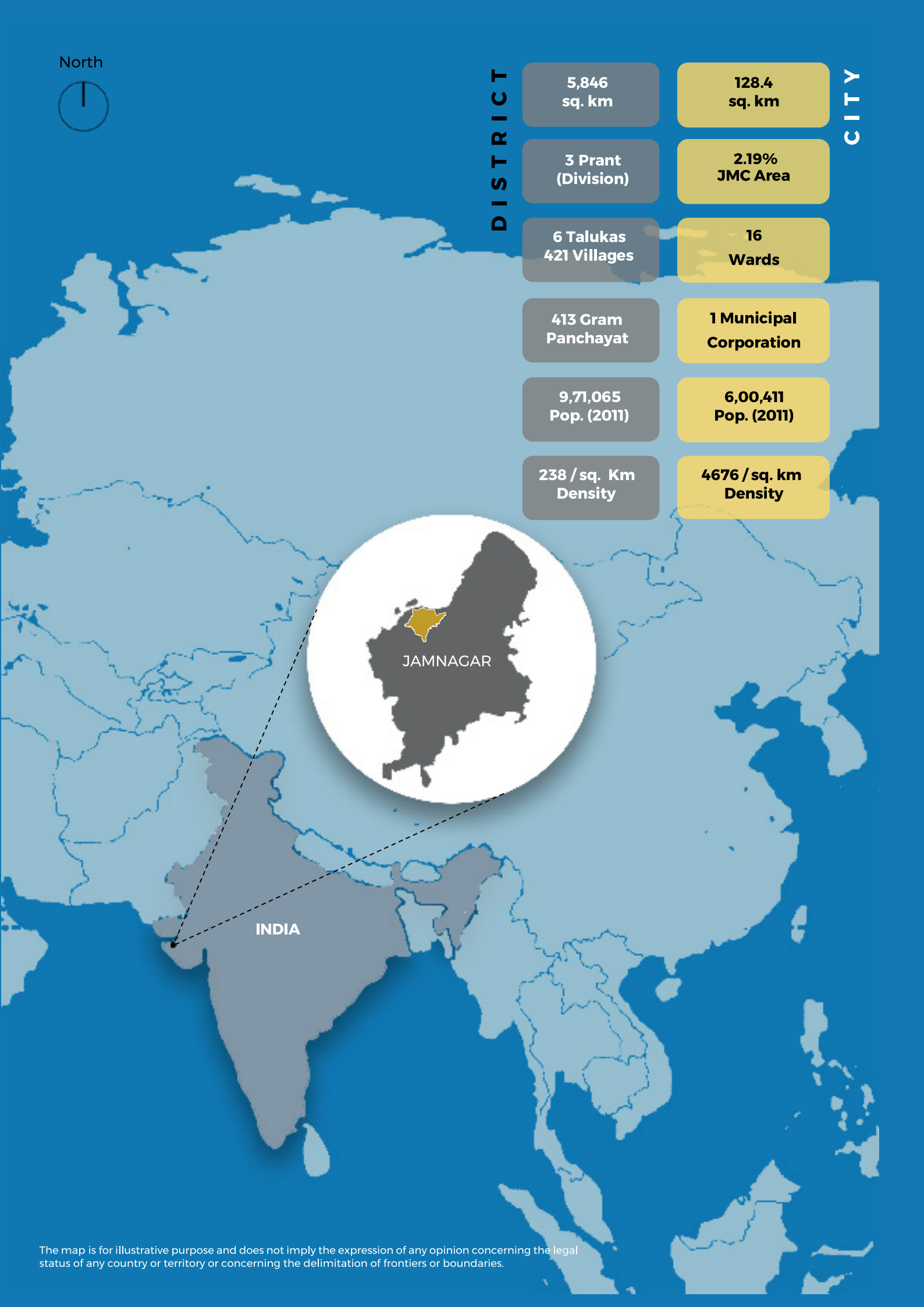
$MTCO_2e$ emissions from Stationary Energy consumption

4x

Increase in GHG emissions by 2050

02 Profile

Regional Context
City Profile
Climate Change Impact



The map is for illustrative purpose and does not imply the expression of any opinion concerning the legal status of any country or territory or concerning the delimitation of frontiers or boundaries.

2.1 Regional Context

Jamnagar, the "Jewel of Kathiawar," is a coastal city situated in the Jamnagar district of Gujarat's Saurashtra region. It serves as the district's administrative headquarters, encompassing the Jamnagar Municipal Corporation (JMC) and overseeing a network of 6 talukas, 421 villages, and 4 municipalities. As per the 2011 census, Jamnagar district has a population exceeding 1.38 million, with a growth rate of 10.22% observed between 2001 and 2011. The district exhibits a balanced sex ratio with approximately 934 females per 1000 males. The population density is approximately 238 people per square kilometre, with a significant portion residing in urban areas (6,00,411). The district boasts a literacy rate of 76.72%.

Jamnagar district enjoys an average annual rainfall of 1100 mm (based on data from 2012 to 2016), fostering agricultural activities. Groundnut, cotton, wheat, guar beans, castor seeds are a mainstay of the agricultural sector. Additionally, the district possesses mineral reserves of bauxite and black & white stones. Jamnagar's economy thrives on a diverse range of industries, including agriculture, animal husbandry, the renowned brass industry, oil mills, and a significant oil refinery complex. The district is well-connected by a network of rivers, including the Und, Vartu, Aji, Ruparel, Rangmati, Nagmati, Fulzar, and Venu.

Jamnagar facilitates education with a robust network of primary schools (746), secondary and higher secondary schools (293), and 29 colleges. The district provides comprehensive healthcare services through a network of 31 Primary Health Centres (PHCs), 9 Community Health Centres (CHCs), 210 sub-centres, and 4 urban centres.

2.2 City Profile

Jamnagar city is situated at 22.28° N and 70.04° E, with an average elevation of 20 meters (65 ft) above mean sea level (MSL), is geographically bordered by Morbi to the east, Rajkot to the southeast, Porbandar to southwest, Devbhoomi Dwarka to west and Gulf of Kachchh to the north. According to the 2011 census of India, the city's population was 600,411, and it currently is 8,01,934 in 2022 covering an area of approximately 128.4 km2. Notably, the city houses military bases for the Indian Air Force, Army, and Navy.

2.2.1 History

Jamnagar's rich history stretches back to 1540 AD, when Jam Rawal, a descendant of the Jadeja Rajput rulers, established the city. Initially named Nawanagar ("new town"), it was built around the Ranmal Lake and at the confluence of the Rangmati and Nagmati rivers. Believed to be descendants of Lord Krishna's Yadava clan, the Jadeja Rajputs ruled the region for centuries.

The city underwent a significant makeover in the 1920s under the reign of Maharaja Kumar Shri Ranjitsinhji, a world-famous cricketing personality. Inspired by European architecture, he collaborated with architect Sir Edward Lutyens to redesign Jamnagar. The previously walled city opened up, houses adopted standardized architecture, and the city earned the moniker "Paris of India" for its uniform aesthetics.

2.2.2 Connectivity

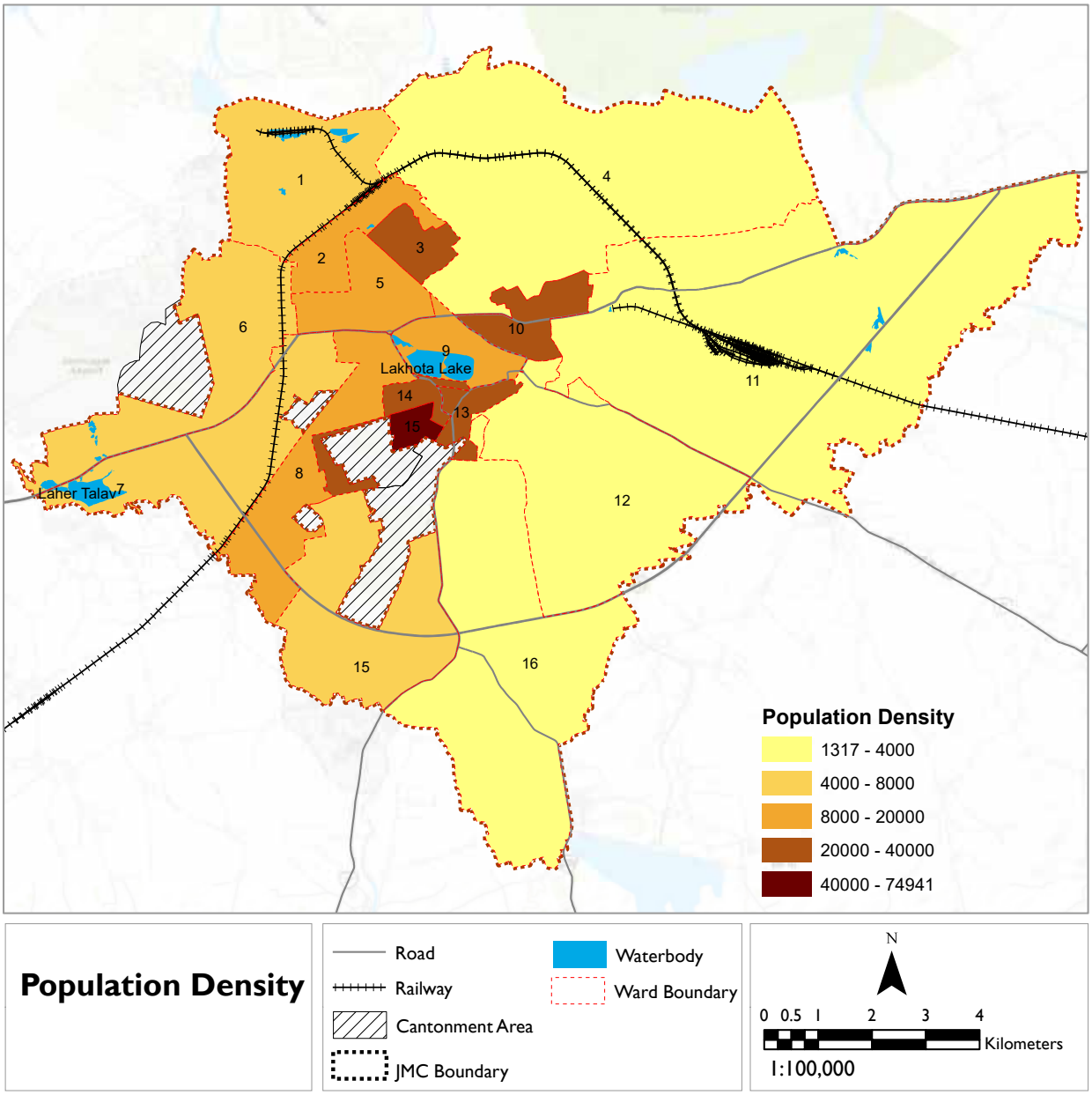
The city is well-connected by air, rail, roadways and waterways. Jamnagar Airport (JGA), also known as Govardhanpur Airport, is owned by the Indian Air Force and is located 10 km from the city center. It offers domestic air connectivity with a daily direct flight to Mumbai and thrice-weekly flights to Hyderabad and Bengaluru.

Rail connectivity under the India Western Railway Zone network connects Jamnagar to Mumbai (with four daily trains), and weekly trains to major cities in the north, east, and south of the country. The major stations are : Hapa (HAPA), Jamnagar (JAM), and Modpur (MDPR).

There are two important ports close to Jamnagar. Rozi Port is on the shore of the Gulf of Kutch; Bedi Port is two nautical miles (4 km) inland on the Rangamati River. Bedi Port is an all-weather intermediate seaport that exports various commodities, including bauxite, soya meal extracts, and ground nut extracts. The port's imports include coal, fertilizer, brass scrappage and other items. For Roadways, major highways connect peripheral districts - Rajkot Porbandar, Dwarka, Junagadh and more. Numerous State (GSRTC) and private bus service providers operate in Jamnagar, offering connections to Bhuj, Ahmedabad, Surat, Vadodara, Mumbai, Pune, and other major cities.

Jamnagar stands to benefit significantly from the under-construction Amritsar-Jamnagar Expressway. This record-setting 1,257 km expressway, part of the Bharatmala Pariyojana initiative, will connect Jamnagar to key economic zones like Amritsar and Bathinda, boosting trade and economic activity across four states. Notably, the expressway will be the first in India to directly connect three major oil refineries, streamlining oil transportation within the country. Perhaps the most impactful change for Jamnagar will be the drastic reduction in travel time to Amritsar, from 26 hours to an estimated 13 hours, facilitating faster movement of oil, goods and people.

2.2.3 Urban Profile



Map 1: Ward-wise Population Density

Jamnagar is administratively divided into 16 wards. Ward 9, located around Lakhota Lake, serves as the city's central core and houses the main market area. Wards 11, 12, and 16 represent newer developments with land dedicated to agriculture. Most historical settlements are concentrated within Wards 5 and 9. The city's industries are predominantly small and medium-sized enterprises (MSMEs) and are concentrated in Wards 1, 11, and 15. The remaining wards are primarily residential and commercial.

The cantonment area to the west and southwest restricts development within Ward 15. Similarly, the seacoast and low-lying areas to the north limit further expansion in that direction. Consequently, future development can only occur eastward along Rajkot Road, southward along Lalpur Road, and westward along Khambhalia Road.

The semi-circular bypass has created three key nodal points: one towards Naghedi, a second near the proposed G.I.D.C. Industrial Estate north of Dared, and a third at Hapa. These entry points to the urban area hold significant importance as they will experience intense development activities and land pressure due to their accessibility to the city, water resources, and environmental considerations.

2.2.4 Demography

Jamnagar's population is projected to have increased from 600,411 in 2011 to 8,01,934 in 2022. The city has a gross density of approximately 62.4 people per hectare, with the highest concentration in Ward 15, followed by Wards 3, 10, 13, and 14. Ward 4, a low-lying area, houses vulnerable slum settlements. In contrast, Wards 11, 12, and 16 are sparsely developed. Based on current trends, the population of Jamnagar is expected to increase to 16,60,677 by 2050 (Table on the below).

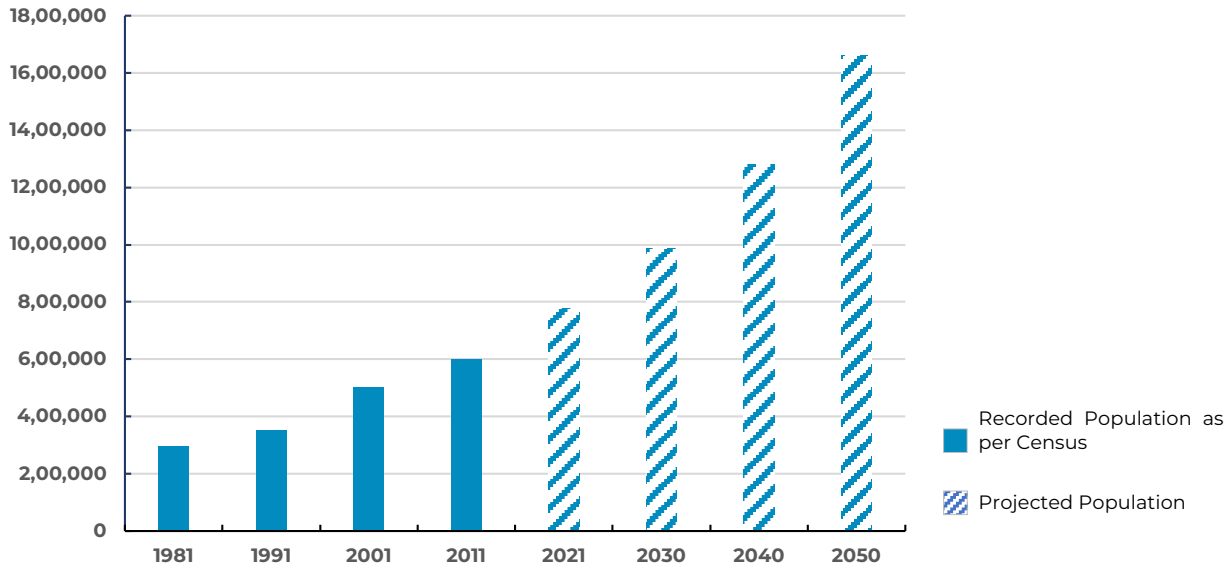


Figure 4: Population Growth in Jamnagar

Source : Calculated as per data obtained from Census 2011

Jamnagar has an average literacy rate of 82.14%, exceeding the national average of 74.04%. The male literacy rate stands at 86.90%, while the female literacy rate is 77.05%. The sex ratio in Jamnagar city is 928 females per 1000 males. However, the child sex ratio presents a concern, with only 864 girls per 1000 boys.

Gujarati is the primary language spoken by most residents of Jamnagar. A smaller portion of the population speaks Kutchi, a distinct language with its own script that is not mutually intelligible with Gujarati. Additionally, Kathiawadi, a colloquial dialect of Gujarati, is widely used for everyday communication.

2.2.5 Economy and Tourism

Jamnagar is a major industrial hub, housing a thriving oil refinery complex and a strong presence of petrochemical industries. Brassware production is the significant contributor to the city's economic landscape. It also has sizable reserves of bauxite, with its mines contributing 95% of the total production in the state. Once renowned for its pearl fishing industry, the city has transformed into a leading centre for meticulously crafted traditional tie-dye and Bandhani fabric colouring techniques, practiced for centuries.

Beyond its industrial prowess, Jamnagar attracts visitors with its cultural and natural wonders. Historical sites like the magnificent marble Jain temples (Vardhman Shah Temple, Raisi Shah Temple, Sheth Temple, and Vasupujya Swami Temple) and the Lakhota Tower, a testament to resilience built during a drought, offer a glimpse into the city's past. The Bala Hanuman temple holds a unique record for the longest continuous chanting of "Ram Dhun" since 1964.

For nature lovers, Jamnagar boasts the stunning Marine National Park, encompassing 42 islands, with Pirotan being the most famous coral reef island. The Khijadiya Bird Sanctuary, established in 1982 and located northeast of the city, serves as a haven for a diverse range of birds, attracting birders and wildlife enthusiasts.

2.2.6 Climate

Jamnagar experiences a hot semi-arid climate with distinct seasonal variations. Winters, spanning December to February, offer mild temperatures with average lows of approximately 11.6°C (53°F). Monsoons arrive in June and persist until September, bringing significant precipitation and a rise in average humidity to around 80%. This period provides a necessary respite from the preceding hot season, where May experiences the highest average temperatures, reaching up to 36°C (97°F). October and November witness a gradual transition back to drier conditions, with average humidity levels falling to a range of 60-75%.

The annual average rainfall for Jamnagar is 527 mm (20.7 in), with approximately 95% of this precipitation concentrated within the monsoon season. This highlights the city's dependence on the monsoon for replenishing water resources. Historical records indicate a wide range in annual rainfall, with the lowest recorded amount being 36 mm (1.4 in) in 1987 and the highest reaching 2114 mm (83.2 in) in 2010.

2.2.7 Soil, Hydrology and Vegetation

Jamnagar primarily features black and medium black soils. Black soils, rich in minerals and organic matter, offer superior fertility. Medium black soils, with a depth of 25 to 50 cm is present in the city, lying on the coastal and alluvial plains, characterized by flat, low-lying landforms. Geologically, the region is underlain by Deccan Traps, a formation of hard rock.

The Jamnagar district possesses two significant aquifer systems[1], extending up to a depth of 500 meters. The quality of groundwater varies from fresh to saline, and its general flow direction is from northeast to southwest. Since the city's soil is alkaline, it makes sustaining tree cover difficult. Neem, Bakam, and Vad are the most prominent trees found in the city. Current total groundwater extraction in Jamnagar city is estimated at around 105 million cubic meters (mcm) per year. Based on the Ground Water Resource Estimation (GWRE-2017), the city's current level of groundwater extraction is approximately 66.95% of its available resources.

1 'Aquifer Mapping and Management of Ground Water Resources' of Jamnagar District, Central Ground Water Board, Ministry of Jal Shakti, Government of India

03 Methodology

Project Approach
Methodology for GHG inventory
Methodology for HVRA

3.1 Project Approach

This climate action plan looks at Jamnagar, a historically significant city with a diverse ecosystem and less than a million population, faces growing environmental challenges. Rising temperatures, a decline in natural green cover, and increasingly frequent extreme weather events, including floods, pose significant risks to the city's economy and well-being. Additionally, the recent rise in coastal tropical cyclones and projected sea level rise over the next 30 years necessitate proactive measures.

In this context, aligning with the National Mission for Sustainable Habitat under the National Action Plan for Change and the ClimateSmart Assessment Framework developed by the National Institute of Urban Affairs, this City Climate Action Plan looks at minimising Jamnagar's contribution to climate change by reducing its emissions and building resilience against the predicted impacts of climate change. The overall structure of the plan follows the four main stages as highlighted below:

Baseline Analysis	Based on the CSCAF framework, the baseline developed provides a comprehensive picture of disaster vulnerability and Green House Gas Emissions in Jamnagar.
Future Projections	Future projections of both GHG Emissions and Climate Patterns to understand how global weather patterns and climate changes affect the city and Jamnagar's own contribution.
Problem Identification and Vision Setting	Discern areas where climate action is needed in Jamnagar and establish a Vision and climate targets for the city.
Implementation Road Map	Developing structural and non-structural measures to meet the climate targets set by the city, including recommendation timelines, financial and responsibility mapping and MEL frameworks.

Through multiple rounds of stakeholder consultations, the plan incorporates the recommendations, feedback and on-ground knowledge of the residents, NGOs and government officials working in Jamnagar. This Climate Action Plan has been developed for the Municipal area of 128.4 Sq Km; however, the thrust areas and recommendations of this plan can be scaled up and expanded should the municipal area of Jamnagar expand to include outgrowth areas.

August 2023

Data Collection & Literature Review

Extensive data, crucial for analysis and projections in the Action Plan development, was gathered from various departments and categorised into Hazards, Vulnerability, Risk Assessment, and Greenhouse Gas Emissions Inventory, utilising tabular and spatial formats to assess parameters and identify physical hotspots.

Hazards
Vulnerability
Risk Assessment
GHG Emissions

Sept. 2023

1st Stakeholder Consultation

Primary objective was to validate identified challenges and issues through interactive exposures, based on data collection and literature review.

Nov. 2023

Field Survey & Data Analysis

Field visits to natural resources, followed by data analysis that involved translated collected data into city implications for climate change, overlaying timelines and hotspots on spatial maps and conducting rigorous calculations to comprehend climate change effects in different city areas within the Hazards, Vulnerability, and Risks Assessment (HVRA)

Feb. 2024

Second Stakeholder Consultation

Goal was to collaboratively define the plan's vision, and pinpoint key focus areas with all relevant public, private and not-for-profit agencies. Recommendations were captured on maps, table, digital forms and through focused group discussions. It helped in creating a robust inventory of contextually relevant and locally integrated solutions

April 2024

Development of Recommendations

As per the estimated targets, recommendations were formulated in the shape of policies, projects and institutional frameworks

May 2024

Final Report Development

The last round of stakeholder consultations aimed to secure approval from city officials for the proposed actions outlined in the plan

Target Setting

On the basis of the 2nd stakeholder consultation, target setting was done with the support of esteemed dignitaries and officials

April 2024

Review and Feedback

The conclusive report has been presented to the city and GCoM for review and their feedback.

Final Submission to city

July 2024

3.2 Methodology for GHG inventory

A Greenhouse Gas (GHG) inventory seeks to accurately quantify and track the amount of greenhouse gases emitted (source) and removed (sink) by cities. The inventory provides a comprehensive picture of the sources of emissions, including the type and quantity of greenhouse gases emitted. This allows cities to establish baselines and identify and prioritise mitigation actions for reducing emissions in line with various national and international targets. Additionally, a uniform system of establishing GHG inventories enables centralised reporting by cities allowing for scrutinization of actions, comparisons of efficiencies and ensuring the achievement of national/sub-national targets.

Emissions generated by various activities in cities are broadly divided into three categories based on where the emissions occur. These are as follows:

Scope 01	GHG emissions from sources located within the city boundary
Scope 02	GHG emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam and/or cooling within the city boundary
Scope 03	All other GHG emissions that occur outside the city boundary as a result of activities taking place within the city boundary

For the purposes of this Climate Action Plan, only Scope 1 and Scope 2 emissions of activities occurring within the 128.4 sq km municipal boundaries of Jamnagar are considered. The inventory developed will account for emissions of the seven gases currently required for most national GHG inventory reporting under the Kyoto Protocol: carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF6), and nitrogen trifluoride (NF3). The development of the baseline will consider various activities categorised under Stationary Energy, Transportation and Waste as per below.

Emission Sources Considered for Junagadh Climate Action Plan

Stationary Energy	Residential buildings	Scope 01	Scope 02
	Commercial buildings	Scope 01	Scope 02
	Institutional buildings	Scope 01	Scope 02
	Manufacturing industries and construction	Scope 01	Scope 02
	Energy industries	Scope 01	Scope 02
	Agriculture, forestry, and fishing activities	Scope 01	Scope 02
	Non-specified sources (Municipal services, charging stations)	Scope 01	Scope 02
	Fugitive emissions from mining, processing, storage, and transportation of coal	Scope 01	Scope 02
	Fugitive emissions from oil and natural gas systems	Scope 01	Scope 02
Transportation	On-road transportation – Petrol, Diesel, CNG, LPG & PNG	Scope 01	Scope 02
	Railways	Scope 01	Scope 02
	Water-borne transportation	Scope 01	Scope 02
	Aviation	Scope 01	Scope 02
	Off-road transportation	Scope 01	Scope 02
Waste	Solid Waste Disposal	Scope 01	Scope 02
	Biological treatment of waste	Scope 01	Scope 02
	Incineration & open burning	Scope 01	Scope 02
	Waste water treatment & discharge	Scope 01	Scope 02

3.3 Methodology for Climate Risk Assessment

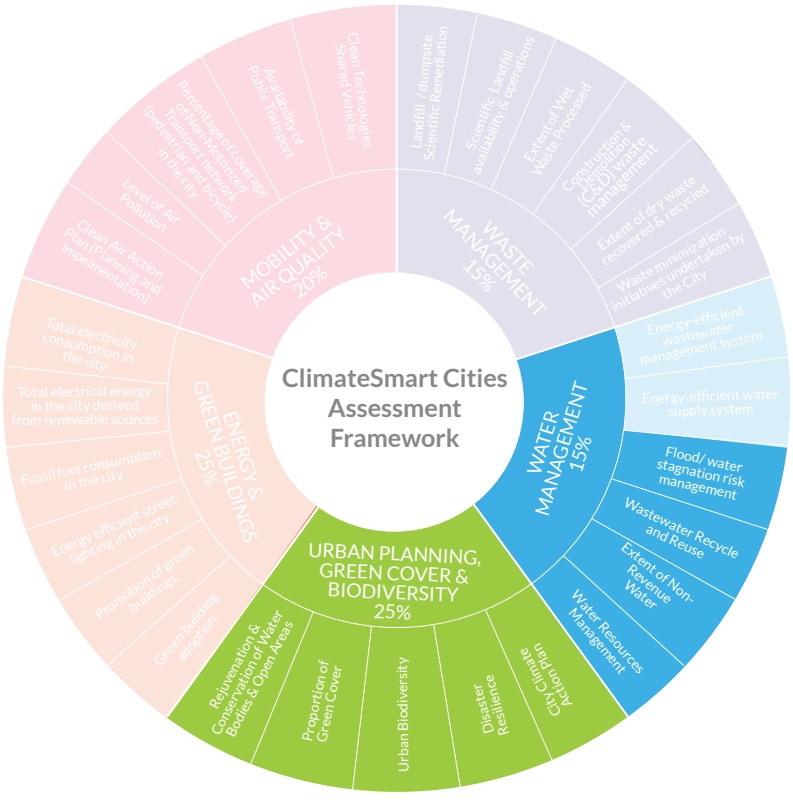
Climate risk and vulnerability assessments (CRVAs) are critical to a city's climate risk management strategy and form the basis for developing adaptation actions and climate action plans. Climate risk assessments identify the likelihood of future climate hazards and their potential impacts on cities and their communities, contributing to overall climate risk. The assessment for this Climate Action Plan focuses on the impacts of short-term risks posed by extreme weather events like heatwaves or cloud bursts and the long-term slow-impact effects of climate change. The climate risk analysis has been conducted in the following four stages:

Hazard assessment — Hazard assessment identifies the probability, intensity and timescale of critical current and future climate hazards in a city and where these hazards are prevalent / are likely to manifest (2050 and beyond where possible)

Impact assessment — Impact assessment looks at the potential impacts of those climate hazard events on people, assets, services, and the natural environment

Risk assessment — Risk assessment determines the critical risks based on the interplay of hazards and impacts

The CSCAF framework has been used as a baseline for this analysis; two themes and nine indicators from the framework focus on understanding the past climate and disaster risks that the city has faced. The hazards identified have been spatialised, and multi-criteria decision analysis using the Analytical Hierarchy process was used to understand current and future risks. This understanding, in combination with climate modelling, temperature and rainfall projections, has been used to develop a comprehensive profile of future climate risks for the city.



04 Baseline

Baseline Analysis
Summary GHG Inventory
Summary HVRA

Baseline Analysis

THEME 01: Urban Planning, Green Cover & Biodiversity

Rejuvenation And Conservation Of Water Bodies

Proportion of Green Cover

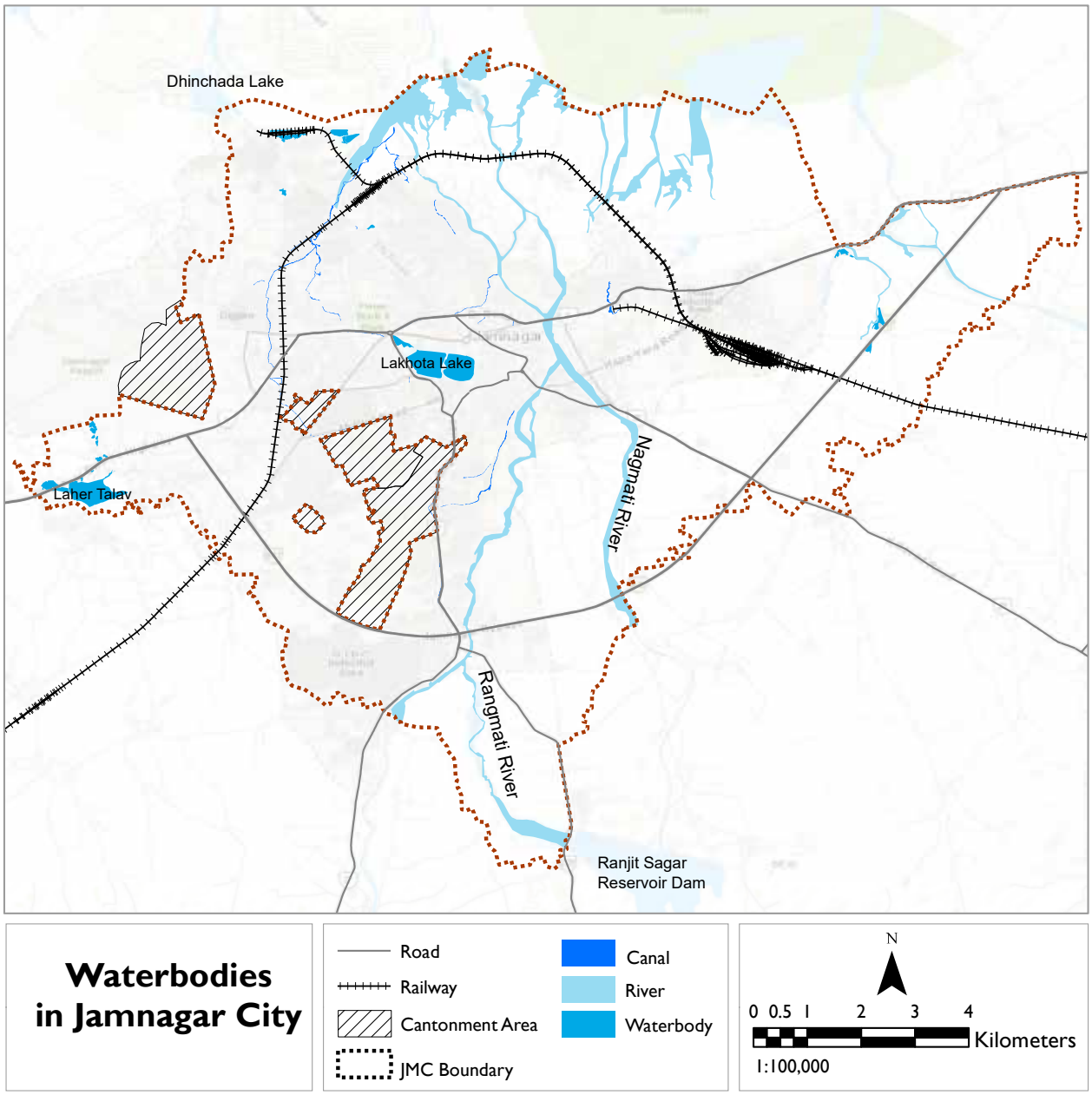
Urban Biodiversity

Disaster Resilience

4.1 Urban Planning, Green Cover & Biodiversity (UPGCB)

4.1.1 Rejuvenation & Conservation of Water Bodies

Jamnagar has a total of 5 water bodies comprising of 3 lakes and 2 major rivers, Rangmati and Nagmati. The rivers flow south-north through the eastern central fringe of the city. These rivers, seasonal in nature, branch into many distributaries before meeting the Arabian Sea at the Gulf of Kachchh. In the heart of the city lies Ranmal Lakhota Lake, historically said to be constructed by Jam Ranmalji-II between 1820 and 1852. Lakhota lake is divided into three parts : Part I (0.22 sq.km) is a thriving lakefront with the City Museum at its centre. Part II (0.24 sq.km) and Part III are lake reservoirs that are yet to be rejuvenated. Other water bodies are Laher Talav, Dhinchada Lake and Ranjit Sagar Reservoir Dam on the periphery contributing to the overall water network. The city's water bodies, covering a total area of 0.75 sq. km (0.58% of the city area), play a significant role in storing excess rainwater and mitigating floods. However, they are degrading due to sediment accumulation, improper sewage and solid waste disposal reducing their depth.



Map 2: Waterbodies in Jamnagar city

4.1.2 Proportion of Green Cover

Urban green cover has expanded significantly, increasing from 5.01% in 2001 to 10.4% in 2021, as per satellite imagery study. To contribute to this increase, the city has undertaken projects for the development of Public Parks, Oxygen Parks, Miyawaki Forests, and Biodiversity Parks across 57 locations. The city covers a rich diversity of around 74 tree species and most prevalent (2011) are,

Species	Scientific Name	Count	Species	Scientific Name	Count
Neem	Azadirachta indica	6,838	Nariyali	Cocos nucifera	1,375
Bakamlimdo	Melia azedarach	2,851	Subaval	Leucaena leucocephala	1,295
Gandobaval	Prosopis chilensis	2,184	Karanj	Pongamia pinnata	1,249
Asopalav	Polyalthia longifolia	1,792	Jamfal	Psidium guajava	1,043
Vad	Ficus benghalensis	1,666	Deshibaval	Acacia nilotica	1,378
Others	-	24,206	Total		45,877

Natural disasters, such as cyclones and flash floods, result in the loss of 100+ trees. Additionally, a few residents choose to remove trees due to leaf litter management concerns. The city's soil composition, primarily black alluvial soil on Deccan Trap geology, challenge the growth of deep root systems tree species. Furthermore, Jamnagar's coastal location leads to salinity ingress in its groundwater and soil, limiting the growth of many tree species. However, the intertidal areas beyond the city boundary holds a forest cover of 'Prosopis chilensis' mangroves bushes.

4.1.3 Urban Biodiversity

Jamnagar, a "Paradise of Birds," habitats rich migratory and resident avian diversity. Several locations, including Lakhota Lake, Khijadiya Bird Sanctuary, Gagha Gorad Sanctuary, Dhinchada Lake and the Marine National Park, contribute to this biodiversity.

Commonly spotted birds are peafowl, mynas, crows, sparrows, bulbuls, babblers, doves, and other insectivorous birds like bee-eaters, wagtails, white-breasted kingfishers, egrets, swallows, Indian rollers, larks, and more thrive near water bodies and in areas with low vegetation.

Khijadiya Bird Sanctuary (KBS) - A Ramsar Site

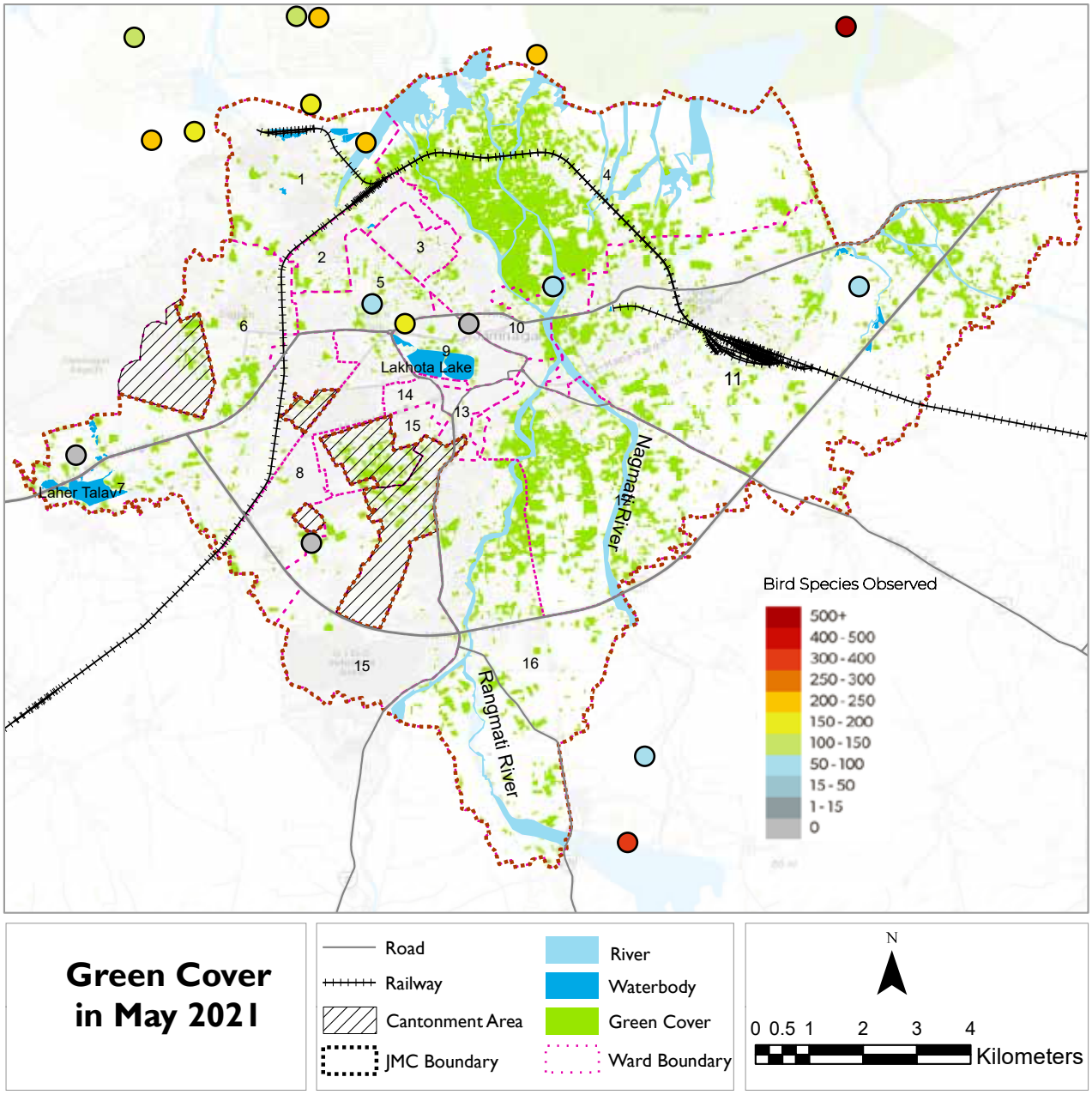
The Sanctuary located about 12 km Northeast from Jamnagar city came into existence with two bunds/ embankments built by the Princely state of Navanagar in 1920; and the State Government in 1956 to prevent fresh rain water draining into the Gulf of Kachchh, with the primary goal of preventing salinity ingress. This created a unique complex 'Saltwater-Freshwater' ecosystem with 7 habitat types including freshwater wetland, seasonal rivers, intertidal zones, tidal creeks, mangroves, saltpans and agriculture fields.

Today, it habitats over 310 bird species, including 125 water birds; over 165,000 individual water birds and 180 plant species, including the CE- Indian bdellium-tree (Commiphora wightii). The Site contributes to the maintenance of hydrological regimes, erosion protection & nutrient cycling.

Recently, the wetland was identified as a Ramsar site on World Wetlands Day in 2021 with recognition by Wetlands International (2009) and as an Important Bird Area (IN-088) by Birdlife International, (Islam & Rahmani, 2004). The Khijadiya wetland is also declared as one of the Wetlands of National Importance by the Government of India, The Ministry of Environment, Forest and Climate Change.

The area attracts a remarkable variety of migratory species of the global Indo-Pacific migratory route, including flamingos, pelicans, spoonbills, Indian skimmers, grebes, moorhens, cormorants, herons, egrets, storks, ibises, gulls, terns, jacanas, darters and various raptors. Common reptile sightings include kachindo, padaku, naag (cobra species, Naja spp.), patlagho, nolio (refers to monitor lizards, Varanidae family), Asiatic water snake (Natrix natrix), and Andhali chakan.

Further, the fish population in Jamnagar's water bodies act as bio-indicators, reflecting the health of the aquatic environment. Freshwater fish varieties include rohu (Labeo rohita) and catla (Catla catla), while other important local fish include tuna (Thunnus spp.), ribbonfish (Trichiurus lepturus), kingfish (Scombridae family), sole (Soleidae family), yellow croaker (Larimichthys crocea), silver croaker (Pennahia argentata), katti, jawla, and silver pomfret (Pampus argenteus).



Map 3: Green Cover & Biodiversity Hotspot in Jamnagar city

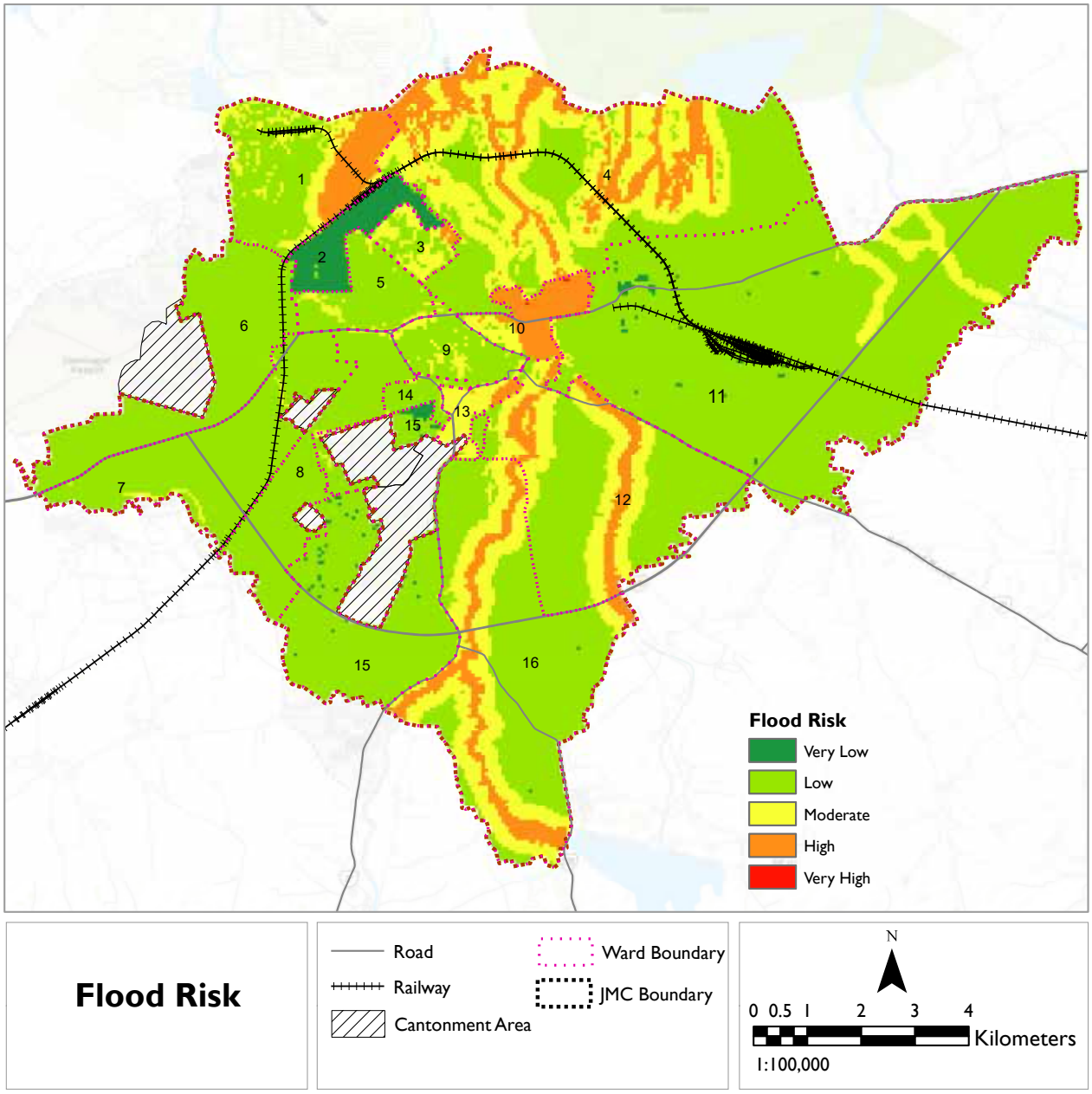
Source : Satellite imagery & ebird.org

The city has a Biodiversity Management Committee (BMC) established by JMC in 2022. This committee is partially functional yet to document and develop PBR and LBSAP.

4.1.4 Disaster Resilience

City faces a multitude of natural hazards. The Gujarat State Action Plan on Climate Change (GSAPCC) - 2021 and District Disaster Management Plan (DDMP) identifies these vulnerabilities, highlighting the importance of understanding them and the city's resilience strategies to mitigate disaster risk.

Flood Hazard : Due to its low elevation (20 m MSL) and erratic rainfall patterns, Jamnagar faces unique flood risks. The city receives an annual average rainfall of 527 mm, concentrated within the monsoon season from June to September (around 95%). The city has witnessed both extremes of weather, with severe droughts (in 1987 with only 36 mm of rain) and devastating floods (in 2010 with the record-breaking 2114 mm of rain). The DDMP states flooding in the urban areas is also prevalent due to drainage blockage and increased run-off loads in hard surfaces.



Map 4: Composite Flood Risk

Composite flood risk mapping identifies high flood risk (9%) at the meeting point of the Rangmati and Nagmati rivers in Ward 10 and near Jamnagar Railway Station in Ward 1. Other areas classified as medium risk (18%) include Wards 4, 9, and 12. Ward 4, a low-lying area, requires particular attention for settlements in the floodplain.

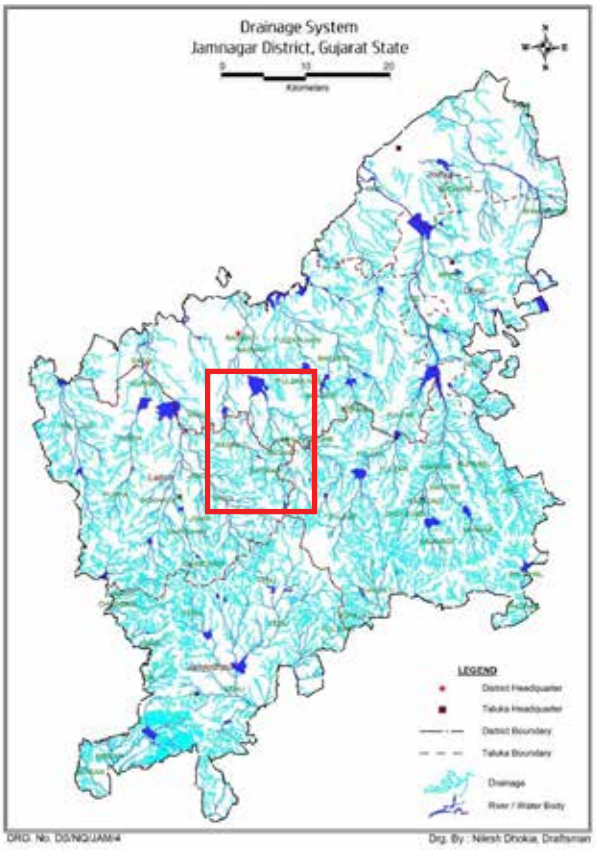
Exceeding dam capacity during heavy rainfall events also contributes to riverine flooding, estimated at around 20%. Heavy precipitation in the Rangmati and Nagmati river catchment areas (highlighted as red box) exceeding Ranjit Sagar dam and Rangmati dam capacity caused the 2021 flash floods. These floods highlight the importance of strategic planning at district level with efficient dam management practices, upgraded drainage capacity and early warning systems.

Cyclone Risk :

Jamnagar's coastal location makes it highly vulnerable to cyclones. Over 120 cyclones from the Arabian Sea have impacted the Gujarat coastal region of Saurashtra and Kachchh in the past century. The district has experienced wind speeds exceeding 55 m/sec (almost 200 km/h), with inland city areas experiencing 48-50 m/sec (173-180 km/h). Heavy storm surges cause saline water intrusion, rendering fertile land unproductive. Investing in cyclone shelters, enforcing wind-resistant building codes as per Bureau of Indian Standards, and strengthening communication networks are vital mitigation strategies for the city.

Seismic Vulnerability :

Jamnagar falls under Zone-IV (0.24 g) of seismic vulnerability as captured by Vulnerability Atlas, exceeding the recommended Design Basis Earthquake (DBE) standard of 0.18 g. This translates to a moderate risk of experiencing earthquakes with a shaking intensity 2.3 times greater. Considering the major 2001 earthquake (magnitude 6.0) felt in the region, stricter building codes and retrofitting programs are essential for existing structures.



Map 5: Drainage Network, Jamnagar District

Source : Aquifer Maps and Groundwater Management Plan, Jamnagar District, Gujarat

Climate Change Threats :

As per GSAPCC, a minimum temperature rise of 0.1 to 1.5°C is observed in Jamnagar city with increased frequency of drought and intensifying saltwater intrusion in estuaries due to reduced freshwater of rivers causing 'Salinization'. The state report also mentions change in the frequency of hot days increasing to 30 and hot nights to 24 numbers in Jamnagar.

Data from the Standardized Precipitation and Evapotranspiration Index (SPEI) reveals that Jamnagar has faced 3 severe drought events since 1951, highlighting the predicted challenge. The presence of dry vegetation during the pre-monsoon season amplifies the risk of wildfires. These fires can devastate forests, wildlife habitats, and threaten human settlements. Forest management practices that reduce dry fuel loads through controlled burns and proper maintenance can mitigate this threat.

Baseline Analysis

THEME 02: Energy & Green Buildings

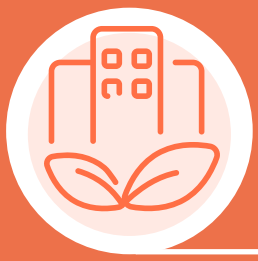
Electricity Consumption

Energy Derived from Renewable Sources

Fossil Fuel Consumption

Energy Efficient Street Lighting

Promotion and Adoption of Green Buildings



4.2 Energy & Green Buildings

4.2.1 Electricity Consumption in the city

Jamnagar city annually consumes about 632,700 MWh of energy, equating to approximately 812 kWh per capita. The primary consumers are the residential sector, LT industries, and HT industries, which account for 47%, 31%, and 19% of total consumption, respectively (Figure 5). LT industries mainly include commercial and institutional establishments within the city. The average household consumes 1,339 kWh annually, indicating a significant reliance on fans for cooling.

Projecting future trends (Figure 6), residential electricity consumption is projected to increase fourfold by 2050. The most substantial growth is expected in general lighting, with consumption anticipated to rise 21 times compared to 2022 levels. LT industries are projected to grow 5 times, while HT industries are expected to grow by 2.5 times. Overall, electricity consumption is forecasted to increase by 423% by the inventory year.

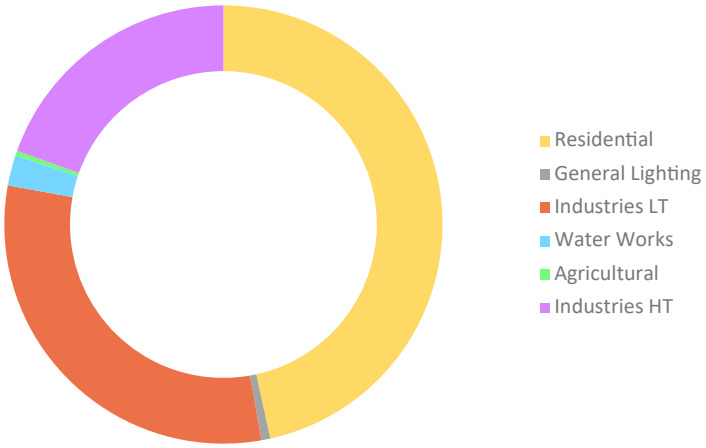


Figure 5: Electricity consumption of Jamnagar city in the year 2021-22
Source : PGVCL, Jamnagar

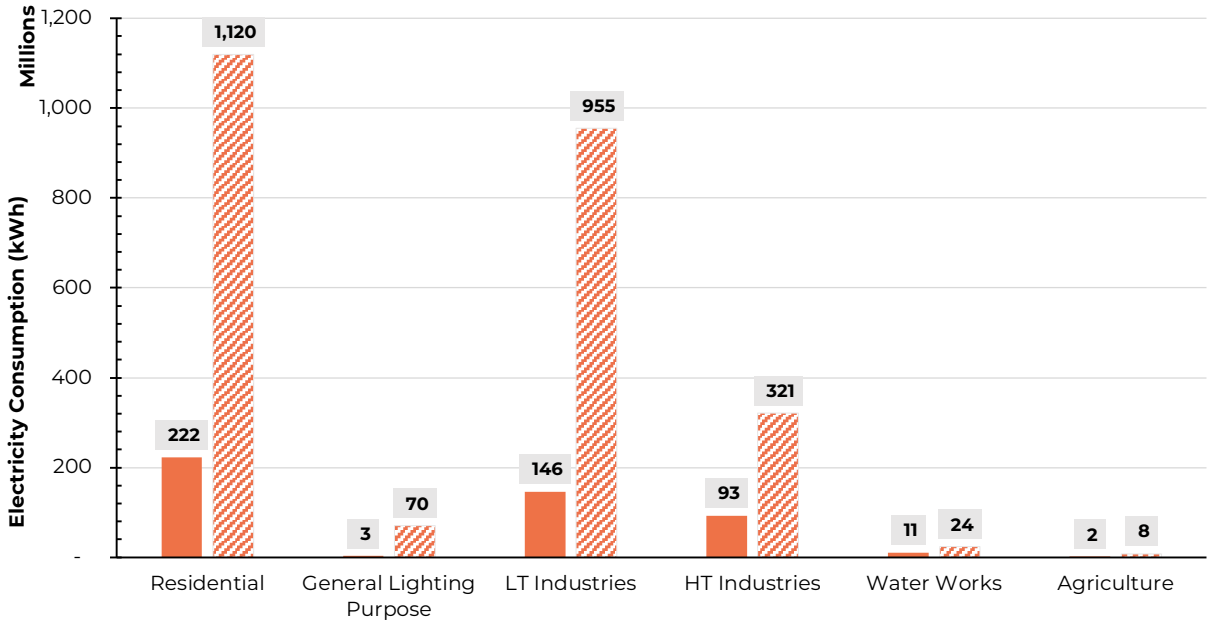


Figure 6: Projected electricity consumption of Jamnagar city in the 2050
Source : PGVCL, Jamnagar

4.2.2 Energy derived from Renewable Sources

In Jamnagar, renewable energy sources contribute 4.5% to the city's overall electricity demand, supported by a total installed capacity of 19.9 MW. 7% of residential consumers in the city utilize RE, followed by HT industries at 5%, and LT industries at 1.3% (Figure 7). This data highlights the urgent need to expand the use of RE across all sectors in Jamnagar. Increased adoption could be encouraged through policies and incentives aimed at reducing the barriers to entry for both residential and industrial consumers. By fostering a more robust RE infrastructure, Jamnagar can significantly reduce its carbon footprint and set an example for other cities in the region.

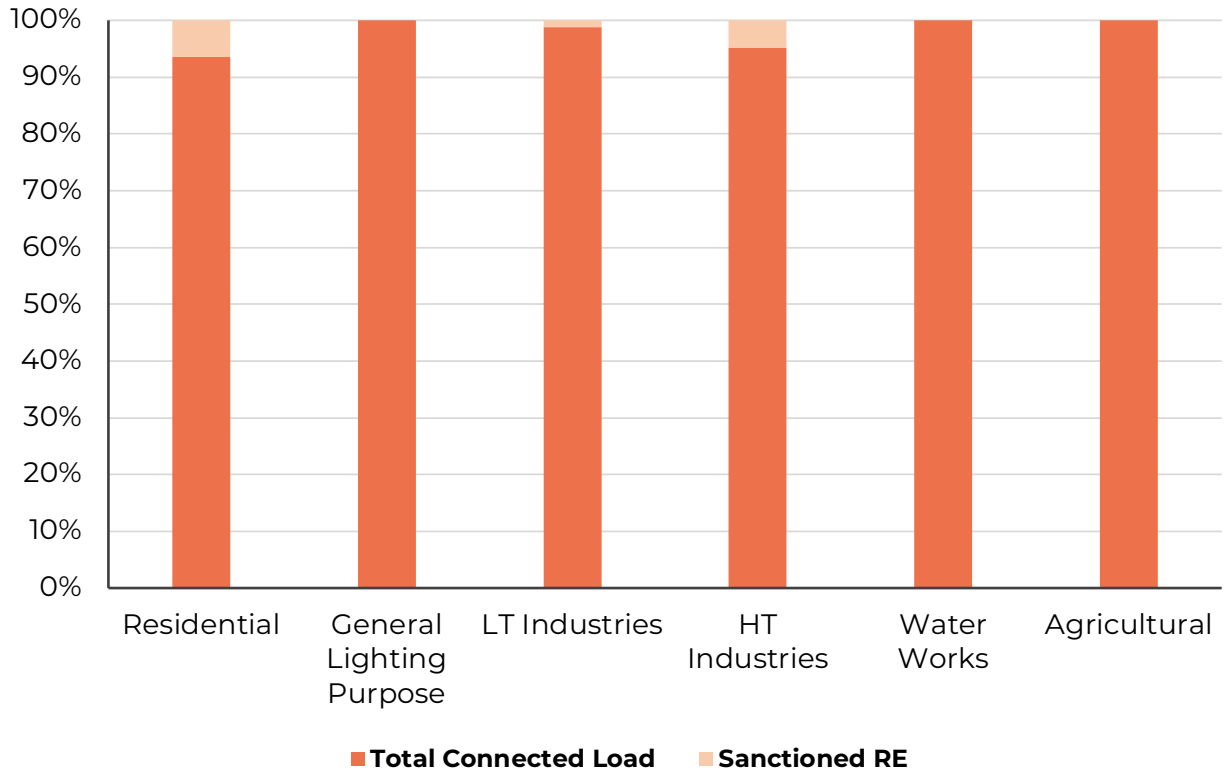


Figure 7: Percentage share of installed renewable energy load in different sectors
Source : PGVCL, Jamnagar

The Jamnagar city has a potential of generating 1,666 kWh/kWp in a year from SPV panels [1]. The monthly average of solar energy generation is within the range of 90-170 kWh/kWp as shown in Figure 8.

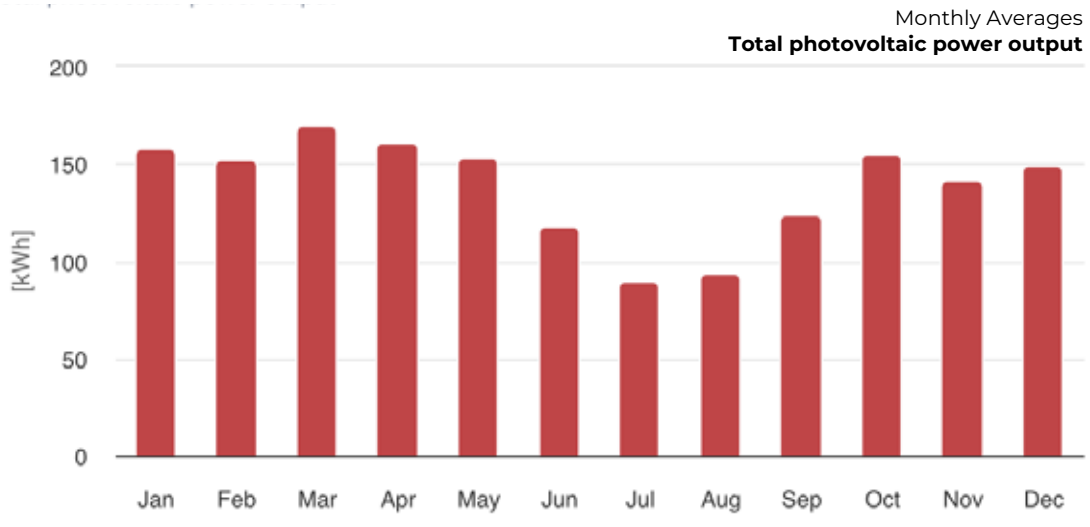


Figure 8: Monthly averages of solar photovoltaic power output of 1kWp panel in Jamnagar
Source : Global Solar Atlas by the World Bank Group

1 Global Solar Atlas by the World Bank Group https://globalsolaratlas.info/map?c=22.123174,70.068054,10&s=22.470685,70.044708&m=site

4.2.3 Fossil Fuel Consumption

In 2021-22, diesel consumption contributed the most (33%) to Jamnagar city's GHG emissions from fossil fuels, followed by petrol (26%), LPG (28%), CNG (8%), and PNG (5%). This high diesel use can be attributed to commercial trucks for industrial transport and tourist buses traveling to nearby cities like Dwarka and Porbandar, despite roughly one-third of the city's vehicles being private diesel cars.

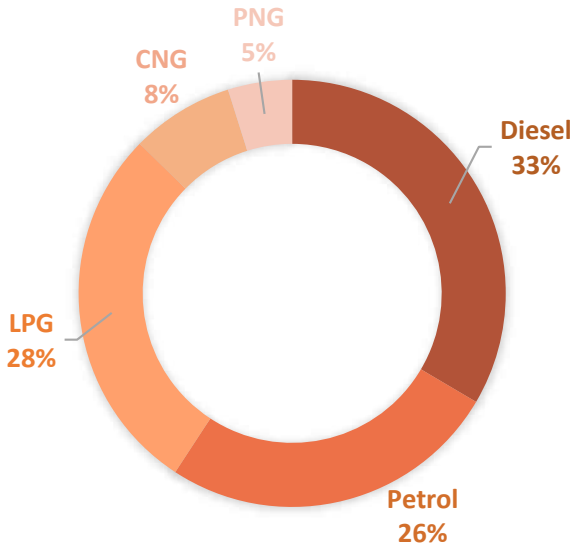


Figure 9: Percentage share of installed renewable energy load in different sectors
Source : PGVCL, Jamnagar

Projections for 2050 indicate a tripling of GHG emissions from diesel in Jamnagar city compared to the base year. Emissions from petrol and CNG are also anticipated to rise significantly, with a 3.3-fold and 3.1-fold increase, respectively (Figure 10). This substantial growth in fuel consumption and emissions highlights the urgent need for investment in zero-emission vehicles. Furthermore, emissions from cooking fuels (LPG and PNG) are also expected to double by 2050.

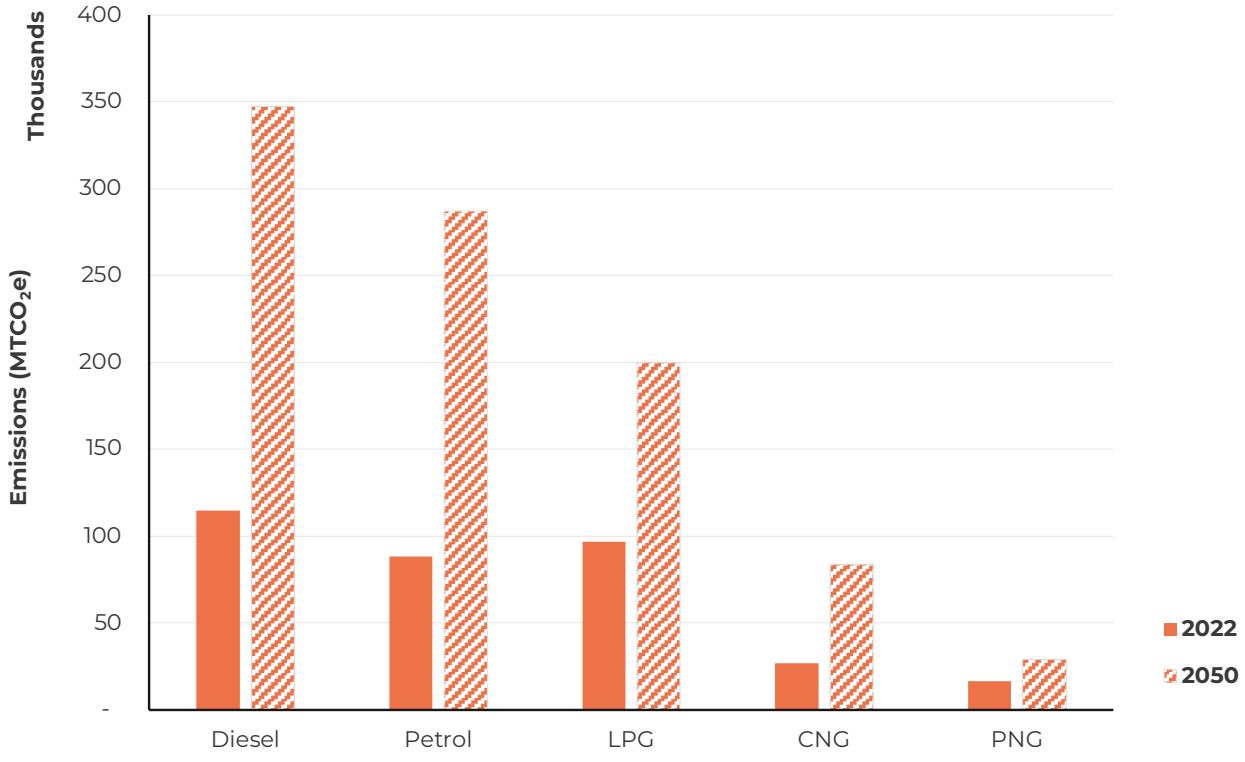
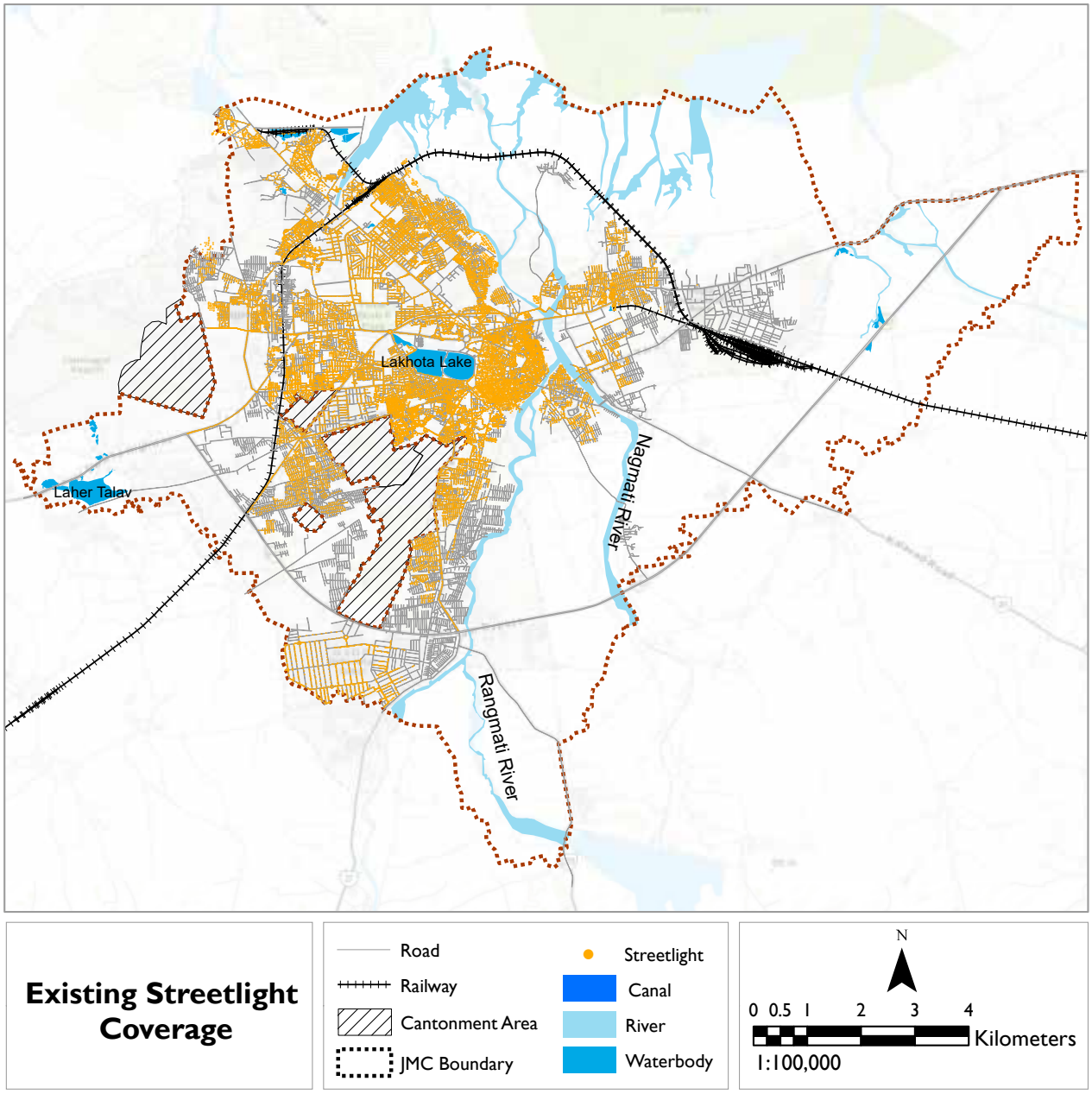


Figure 10: Projected emissions from fossil fuel consumption in 2050

4.2.4 Energy Efficient Street lighting

The city has steadily increased LED street light installations, reaching 41,233 units in 2021-22 (from 40,851 in 2019-20). This shift has demonstrably reduced energy consumption for streetlights by 204,378 kWh (from 5,105,146 kWh to 4,900,768 kWh) between 2019-20 and 2021-22. While the city's annual electricity bill associated with street lighting has increased by 18% from 2019-20 to 2021-22, attributed to factors beyond just lighting costs, such as inflation or changes in electricity rates.

Jamnagar has achieved 100% LED lighting, there remains potential for further advancement. The city is yet to explore the integration of RE sources, such as solar power, to power its street lighting system and reduce dependence on grid supplied energy.



Map 6: Existing Streetlight Coverage in Jamnagar city
Source : JMC

4.2.5 Promotion and Adoption of Green Buildings

Jamnagar currently has one building that has achieved a pre-certified IGBC rating. Green building certifications are awarded based on the number of credits a building earns by meeting specific environmental sustainability criteria. While achieving a high certification level like platinum requires exceeding these criteria (as demonstrated by the Waste-To-Energy plant's score of 81 points out of 100), some baseline requirements are mandatory for all green building certifications. This existing pre-certification signifies an emerging interest in green building rating systems in Jamnagar. Public education and information campaigns (IEC activities) could further promote their adoption.

Figure 11: Waste-to-Energy Plant, Jamnagar

Jamnagar - 'The Brass city of India'

India's brass industry is geographically diverse, with each region specializing in different products. States like Haryana, Orissa, Assam & Uttar Pradesh focus on handcrafted decorative items & utensils for consumers, using sheet metal or castings. In contrast, Gujarat excels in machined parts for industrial supply, requiring various processes like turning, milling, and threading.

Jamnagar's brass ecosystem thrives due to its vast network of around 3,500 brass-related work units, established primarily in the last 15-20 years. These units specialize in various aspects of brass operations, including 2,100 machining units, 900 brass foundries, 350 electroplating units, and 150 extrusion units.

Energy consumption of brass units is primarily electricity and fossil fuels like High grade coal, furnace oil, and LPG to meet their energy needs. The brass cluster's total annual electrical energy consumption is estimated at around 50,770 MTOE (Metric Tonnes of Oil Equivalent). Foundry units account for the largest share (57%), followed by extrusion (31%), machining (10%), and electroplating (2%). Major energy consuming processes are melting of metal, reheating, and electroplating.

Energy Saving Recommendations

1. Reheating furnaces need a balanced air-fuel mix. Too little air and fuel burns incompletely. Too much air wastes energy by carrying heat away in exhaust. Proper air-fuel control systems ensure efficient combustion for optimal performance.
2. Energy studies in brass extrusion units revealed a neglected area - furnace insulation. Poor insulation resulted in high skin temperatures (up to 130°C) and significant heat loss (3-7% of total energy use). To address this, a furnace zone-based insulation redesign is required. This involves using high-quality materials like Hysil sheets and ceramic blankets, replacing the previous inadequate firebrick linings.
3. Installation of temperature gauges in reheating furnaces for proper temperature control.
4. Replacement of conventional coal fired furnace with gas fired rotary furnace to increase the efficiency by 2x.
5. Replacement of conventional oil fired pit furnace with energy efficient oil fired furnace
6. Replacement of conventional under loaded motors with suitable rating energy efficient motors in Hydraulic press, as motors consume 40-60% of electricity and underload motors pull more electricity to perform.
7. Installation of timers in cooling towers, that switch on/off the cooling tower fans depending on water temperature.

Source : Bureau of Energy Efficiency (BEE), Ministry of Power, Government of India. (Prepared by Winrock International India). 'Manual on energy conservation measures in brass cluster Jamnagar'

Baseline Analysis

THEME 03: Mobility & Air Quality

Clean Technologies Vehicles

Availability of Public Transport

Coverage Of Non-Motorised Transportion

Air Pollution and Clean Air Action Plan

4.3 Mobility & Air Quality (MAQ)

4.3.1 Clean Technologies Vehicles

City's development catalyses an increase in private vehicle ownership (two- and four-wheelers), likely due to affordability and car-centric infrastructure. The number of vehicles registered in Jamnagar has fluctuated between 2014 and 2022. A decrease in total registrations was observed in 2020-2021, likely due to the COVID-19 pandemic. Petrol vehicles consistently held the largest share of registrations, but their numbers have declined from 43,932 in 2014 to 1,190 in 2020. Diesel vehicle registrations remained relatively constant, although there was a 16.7% decline from 7,103 in 2014 to 5,911 in 2022.

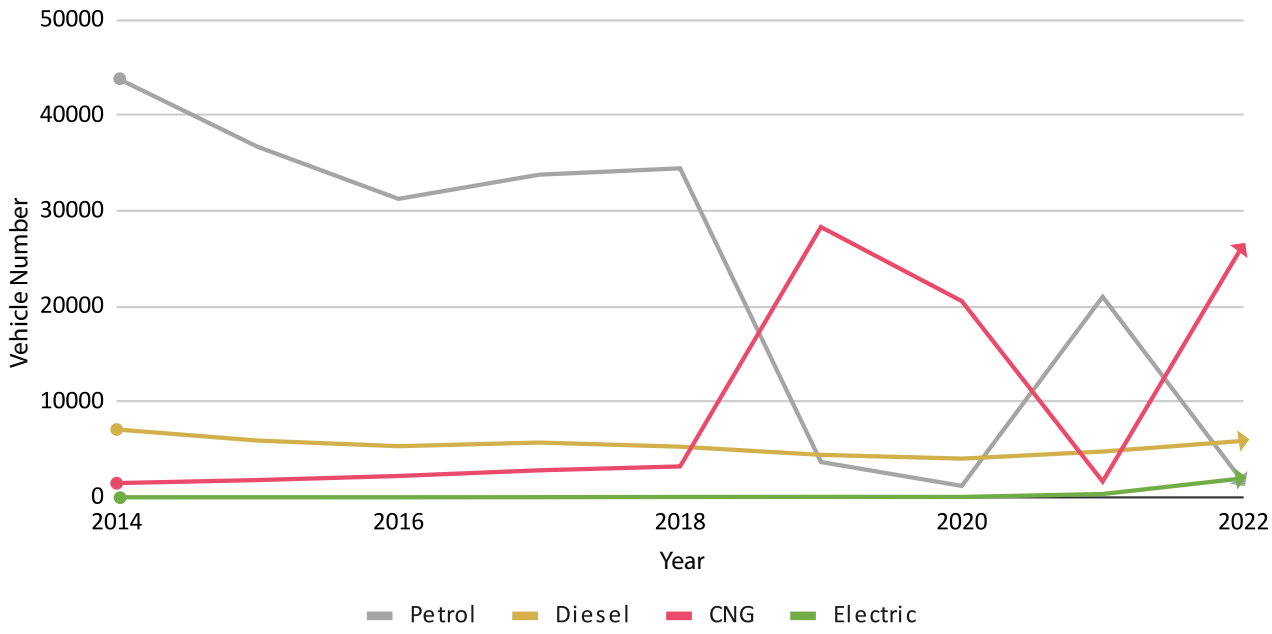


Figure 12: Fuel Type - Vehicle Registration

A potential shift in consumer preference from conventional fuels (diesel, petrol) to clean energy fuels (CNG, electric) has been observed. Registrations for CNG vehicles have shown a seventeen fold increase, rising from 1,486 in 2014 to around 26,512 in 2022. Similarly, electric vehicle registrations, while representing a lower share overall, have witnessed a steady climb from 0 in 2014 to 1,991 in 2022, indicating the adoption of clean fuel technology.

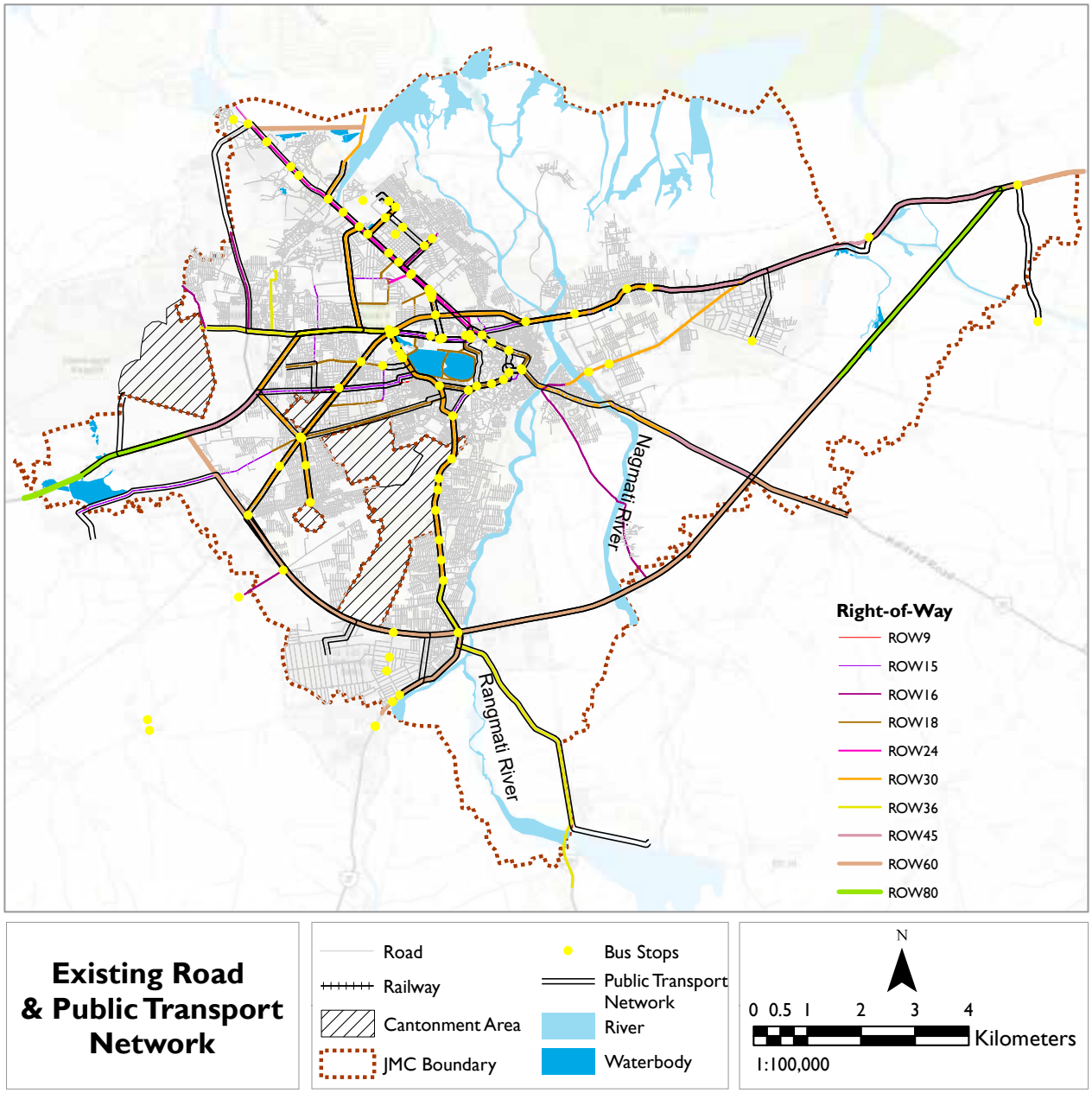
Two- and three-wheelers constitute the majority of the city's vehicle landscape. In 2022, Jamnagar RTO (GJ10) registered a total of 23,505 two-wheelers, with approximately 8% being electric vehicles. However, a positive shift towards low-carbon transportation is evident in the CNG three-wheeler passenger vehicles share rise from 21% in 2014 to 73% by 2022.

4.3.2 Availability of Public Transport

Jamnagar's public transportation system consists of shared three-wheeler rides (cost-effective at ₹10 - ₹30) and buses serving both inter-city and intra-city routes. The intra-city buses, managed by the JMC, connect high-demand areas like Darbargadh, Town Hall (Hapa Railway Station), Awash, Gandhinagar Railway Station, Rameshwaranagar, Gokulnagar, Patel Samaj, and Dhuvav. These routes see buses every 1:30 hours. Conversely, routes with lower demand, like those connecting Rameshwaranagar to GIDC Dared and Kansumra village, have frequency every 2 hours.

The city currently operates a fleet of 20 non-air-conditioned buses, with 10 diesel and 10 CNG-fuelled vehicles (average age of 2.7 years). These buses average a daily route distance of 150 km with

a staged fare system of ₹5 base for the first 2 km and ₹1 per additional 2 km. The average monthly bus ridership from 2019 to 2022 was 64,006 passengers, with a peak of 79,067 in 2022. However, ridership dipped to 63,135 passengers in 2023 compared to the previous year.



Map 7: Existing Road & Public Transport Network

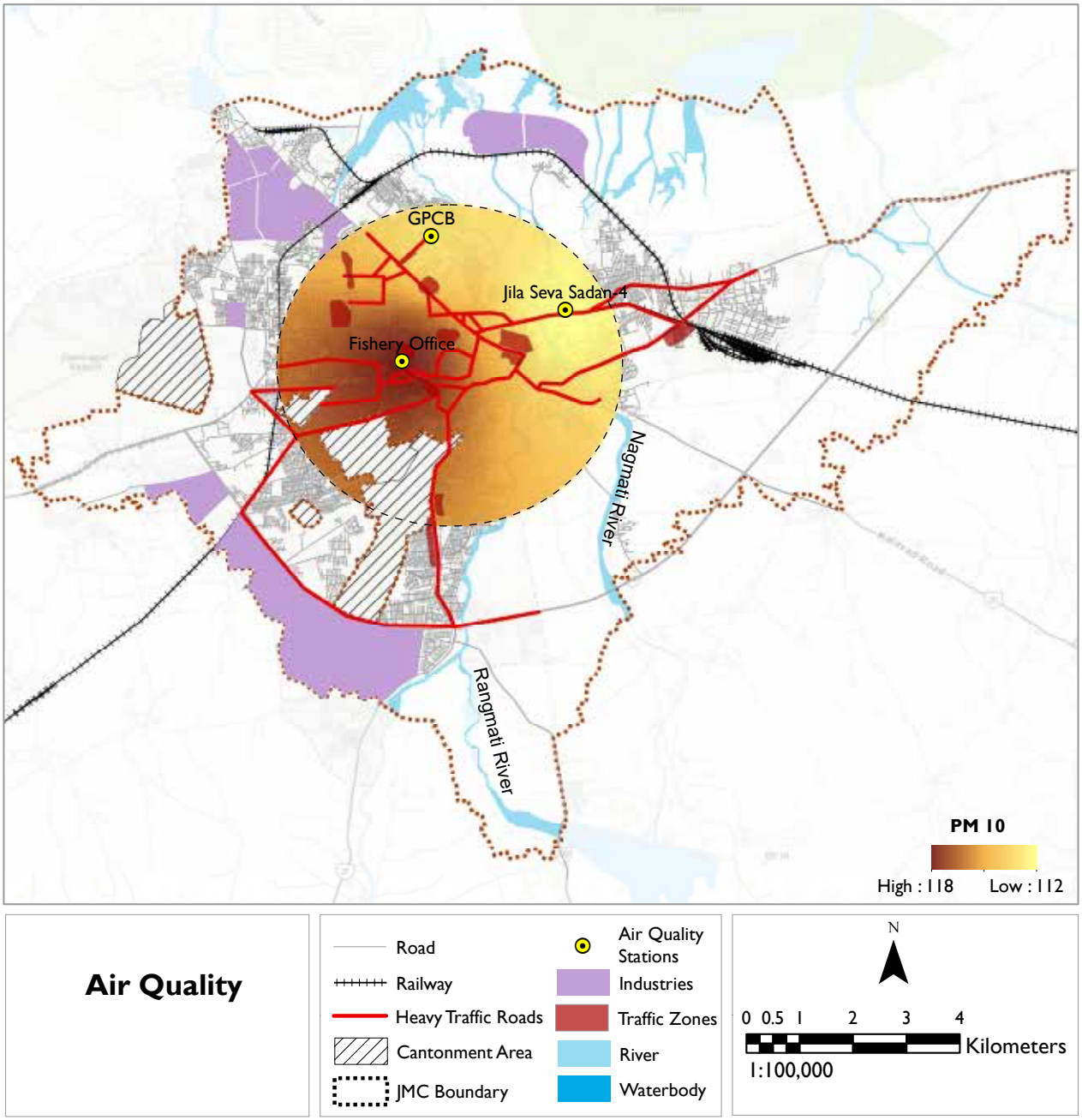
Source : Development Plan Report for JADA – 2031; JMC

4.3.3 Non-Motorised Transportation (NMT)

Jamnagar's current NMT infrastructure presents limitations for pedestrians and cyclists. Only 21 km designated footpaths (constituting only 1.76%) of the total 1192 km road network. These are primarily placed along Bedi road, Aerodrome road, and parts of Saru Section road. Roadways with available Right-of-Way (RoW) have undeveloped shoulders that are currently used for parking and vending spaces. The lack of dedicated sidewalks and cycle paths, combined with vehicles and vendors occupying road edges, forces pedestrians and cyclists to share the vehicle carriageway, potentially compromising their safety.

4.3.4 Air Quality

GPCB is the state's nodal agency for pollution control and environmental protection in Jamnagar city with 3 monitoring stations installed in the city under National Air Quality Monitoring Programme (NAMP) station at Fisheries Office, GPCB Office and Jila Seva Sadan as shown in the map. These stations monitor : PM2.5, PM10, NOx, SOx.



Map 8: Air Quality with PM 10 levels

Data collected from monitoring stations between 2014 and 2022 reveals a concerning trend in Jamnagar's air quality. The average concentration of Particulate Matter (PM10) stands at 107µg/m3, exceeding the permissible limit of 60µg/m3. Notably, the highest concentrations are observed in the core city area surrounding Lakhota Lake (Wards 05, 09, 13, and 14). PM10 refers to a category of air pollutants encompassing microscopic solid particles and liquid droplets suspended in the air. These particles can originate from various sources, both anthropogenic and natural. Common anthropogenic sources in Jamnagar include traffic emissions (heavy traffic roads and zones highlighted in red), industrial processes (both combustion and non-combustion, power plants), and construction activities.

Baseline Analysis

THEME 04: Water Management

Water Resources Management

Extent of Non-Revenue Water (NRW)

Water Recycle & Reuse

Flood And Water Stagnation Risk Management

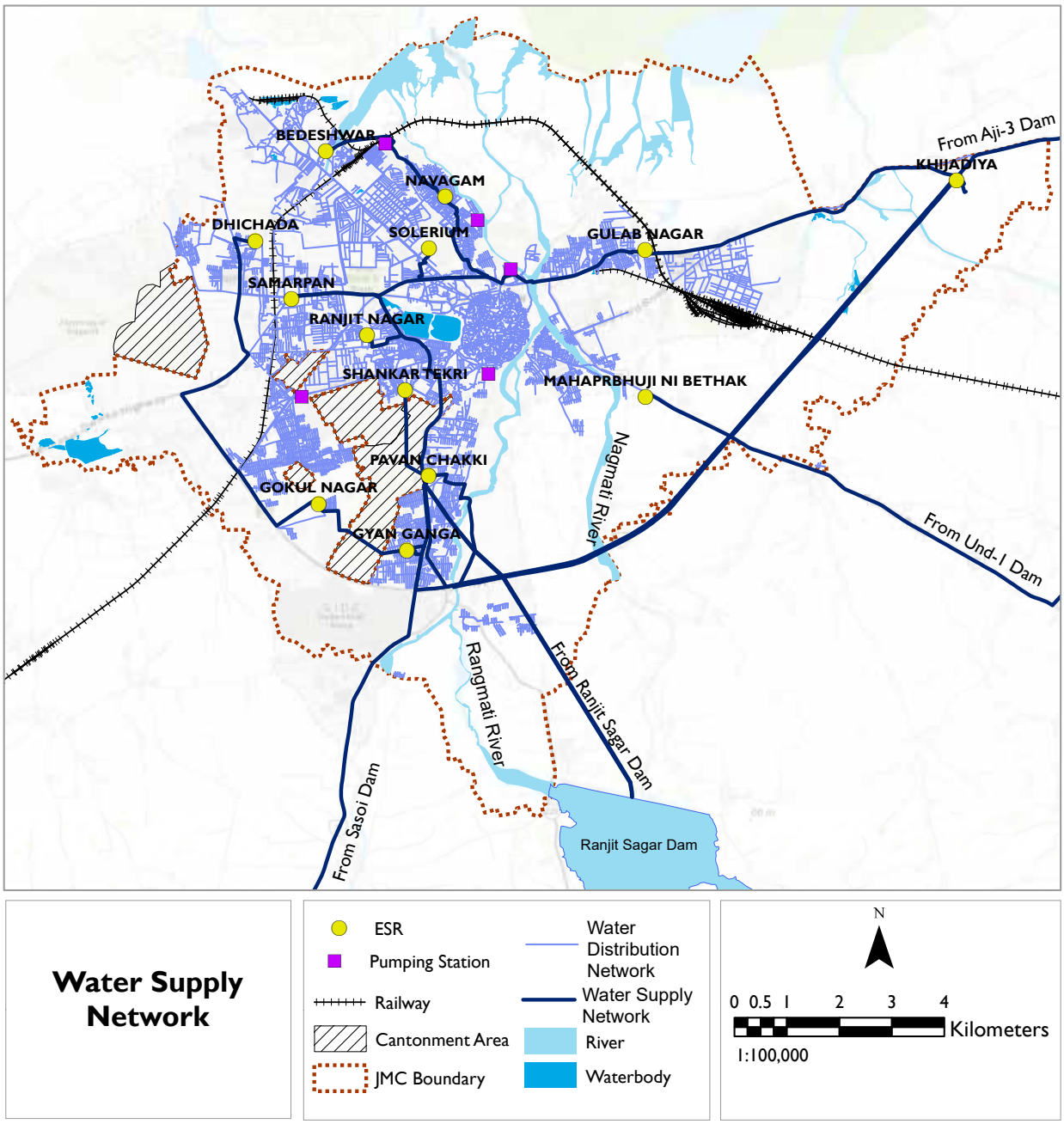
Energy Efficient Water Supply And Waste Water Management System

4.4 Water Management

4.4.1 Water Resources Management

JMC manages the city's water supply, drawing its raw water entirely from five surface reservoirs: Ranjit Sagar Dam (9,125 million litres per annum [ML]), Und-1 Dam (9,125 ML), Sasoi Dam (9,125 ML), Aji-3 Dam (14,600 ML), and the Narmada Pipeline NC-8 (9,125 ML). Water from these sources undergoes treatment at three water treatment plants (WTPs): Pumphouse Filter Plant (3 units), Gyanganga Filter Plant (1 unit), and Khijadiya Filter Plant (2 units). These plants have a total designed capacity of 140 MLD and a current operational capacity of 128 MLD.

140 MLD (equivalent to 155 LPCD) treated water is supplied on alternate days to an area of 62km² out of 70km² developed city area. This area represents approximately half of the total city area (128.4 km²), with the remaining area being industrial, farmland and fallow land. The current water supply network stretches over 1,100 km and connects approximately 1,46,850 households (73.41% of the total in JMC as of 2024). An expansion project is underway to add a 70 km network extension, aiming to serve an additional 20,000 households.



Map 9: Water Reservoirs and Supply Network

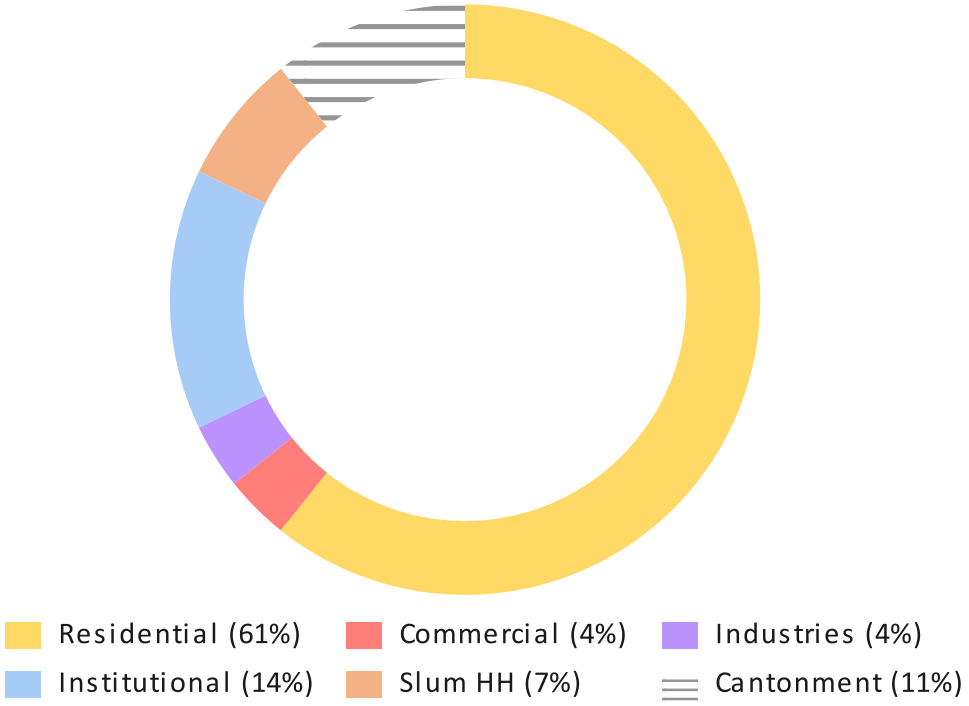


Figure 13: Sector-wise Water Supply

Source : JMC

4.4.2 Extent of Non-Revenue Water (NRW)

Supplying 140 MLD of water on alternate days results in a 25% revenue loss (SLB 2020-21), with the majority of losses (up to 70%) occurring in residential areas. Revenue and water loss can be attributed to two main issues: unauthorized consumption and transmission inefficiencies. Unauthorized use includes unmetered or unbilled water, whereas transmission inefficiencies include water losses occurring due to physical leaks (real losses) in the system before reaching customers, and discrepancies between water delivered and what's metered or billed (apparent losses).

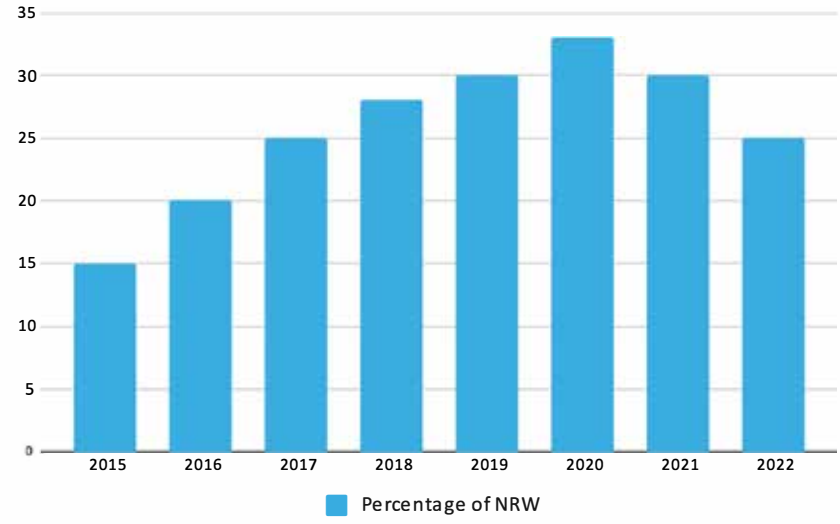


Figure 14: Extent of Non-Revenue Water (NRW)

Source : JMC

For authorized water connections, the city charges a base amount of ₹1,200 per connection, regardless of water consumption. Few housing societies in the city have installed water meter connections to regulate water usage by residents. However, the extent of metered water connections is only 0.5% (SLB 2020-21).

4.4.3 Used Water Recycle & Reuse

City data highlights a rise in used water generation from 70.8 MLD in 2014-15 to 95 MLD in 2022-23, with a peak generation of 135.6 MLD in 2019-20. This trend necessitates the expansion of the city's underground drainage network, which grew from 180km in 2014-15 to 631 km in 2022-23, currently serving 1,01,348 households (50% of the total in JMC). This network collects only domestic used water, with no input from industries.

The city has a centralized Sewage Treatment Plant (STP) built in 2016. This plant, with a capacity of 70 MLD, employs a biological treatment using a Sequential Batch Reactor (SBR) process. This four-step process involves filling tanks with used water, aeration for biological breakdown, settling of solids, and decanting the treated water. Currently, the treated water is discharged into River Nagmati and average electricity consumption of the STP is 52,994 KW. Additionally, the city leverages over 121,672 decentralized on-site sanitary facilities, showcasing a commitment to comprehensive used-water management.

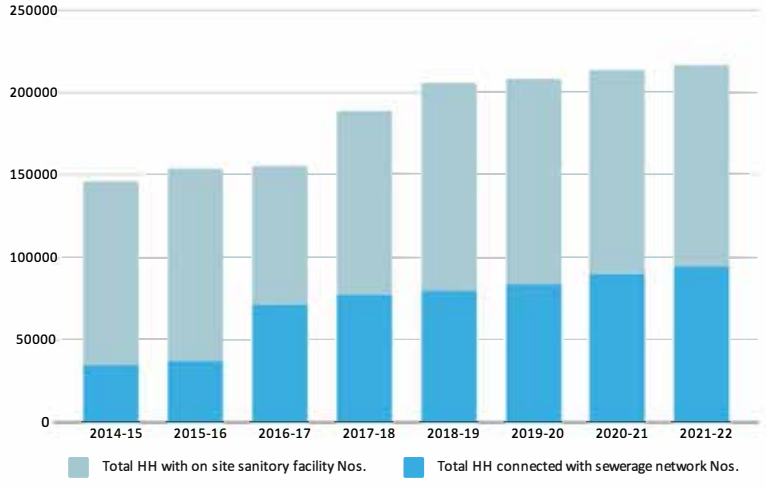


Figure 15: Sewerage Network Coverage

Source : JMC

4.4.4 Flood and Water Stagnation Risk Management

The city experiences water logging in several areas, primarily due to a lack of consideration for natural slopes and topography during infrastructure expansion projects for sewerage, roads, and other development activities. Jamnagar city has experienced flooding multiple times due to the aforementioned causes (in indicator 1.4). Mapping the risk analysis, Jamnagar has 9% high risk, 18% medium risk, and 72% low flood risk.

The city's natural slope ranges from 2 to 5 degrees, with a southwest to northeast flow. This inclination leads to water accumulating in specific wards. Wards 11 and 12 are the most affected due to water runoff from the higher lying Wards 15 and 16. Similarly, Wards 10, 4, and 7, located on the downward slope and densely populated with significant built-up areas, are also susceptible to water logging. Slum settlements in Ward 1 (near the railway station), Ward 10, and Ward 12 also require attention due to potential flooding risks.

City Stakeholder consultations identified specific areas experiencing severe water logging, with water levels reaching up to 1.5 meters. These include the areas near the gurudwara and Patrakar Colony (Ward 9), Mangal Bag (Wards 4/5), and Patelwadi (Ward 4). Addressing water logging and urban flooding effectively, a comprehensive plan is needed.

Storm Water Drainage Network covers up to 40% of developed area only. This plan should involve a careful assessment of the city's natural slopes and the development of a strategy to channel excess water towards designated drainage points, rivers, gulf or other water bodies.

4.4.5 Energy Efficient Water Supply and Used Water Management System

Jamnagar's water treatment system has a designed capacity of 140 MLD, currently operating 128 MLD. These plants consume 16.2 MW of electricity, accounting around 33% of the Water Supply Department's total consumption. Annual electricity consumption by the JMC's Water Supply Department (Sourcing and Supplying) is 49.2 MW. The Pumphouse Filter Plant, built in 1940, is the oldest and has an electricity usage of 7.2 MW. The Khijadiya Filter Plant (2007) and the Gyanganga Filter Plant (2014) utilize 6 MW and 3 MW, respectively.

The Sewerage Department for Used Water Management requires a significantly higher average of 591.4 MW (2016-2022) of electricity. A rise in overall energy consumption is evident from 2016 (238.2 MW) to 2022 (772 MW). This increase likely coincides with the installation of a Sewage Treatment Plant (STP) that alone consumes an average of 52.9 MW, representing 9% of the department's total energy usage.

Baseline Analysis

THEME 05: Waste Management

Waste Minimisation Initiatives

Extent Of Dry Waste Recovered And Recycled

Extent Of Wet Waste Processed

Scientific Landfill Availability & Operations

Landfill/ Dumpsite Scientific Remediation

4.5 Waste Management

4.5.1 Waste Minimization Initiatives

Jamnagar's waste generation trends show a rapid increase, with total waste generation having risen from 275.2 MTPD in 2019-20 to 357.7 MTPD in 2021-22, reflecting a 30% annual increase. The daily waste generation stands at 0.5 kg per capita. If current trends continue, Jamnagar would exceed the CPHEEO norms of per capita waste generation up to 0.6 kg per capita[1]. Initiatives to minimize waste have yet to be implemented by the city. Whereas, waste collection is optimized efficiently with 100% door-to-door collection in developed areas leading to a reduction in the number of silver bins open points from 450 to 200. JMC charges residents an annual SWM fee of ₹120, however, only 4% of this cost is collected.

A significant development in Jamnagar's waste management strategy is the Waste-to-Energy Plant - 'Goodwatts Wte Jamnagar Pvt Ltd' constructed on a PPP model between JMC and Abellon CleanEnergy Limited. This plant, with a capacity of 450 MTD, processes 100% of the waste (segregated or unsegregated) generated in Jamnagar and even handles waste from nearby regions (currently Rajkot city).

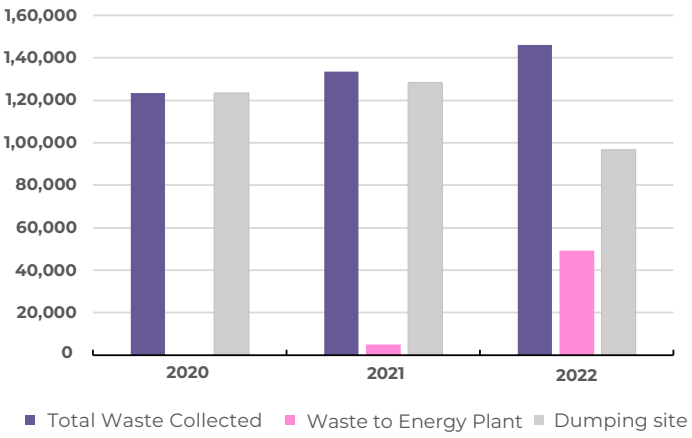


Figure 16: City Waste Management
Source : JMC

Figure 17: Waste Segregation at the Waste-to-Energy Plant

4.5.2 Extent of Dry Waste Recovered and Recycled

The Material Recovery Facility (MRF) at Jamnagar for dry waste recovering and recycling is operated on a PPP model between JMC and Nepra Resource Management Pvt. Ltd. The facility is designed, built, financed, owned and operated by Nepra Resource Management.

The daily dry waste collected from the plant is around 8 to 10 tonnes. Dry Waste is collected with the help of waste pickers or through collection vehicles brought to MRF. Here, it is manually segregated into various categories and passed through a stringent quality check to meet the requirement and standards of the recyclers. The segregated waste is then sold to the authorized recyclers.

Segregation of dry and wet waste at source level is still not practiced.

1Swwach Bharat Mission - Municipal Solid Waste Management Manual by Ministry of Urban Development, 2016

4.5.3 Construction & Demolition (C&D) Waste Management

Jamnagar currently lacks a policy or system for handling C&D waste, however, plans to propose a C&D plant in the future. The city generates an estimated 30 to 50 MT of C&D waste weekly, accumulating to 2,627.57 MT of annual waste in 2019-20. This amount has further increased by 26% in 2021-22. Untreated C&D waste is often left on construction sites or dumped on vacant plots, along roads, into rivers, water bodies, or storm water drains, creating a serious environmental concern.

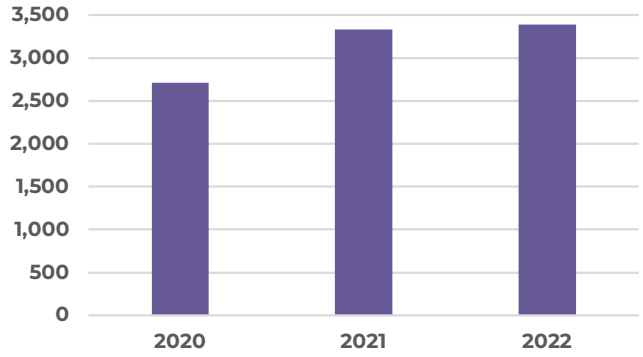


Figure 18: C&D Waste Generated (MT/ year)
Source : JMC

4.5.4 Extent of Wet Waste Processed

The city lacks source-level waste segregation, making it difficult to estimate wet waste generation. However, organic waste is collected separately from various sources like hotels, party plots, vegetable markets, and stray cattle shelters for processing. A Biogas Generation Facility with a capacity of 50 tonnes, operated on a PPP model between JMC and Maxim Environmental Engineering Pvt. Ltd, currently processes 7-8 tonnes of organic waste daily. This waste undergoes separation on a conveyor system, with inorganic waste sent to registered recyclers. The organic portion undergoes size reduction and pre-treatment before being processed. The resulting slurry from the biogas dome is further processed into a granular fertilizer. Purified Bio-CNG is supplied to the Gujarat Gas Ltd Grid and Purified Biogas is supplied for cooking in centralized kitchens of the Daudi Bohra Community.

4.5.5 Availability of Scientific landfill and Landfill remediation

The Waste-to-Energy Plant has eliminated the need for dumping waste at the Gulabnagar landfill site in Ward 11, effectively remediating it. With 66% of the legacy waste already processed, there are future plans to convert the landfill site into an Urban Forest. Parallelly, the disposal of animal carcasses at Theba Chokdi lacks proper hygiene, impacting both residents and the environment with foul odours. JMC is currently in the process of identifying and developing a scientific landfill site also.

4.6 Impact of Climate Change

Jamnagar, located in Gujarat, experiences significant climatic variability and is particularly vulnerable to extreme temperature events. The region faces a high frequency of hot days and nights, with increasing trends observed in recent years. Jamnagar, along with other districts in Saurashtra, has seen a notable rise in the number of extremely hot days (30+) and hot nights (18 – 24), reflecting a broader trend of rising temperatures.

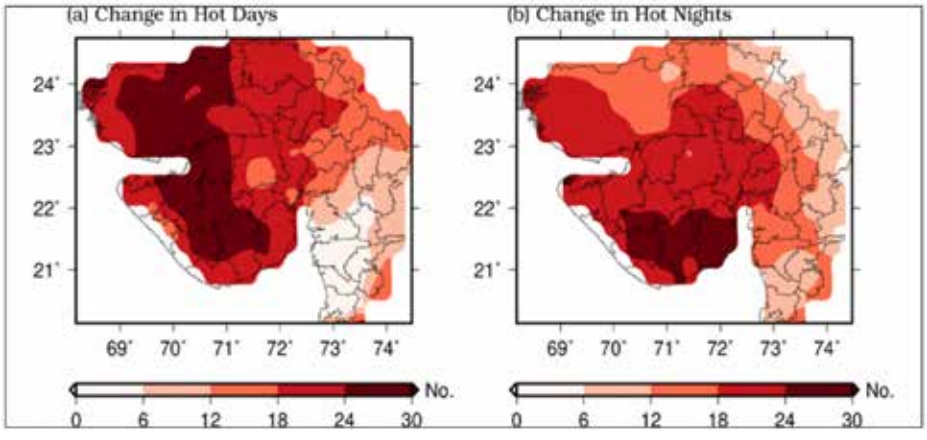


Figure 19: Annual average frequency of (a) change in the number of hot days, and (b) change in the number of hot nights for the period of 1951 – 2019.

The frequency of the number of cold days/night for Gujarat state has varied between the ranges of 36.4 to 36.7 days per year, and its change in frequency of cold days (-11.7 to 11.4) and nights (-21.8 to 4). Likewise, for Jamnagar, cold days and nights have reduced by 12 days and 16 nights, respectively. This makes the region prone to heatwaves, which are expected to become more frequent and intense due to climate change.

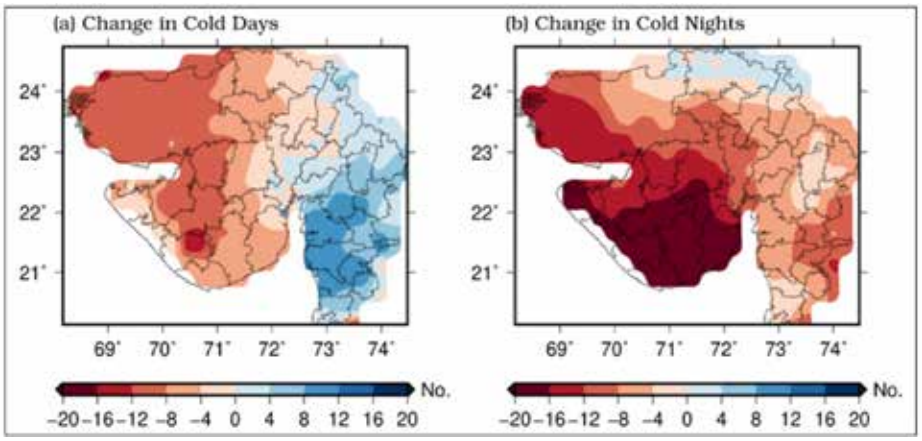


Figure 20: The annual average frequency of (a) change in cold days and (b) change in cold nights for the period of 1951 – 2019

Source : GSAPCC - 2021

The Jamnagar CAP employs multi-model climate high- resolution projections for the baseline period (1970-2014), which were validated from Indian meteorological Department (IMD) climate data of Rajkot station which is 90.5km away from Jamnagar. The temperature projections from the MRI-ESM2.0 model are found to be in good agreement with the observations.

Two climate scenarios under the Shared Socioeconomic Pathways, defined in the IPCC Sixth Assessment Report on Climate Change in 2021, are considered for this modelling. These scenarios SSP2-4.5 (Middle of the road) and SSP 5-8.5 (Fossil-Fuelled Development) are defined as:

SSP 2-4.5

The "Middle of the road" or medium pathway extrapolates the past and current global development into the future. Income trends in different countries are diverging significantly. There is a certain cooperation between states, but it is barely expanded. Global population growth is moderate, leveling off in the second half of the century. Environmental systems are facing a certain degradation. This can be understood as an update to scenario RCP4.5.

SSP 5-8.5

Fossil-fueled Development. Global markets are increasingly integrated, leading to innovations and technological progress. The social and economic development, however, is based on an intensified exploitation of fossil fuel resources with a high percentage of coal and an energy-intensive lifestyle worldwide. The world economy is growing and local environmental problems such as air pollution are being tackled successfully. It can be understood as an update of the CMIP5 scenario RCP8.5, now combined with socioeconomic reasons.

As per the IPCC, the projected temperature changes under the SSP 2 -4.5 scenario is 2.0°C by 2060 and 2.7°C (with an estimated range between 2.1°C – 3.5°C) by 2100, while it is 2.4°C by 2060 and 4.4°C (with an estimated range between 3.3°C – 5.7°C) by 2100 in the SSP 5 - 8.5 scenario. Estimated temperature changes in Jamnagar till 2100 have been projected[2] as following.

2Disclaimer : Considering Data Gap, Temperature projections are done using Gridded Dataset for location 22.5 N latitude & 71.25 E longitude

4.6.1 Temperature

Under the model MRI-ESM2.0, Jamnagar is projected to witness an average decadal temperature increase of 5.9°C by 2100 under the SSP 5-8.5 scenario and 1.6°C under the SSP 2-4.5 scenario. By 2050, the temperature is expected to increase by 1.4°C under SSP 5-8.5 and 0.7°C under SSP 2-4.5 scenarios, respectively. The projected increase in temperature till 2100 is shown in the graphs below. Peak temperatures, however, are projected to go up by 4.2°C to 5.2°C during the summer months, while the winter maximums are expected to increase by around 6.6°C as per SSP 5-8.5 scenario.

The monthly breakdown of the projected temperature increase provides a much more telling picture of the effect on Jamnagar. While the increase in temperature in the early summer months is relatively modest in both the scenarios by 2050, the increase across winter months is significantly steeper in both 2050 and 2100.

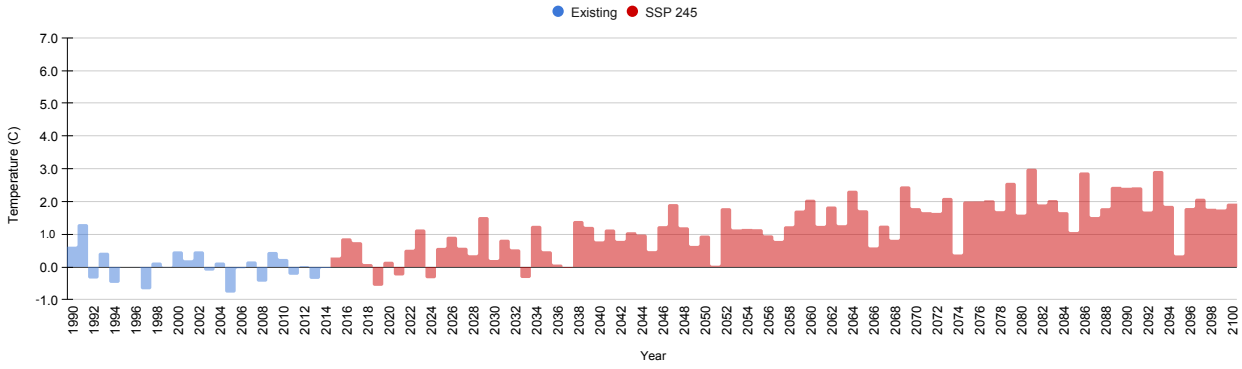


Figure 21: Projected Temperature variation till 2100 compared to average observed temperature between 1970-2014 SSP 2-4.5

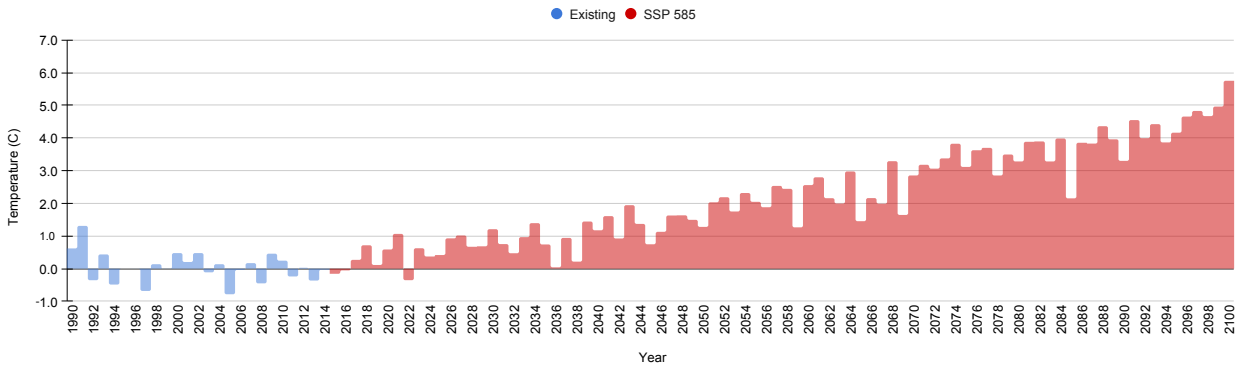


Figure 22: Projected Temperature variation till 2100 compared to average observed temperature between 1970-2014 SSP 5-8.5

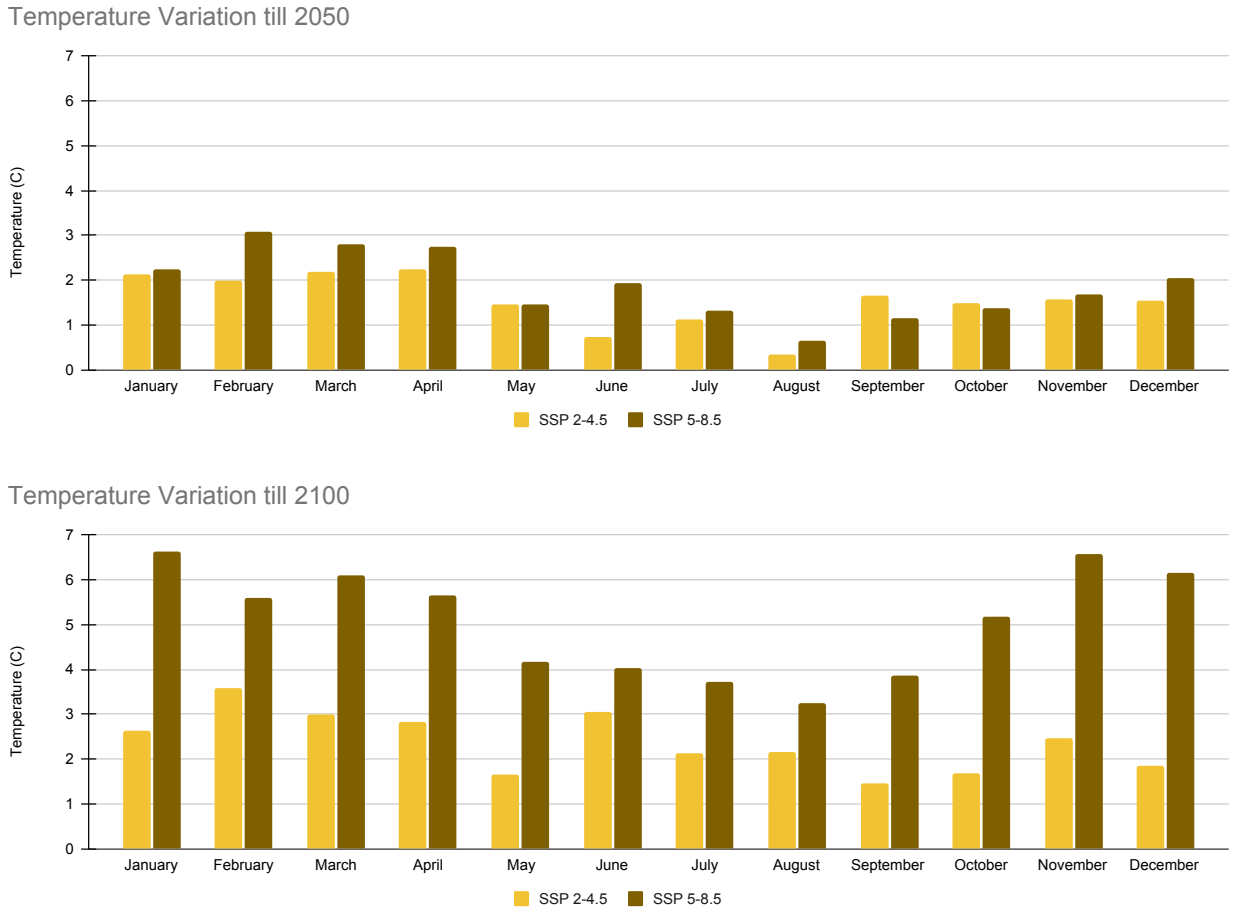


Figure 23: Monthly temperature variation projected in both scenario by A) 2050 B) 2100

4.6.2 Precipitation

Precipitation patterns in Jamnagar show variability, with an increase in extreme rainfall events. The annual average rainfall is 527 mm. About 95% of this rain is received during the monsoon season. The lowest rainfall of 36 mm was recorded in 1987, while the highest rainfall of 2114 mm occurred in 2010.

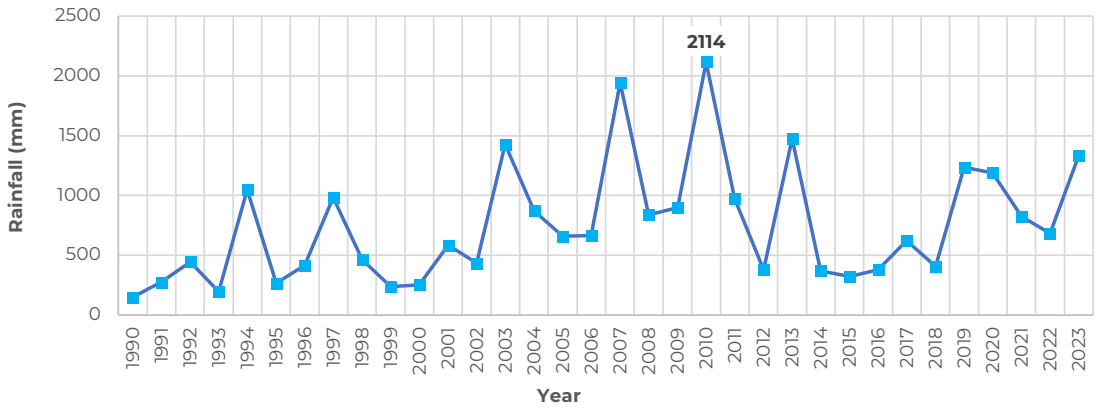


Figure 24: Annual Rainfall in Jamnagar City

Source : CDMP-2024 Report

4.7 Summary of GHG Inventory

Based on the analysis in the previous sections, a baseline emission inventory has been developed for the year 2021-22. Jamnagar's total emission for the inventory year is 8,61,532 MTCO2e. This translates to a per capita emission rate of 1.1 MTCO2e. Stationary energy accounts for more than 67% of the emissions, with Residential, LT Industries and LPG consumption contributing the most to it. The other big component of city's emission inventory is transportation emissions, which account for almost 27% of the total and are composed of petrol, diesel and CNG vehicles. The emissions from waste contribute only 6% of the total emissions which includes emissions from solid waste disposal and waste water treatment & discharge (Figure 25).

The GHG emissions for Jamnagar are projected to increase by at least 4.1 times to 26,72,086 MTCO2e by the horizon year of the plan (2050). The contribution of Residential usage, LT Industries usage, transmission losses and usage from General Lighting Purpose is expected to increase. Overall, the contribution of stationary energy is expected to increase to 76%, while the contribution of the transportation and waste sectors is expected to come down to 20% and 4%, respectively. The graphs on the following page highlight these projections and changes.

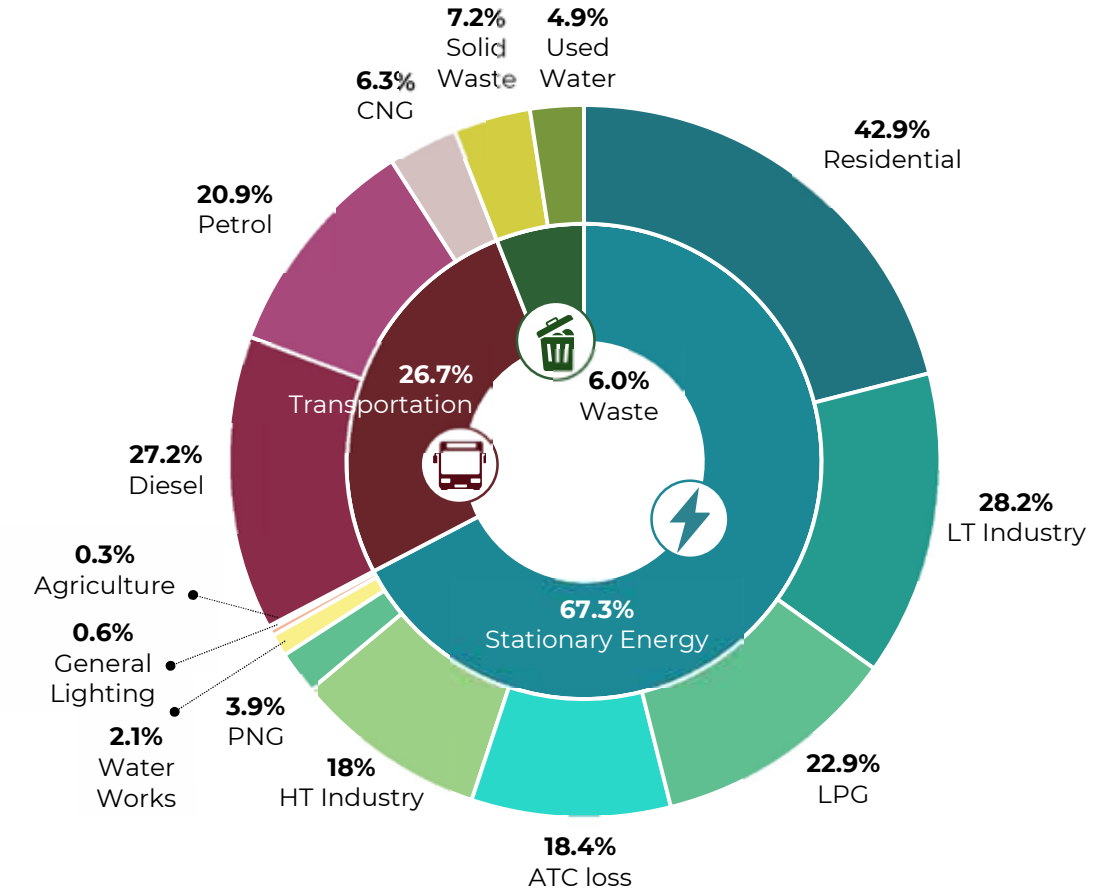


Figure 25: Baseline year GHG inventory for Jamnagar 2021-2

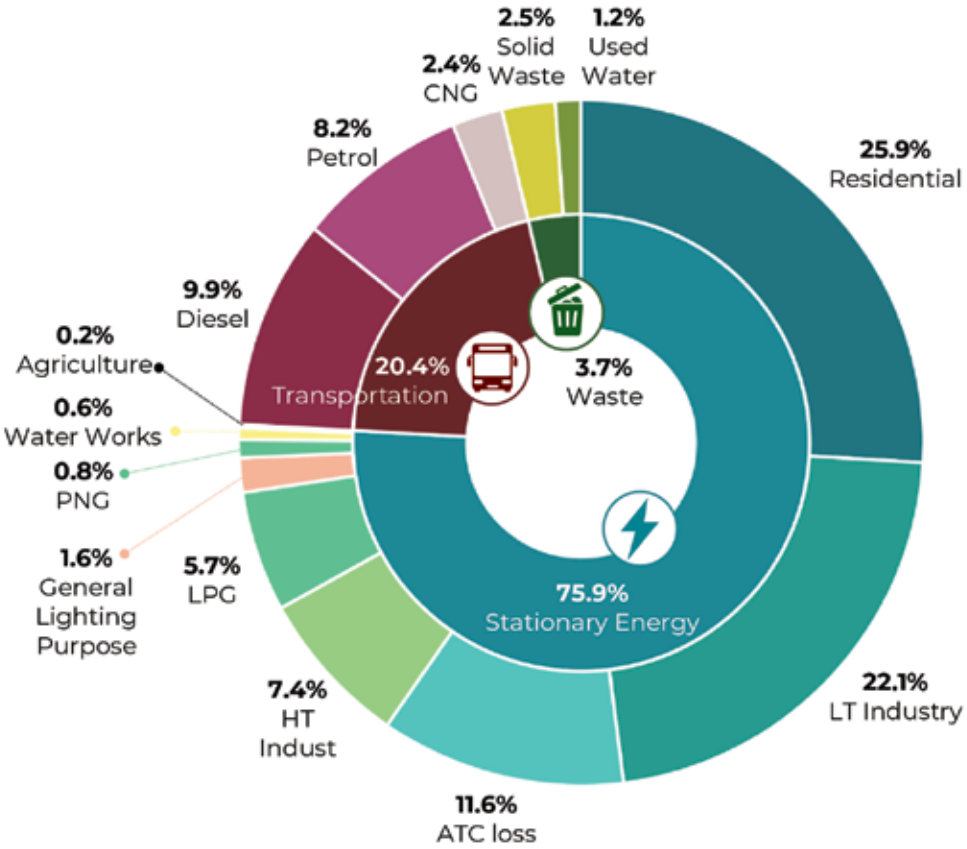


Figure 26: Horizon year GHG inventory for Jamnagar 2050

4.8 Summary of Risk Analysis

Based on the insights of the analysis presented in the previous sections, this report looks at the two main climate risks that Jamnagar is likely to face: Urban Floods and Storm Surge Hazard Risk. The risks of flooding are driven by the projected increase in rainfall intensity and challenges in watershed management. Increased tropical cyclones, along with the projected rise in sea level due to rising temperatures cause storm surges, that will damage infrastructure. Saltwater surge penetrates into groundwater, putting freshwater resources at risk and exacerbating water shortages. The specific risk profile due to these two disasters is as follows:

Urban Flood Risk: Jamnagar's flood risk is high due to its low elevation (20m MSL) and unpredictable rainfall (as detailed in 4.1.4 Disaster Resilience). The city experiences an average of 527 mm of rain annually, almost all of it concentrated in the monsoon months (June-September). This creates a risk of flooding, especially considering the historical extremes Jamnagar has faced – droughts with minimal rainfall and devastating floods with record-breaking downpours. The situation is further complicated by drainage blockages and increased runoff from hardened surfaces within the city, as highlighted in the District Disaster Management Plan (DDMP).

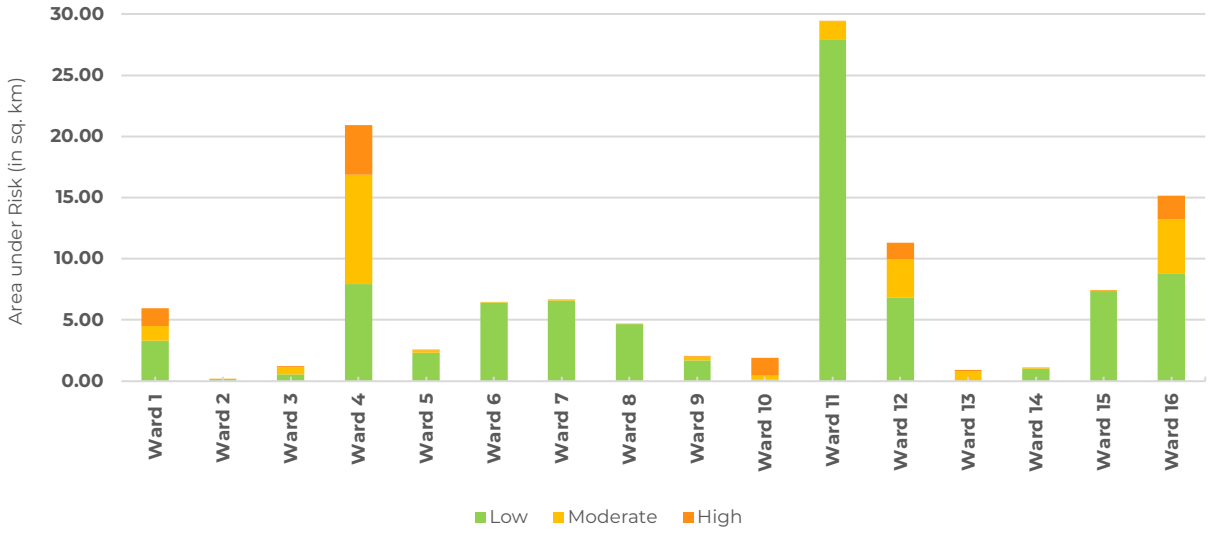


Figure 27: Ward wise Flood Risk Profile

Composite flood risk mapping identifies high risk (9%) and moderate risk (18%). These include Ward 10 at the meeting point of the Rangmati and Nagmati rivers, Ward 4 a low-lying area, and Ward 1 near Jamnagar Railway Station. Other wards with low risk (73%) that require immediate attention for settlements in the floodplain include Ward 11, 12, 15, 16.

Further, exceeding dam capacity during heavy rainfall events also contributes to riverine flooding, estimated at around 20%. Heavy precipitation in the river catchment areas (as detailed in 4.1.4 Disaster Resilience) exceeding Ranjit Sagar dam and Rangmati dam capacity caused the 2021 flash floods. These floods highlight the importance of strategic planning at district level with efficient dam management practices, upgraded drainage capacity and early warning systems. A promising solution lies in integrating overflow water with groundwater recharge systems, potentially addressing both excess water and water quality depletion.

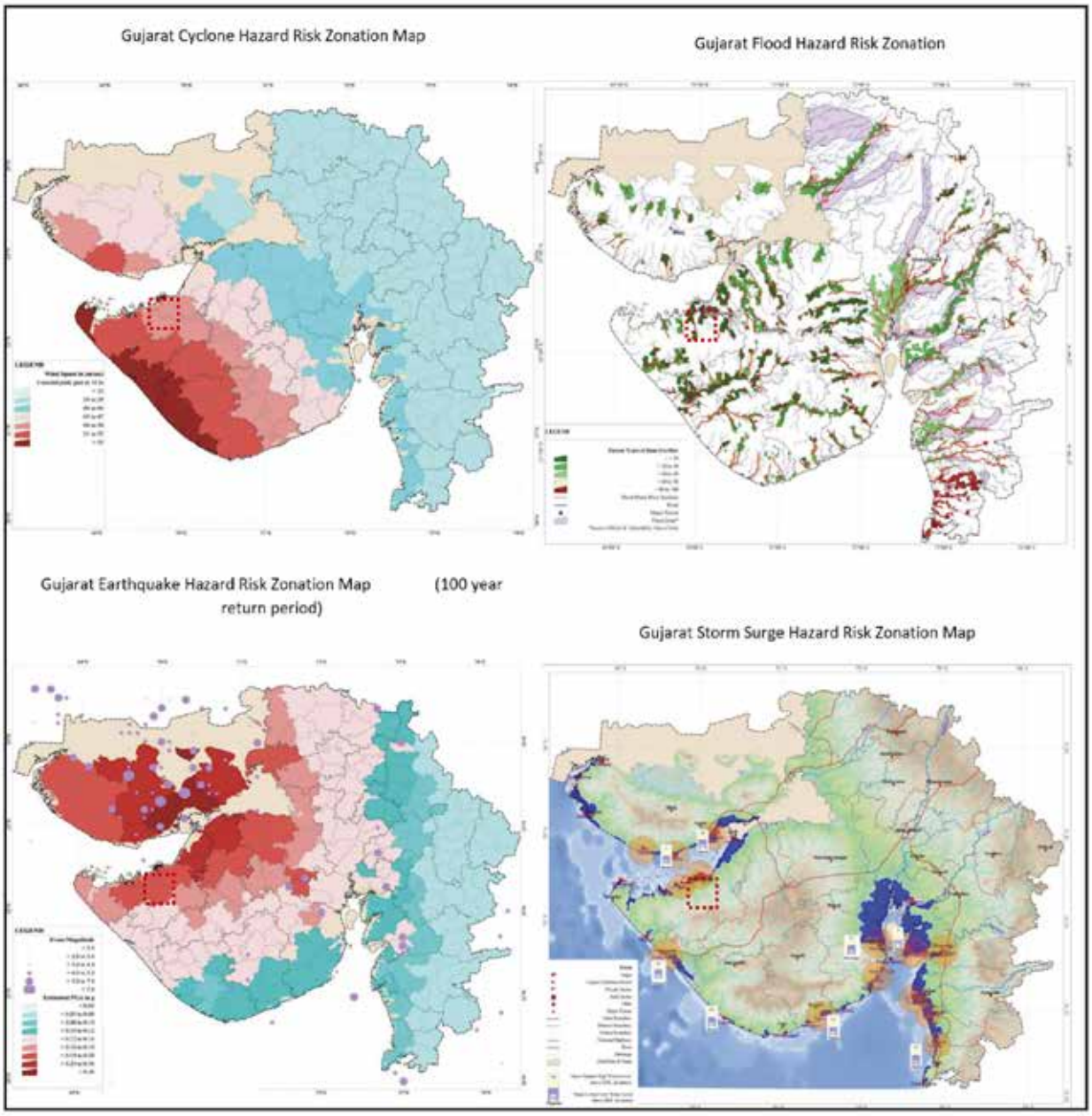


Figure 28: Jamnagar in context to Gujarat Hazard Risk Zonation Map
Source : GSDM 2016-17

Storm Surge Hazard Risk:

Jamnagar's coastal location makes it highly vulnerable to cyclones. As per GSDM study (figure 18), over 120 cyclones from the Arabian Sea have impacted the Gujarat coastal region of Saurashtra and Kachchh in the past century. The district has experienced wind speeds exceeding 55 m/sec (almost 200 km/h), with inland city areas experiencing 48-50 m/sec (173-180 km/h). Heavy storm surges cause saline water intrusion, rendering fertile land unproductive. This poses threat to city's freshwater supply and increase dependency on groundwater resources.

Investing in cyclone shelters, enforcing wind-resistant building codes as per Bureau of Indian Standards, and strengthening freshwater supply network will be vital resilient strategies for the city.

05 Recommendation

Mitigation Scenarios
Costing of Mitigation Interventions
Recommendation and Strategies

5.1 Vision of the Jamnagar CAP

The climate action plan lays down strategies and targets with a vision towards a 'Net Zero' & 'Climate Resilient' Jamnagar by 2050. The Climate Action Plan comprises two key objectives, directly addressing the twin pillars of climate action: Mitigation and Adaptation.

Net Zero By 2050 **Climate Resilient Jamnagar**

The first objective,

"Adoption of Green Power, Green Streets, Green City: crafting a sustainable blueprint for the future", lays the foundation for the collective mitigation actions of government agencies, individuals, businesses, and the community for the purpose of:

A] Decarbonizing stationary energy emissions
B] Adopting a Green Transportation Network
C] Establishing a Resource-Efficient Circular Waste Economy

The second objective,

"Foster a 'Sponge City' approach for Jamnagar, prioritizing the integration of nature-based solutions with urban infrastructure", proposes a Whole-of-Government adaptation strategy to:

D] Build Heat & Flood Resilience
E] Sustainable Water & Used Water Management
F] Environmental Health and Biodiversity

This transformative vision has been set in consultation with the public representatives, and the administration. This collective aspiration reflects Jamnagar's determination to outline a comprehensive strategy across key sectors. This strategy fosters environmentally sustainable industrial growth, promotes cleaner energy consumption, and prioritizes waste reduction. It also includes measures for managing infrastructure towards carbon neutrality, creating jobs in green sectors, and promoting public health.

5.2 Thrust Areas

Six thrust areas have been identified through which the vision set out in this Climate Action Plan is proposed to be achieved. The thrust areas are further divided into 17 intervention objectives and 38 actions. These proposals are a combination of mitigation and adaptation actions which are either policies, plans, projects, institutional mechanism or advocacy.

Decarbonize stationary energy emissions

The city's goal of decarbonizing its energy grid and transitioning to a climate-resilient future by 2050 aligns with the national target of achieving 500 GW of installed RE capacity in India by 2030. This national target includes a focus on increasing solar and wind energy sources. Similarly, the Gujarat Renewable Energy Policy (2023) also aims for a 50% RE target by 2030. This policy leverages Gujarat's significant potential for solar (36 GW) and wind (143 GW) energy generation. Given its own potential for both wind and solar resources, Jamnagar is positioned to contribute to these national and state-level goals and addresses both the supply side – increasing RE– and the demand side – improving energy efficiency (EE).

Adoption of Green Transport Network

The focus is on integrating various transport modes, encouraging public transport ridership, and promoting adoption of electric vehicles (EVs) in Jamnagar city. This shift away from car-centric infrastructure aims to establish a robust public transport network, reducing traffic congestion, emissions, and parking space demands. To achieve this, the plan emphasizes people-centric urban design, prioritizing NMT like walking and cycling, a phased transition to zero-emission private vehicles by 2050 with electrification of public buses by 2030 as a first step. Furthermore, a sustainable freight policy will promote clean fuel for light-duty trucks will strengthen the efforts.

Resource-Efficient Circular Waste Economy

The city will build upon its existing proactive waste management strategy, which includes a Waste-to-Energy plant, a Material Recovery Facility, and a Biogas Generation Facility. To further optimize these facilities, the city will prioritize source-level initiatives. This will involve implementing actions such as source segregation, organic waste composting at the neighbourhood level, construction and demolition (C&D) waste management with reuse as building material, and bioremediation of the dumpsite. Additionally, used water treatment targeted for reuse in horticulture, commercial, and industrial sectors (excluding human consumption), further upgraded to a tertiary level by 2050. Low-carbon treatment technologies could also be explored to generate energy from wastewater in the future.

Build Heat & Flood Resilience

Jamnagar will adopt the principles of 'Sponge cities' as a cornerstone of its climate adaptation strategy. This approach prioritizes a nature-based solution in Rangmati-Nagmati riverfront development, utilizing natural water retention and infiltration basins to mitigate flooding risks associated with changing rainfall patterns, water logging at various low-lying areas and limited drainage capacity due to rapid development. Parallelly, as outlined in the Gujarat's SAPCC- 2021, the city has experienced a temperature rise of 1.5°C since 1950. To combat potential heatwaves, the city will develop a comprehensive prevention strategy measures like prioritizing the well-being of vulnerable populations, implementing a cool roof policy for buildings, encouraging the development of low-carbon and climate-resilient neighbourhoods, and promoting equitable access to green spaces and healthcare facilities.

Environmental Health and Biodiversity

Jamnagar's rich biodiversity, including the Marine National Park, Ramsar-listed Khijadiya Bird Sanctuary, and vibrant marine life, face threats due to water pollution. The city will address this by activating its Biodiversity Management Committee and implementing measures to protect green cover, strengthen ecological buffers, and develop a wildlife restoration strategies.

Similarly, recognizing the multi-sectoral impact on air quality, the strategy will include sustainable practices in transportation, waste, energy, and construction to achieve a 20-30% pollution reduction by 2030. This will be achieved through public awareness initiatives, fostering community health resilience, implementing data-driven monitoring and forecasting systems, and capacity building programs.

Sustainable Water & Used Water Management

Recognising finite nature of traditional freshwater sources, Jamnagar will develop strategy focused on both curbing municipal water demand and supply while integrating used water management practices. Public awareness campaigns will promote water conservation practices and incentivizing adoption of water-efficient appliances. Additionally, leak detection and repair programs will be implemented to minimize water loss within the distribution network.

To further reduce reliance on traditional freshwater sources, Jamnagar will explore alternative water sources. This includes rainwater harvesting, treated wastewater reuse, and potentially other methods being investigated. Upgrading and maintaining the city's water distribution network will ensure efficient delivery of this diversified water supply.

5.3 Mitigation Actions

5.3.1 Overview of Actions

The 11 proposals addressing mitigation actions are divided into three main categories: Existing & Planned Actions, Ambitious Actions, and the Extended Scenario. Together, these interventions are projected to reduce emissions by 35,21,755 MTCO2e by 2050. Existing & Planned Actions are those already being undertaken by national, state, and local governments. Ambitious Actions include adopting energy efficiency in all buildings, installing rooftop solar panels, developing a multimodal public transport network, and transitioning to zero tailpipe emission vehicles. To ensure the successful implementation of these actions, IEC measures are necessary to promote resource-efficient individual behaviours aligned with Mission LiFE.

Implementing all strategies under the Ambitious Scenario can lead to 60% emission reductions from BAU Scenario. Therefore, Jamnagar must identify additional strategies to address the remaining emissions. These actions include development of On-grid Renewable energy farms, Municipal Solid waste management, efficient treatment of used water and plantation of trees to increase the carbon sink of the city.

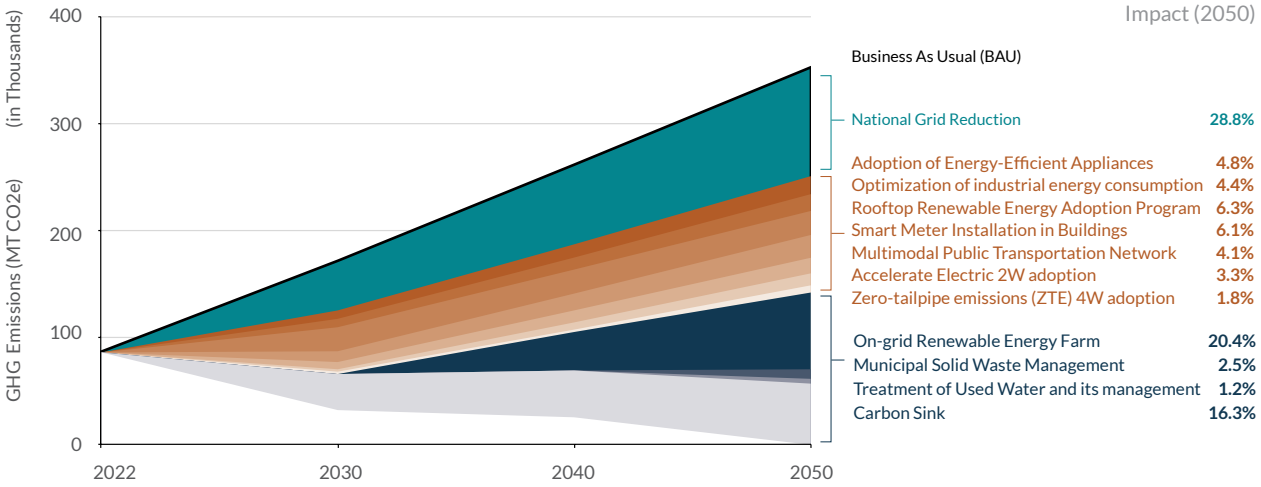
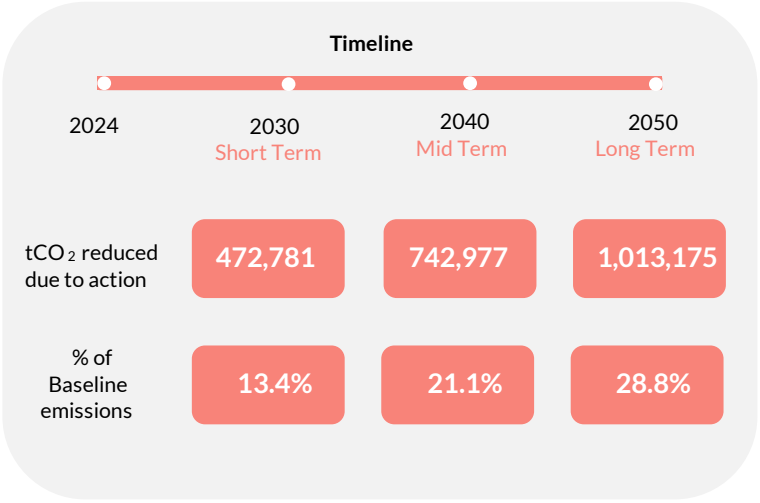
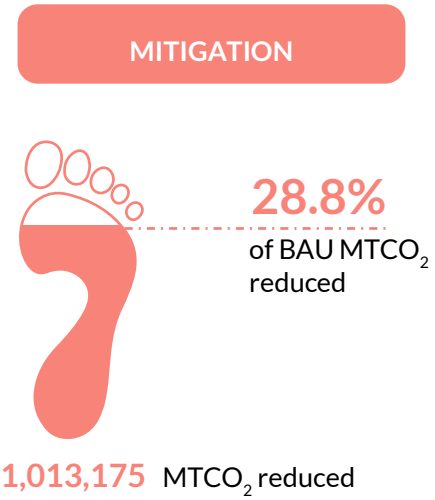


Figure 29: Summary of Mitigation actions under Jamnagar CCAP

National Grid Reduction

India has articulated ambitious national objectives for 2030, emphasising the reduction of the national grid emission intensity to 0.000477 MTCO2e/kWh. At the core of this initiative is the development of 500 GW of renewable energy seamlessly integrated into the national grid. This strategic undertaking holds considerable environmental significance, particularly in the locale of Jamnagar, where it is projected to yield a substantial reduction exceeding 28.8% of emissions.





5.3.2 Action to Implementation Strategies

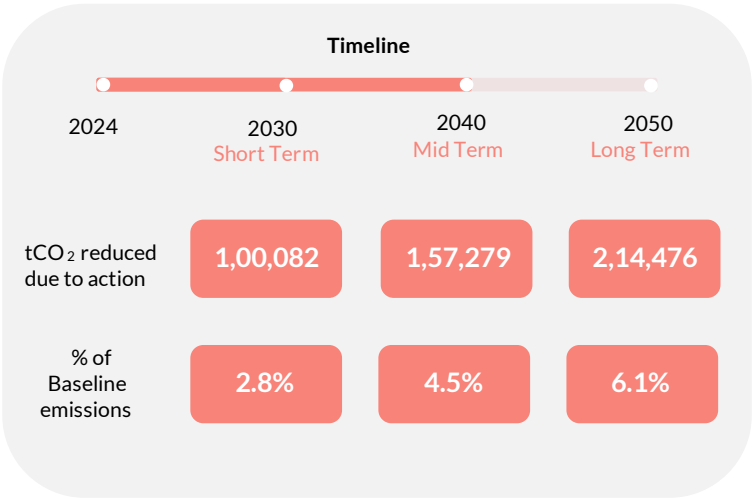
Intervention M 1: Energy Efficiency Management

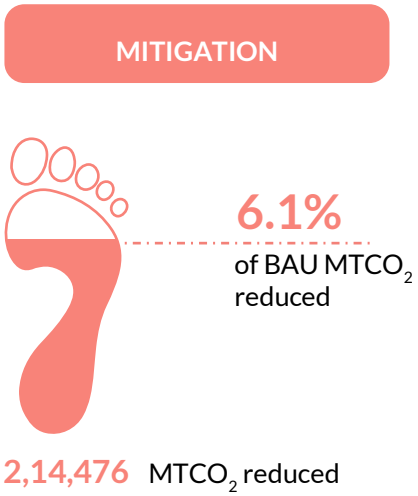
To achieve a complete transition to 100% energy efficiency, Jamnagar needs interventions across the entire energy chain – from transmission and distribution to consumption. Firstly, to reduce the current challenge of 21% Aggregate Technical & Commercial (ATC) losses, several strategy will be implemented. This include upgrading infrastructure through grid modernization and stricter measures like advanced metering and collaboration with law enforcement will combat energy theft. Finally, improved billing practices will minimize errors and ensure accurate consumption data.

Secondly, the focus will shift to the consumer level by accelerating the adoption of energy-efficient appliances and fixtures within homes and businesses, experimenting time-of-day pricing structure, and launching public awareness campaigns. These solutions combined aim to create a more efficient energy management system for Jamnagar.

02	00	02	00	00
Project	Planning	Policy	Research Study	Institutional Mechanism

Action M1.1 : Smart Meter Installation in Building





About

Installing smart meters in Jamnagar's buildings offers advantages for both residents and the city's energy system. Consumers benefit from real-time energy usage data, enabling them to identify areas for saving on electricity bills. Smart meters also eliminate manual meter reading errors and provide greater convenience. For the city, smart meters can lead to reduced overall energy consumption due to empowered consumers making informed choices. Additionally, real-time data can optimize grid operations and minimize energy losses. Smart meters also facilitate the integration of renewable energy sources and contribute to Jamnagar's environmental goals by lowering greenhouse gas emissions.

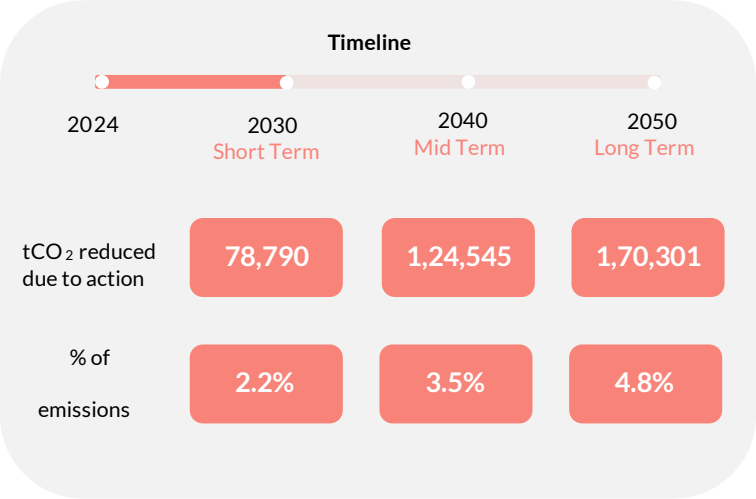
Description	Aspect	Responsible Agency
1. Smart Meter Installation in Buildings (Residential & Non-Residential) ● Collaboration and Partnerships: ❖ Partner with building management companies, resident associations, and industry groups to facilitate access to buildings, streamline communication, and ensure smooth implementation. ❖ Collaborate with manufacturers and retailers to secure efficient procurement and installation of smart meters at competitive rates. ● Phased Implementation: ❖ Prioritize installation in high-consumption areas and buildings (such as Housing Society, Commercial complex) with large energy footprints to maximize initial impact. ❖ Conduct pilot programs in select areas to test the technology, gather consumer feedback, and refine implementation strategies before wider rollout. ● Consumer Incentives: ❖ Offer initial 200 units of electricity at zero cost, to nudge consumers to shift to smart meter and also offset the installation cost ❖ Introduce tiered pricing plans based on real-time energy usage data, and initiate Demand Response Programs, where consumers are rewarded for reducing their electricity consumption during peak hours. ● IEC Activities: ❖ Develop and implement public awareness campaigns to educate consumers about the benefits of smart meters, including cost savings, environmental impact reduction, and improved energy management.	Project Medium Term	*PGVCL*

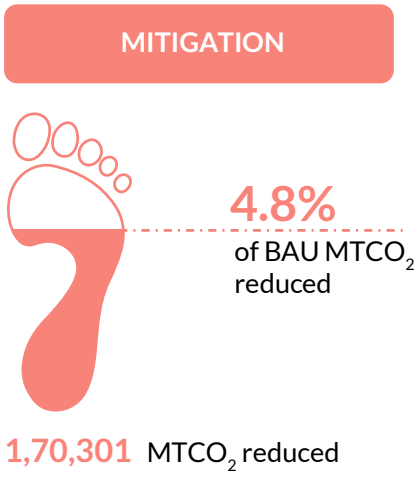
Case study : PAT System implementation in Pune

The Perform, Achieve, and Trade (PAT) scheme, implemented by the Bureau of Energy Efficiency (BEE) under the National Mission for Enhanced Energy Efficiency (NMEEE), is a flagship program aimed at improving energy efficiency in energy-intensive industries across India. Pune, a prominent industrial hub, stands to benefit significantly from the implementation of the PAT system. It sets specific energy consumption (SEC) reduction targets for designated consumers (DCs) in energy-intensive sectors. These targets are defined over a three-year cycle, and industries that exceed their targets can trade the excess energy savings as Energy Saving Certificates (ESCerts) with other industries that fall short of their targets.

Description	Aspect	Responsible Agency
2. Addressing Exceeding Connected Load: Implement a tiered penalty structure for exceeding the sanctioned connected load capacity. ● Without Smart Meter System: ❖ Begin with clear warnings for first offenses. ❖ Progressively escalate to higher penalty charges (e.g., 5 to 10 times the connected load charge) for persistent violations. ● With Smart Meter System: ❖ Tier 1: Issue reminders and notifications when exceeding connected load for short durations (e.g., 8 hours) to encourage immediate corrective action. ❖ Tier 2: Implement a moderate penalty (e.g., 25% surcharge) for exceeding connected load for a longer duration (e.g., consecutive 2 days) to deter repeated offenses. ❖ Tier 3: Reserve a higher penalty (e.g., 50% surcharge) for repeated or extensive exceeding of connected load, targeting serious and persistent violations.	Project Medium Term	*PGVCL*

Action M1.2 : Accelerate Adoption of Energy-Efficient Appliances and Fixtur





About

Promoting the adoption of energy-efficient appliances and fixtures within residential and commercial spaces will create a future with dual benefits. Residents can expect to experience direct financial advantages through lower electricity bills. This stems from the inherent ability of these appliances to significantly reduce energy consumption (up to 63% in some cases). This translates to cost savings with extended lifespans that requires less maintenance compared to traditional counterparts, resulting in long-term economic advantages.

From the perspective of Jamnagar's energy system, widespread adoption of these appliances will translate to a significant reduction in overall energy demand. This lessened strain on the power grid will reduce the need for investment in additional power generation infrastructure. Furthermore, improved grid efficiency due to lower demand will minimize energy losses during transmission and distribution.

Recommendations

Description	Aspect	Responsible Agency
1. Promote Energy-Efficient Appliance Adoption ● Brushless Direct Current Motor (BLDC) Fans: Offer a subsidy of ₹ 1,200 per BLDC fan, with a maximum of 2 fans subsidized per consumer. BLDC fans can offer a substantial energy reduction of up to 63%. ● LED Lighting: Implement incentive programs to promote the adoption of LED lighting, which offers substantial energy savings compared to traditional incandescent bulbs. ● 5-Star Air Conditioners: Encourage the purchase of 5-star rated air conditioners, the most energy-efficient category available in India.	Policy Short Term	*PGVCL* *JMC*
2. Financial Sustainability ● Partner with companies interested in fulfilling their CSR obligations by contributing to local sustainability initiatives. ● Explore innovative financing models such as microloans or pay-as-you-save schemes to make energy-efficient appliances more accessible for low-income households.	Project Short Term	*PGVCL*

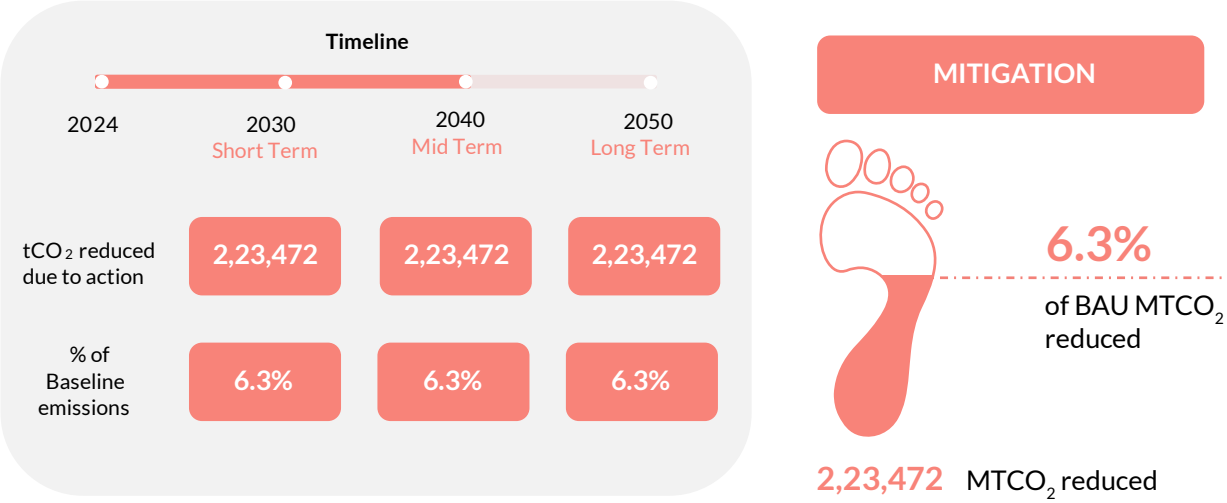
Type	Wattage (kW)	Energy use per day (kWh)	Energy use per year (kWh)	Cost per unit (INR/ kWh)	Total Cost (INR)	Savings (INR)
Conventional Fans	0.075	1.125	411	6	2,464	
BLDC Fans	0.03	0.45	164	6	986	**1,478**

Figure 30: Energy consumption and savings: Conventional Fans vs BLDC Fans
(Assumption: Ceiling fans run regularly for 15 hours per day for 365 days)

Intervention M 2: Increase the share of renewable energy (RE) to 80% by 2050

Jamnagar's goal of reaching 80% RE by 2050 will be achieved through a comprehensive plan. This plan prioritizes diversification, focusing on expanding solar power (large-scale photovoltaic plants and rooftop installations) and wind farms. To enable this transition, the city will invest in smart grid technology alongside regulatory policies that accelerate the adoption of RE sources. These policies will include stricter RE purchasing obligations, attractive feed-in tariffs to incentivize private investment, net metering policies, and streamlined permitting processes. PPP model and skill development programs will be essential for attracting investment and building a skilled workforce to support this significant shift towards a more sustainable energy future.

Action M2.1 : Sector-Specific Rooftop RE Adoption Program by 2x



About

This ambitious program aims to double rooftop RE adoption in Jamnagar with a potential capacity of 282 MWp (to cover the present built-up area). A city-wide roadmap for distributed RE will be a key driver, including a rooftop solar potential assessment, streamlined permitting processes, and the integration of RE requirements into building codes. Exploring on-site generation options like rooftop solar panels and wind turbines for existing buildings will be prioritized.

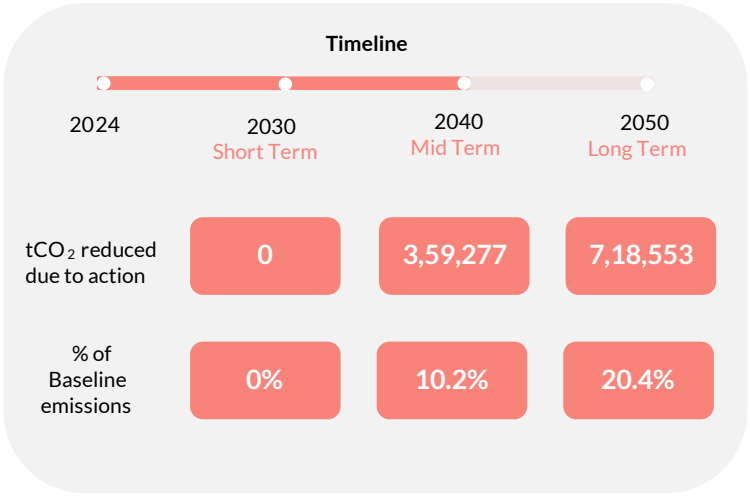
By 2030, the city's own operations (JMC and government agencies) will transition to 100% RE, utilizing rooftops and land for solar and wind installations. Additionally, a program to replace all public lighting with RE alternatives by 2040 is planned.

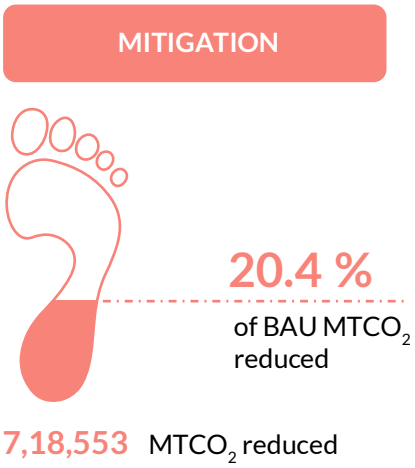
Residents will benefit from a suite of measures to encourage rooftop solar adoption, including financial incentives, community solar projects, and public awareness campaigns. Businesses and industries will enjoy a net metering policy allowing excess solar power to offset electricity bills, while power purchase agreements will facilitate access to clean energy at competitive rates. Technical assistance for feasibility studies and system design will be provided to consumers, making rooftop RE a viable and attractive option for all sectors in the city.

Recommendations

Description	Aspect	Responsible Agency
1. Reduce dependence on grid-supplied electricity: ● Develop a roadmap for distributed renewable sources in the city by, ❖ Documenting city-level rooftop solar potential, ❖ Making the information on installation and information regarding savings accessible to users, ❖ Incentivizing RE-based power through open access and integrating RE systems within building by-laws to cover 25% requirement. ● Explore and invest in the feasibility of on-site renewable energy generation, such as rooftop solar panels or small-scale wind tulip turbines, for suitable existing buildings.	Research Study Short Term	*PGVCL* *JMC*
2. Municipal and Public Infrastructure: ● Ensure that by 2030, 100% of the electricity used by JMC and other government agencies comes from renewable sources. Assess the potential of land and rooftop space to install solar panels and small-scale wind tulip turbines. ● Implement a program to replace all general lighting systems including streetlights, public space lighting, public institute with RE-powered alternatives by 2040	Policy Short Ter	*JMC*
3. Residential Sector: ● Financial Incentives: Offer subsidies or rebates, specifically for residential rooftop solar installations. Leverage existing programs like 'PM Surya Ghar: Muft Bijli Yojana' that cover up to 40% of the cost of solar panels. ● Community Solar Programs: Explore the feasibility of developing community solar projects where residents can subscribe to shared solar installations. ● IEC Activity: Conduct public awareness campaigns and educational programs to promote the benefits of rooftop solar for residents.	Project Short Term	*PGVCL* *JMC*
4. LT & HT Connections (Industries, Businesses and Institutions): ● Net Metering Policy: Implement a net metering policy allowing industries and businesses to offset their electricity bills by feeding excess solar power back to the grid. ● Power Purchase Agreements (PPAs): Facilitate PPAs between solar power developers and HT consumers, enabling them to purchase clean energy at competitive rates. ● Technical Assistance: Provide technical support to consumers for feasibility studies, system design, and installation of rooftop solar systems.	Policy Medium Term	*PGVCL* *GEDA* *GIDC*

Action M2.2 : On grid 2 x 350 MW Renewable energy Farm





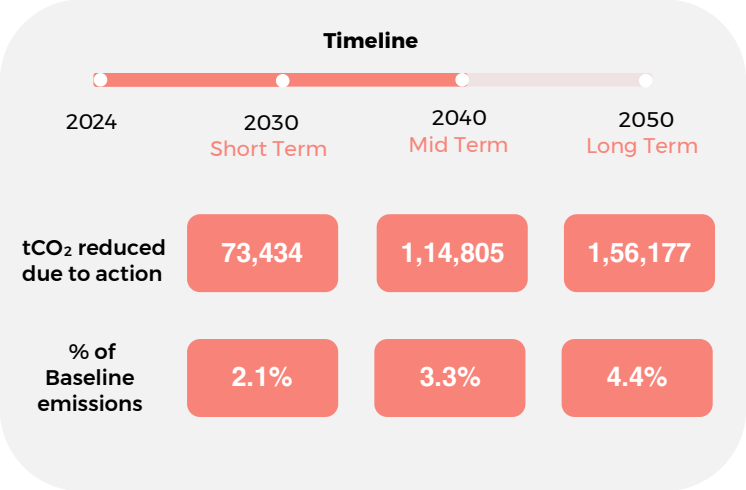
About

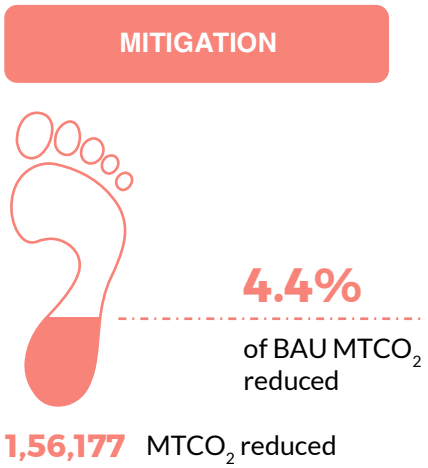
The city currently utilizes grid-supplied electricity, and this initiative focuses on two key areas: developing large-scale renewable energy farms and establishing a dedicated team to spearhead city-wide renewable energy efforts. By relying on local, renewable sources, the city reduces vulnerability to global fossil fuel price swings and disruptions, fostering independence. Additionally, construction and operation of these farms will create local jobs and long-term cost savings for residents and businesses through reduced reliance on expensive fossil fuels.

Recommendations

Description	Aspect	Responsible Agency
1. Large-Scale RE Farms (2 x 350 MW): ● Explore the feasibility of establishing a 350 MW wind farm. Suvarda village near Ranjit Sagar Dam, is one of the potential sites recommended by Gujarat State Petroleum Corporation Limited report on 'Feasibility report for the proposed 100 MW wind power project in Gujarat'. Conduct a comprehensive feasibility study to assess technical viability, economic feasibility, and environmental impact. ● Identify a suitable location for a 350 MW solar power plant and conduct a similar feasibility study.	Research Study/ Project Medium Term	*JMC*
2. Establish an 'RE Cell' in JMC in collaboration with PGVCL: ● Facilitate city-wide implementation of renewable energy and energy efficiency initiatives. Coordinate with government agencies, research institutions, and private stakeholders. ● Develop strategies to ensure equitable access to clean energy solutions for low-income groups. ● Collect and analyse benchmarking data to track progress and identify areas for improvement. Encourage businesses to report annual RE generation and consumption data for annual progress tracking.	Institutional Mechanism Medium Term	*JMC*

Action M2.3 : Optimization of industrial energy consumption





About

Jamnagar aims to cut industrial energy emissions of BAU scenario by 5% by 2050. RE integration and standardized energy audits (based on consumption) will be key. These ISO-compliant audits will identify efficiency areas and track progress towards a cleaner industrial sector.

Recommendations

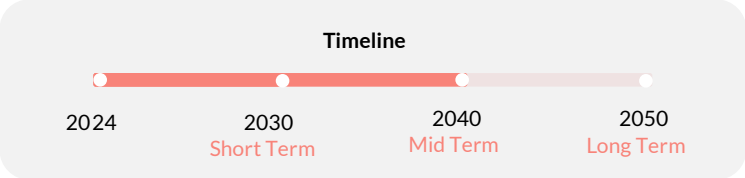
Description	Aspect	Responsible Agency
1. Study on Renewable Energy Integration: A collaborative study by PGVCL and GIDC will explore the feasibility and benefits of integrating renewable energy sources into industrial operations.	Research Study Short Term	*PGVCL* *GEDA* *GIDC*
2. Implementing a Cyclical Energy Audit Program: ● Industrial units will undergo mandatory energy audits based on their electricity consumption levels. ❖ HT users (above 100 kW) : Every 3 years ❖ LT users (below 100 kW) : Every 5 years ● All energy audits will adhere to established international standards for quality and consistency: ❖ ISO 50001:2018 - Energy Management Systems ❖ ISO 50002:2014 - Energy Audits requirements ❖ ISO 50003:2021 - Energy Management Systems (bodies providing audit and certification	Policy Medium Term	
3. IEC Activity, Public awareness campaigns and educational programs ● Reward industrial facilities demonstrating exceptional achievements in energy efficiency and sustainability	Advocacy Short Term	

Intervention M 3: Adoption of Green Design Building Regulations and Programs

Jamnagar's growing urban development necessitates a focus on building-level energy efficiency. The 43% share of existing energy consumption within the city's buildings highlights the need for strategic action. Implement green building regulations aligned with the Energy Conservation Building Code (ECBC), retrofit accelerator programs, providing incentives and technical support are the key steps to encourage widespread adoption of green building practices.

02	00	03	02	01
Project	Planning	Policy	Research Study	Institutional Mechanism

Action M3.1 : Building-Level Energy Efficiency through Enhanced ECBC Compliance



MITIGATION

About

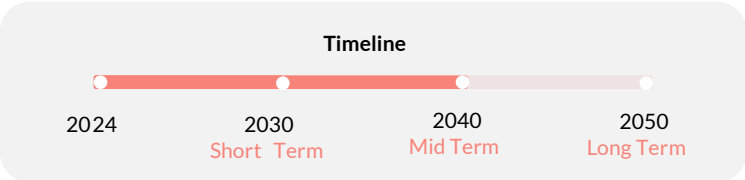
The ECBC establishes minimum energy performance standards for building elements like walls, windows, lighting systems, and mechanical equipment. These standards directly impact a building's overall energy consumption. By implementing stricter enforcement mechanisms and establishing a dedicated ECBC cell within the JMC, Jamnagar can leverage the code's effectiveness to achieve significant reductions in building energy demand. This will lead to lower electricity costs for residents and businesses, while contributing to a cleaner environment and a more sustainable future for the city.

Recommendations

Description	Aspect	Responsible Agency
1. City-Level Measures: ● Enhancing Building Codes: ❖ Mandate compliance with ECBC for all new construction building approvals and major renovations. ❖ Establish a dedicated ECBC/Green Building Cell within the JMC at the city level. This cell will provide technical support, training, and guidance on green building practices. Additionally, ward-level committees can be formed to facilitate implementation and address local concerns. ● Benchmarking systems and O&M Efficiency: ❖ Implement a system for regular energy performance benchmarking for all buildings by 2030. This will involve collecting and analysing energy consumption data to identify areas for improvement. ❖ Mandate the installation of Building Energy Management Systems (BEMS) in all buildings. BEMS continuously monitor and optimize building energy use, leading to significant energy savings. ❖ Develop and promote guidelines for energy-efficient operation and maintenance practices that can cover aspects like lighting schedules, HVAC system optimization, and water conservation measures. ● Voluntary Certifications: ❖ Encourage the adoption of voluntary green building certifications like LEED or IGBC standards. These certifications provide a framework for achieving high levels of sustainability in building design and construction	Institutional Mechanism / Policy Medium Term	*JMC – TPVD*

Description	Aspect	Responsible Agency
2. Existing Building Retrofitting: ● Retrofit Accelerator Program: ❖ Conduct a comprehensive retrofit program considering factors like building type, ownership structure, and cost-effectiveness to identify and prioritize existing building retrofitting projects (such as government school, university) ● Technology Upgrade: ❖ Mandate the gradual transition to energy-saving technologies such as replacing traditional lighting with LED fixtures, upgrading HVAC systems to improve efficiency, and installing water-efficient appliances.	Project Short Term	*JMC – TPVD*
3. New Building Design: ● Green Building Codes: Enforce mandatory green building design codes for all new constructions. These codes should incorporate, ❖ Passive Design Strategies: Promote building orientation, natural ventilation, and daylight harvesting to minimize reliance on mechanical heating, cooling, and lighting systems. ❖ High-Performance Materials: Mandate the use of energy-efficient building materials and envelope systems that provide superior thermal insulation, reducing energy demand for climate control. ❖ Sustainable Water and Waste Management: Integrate practices like rainwater harvesting, greywater recycling, and efficient wastewater treatment systems into new building designs.	Policy Short Term	*JMC – TPVD*
4. IEC Activity: ● Thermal Comfort Guidelines: ❖ Collaborate with architects, planners, and academic institutions to develop thermal comfort guidelines for various building types in Jamnagar. This should include specific considerations for low-income housing and multi-story buildings to ensure these guidelines are accessible and relevant to the city's context. ❖ Integrate these thermal comfort guidelines into city development plans, urban design strategies, and land-use schemes to promote their adoption in new construction projects. ● Public Resource Guide: ❖ Develop a publicly accessible resource guide available in English and Gujarati. This guide should outline best practices for incorporating passive design strategies in various building types. Additionally, it can showcase case studies of successful green building projects within the city to inspire and educate residents.	Research Study/ Advocacy Short Term	*JMC – TPVD*

Action M3.2 : Achieving Carbon Neutrality in Government and Municipal Buildings



MITIGATION

About

Government and municipal buildings represent a crucial starting point for achieving carbon neutrality within the city. By setting a strategic example for its citizens, these buildings can demonstrate a shift towards zero-carbon building practices. City-wide programs, such as mandatory green building certifications or financial incentives for energy efficiency upgrades, can be implemented based on these learnings.

Recommendations

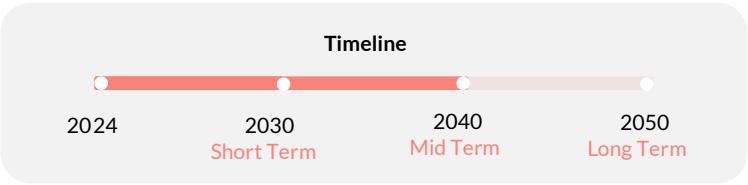
Description	Aspect	Responsible Agency
1. Energy Efficiency Retrofits: ● Conduct comprehensive energy audits, aligned with ECBC compliance standards, for all municipal buildings and infrastructure. ● Based on the audits, implement energy efficiency upgrades and integrate RE sources by 2030.	Research Study Short Term	*JMC*
2. Low/Zero Carbon Building Showcase Project: ● Develop a Zero Carbon Building (ZCB) demonstration project (e.g., municipal building, bus station, hotels, EWS housing). ● This project will serve as a public example of best practices in sustainable building design, construction, and operation.	Project Medium Term	*JMC – Project & Planning*
3. Green Building Certification for All (Fees Covered by JMC): ● Mandate Green Building Certification for all existing and new government buildings, including 50 new Pradhan Mantri Awas Yojana (PMAY) residential units. ● To incentivize participation, the JMC will cover the associated certification fees.	Policy Medium Term	*JMC – TPVD*

Intervention M 4: Reduction of industrial emissions and effluents

Jamnagar industrial facilities generate significant water and air pollution through emissions and effluents. These pollutants harm human health (respiratory issues, water contamination) and damage ecosystem. By implementing stricter regulations and cleaner technologies, industries can minimize their environmental footprint.

06	03	01	02	00
Project	Planning	Policy	Research Study	Institutional Mechanism

Action M4.1 : Prevent Untreated Industrial Wastewater Discharges into River



MITIGATION

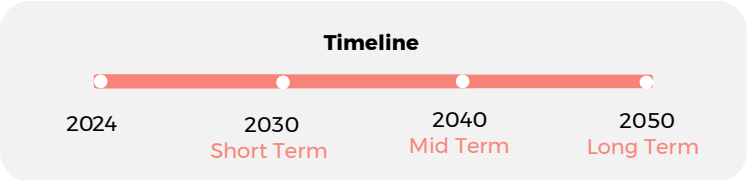
About

Untreated industrial wastewater pollutes rivers with harmful chemicals and reduces DO & BOD levels, threatening aquatic life and drinking water sources. Jamnagar prioritizes preventing these discharges from industries by implementing mandatory wastewater treatment plants and monitoring groundwater contamination to safeguard its vital waterways for future generations.

Recommendations

Description	Aspect	Responsible Agency
1. Expanding Wastewater Treatment Capacity: ● Effluent Treatment Plants (ETPs) mandated to install and operate in all industrial units within GIDC areas. These on-site plants will treat wastewater to meet established discharge standards. ● Centralized Effluent Treatment Plant (CETP) at city-level to handle wastewater from smaller industries or those lacking the space for on-site treatment before discharged into the river.	Policy/ project Medium Term	*JMC* *GIDC* *GEDA*
2. Groundwater Study in GIDC Areas to assess potential soil and groundwater contamination by pollutants like Nitrogen Oxides (NOx), a key concern identified by the Central Ground Water Board (CGWB) report (2019).[1]	Research Study Medium Term	

Action M4.2 : Optimizing Brass Industries with Improved Combustion & Energy Conservation



MITIGATION

About

Jamnagar's brass industry current practices lead to wasted fuel, excess emissions, and high energy consumption. To remain competitive and environmentally responsible, a mandatory policy program promoting improved combustion technology, energy-efficient upgrades, and responsible fuel management is crucial.

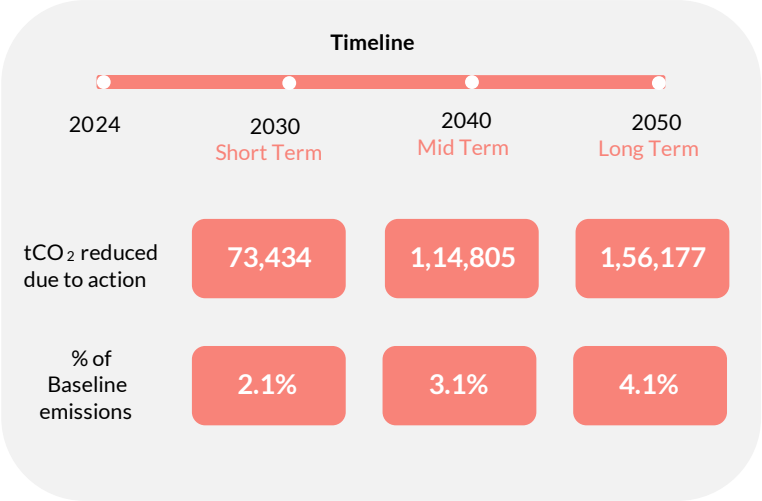
Recommendations

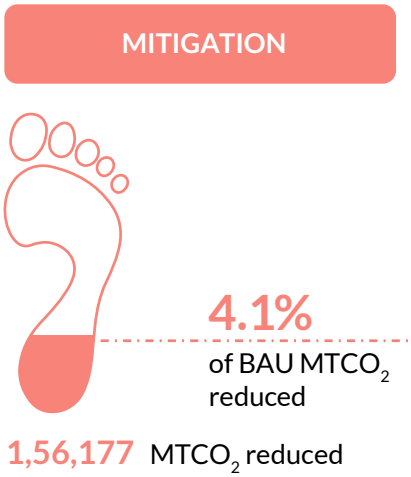
Description	Aspect	Responsible Agency
1. Enhancing Furnace Combustion: ● Precision Combustion: All reheating furnaces are to be equipped with advanced air-fuel control systems. ● Minimizing Heat Loss: ❖ Furnace Zone-Based insulation redesign using high-quality materials like Hysil sheets and ceramic blankets to replace inadequate firebrick linings. ❖ Install Temperature Gauges in all reheating furnaces to enable precise temperature control and prevent unnecessary heating.	Policy Medium Term	*GIDC* *GEDA*
2. Furnace System Efficiency: ● Replace conventional coal-fired furnaces with gas-fired rotary furnaces to increase efficiency 2x times. ● Replace conventional oil-fired pit furnaces with energy-efficient oil-fired furnaces. ● Replace conventional under-loaded motors with suitable rating energy-efficient motors in hydraulic presses, to reduce wasted electricity consumption. ● Install timers in cooling towers to regulate cooling tower fan operation based on water temperature, optimizing energy usage. ● Monitoring of Carbon Black Feed Stock (CBFS) supply as furnace oil for industry	Policy Long Term	

1https://gwilws.gujarat.gov.in/web/public/content/cms.portal.document/829/document/GW%20Scenario%20of%20Gujarat.pdf)

Intervention M 5: Multimodal Public Transportation Network

Jamnagar is currently implementing certain initiatives within the transport sector, as 26.7% of the total emissions generated in the city (amounting to 0.23 million tonnes CO2e) is from road transport. The actions proposed within the CAP, integrates climate lens with multimodal public transportation network integration (PT, IPT, cabs, cycle). It aims to create a seamless user experience through physical transfer hubs, unified ticketing systems, and real-time information sharing across all modes. Multimodal networks offer potential benefits including increased accessibility, reduced traffic congestion and associated air pollution, and enhanced mobility choices for citizens.





05	02	00	02	00
Project	Planning	Policy	Research Study	Institutional Mechanism

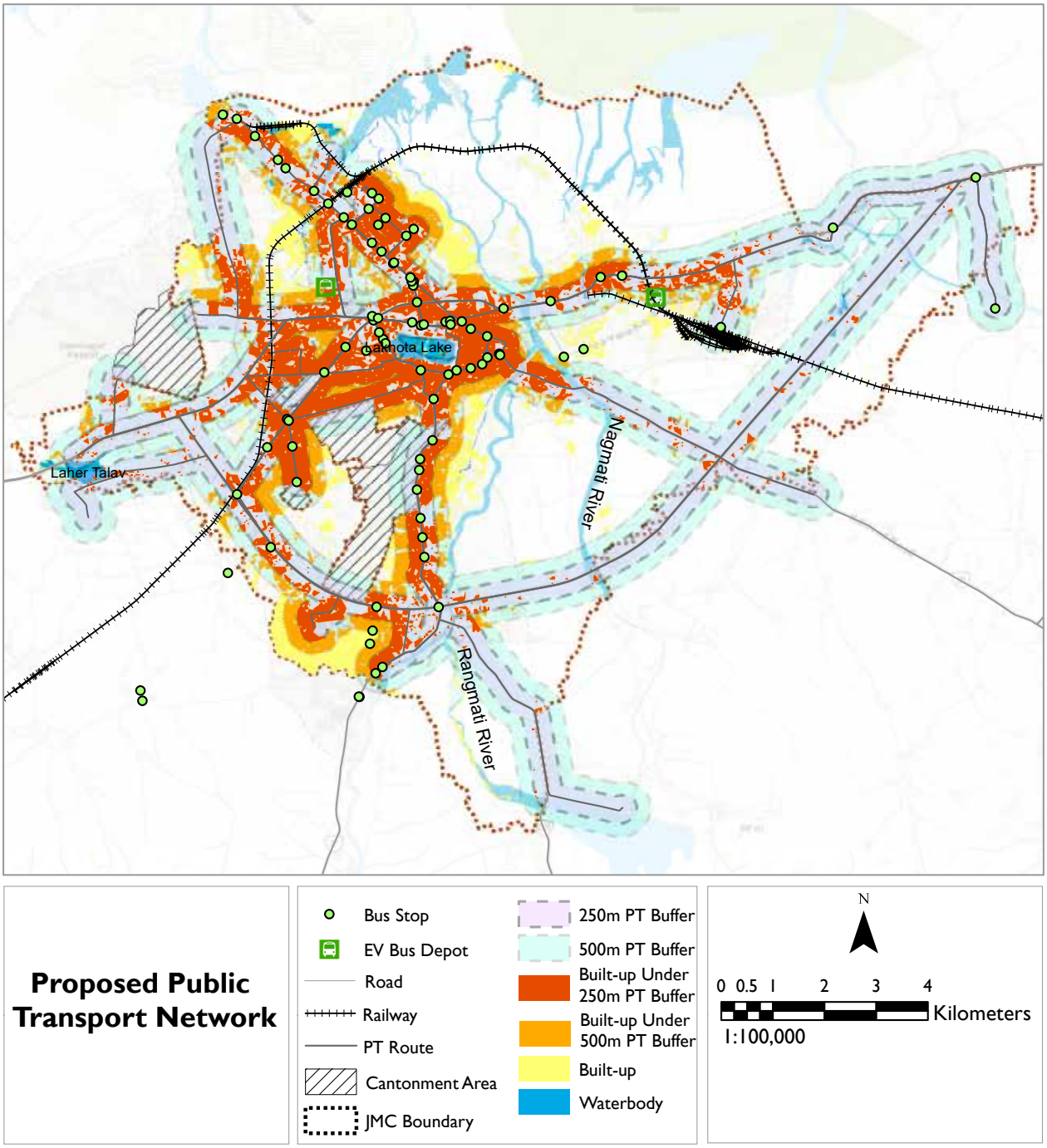
Action M5.1 : Encouraging Public Transport Use and Route Optimization

According to SLB standards[2], an efficient bus-based public transportation system in cities with a population between 1 and 0.5 million requires 30 buses per lakh (100,000) population. To achieve this level of service and encourage residents to prioritize public transportation, Jamnagar would need a total of 498 intra-city buses by 2050. This increase would improve service quality, bus frequency, and reduce passenger wait times.

Recommendations

Description	Aspect	Responsible Agency
1. Phase 1 : Immediate Improvements ● Fare Accessibility Programs: Implementation of discounted fare programs for targeted groups, such as students, senior citizens, and low-income individuals, will incentivize ridership and promote inclusivity. ● Route Optimization : Initial route optimization considering first-and-last mile connectivity. This may involve extending existing routes with a buffer zone approach (250 meters and 500 meters radius) to improve accessibility, as shown in Map 10. ● Enhanced Passenger Experience: Upgrades to existing bus stops and stations will include improved waiting facilities (seating, weather protection), real-time arrival information displays, and enhanced security measures. These improvements will create a more comfortable and reliable experience for existing riders. ● Data-Driven Decision Making: Data collection and analysis of public transportation ridership patterns will commence to understand usage patterns and identify areas for improvement. This data will be crucial for future planning phases. ● Dedicated Commuter Helpline: A dedicated commuter helpline will be established to address passenger concerns regarding service, safety, and offer feedback mechanisms. This will foster trust and encourage continued ridership.	Project Short Term	*JMC*
2. Phase 2 : System Integration and Optimization ● Integrated Ticketing System: Integration of the National Common Mobility Card (NCMC) system across all public transportation and intermediate public transport modes will streamline ticketing and encourage multi-modal journeys. ● Express Bus Services: Introduction of express routes with limited stops will cater to commuters who prioritize speed for faster long-distance travel.	Project Medium Term	

[2]Ministry of Urban Development (MoUD) Service Level Benchmarks (SLB) : https://mohua.gov.in/upload/uploadfiles/files/Service_level.pdf



Map 10: Proposed Public Transport Network

Action M5.2 : Improving Last-Mile Connectivity with Smart IPT and NMT

IPT i.e. autorickshaws and cabs, supplementing public transport and providing door-to -door as well as last-mile connectivity. The RTO GJ-10 has registered 17,549 Three Wheeler (Passenger) till today, out of which 73% are clean-fuel (CNG, EV) based share.

NMT i.e. walk, cycle and cycle rickshaw are green modes of transport that belong to the low carbon path, do not consume energy or cause pollution, provide social equity and in addition provides employment.

Recommendations

Description	Aspect	Responsible Agency
1. Adherence to 'National Urban Transport Policy' - 2014[3], which focuses on the movement of people rather than vehicles, such as ● Prioritized movement: Pedestrians, Persons With Disabilities (PWD), NMT (bicycles), public transport, IPT users, private vehicles (in that order) - aims to reduce congestion and emissions. ● Public Transport: Pedestrian/bicycle access within 50 meters, followed by feeder services (pick-up/drop-off <100 meters), IPT stops, and private vehicle facilities.	Policy Short Term	*JMC*
2. Data Collection and Analysis: ● On passenger origin-destination data and travel patterns. This data will be crucial for designing efficient routes and identifying high-demand areas. ● Utilize passenger data to design and review efficient IPT routes that minimize waiting times, focusing on high-demand areas identified.	Research Study/ Planning Short Term	
3. Designation of Pick-Up and Drop-Off Zones: ● Identify strategic locations within walking distance of major public transport stations and high-traffic areas. Designate these locations as official pick-up and drop-off zones for IPT vehicles. Clearly mark these zones with signage for easy identification. ● With common ticketing system with PT, Users can manage IPT vehicles booking in advance (e.g., e-rickshaws, auto-rickshaws) on-demand for last-mile connections.	Project Medium Term	

Action M5.3 : Vision for the Future: Exploring Tramway Integration

By 2050, Jamnagar's population within the current JMC boundary is projected to reach over 1.6 million. This necessitates a simple, sustainable, and efficient public transport system.

Tramway systems, a more advanced version of electric buses, are also powered by electricity but boast a higher fleet capacity. Strategically planned tram lines, operating on a schedule within and around high-density areas, can offer seamless connectivity, improve intra-city mobility, encourage ridership, thereby reducing reliance on private vehicles.

Recommendations

Description	Aspect	Responsible Agency
1. A comprehensive study will be essential to identify optimal routes, considering factors like traffic patterns, existing infrastructure, and future development plans.	Research Study Long Term	*JMC* *JADA*
2. Seamless integration with existing bus networks and other modes of transport will be crucial for a user-friendly and efficient public transport system.	Planning Long Term	
3. Careful planning will be required for track construction, power supply, signalling systems, and dedicated stops with passenger amenities. The tramway system design (single-track, double-track, etc.) and vehicle selection (low-floor, high-floor) will be based on ridership projections, passenger needs, and integration with existing public transport networks.	Project Long Term	
4. Exploring PPP can offer innovative financing models for project development and operation.	Project Long Term	

[3]https://www.changing-transport.org/wp-content/uploads/E_K_NUMP_India_2014_EN.pdf

Case study : Amsterdam Model for Sustainable Urban Mobi

Amsterdam is world-renowned for its cycling culture. Over 60% of trips within the city are made by bike, making it a shining example of a city prioritizing sustainable transportation. This success story is the result of a long history of cycling infrastructure development, cultural acceptance, and government policies that have made cycling the most convenient and safe way to get around.

Post War Era : Dutch car boom with rising incomes and urban policy focus on cars as the future of transportation.

1943 : Amsterdam's tram system, dating back to 1875, came under municipal control in 1943.

1970s : Dutch government prioritized cycling safety with 'Stop de Kindermoord' campaign and cycle infrastructure investment.

Intervention M 6: Adoption of Zero-tailpipe emissions (ZTE) vehicles

The city's current transportation, with only 1.2% of vehicles being electric of total fleet, necessitates a critical shift towards zero-tailpipe emission fuels. Within Jamnagar, conventional fuel vehicles contribute approximately 23.5% of total emissions under a BAU scenario. As the number of vehicles increases, this figure is projected to rise.

To address this challenge, a shift towards ZTE vehicles such as electric vehicles (EVs) offers a potential solution. While EVs are not entirely emission-free due to the current energy mix used for electricity generation, they demonstrably reduce tailpipe emissions per kilometre travelled. Studies indicate that EVs can emit as little as 0.07 kg/km compared to 0.15 kg/km for conventional vehicles.

Furthermore, the remaining emissions associated with EVs can be progressively mitigated in the long term. Transitioning the electricity grid to renewable energy sources like solar and wind power can lead to a significant reduction in the life-cycle emissions of EVs. This creates a synergistic effect where EV adoption reduces emissions, and a cleaner grid further reduces EV emissions over time.

07	01	08	02	03
Project	Planning	Policy	Research Study	Institutional Mechanism

Action M6.1 : EV adoption for PT & IPT

Timeline

2024 | 2030 Short Term | 2040 Mid Term | 2050 Long Term

MITIGATION

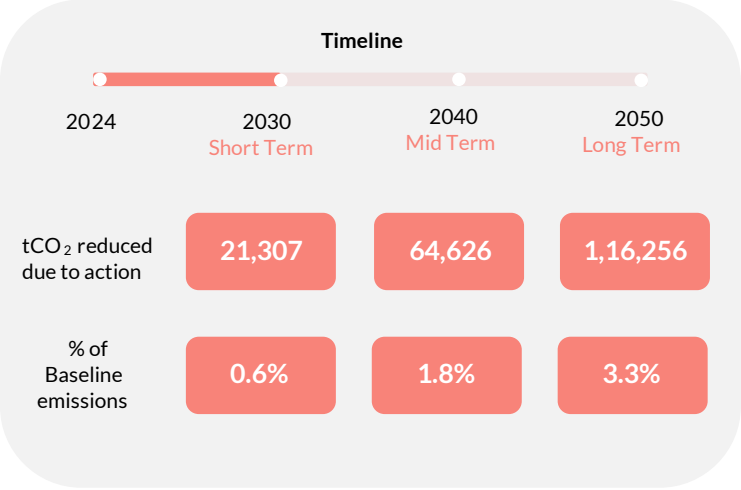
About

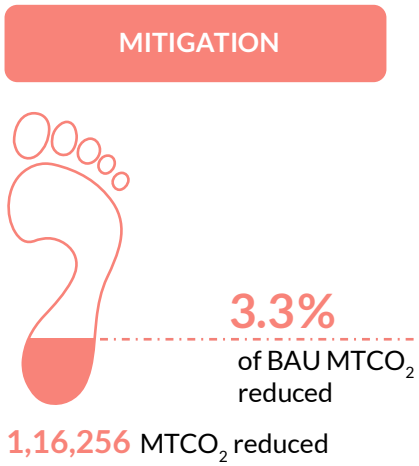
In an effort to transition to low-carbon mobility, the city has identified a current need for 50 electric vehicles, 25 new bus routes, and 2 new electric bus depots. To achieve its target, Jamnagar has joined the "PM-eBus Sewa" scheme. This initiative aims to increase the use of electric buses (e-buses) and implement an Intelligent Transit Management System (ITMS) alongside a National Common Mobility Card (NCMC)-based Automated Fare Collection System (AFCS) for bus operations, as mandated by the scheme.

Recommendations

Description	Aspect	Responsible Agency
1. Explore business models for e-bus procurement: ● Phase I: Consider the Gross Cost Contract (GCC) model. Here, JMC will pay a per-kilometre fee, sets service standards, and handles scheduling, route planning, and fare collection. The operator will procure the buses and infrastructure, operates and maintains the buses, and provides drivers and crew. ● Phase II: In a pilot program, explore and implement a dry lease model (by dry leasing drivers and conductors) to ease pressure on operators and allow JMC to provide intensive training to the staff on e-bus technology.	Project Medium Term	*JMC*
2. Skill Development for Existing JMC - PT Employees ● The transition e-buses presents a challenge for drivers and support staff accustomed to fossil fuel buses. Unlike traditional buses, e-bus performance relies heavily on optimized driving and efficient passenger loading. Factors like range, battery life, and overall vehicle lifespan depend on skilled operations. ● Providing targeted training and skill development programs for existing employees. ● Equipping staff with the knowledge and skills necessary for optimal e-bus operation. Skilled employees will attract competitive bids from Original Equipment Manufacturers (OEMs) in future tenders, leading to potentially lower costs.	Advocacy Short Term	
3. Mandating Electric Fleets: This policy proposes a phased transition for fleet aggregators, including e-commerce companies and industry buses (e.g., Reliance, Nayara), towards EV, ● By 2025: At least 15% of all fleet vehicles operated by these companies must be electric. ● By 2030: 100% of their fleets must be electric	Policy Medium Term	
4. For E-Auto (IPT) adoption : Host a week-long E-Auto Mela for prospective drivers to explore and experience various e-auto models, test drives, and loan options at the Mela. This initiative aligns with Delhi's plan offering a first-come, first-served e-auto permits with 33% quotas reserved for women drivers.	Project Short Term	

Action M6.2 : Accelerate Electric Two-Wheelers (e2Ws) adoption





About

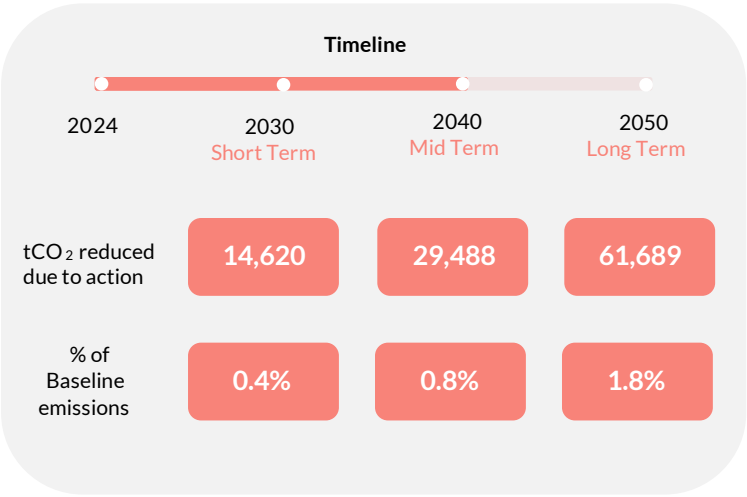
India has set an ambitious target of achieving an 80% penetration rate for e2Ws by 2030. The nation is experiencing significant growth in e2W adoption, reaching 5.63% in 2023 compared to 4.05% in 2022. While Gujarat, with an e2W adoption rate of 8.16% in 2023, surpasses the national average. The success of the Gujarat EV Policy 2021, which achieved its target of supporting 110,000 e2W purchases in four years by 166%, underscores the effectiveness of well-designed incentive programs.

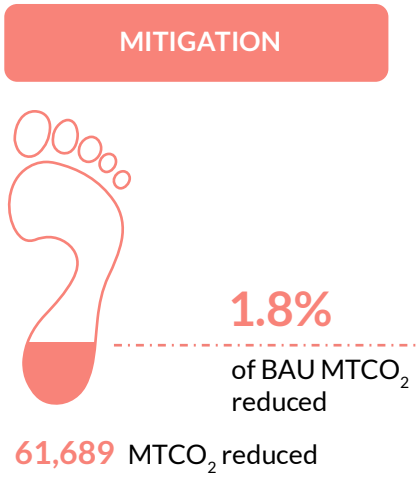
Jamnagar currently accounts for only 1.15% of the total e2Ws in the state. This highlights the need for a city-specific e2W adoption policy. Collaborative efforts with the Jamnagar district collector's office and the Regional Transport Office (RTO) are crucial for the successful implementation of such a program at city-level.

Recommendations

Description	Aspect	Responsible Agency
1. Pilot the implementation of battery swapping stations as a convenient fuelling alternative for specific e2W segments.	Project	*JMC* *RTO*
2. Launch targeted campaigns and organize test drive events in partnership with RWAs/NGOs and e2W dealerships to educate residents about e2W benefits (environmental, cost-saving, performance features)	Advocacy	
3. Reduced Parking Fees & Toll Waivers with entry allowed in Low-Emission Zones	Policy	
4. Encourage the transition of government department two-wheeler fleets to electric models to showcase commitment and set an example for other organizations.	Advocacy	

Action M6.3 : Zero-tailpipe emissions (ZTE) Four-Wheelers adoption





61,689 $MTCO_2$ reduced

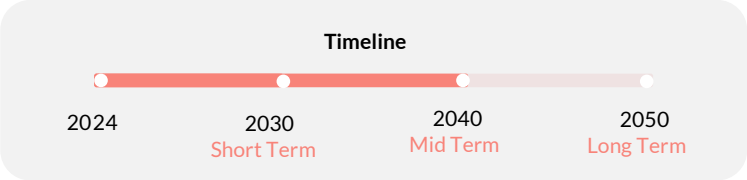
About

Jamnagar's current EV adoption rate is concerningly low, with only 84 EV cars registered from 2014 to 2023. While financial benefits exist, these might not be sufficient to incentivize large-scale adoption at the necessary pace. The existing Gujarat EV policy, which offers subsidies of up to ₹1,50,000 for 20,000 four-wheeler EVs over a four-year period, is unable to attract citizens to adopt EVs due to the limited availability of fast-charging stations across the city.

Recommendations

Description	Aspect	Responsible Agency
1. Establish a single-window online portal dedicated to EV registration and permit issuance	Policy Medium Term	*JMC* *RTO*
2. Offer significant scrapping bonuses for older, high-polluting vehicles (> 10 years old), with additional incentives for purchasing an EV in exchange.		
3. Offer incentives for EVs, such as reduced parking fees, toll charges, and waivers on fitness certificates. Switch to electric vehicles for all government officials' transportation needs through a PPP model.		
4. Levy a surcharge on inefficient or polluting vehicles (through pollution cess, road tax, congestion tax, and environment compensation charges). Utilize the revenue generated from the feebate system to fund subsidies for electric four-wheelers (EVs).		

Action M6.4 : Building a Robust EV Charging Infrastructure Network



MITIGATION

About

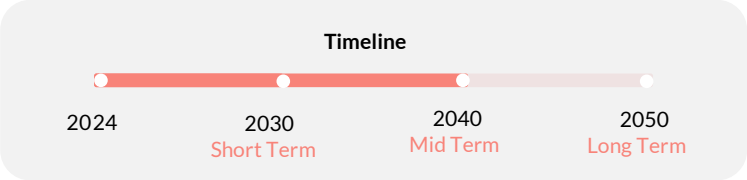
The successful transition to EVs, hinges on the accessibility and availability of a robust charging infrastructure to influence consumer behaviour. To this end, establishing a network of EV fast charging stations within Jamnagar city and its peripheral areas, such as Bedi Port and Ranjit Sagar Dam, is crucial. To further enhance the environmental benefits of EVs and incentivize early adopters, the charging infrastructure should ideally utilize RE sources like solar and wind power. This approach would not only reduce reliance on fossil fuels but also potentially allow for concessionary electricity rates for early EV users till 2030.

Recommendations

Description	Aspect	Responsible Agency
1. Conduct a comprehensive study to assess the current and projected demand for EV charging stations across the city. This will inform the optimal placement and type (slow, fast) of charging stations needed.	Research Study Short Term	*JMC* *PGVCL*
2. Partner with Google Maps or develop a city-specific platform to digitally map all charging stations, providing real-time data on availability, charging costs, and station types.	Planning Medium Term	
3. Introduce property tax rebates for individuals and businesses installing charging stations at homes, workplaces, and public locations. This incentivizes private investment in charging infrastructure.	Policy Short Term	
4. Implement pilot projects to test the integration of EV chargers into existing urban infrastructure, such as streetlights. This can be a cost-effective way to expand charging options.	Project Short Term	

Description	Aspect	Responsible Agency
5. Adhere to the guidelines set forth by the Ministry of Power: ● At least one Public Charging Station (PCS) should be available within a 3x3 km grid across the city. ● Encourage building owners to install private charging stations (non-commercial) for residents & employees. ● Along key highways connecting Jamnagar city mandate PCS at every 25 km and Fast Charging (FC) Facilities at every 100 km on both sides of the highway.	Policy Short Term	*JMC* *PGVCL*
6. Streamline EV infrastructure deployment with a single window clearance system. This one-stop shop will expedite approvals for private and fleet (captive) charging/ swapping stations. PGVCL, as the nodal agency, will: ● Identify & approve EV infrastructure providers ● List approved station models ● Standardize & centralize documents ● Post timelines for connection requests This will simplify the process for residents and businesses, fostering network growth	Project Medium Term	*JMC* *PGVCL*
7. Continuously monitor the usage of charging stations, user feedback, and overall effectiveness of the strategy.	Project Medium Term	

Action M6.5 : Enhance Sustainability of Freight Movement



MITIGATION

About

India's road freight transportation sector, representing 71% of the total freight movement and contributing to 7% of national emissions, necessitates urgent action towards decarbonization. With the upcoming Amritsar-Jamnagar Expressway (NH-754A) connecting key industrial hubs (3 big oil refineries of HMEL Bathinda, HPCL Barmer and RIL Jamnagar), Jamnagar can anticipate a significant increase in freight movement. This necessitates proactive strategies to manage emissions from this sector. A major barrier to EV adoption within freight transportation is the high upfront cost compared to conventional ICE vehicles, requires collaboration between government agencies, industry stakeholders, and research institutions.

Recommendations

Description	Aspect	Responsible Agency
1. Conduct a comprehensive study to understand freight movement patterns, vehicle types, fuel usage, and routes within the city. This data will inform future policy decisions and GHG inventory development.	Research Study Short Term	*JMC*
2. Implement pilot projects electrifying fleets of municipal vehicles, such as those used for solid waste management (SWM) or marketplaces (mandis) with work tender specifying EV mandate. This allows for real-world testing and data collection.	Project Short Term	
3. Offer a tax incentive package including tax credits, parking fee reductions, and toll and road tax exemptions to further incentivize adoption of electric freight vehicles. Consider offering flexible operating hours as an additional incentive.	Policy Medium Term	

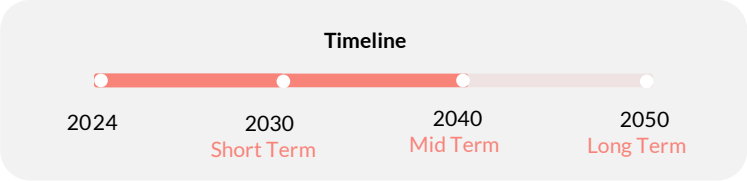
Description	Aspect	Responsible Agency
4. Develop a well-designed scrappage program that provides financial support for retiring older, polluting diesel vehicles and switching to cleaner electric alternatives.	Policy Medium Term	*JMC*
5. Introduce a feebate system in LEZs for electric trucks receive rebates while high-emission vehicles incur fees. This creates a market-based incentive for cleaner technologies alongside restricted access zones.	Policy Medium Term	

Intervention M 7: Augment Non-Motorized Transport (NMT) and Street Vending

Jamnagar is prioritizing healthy and sustainable travel options by promoting NMT in compliance to the National Urban Transport Policy (NUTP) 2006. This initiative encourages walking and cycling through improved infrastructure and user-friendly policies. By creating dedicated lanes, secure parking spaces, and well-maintained sidewalks, the city aims to make NMT a safe and attractive choice for daily commutes. Additionally, educational programs and awareness campaigns will highlight the health and environmental benefits of active travel. Ultimately, a thriving NMT network will reduce traffic congestion, improve air quality, and foster a more vibrant and liveable city for all.

02	01	02	02	02
Project	Planning	Policy	Research Study	Institutional Mechanism

Action M7.1 : Developing walkable and cyclable green corridors



MITIGATION

About

Jamnagar will transform its streets with a network of green corridors dedicated to pedestrians and cyclists. These zones will feature wide, well-maintained sidewalks, universally accessible pedestrian infrastructure as per 'Persons with Disabilities Act 1995 (Sec 44)' and protected cycling lanes, making active travel a more attractive choice. This will include features like tactile paving, dropped curbs, sufficient lighting and pedestrian refuges to ensure safety and inclusivity for all users. These corridors will connect key areas within the city, making it easier and safer for residents to travel short distances without needing a vehicle. Landscaping with native, low-maintenance vegetation will provide shade, improve air quality, and beautify the city. This initiative aims to encourage active travel, reduce traffic congestion, and create a healthier, more sustainable Jamnagar.

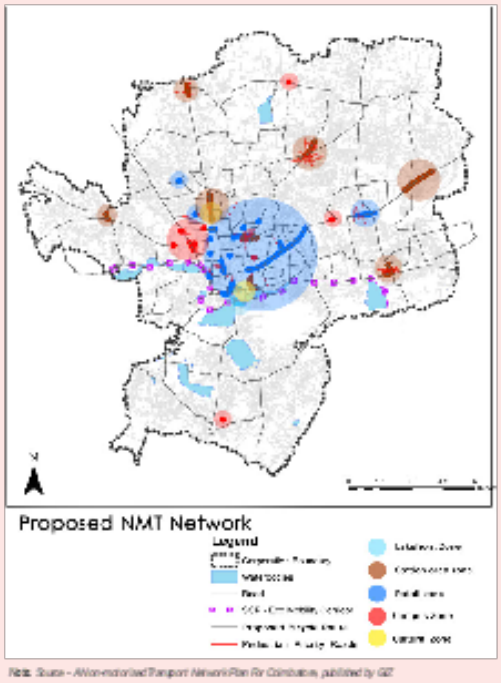
Recommendations

Description	Aspect	Responsible Agency
1. NMT Network Plan ● Create a multi-stakeholder NMT cell within the JMC - Transport Department. ● Conduct an audit of the existing pedestrian infrastructure (accessibility, encroachments, lighting, green shading etc.) ● Implement pilot pedestrianization projects with programs such as 'Street for People' in high footfall areas (e.g. Darbargadh, etc)	Project / Institutional Mechanism Short Term	*JMC*
2. NMT Infrastructure development ● Develop NMT street design guidelines, a cycle master plan, and an NMT policy for Jamnagar. ● Construction of accessible footpaths and efficient cycling tracks, taking into account existing RoW, accompanied by amenities such as street furniture, play areas, good lighting, and ramps to further encourage NMT use within the city. Installation of signages and zebra crossing near pedestrian crossings, and increase signal timings for pedestrians.	Policy / Project Medium Term	

Case study : Coimbatore NMT Network Plan, India

Coimbatore is the second-largest city in Tamil Nadu, with a population of about 2 million in 2019 across 257 sq. km. A growing dependence on private vehicles threatened the safety of pedestrians and cyclists, who comprised 57% of all trips and 70% of first/last-mile bus connections.

The Coimbatore City Municipal Corporation (CCMCC), with support from Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, developed a NMT Network Plan. This plan focuses on 26 key pedestrian areas and creating a safe 290 km network for cycling and walking.



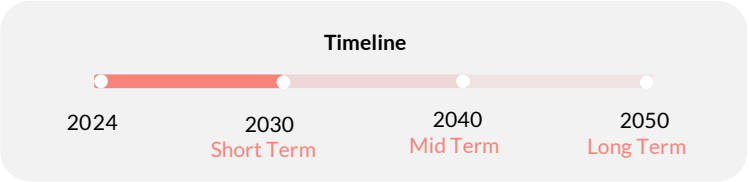
Impact: The NMT plan aims to directly benefit 1 million citizens by promoting safe and convenient NMT options. This shift towards active travel will contribute to a more sustainable, low-carbon transport system for Coimbatore by 2035.

Implementation: The phased plan covers 294 km across five zones and is estimated to cost ₹1704 crore. Construction contracts and public financing will support implementation.

Monitoring & Evaluation: Existing CCMC monitoring mechanisms will be utilized, with a dedicated NMT Cell established for ongoing management.

Key Takeaways: The Coimbatore NMT Network Plan highlights the importance of prioritizing pedestrian and cyclist safety to create a healthier, more sustainable urban environment.

Action M7.2 : Climate-Smart Street Vending Management



MITIGATION

About

Jamnagar's street vendors, offering delights like sizzling katka bread to refreshing sugarcane juice, are vital to the city's vibrant food culture. However, climate change poses a significant threat, with rising temperatures, erratic rainfall, and extreme weather events impacting both vendors' livelihoods and environmental sustainability.

The National Policy on Urban Street Vendors highlight these vendors as legitimate economic actors, calls for attention to combat climate challenges. The Policy provides guidelines for the requirements of designated vending zones (such as RoW sidewalks), self-regulation by the vendors (such as neighbourhood hygiene maintenance and cleanliness), and constitution of a ward-wise multi-stakeholder Town Vending Committees by the Municipal Authorities (here JMC).

Recommendations

Description	Aspect	Responsible Agency
1. Baseline Assessment: Conduct a comprehensive study to understand the current environmental footprint of street vending in the city. Analyse waste generation patterns, energy consumption, and vulnerability to climate risks.	Research Study Short Term	*JMC*
2. Policy and Regulatory Framework: Develop and enact regulations that incentivize sustainable practices like ● Transition to clean cooking fuels, such as LPG or biogas, ● Utilisation of solar-powered lighting ● Adoption of compostable or reusable packaging for food and beverages. ● Facilitate waste segregation and collection systems	Policy Short Term	
3. **Enhance climate resilience:** ● Integrate heat stress mitigation strategies like canopy covers and water misting systems in vending zones. ● Demonstrate flood-resistant designs for vending stalls in areas prone to flooding. ● Educate street vendors and develop SOPs on adapting their practices to extreme weather events. Partnering with local NGOs to develop training programs and awareness campaigns.	Advocacy Short Term	

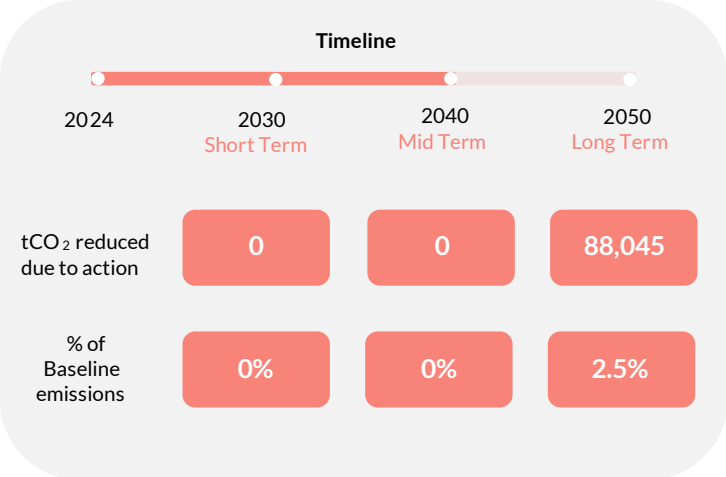
Intervention M 8: Make Jamnagar 'Garbage free city'

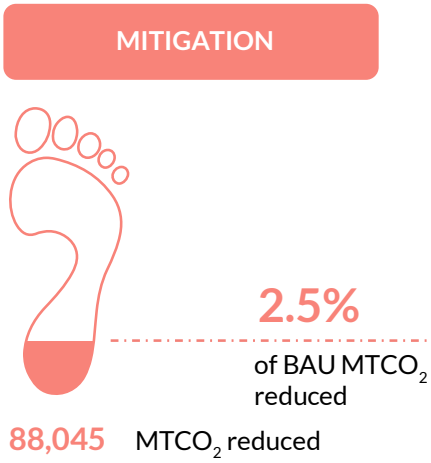
The Solid Waste Management and Sanitation Policy , 2018 by the Government of Gujarat sets 10 clear goals including: achieving "Zero Waste" cities. This vision is supported by key sub-goals:

- All waste, including residential, commercial, industrial, and construction & demolition (C&D) waste, must be segregated at the source and collected door-to-door.
- 100% of collected waste will be treated, processed, or recycled, eliminating landfill disposal.
- Biodegradable waste will be processed locally at the neighbourhood/ward level.
- All non-biodegradable waste and C&D waste will be recycled or processed, with both centralized and decentralized processing options available for C&D waste.
- This ambitious target ensures all C&D waste finds a new life through recycling or reuse

The primary strategy for improving management of municipal solid waste is to imbibe the principle

of 3R: Reduce – Reuse – Recycle and improving quality of services across the value-chain. Jamnagar need to introduce strategies that encourage reducing waste generation at source and reuse and recovery of waste.





04	01	02	01	01
Project	Planning	Policy	Research Study	Institutional Mechanism

Action M8.1 : Municipal Solid Waste (MSW) Management

Effective MSW management is demonstrably crucial for mitigating GHG emissions in Jamnagar. Data from 2021-22 indicates that solid waste currently contributes 6.6% to the city's total GHG footprint. However, by implementing robust waste management strategies, projections highlight a substantial decrease to 2.2% by the year 2050.

Recommendations

Description	Aspect	Responsible Agency
1. Expand MRFs and recycling centres to substantially decrease the volume of waste directed to landfills Case Study: Zero Waste initiative in San Francisco, USA San Francisco implemented a comprehensive recycling and composting program with an extensive network of MRFs and recycling centres thereby achieving an 80% diversion rate from landfills.	Project Short Term	*JMC - Solid Waste Department*
2. Offer discounts on utility bills for residents and tax rebates for businesses that actively participate in recycling programs Case Study: Green Exchange Program in Curitiba, Brazil Residents exchange recyclable waste for bus tokens, food, or school supplies which significantly increased recycling rates and waste diversion from landfills	Policy Short Term	

Description	Aspect	Responsible Agency
3. As per Policy Guidelines Promoting Behaviour Change for Strengthening Waste Segregation at Source by Niti Aayog (2021), BIS codes can be applied for adoption of different recycled materials to promote their acceptability Case Study: BIS Codes for recycled aggregates in Ahmedabad, Gujarat The Ahmedabad Urban Development Authority (AUDA) and the Ahmedabad Municipal Corporation (AMC) have established guidelines to ensure compliance with BIS 383:2016, promoting the use of recycled coarse and fine aggregates in construction. These projects reported a 30% reduction in the use of natural aggregates and an average cost saving of 20-25% compared to using virgin raw materials.	Policy Medium Term	*JMC - Solid Waste Department*

Action M8.2 : Leaf Litter Processing Unit (LLPU) at ward and neighborhood level

Leaf/garden waste is all horticulture waste and includes leaf litter, garden pruning, branch cuttings, etc. With dense foliage along several roads and frequent cutting of trees by the residents is estimated to be a large proportion of street sweeping waste, especially in certain seasons.

LLPUs established within neighbourhoods would enable the processing of this organic matter at the local level and convert leaf litter into high-quality compost. This will be utilised for various purposes, including amending soil fertility in public parks, gardens, and landscaping projects, providing residents with organic fertilizer options for sustainable gardening practices or generating potential revenue for the city through the sale of the produced compost. This could lead to a substantial reduction in the volume of waste requiring collection and transportation to centralized processing facilities.

Landfill-bound leaf litter decomposes slowly, consumes valuable space, and potentially generates methane, a greenhouse gas. Additionally, decaying leaves can attract mosquitoes and other insects. LLPUs can mitigate these issues by promoting cleaner neighbourhoods through rapid organic waste processing. Furthermore, LLPUs can serve as educational centres, fostering responsible waste management practices and fostering community ownership of green spaces and their maintenance.

Recommendations

Description	Aspect	Responsible Agency
LLPU process : 1. Site Identification: The city will identify potential sites within the Town Planning (TP) scheme and Local Area Plan (LAP) for installing LLPUs in each ward. Larger wards will have 2-3 units installed at the neighbourhood level to improve accessibility. 2. Input Material Segregation: ● Residents will be educated on properly separating recyclables (paper/plastic) from leaf litter and submit it at LLPU for monetary benefits (such as ₹ 10/ kg) ● Leaf litter collected from road sweeping by sanitation workers will be placed in jumbo bags for transport to the LLPUs. These bags will be labelled and stored properly to prevent attracting pests. 3. Size Reduction: Segregated materials will be sieved to remove smaller materials that don't require shredding. Identified coarser materials will then be shredded to increase surface area and optimize composting. 4. Composting: The shredded materials will undergo natural aerobic composting using water and cow dung as additives.	Planning/ Project Short Term	*JMC*

Action M8.3 : C&D waste management

The Construction and Demolition (C&D) waste rules, 2016 issued by the Ministry of Environment, Forests and Climate Change, Government of India, under the Environment (Protection) Act, 1986, defines the procedure for ULBs to undertake construction and demolition waste management. This includes process to be followed for collection, segregation, storage, transportation, processing and disposal of waste generated within their jurisdiction. Also, the ULBs shall follow 14 directions and strategies and oblige the duties as stated in rules 4,12, 15 and other relevant rules of SWM Rules, 2016.

Recommendations

Description	Aspect	Responsible Agency
1. C&D Processing Facility on PPP model: ● JMC shall take the initiative by issuing a Request for Proposal (RFP) to attract qualified private companies for a PPP model. ● JMC shall identify and allocate a suitable plot of land for the C&D waste processing facility for a predetermined period.	Project Short Term	JMC – Solid Waste Management
2. Market Development for Recycled C&D Products: ● Develop a range of high-quality construction materials from recycled C&D waste, such as finished-surface paver blocks, rough paver blocks, rectangular paver bricks, and masonry bricks. ● Develop a strategy to incentivize the use of recycled C&D products. This could include: ❖ Setting competitive prices/ subsidy for recycled construction projects that utilize recycled C&D materials. ❖ Promoting the benefits of recycled C&D products through public awareness campaigns and partnerships with architects and builders.	Project Medium Term	
3. Enforcement of the C&D Waste Rules, 2016: ● This will clearly define the responsibilities of each stakeholder involved (waste generators, collectors, and processors) in C&D waste management, with penalties for non-compliance. ● Establishing designated collection points for C&D waste to encourage responsible disposal.	Policy Short Term	
4. Public Awareness Campaign: ● Educate residents and construction companies about C&D waste segregation, responsible disposal practices, and the benefits of using recycled construction materials.	Advocacy Short Term	

Action M8.4 : Streamline Bio-methanation Plant Operations

JMC can leverage bio-methanation, a promising technology, to effectively manage the city's wet waste (from kitchen, hotel, market). This process harnesses the power of organic waste through a series of biochemical transformations - hydrolysis, acidification and liquefaction followed by methane formation. The plants can be set up at decentralized (up to 5 TPD) or centralized locations depending on waste volume and feasibility within Jamnagar city. The process generates biogas, a clean and renewable energy source which can potentially use biogas-powered engines to generate electricity for the plant itself or even feed it into the city's natural gas grid.

Recommendations

Description	Aspect	Responsible Agency
1. Expanding Existing Biogas Plant: ● Maximize Capacity: JMC can explore a long-term contract with Maxim Environmental Engineering Pvt.Ltd. to process larger volume of the city's wet waste management. ● Sustainability Assessment: Conduct a life-cycle environmental impact assessment (EIA) of the plant.	Project Short Term	JMC
2. Efficient Wet Waste Collection: ● Incentivize Segregation: Implement incentive programs for citizens to effectively segregate and manage wet waste. This could involve reduced waste collection fees or public recognition for responsible waste management practices. ● Consistent Feedstock: Bio-methanation plant require a steady supply of biodegradable waste at source is crucial to ensure optimal plant performance.	Policy Short Term	
3. Utilizing End Products: ● Marketing Compost: JMC will develop a strategy for marketing and selling the compost produced from the bio-remediation process. ● Biogas Utilization: JMC will explore options for utilizing the biogas generated by the plant. This could involve using it for energy generation within the processing facility itself, or even feeding it into the city's natural gas grid for wider use. Case Study: Deonar Abattoir Biogas Plant in Mumbai, Maharashtra Cow dung, slaughterhouse waste, and other organic waste is used to generate renewable energy Capacity : 1.2 MW (megawatts) of electricity per day	Project Medium Term	

5.4 Adaptation Actions

5.4.1 Overview of Actions

Jamnagar's climate action plan outlines a comprehensive adaptation strategy to address water security and flooding challenges through a network of interconnected solutions.

The cornerstone of the plan will be the "sponge city" approach. This strategy will utilize natural features like rejuvenated lakes and strengthened canal networks, alongside newly built flood basins. This network will absorb, store, and reuse rainwater, reducing flooding and replenishing groundwater – a critical step towards water security. Furthermore, crucial upgrades to drainage systems and a comprehensive groundwater study will be conducted. Collaboration across city, district, and state government levels will ensure success in coastal management, construction of check dams on key rivers to control water runoff, and the implementation of rainwater harvesting initiatives.

Addressing rising temperatures and air pollution, the plan prioritizes climate-resilient urban planning. Promoting green infrastructure like parks and urban forests with 2.5 trees per capita covering an area of 1.91 km2 (as per projected population for 2050) will create "heat island" mitigation strategies, combating rising temperatures. Additionally, sustainable building practices with improved insulation and energy efficiency will be encouraged. This focus aligns with India's National Clean Air Programme, aiming to reduce air pollution through stricter vehicle emission controls and the exploration of cleaner energy sources.

Recognizing the importance of environmental health and biodiversity for climate resilience, the plan fosters these areas. Initiatives like tree cover expansion and wetland protection will enhance the city's environmental health. Importantly, the plan embraces Gujarat's Treated Wastewater Reuse Policy. This innovative approach will significantly reduce dependence on scarce fresh water resources by reusing treated wastewater for irrigation and other non-potable purposes.

Build Heat & Flood Resilience

Environmental Health and Biodiversity

Sustainable Water & Used Water Management

By implementing this three-pronged adaptation strategy, Jamnagar aims to achieve water security, enhance its resilience to climate impacts, and ultimately create a healthy environment for all to live.

5.4.2 Action to Implementation Strategies

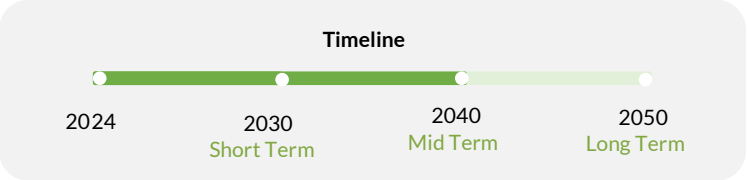
Intervention A 1: Implementing 'Sponge City' Solutions

While basic solutions like drainage upgrades and dam management remain important, a city-wide approach centred around "sponge city" principles is necessary. Sponge cities utilize natural features and innovative infrastructure to mimic a sponge, essentially absorbing, storing, and reusing rainwater. This strategy has the potential to significantly reduce flooding and improve water security in Jamnagar.

By incorporating Nature-Based Solutions (Nbs) in riverfront development, rejuvenating existing and extinct lakes, strengthening canal networks by connecting water bodies and flood retention and detention basins, Jamnagar will create a more natural drainage network that leverages its existing topography.

06	03	01	02	00
Project	Planning	Policy	Research Study	Institutional Mechanism

Action A1.1 : River rejuvenation & Nature-based Solutions (NbS) based Riverfront development



ADPATATION

About

This intervention aims to revitalize the city's river and create a vibrant riverfront environment using 'NbS'. City has already conducted a baseline hydrology study for Rangmati-Nagmati Riverfront development project. Initial concept and drawings of the riverfront project is prepared. Taking it ahead, this plan proposes integration of riverfront development project with Nature-based solution as a part of sponge city concept. Concretisation of river will disrupt the natural geography accumulating the issue of flood.

Recommendations

Description	Aspect	Responsible Agency
1. Hydrological Assessment and Floodplain Mapping: ● A comprehensive assessment of the riverbed's characteristics, including flow patterns, sediment transport, and water depth variations, will be conducted. ● Based on the hydrological study, floodplains for 50-year and 100-year flood events will be identified and demarcated. This information is essential for ensuring the development of a flood-resilient riverfront and minimizing risks to infrastructure and communities.	Research Study/ Planning Short Term	*JMC*
2. NbS-Based Riverfront Strategy for Flood Control and Water Recharge: ● Riparian buffer restoration with native vegetation to stabilize riverbanks, filter pollutants, and provide habitat for wildlife. ● Creation of wetlands to act as natural filters for water purification and flood control. ● Integration of green infrastructure like bio swales and rain gardens to manage storm water runoff and improve water quality.	Project Short Term	
3. Water Quality Management: ● Regular water quality monitoring will be implemented at all entry and exit points of the river. This data will be used to identify any pollution sources and track the overall health of the river ecosystem. ● Decentralized Sewage Treatment System (STP) for informal settlements along the riverbank that offer a sustainable solution for managing used water in these areas.	Project Short Term	

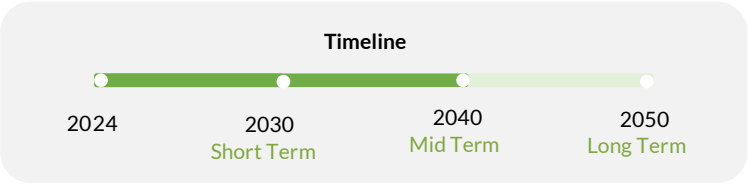
Description	Aspect	Responsible Agency
4. Ecological Restoration: ● Efforts will focus on restoring native plant and animal species within and around the river. This will enhance biodiversity, promote a healthy ecosystem, and provide habitat for wildlife. ● To protect the wetland and marshland ecosystems of the Gulf of Kachchh, a robust solid waste collection system will be extended to cover areas before the river estuary, preventing waste from entering this sensitive ecological zone.	Project/ Planning Medium Term	*JMC*

Case study : Yanweizhou Park in Jinhua, China

Jinhua traditionally used concrete walls to control flooding, sacrificing the natural ecosystem. The Yanweizhou Park project offered a new approach by creating terraced embankments with native plants, the park embraced floods and even benefited from them. Floodwater deposits fertile silt and the park requires no irrigation. This innovative design showcased a replicable and sustainable solution for flood management.

Additionally, the park utilizes permeable surfaces throughout to create a water-resilient landscape. Recycled gravel and permeable pavements allow rainwater to infiltrate the ground, naturally filtering it and replenishing groundwater.

Action A1.2 : Restoration and Connection of existing lakes and other water bodies



ADPATATION

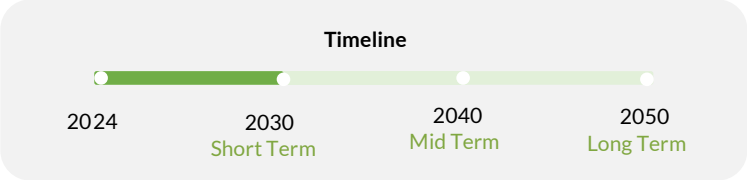
About

Jamnagar's existing network of lakes and water bodies presents an opportunity for the city's long-term climate change adaptation strategy. Restoration efforts focused on connecting these water bodies could yield benefits such as enhanced flood control capabilities, improved water quality, and potential microclimate regulation. Also, the creation of green corridors around restored water bodies will contribute to urban heat island effect and mitigating rising temperatures.

Recommendations

Description	Aspect	Responsible Agency
1. Understanding Historical Morphology: ● By analysing historical data and conducting on-site investigations, the study will aim to reconstruct and restore the original morphology (shape, size, and depth) of existing and extinct water bodies.	Research Study Short Term	JMC
2. Adaptive Watershed Management: ● To optimize water retention and infiltration within the surrounding watershed lands. Strategies may include reforestation, sustainable agriculture, and wetland restoration.	Project Medium Term	
3. Water Pollution Abatement: ● This intervention highlights the need for stricter regulations and effective waste management practices to prevent solid waste and used water dumping into lake and rivers. By reducing pollution, safeguard the health of aquatic ecosystems and quality of water resources.	Policy Short to Medium Term	
4. Structural Audit of Ranjit Sagar Dam: ● Ranjit Sagar Dam, constructed over a century ago, requires a comprehensive structural audit. This audit will assess the dam's current condition and identify any potential vulnerabilities that may require maintenance or repair work. By proactively addressing these issues, we can guarantee the dam's continued safe and reliable operation for water storage and flood control.	Project Short Term	

Action A1.3 : Floodwater Detention and Retention Basins



ADPATATION

About

As highlighted in indicator 4.4, Wards 12, 11, 10, 4, and 7 are the most frequently flooded areas. Developing detention basins, engineered areas designed to capture and manage floodwater, can be a solution. Dry basins for holding water only during storms, and wet basins for maintaining a permanent pool. Beyond flood control, detention basins offer co-benefits like recreation in dry basins and aesthetic value in wet basins.

Recommendations

Description	Aspect	Responsible Agency
1. Identifying potential sites along the watershed: ● Jamnagar city is falls under three broad catchments (north eastern, north western and south central watershed), from which the water flows into the sea. Identifying potential sites along the watershed for riverine flooding and utilizing existing low-lying areas is crucial. ● With the study of TP scheme, areas such as common parks, government vacant plots, and play grounds can be engineered to capture and slow down storm water runoff, reducing downstream flooding and peak flow during high-water events.	Project & Planning Short Term	JADA JMC

Intervention A 2: Addressing Water Balance and Catchment Runoff Challenges

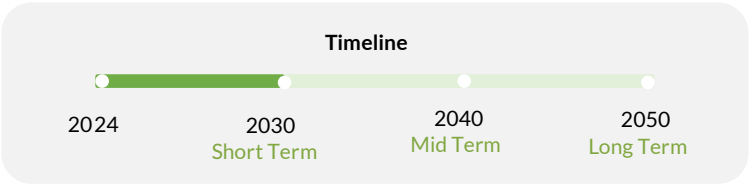
Jamnagar faces two main threats to its freshwater supply : inherent salinity and saltwater intrusion from the Arabian Sea, and potential flooding with seasonal overflows from reservoirs and river catchment areas. Parallelly, overuse of groundwater resources has led to declining water levels, which in turn is causing increased salinity ingress and putting further strain on the system. A promising solution lies in integrating overflow water with groundwater recharge systems, potentially addressing both excess water and water quality depletion.

To build flood resilience, the climate action plan prioritizes upgrading the drainage systems, directing excess water towards designated drainage points, rivers, or the Arabian Gulf, thereby alleviating pressure on the existing infrastructure and water bodies. Secondly, a city-wide borewell survey and the development of ground water usage guidelines, will ensure fresh water security. Also, rainwater harvesting can help in increasing the ground freshwater level.

Water management transcends geographical boundaries, necessitating collaboration between city, district, and state authorities for success. At the district level, coastal and biodiversity management efforts play a key role. Implementing early warning systems for sea level rise and protecting wetlands will further safeguard freshwater resources. Additionally, constructing check dams on the Rangmati and Nagmati rivers in South Jamnagar and Lalpur Taluka can help control excessive water runoff.

04	00	03	01	00
Project	Planning	Policy	Research Study	Institutional Mechanism

Action A2.1: Comprehensive Storm water Management Plan



ADPATATION

About

Stakeholder consultations in Jamnagar identified critical zones in Wards 4, 5, and 9 experiencing urban flooding and waterlogging, with water levels reaching up to 1.5 meters. Recent road infrastructure projects have introduced an additional challenge by creating elevation difference of 1 foot between roads (especially Indira Gandhi Road / Jamnagar-Rajkot Highway) and adjacent plots, disrupting drainage and causing water accumulation on private property. To address these issues comprehensively, a storm water management plan is required.

This plan will encompass the entire city (existing network covers only 40%) and utilize the "Source-Pathway-Receptor" approach[4] to optimize drainage throughout the network, from the source of runoff to its final discharge point. This holistic strategy aims to improve flood protection and adaptability to changing weather patterns.

[4]Managing Urban Runoff – Drainage Handbook 2nd Edition: 2024, by the Public Utilities Board (PUB) and the Institution of Engineers Singapore (IES).

Recommendations

Description	Aspect	Responsible Agency
1. 'Source' : To addresses areas where storm water runoff originates 'Source Control' measures aim to slow down the rate at which storm water enters the public drainage system, reducing peak flow and overall volume. ● A study is required to identify waterlogging hotspots, their connection to nearby water bodies and rivers, to identify potential source control measures. Examples of source control measures at individual level include detention tanks, rain gardens, and bioretention swales. ● Incentivize private property owners with a one-time concession on property tax to implement these measures. Strategies for Planning, Designing and Implementing Source Measures : ● Determine the catchment area served by the drainage system ● Calculate developed runoff coefficients and peak runoff rates ● Determine maximum allowable peak discharge ● Determine and design conveyance, detention and/or retention strategies and discharge outlet	**Research Study / Policy** **Short Term**	*JADA* *JMC*
2. 'Pathway' : To significantly improve drainage and reduce flooding on roadways Pathway refers to the means or routes through which stormwater is conveyed. The pathway measures aim to enhance the capacity of our conveyance systems and include drain widening and deepening and building catchment level detention systems, etc. ● The stormwater network will be expanded from its current 40% coverage of developed area to encompass the entire city (100% coverage). ● Pre-monsoon maintenance SOPs will be developed to ensure the system functions optimally, including cleaning and repairs. ● Practices will be implemented to prevent stormwater and sewage from mixing. This may involve separate drainage systems or natural filtration via green infrastructure. ● Following a drainage capacity assessment study, critical north-eastern and north-western watershed zones will see an increase in required drain capacity.	**Project** **Medium Term**	
3. 'Receptor' : Final Discharge Points Receptors are where stormwater flows may propagate to and affect infrastructure (e.g. basements or underground parking areas). ● Setting minimum platform and crest levels for adjacent plots along road and river to ensure proper drainage and installing flood barriers in extreme cases to prevent water from entering buildings.	**Project** **Short Term**	

Case study : Managing Urban Runoff Programme in Singapore

Singapore, a highly urbanized nation, faces the constant threat of flooding due to intense rainfall events. Traditional methods of flood control, such as expanding canals and drains, have limitations, especially in densely developed areas. The Public Utilities Board (PUB) of Singapore implemented a comprehensive drainage improvement programme with a focus on three key objectives:

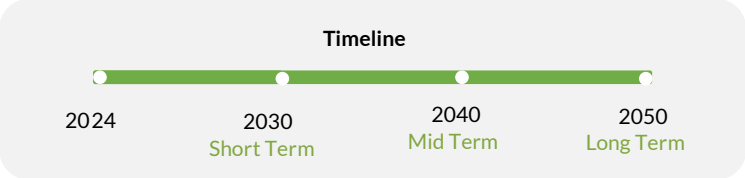
Flood Prevention:
- Proactive planning for new development areas
- Drainage modelling and advanced planning
- Collaboration with other agencies
- Integration of proper drainage infrastructure within new developments

Flood Protection:
- Enforcement of flood protection standards
- Upgrading and constructing new drainage infrastructure
- Adherence to the Code of Practice on Surface Water Drainage
- Reducing flood risks in vulnerable areas

Flood Control:
- Rapid response by dedicated drainage operation teams
- Minimizing the extent and impact of flood events

Recognizing the limitations of traditional methods, PUB adopted a more holistic approach to stormwater management named the “Source-Pathway-Receptor” approach in 2012

Action A2.2 : Managing Groundwater Resources and Combating Saltwater Intrusion



ADPATATION

About

Saltwater intrusion is a major threat to freshwater resources, as rising sea levels and overexploitation of groundwater can cause saltwater to seep into freshwater aquifers, contaminating them and rendering them unusable for drinking, irrigation, and most industrial processes. It also disrupts the delicate balance of coastal ecosystems.

Gujarat state is approved as CRZ in 2011, where Jamnagar city coastal stretches are demarcated under CRZ-IA, CRZ-IB and CRZ-II.

Recommendations

Description	Aspect	Responsible Agency
1. City-Level Strategies – ● Mapping Salinity Ingress and Identifying Contributing Factors: Conduct a comprehensive study to map the extent and severity of saltwater intrusion across the city. This study will identify the primary causes, such as rising sea levels, over-extraction of groundwater, or changes in river flows. ● Groundwater Extraction Management:	Research Study Short Term	*JMC* *Disaster Management Department*
● Metering and Monitoring: ❖ Install Digital Water Flow Meter to monitor the consumption of water from the intake well / Borewell. ❖ Install Piezometer to accurately measure water pressure and monitor water level. ❖ Connect Digital meter and Piezometer to a centralized monitoring system to track water usage from each borewell.	Project Medium Term	
● Regulation and Enforcement: ❖ Establish regulations that limit the volume of water that can be extracted from borewells based on aquifer health assessments and centralized monitoring system. Enforce strict penalties for non-compliance with these extraction limits. ❖ Enact regulations prohibiting drilling new borewells and groundwater extraction in areas with accessible water supply. ❖ Mandate recharge shaft for all existing borewells, setting limit for extraction. ● Information, Education, and Communication (IEC): **Public Awareness and Community Engagement activities promoting permeable surfaces, artificial recharge pits, and planting trees suitable for saline soils at individual and neighborhood levels.**	Policy Medium Term	
2. District-Level Strategies for Coastal Management - ● Coastal Zone Management Plan Adherence : ❖ Restoration and conservation of natural ecosystems such as mangrove forests, breeding grounds of several endangered marine and estuarine species, and low-lying areas susceptible to sea level rise. These ecosystems will act as buffers against storm surges and saltwater intrusion into the city's water table. ❖ Implement setback regulations (200 to 500m) to restrict development in vulnerable coastal areas, provide a buffer to coastal flooding and erosion. ● Constructing check dams on the Rangmati and Nagmati rivers in South Jamnagar and Lalpur Taluka: Check dams are small barriers built across rivers to slow down water flow. This can help control floods during heavy monsoon seasons and regulate water flow throughout the year, preventing excessive runoff that can overwhelm drainage systems and city flooding. ● Monitoring and Early Warning Systems: ❖ Groundwater Salinity Monitoring: Establish a network of monitoring wells to track salinity levels in groundwater with regular analysis (e.g., every five years). ❖ Early Warning System Development: Develop an early warning system to alert authorities and communities about potential saltwater intrusion events.	Project & Policy Long term	*Forests & Environment Department, Government of Gujarat* *JMC – Disaster Management Department,* *District Collector Office,* *District Irrigation Department,* *Marine Forest Department*

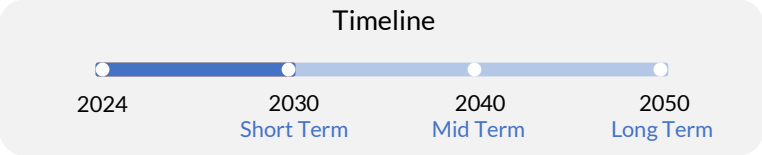
Intervention A 3: Climate-sensitive urban planning

Climate-sensitive planning encourage sustainable building and urban design practices that aim to create a cooler and more comfortable city. This will focus on promoting green infrastructure (parks, urban forests, permeable pavements and green roofs), building level intervention (improved insulation, reflective roofs, and proper ventilation) and vegetation to provide shade, naturally lower air temperature, and improve air quality by absorbing pollutants.

Beyond these direct benefits, climate-sensitive planning will enhance city's aesthetics and create valuable recreational spaces for residents.

06	06	02	00	00
Project	Planning	Policy	Research Study	Institutional Mechanism

Action A3.1: Development of Heatwave prevention strategy



MITIGATION & ADAPTATION

About

Jamnagar city is improving its cover of trees and vegetation, however, in view of the future growth and observed annual mean of daily max, mean and min temperatures of the city is increased by 1°C (from 1950 to 2019) as per Gujarat SAPCC, further predicted to rise. Strategies outlined to balance the urban heat effect are:

Recommendations

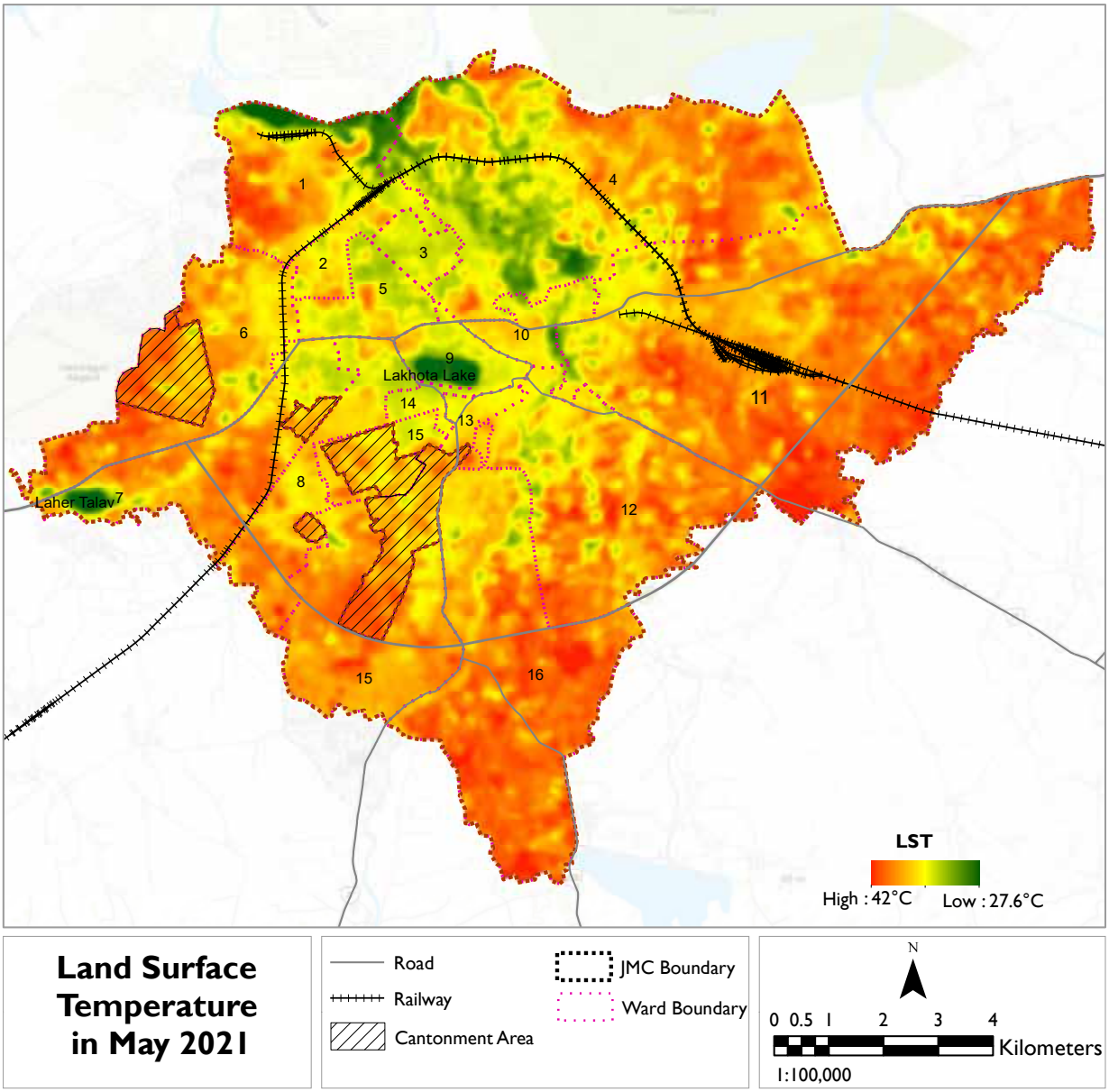
Description	Aspect	Responsible Agency
1. Heat zones identification ● Heat zones (red coloured as per LST Map 11), requires priority attention. The major areas vulnerable to heatwaves are the industrial area (GIDC Dared, Sankar Tekri, Bedeshwar, Navagam), agriculture fallow land and the Cantonment Area. ● To address the hotter zones, Heat Action Plan in association with GIDC is required	**Project** **Short Term**	*JADA* *JMC*
2. Enhancing Green Infrastructure & Heat Shelters: ● Mandate green shade and clean water access at bus stops and along walking pathways. ● Re-paint the current metal members within the bus stops with heat-resistant materials. Cool roof paints on bus stop roof.	**Project** **Medium Term**	*JMC – Project & Planning,*

Description	Aspect	Responsible Agency
3. Reduce impact on Vulnerable Populations: (Vulnerable Population include economically weaker section, socially weaker section, people with disabilities, informal sector workers, elderly, women and children) ● Develop ward-level health plans for slum areas planned for redevelopment by JMC. ● Conduct door-to-door well-being checks and provide medication assistance with medical insurance for informal sector workers. ● Create a SOP during heat waves for, ❖ construction workers ❖ street vendors ❖ outdoor industrial workers ● Provision for shaded vending Zones and heat refuge for street vendors especially near markets and religious places. ● Integrate cool roof strategies into the design of slum redevelopment buildings to improve thermal comfort. ● Deploy portable water tanks and offer transportation to cooling centres during heatwaves.	**Project & Policy** **Short Term**	*JADA* *JMC*
4. Cost-Effective Cool Roof Strategies: ● Mandatory cool roof policy implementation: ❖ For all existing buildings including government buildings such as Anganwadi centres[5], public buildings, health centres, slum redevelopment and more to enhance thermal comfort and cooling efficiency. (Smaller buildings can adopt cool roofs voluntarily). Measure include, » reflective roof coatings with minimum SRI of 90%. » Use of building roof materials such as hollow clay , lime concrete, inverted earthen pots. The performance can further be enhanced with natural water proofing and reflective finish over them such as conventional ceramic tiles, heat resistant tiles or ceramic china mosaic. ● For new construction, expediate building permission process (e.g. single-window clearance) for building designs that promote natural ventilation and utilize heat-resistant insulation materials. Cool roof policy implementation mandatory for all new constructions exceeding 80 sq.mt. of ground coverage. ● Public awareness campaigns will educate the community about the benefits of green buildings and encourage their adoption in both new construction and renovations. ● Feasibility study of green roofs for industrial buildings to provide cooling benefits through evapotranspiration is required.	**Policy** **Medium Term**	*JADA* *JMC*

Case study : Telangana Cool Roof Policy (India)

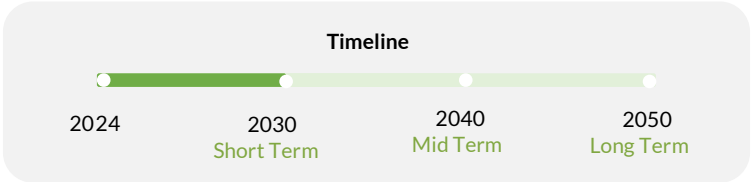
The Indian state of Telangana implemented a cool roof policy in 2023. This policy mandates cool roofs for all government, non-residential, and commercial buildings. The policy aims to achieve a target of 300 square kilometres of cool roof area in the state by 2028.

[5]The word Anganwadi means "courtyard shelter" in Indian languages. Initiated by the Indian government in 1975 as part of the Integrated Child Development Services program to combat child hunger and malnutrition.



Map 11: Land Surface Temperature in May 2021

Action A3.2: Low-carbon and climate-resilient neighborhood development



ADPATATION

About

CAP will be strengthened by incorporating Low-carbon and climate-resilient neighbourhoods. These focused zones will prioritize sustainability and adaptation, fostering a healthier environment. Low-carbon living will promote walkable and cyclable infrastructure, reducing transportation emissions. Additionally, integration of renewable energy sources and energy-efficient building practices to minimize reliance on fossil fuels and overall energy consumption. Beyond climate benefits, this will offer improved air quality and noise reduction through reduced traffic congestion.

Recommendations

Description	Aspect	Responsible Agency
1. Designated Low-Emission Zones (LEZ): ● Zone Definition and Phasing: ❖ Prioritize areas with high population density, traffic congestion, and real-time air pollution levels in coordination with GPCB ❖ Identification of Central Business District (CBD) ❖ Implement LEZs in a phased manner, starting with the most critical areas to test the effectiveness of the program and gather data. Gradually expand the LEZ boundaries based on success and public feedback. ● Vehicle Limitation: ❖ Establish emission standards for vehicles allowed within the LEZ. This could involve restrictions on older vehicles, specific fuel types (e.g., phasing out diesel & petrol vehicles), or requiring cleaner fuel technologies (e.g. EV, Hydrogen). ❖ Consider exemptions for emergency vehicles (e.g., ambulance), public transport with clean technologies, and vehicles used for essential services (e.g., waste collection) with a plan for eventual transition to EV. ● Supporting Infrastructure: ❖ Invest in expanding and improving public transport options within the LEZ and connecting surrounding areas. This could include electric buses, trams, or cycling infrastructure. ❖ Develop a network of electric vehicle charging stations within and around the LEZ to encourage the adoption of cleaner vehicles. ● Enforcement and Signage: ❖ Clearly mark LEZ boundaries with prominent signage informing drivers about restrictions, permitted vehicles, and alternative routes. ❖ Implement automated camera enforcement systems to identify and penalize non-compliant vehicles entering the LEZ. ❖ Co-ordination with Traffic Police Department ● Public Awareness and Incentives: Educate the public about the LEZ program, its benefits for air quality and health, and alternative transportation options.	**Project & Planning** **Short Term**	*GPCB* *JADA* *JMC*
2. Climate-Sensitive Micro-Level Planning: ● Neighborhood level heat reduction and cooling Urban Morphology: ❖ Conduct a redevelopment assessment study for the core city to identify potential sites. Study SOP will focus on climate-resilient strategies incorporating measures like increased green cover and reduced concretization to mitigate the potential impacts of cyclones, floods, heatwave, etc. ❖ Develop rooftop strategy (heat reflective roof), street shading and conduct IEC to adopt energy efficient appliances) especially in dense neighbourhood like Ward 5, 9, 10. Based on the success of pilot projects in priority wards, refine and scale-up to broader urban development plans for Jamnagar. ● **Building-level Urban Design Guidelines: Formulate** climate-resilient **development control regulations and** urban design guidelines for Local Area Plan (LAP) and Town Planning (TP) **with specification on,** ❖ Building orientation for optimal sun exposure and ventilation. ❖ Utilization of light-coloured, reflective building materials. ❖ Integration of passive cooling strategies like natural ventilation and shading. ❖ Strategic placement of trees and green spaces to maximize cooling and manage storm water runoff from individual plot. ❖ Sustainable water management practices like rainwater harvesting and permeable pavements.	**Project & Planning** **Medium Term**	*JADA* *JMC*
3. Building Height Restriction to preserve natural wind flow: ● Maintain Jamnagar's character as a medium-rise (up to 12 stories), wind-friendly city to preserve natural wind flow. ● Designate specific high-rise zones, such as the CBD (Central Business District), based on a comprehensive climate-sensitive wind analysis conducted by the Planning Authority (JADA)	**Project & Planning** **Medium to Long Term**	*JADA* *JMC*

Case study : Paris, France (Balancing Character & Growth)

Paris offers a successful example of building height restrictions. Following the construction of the Tour Montparnasse skyscraper in the 1970s, which disrupted the city's skyline and wind patterns, Paris implemented a height limit of 37 meters (approximately 12 stories) for most new buildings to preserve its low-rise skyline and protect natural wind flow. Exceptions were made for specific areas, such as the La Défense business district, where high-rise development is permitted.

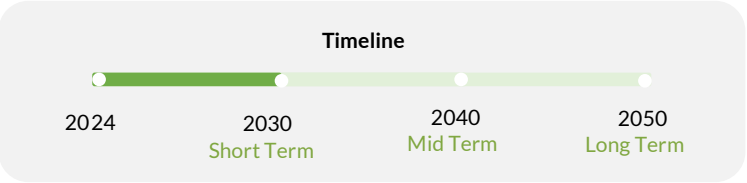
The 1977 height limit was in place until 2010. In 2023, the city reimpose the same regulation followed by construction of Tour Triangle, a 180-meter skyscraper. This approach has helped Paris maintain its historic character and ensure a balance between modern development and preserving a wind-friendly urban environment.

Intervention A 4: Reduce Air Pollution

India's National Clean Air Programme (NCAP) launched in 2019, aims to reduce air pollution by 20-30% by 2024 (compared to 2017 levels) by prioritizing Particulate Matter (PM10 and PM2.5) reductions. Aligning with NCAP, stricter regulations and enforcement for vehicle emissions will significantly help reduce PM contributions from vehicles in Jamnagar city.

06	03	01	02	00
Project	Planning	Policy	Research Study	Institutional Mechanism

Action A4.1 : Clean Air Action Plan for city



ADPATATION

About

A Clean Air Action Plan outlines strategies to combat air pollution within the city. It identifies key sources of pollutants like vehicle emissions, industrial processes, and waste burning. The plan then proposes targeted actions to reduce these emissions. This may involve stricter vehicle emission regulations, promoting clean energy sources, improving public transportation, and encouraging waste management practices that minimize air pollution.

Recommendations

Description	Aspect	Responsible Agency
1. Air Quality Monitoring and Source Identification: ● Study to identify Continuous Ambient Air Quality Monitoring Stations (CAAQMS) locations across city specially GIDC area, and installation in phased manner. ● Air pollution impact study on public health	Project Short Term	*JADA* *JMC* *GPCB*

Description	Aspect	Responsible Agency
2. Industrial Emission Control Strategies: ● Collaborate with industries to identify and implement cleaner production technologies and emission control measures. ● Encourage the use of cleaner fuels and promote the transition to RE sources for industrial operations. ● Establish and enforce stricter air pollution regulations for industries, with penalties for non-compliance. ● Promote regular monitoring and reporting of industrial emissions.	Policy Mid Term	*JADA* *JMC* *GPCB*
3. Construction Site Dust Management: ● Develop and enforce stringent dust control regulations for construction sites specially for the ongoing road infrastructure projects. These regulations will mandate specific measures like: ● Water spraying of exposed soils and construction materials ● Covering stockpiles of sand, cement, and debris ● Enclosing construction sites with tarpaulins to minimize dust dispersion. ● Utilizing wheel washing facilities for construction vehicles to prevent dust from being tracked onto roads.	Policy Short Term	
4. Public Awareness and Education: ● Launch public awareness campaigns in Gujarati, Hindi & English to educate residents about the sources and health impacts of air pollution. Utilize various communication channels like television, radio, social media, and community events to reach a wide audience. ● Promote individual actions to reduce air pollution, such as using public transport, cycling, walking, and adopting eco-friendly practices at home.	Advocacy Short Term	

Intervention A 5: Optimizing Municipal Water Demand and Supply

Reducing demand is just as crucial as increasing supply. The city's current water demand is approximately 150 MLD, while the supply is 140 MLD. Projections from JMC estimate a further rise in demand to 270 MLD by 2054. This anticipated increase presents a potential water gap of 130 MLD for future. To bridge this gap, JMC is undertaking work to increase the capacity of Ranjit Sagar Dam and Und-1 Dam under the AMRUT 2.0 scheme of GoI. This project includes parallel pipeline laying to enhance water supply capacity by an additional 40 MLD. Further with sufficient funding allocation, JMC plans to draw an additional 20 MLD of water from Sasoi Dam in the future.

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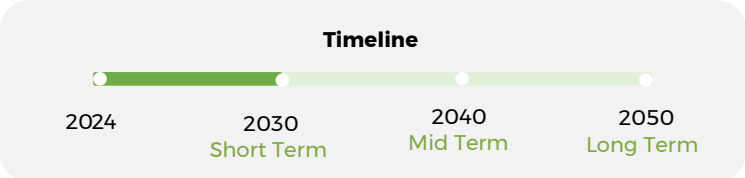
Project	Planning	Policy	Research Study	Institutional Mechanism

Action A5.1 : Efficient Water and Used water system management



ADPATATION

About

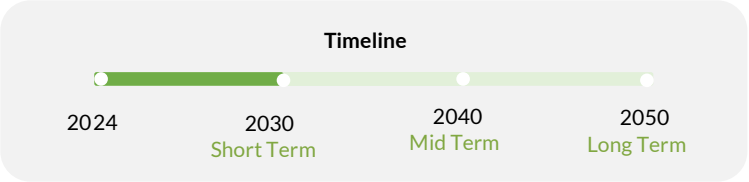
CPHEEO recommends that cities should aim to reduce NRW levels below 20%. Jamnagar is performing well, exceeding this benchmark by 5%. By implementing efficient management practices, such as leakage mapping and a Supervisory Control and Data Acquisition (SCADA) system setup, the city can ensure efficient water resource management. A SCADA system allows real-time monitoring

through sensors placed along the water supply service chain. This will help the city provide freshwater for a longer period and reduce contamination of freshwater resources.

Recommendations

Description	Aspect	Responsible Agency
1. Identifying District Metered Areas (DMAs) and Setting Up a Comprehensive Water Audit System ● DMAs are smaller, defined zones within the city's water distribution network. Each DMA has a single inlet point for treated water and well-defined boundaries with other DMAs or non-revenue water (NRW) areas. ● Identification of DMAs (each covering 1500 to 2000 consumers) in line with American Water Works Association (AWWA) manual / International Water Association (IWA) guidelines. Key components required in each DMA are, ❖ Bulk Meters at the inlet point of each DMA, measuring the total volume of water entering the zone. ❖ Flow Meters at strategic locations within the DMA, such as major junctions or connections to large consumers. ❖ Pumping Stations Maintenance and Optimisation within specific DMAs ❖ Data loggers, pressure sensors, and communication systems will be required to collect, transmit, and store data from meters and other sensors in the network. ● Conducting water audits every 3 years to ensure a periodic assessment of the network's performance. This data-driven approach helps pinpoint water losses and identify areas for improvement.	Policy Medium Term	*JMC*
2. SCADA System Implementation: Installing a Supervisory Control and Data Acquisition (SCADA) system for real-time monitoring of the water supply network by linking DMAs and its key components. ● Benefits of SCADA system, ● prompt identification of leaks, ● potential contamination events, ● optimization of water flow throughout the city, ● proactive maintenance planning, extending the life of the water infrastructure.	Project Medium Term	*JMC*
3. NRW Reduction Strategies for Municipal Water Distribution Systems ● Leak Detection and Repair: Utilizing data from the water audits and DMAs, coupled with advanced leak detection technologies, allows for efficient identification and repair of leaks within the network. ● Pressure Management: Implementing pressure management strategies within DMAs helps minimize leaks caused by excessive pressure and ensures efficient water delivery. ● Metering and Billing: Individual water metering at each user connection promotes responsible water use by providing residents with a clear link between consumption and water bills. Implement individual metering in a phased manner, starting with pilot areas (like new residential developments, high-water consumption zones, commercial establishments) to manage logistics and gauge public response. ● All industrial connection will be equipped with highly accurate and self – powered Electro – Magnetic flow meters replacing ordinary mechanical meters.	Project Short Term	*JMC*

Action A5.2 : Promote Rainwater Conservation



ADPATATION

About

With an average annual rainfall of 527mm, Jamnagar has a valuable but underutilized water resource to reduce dependence on groundwater and ensure the city's long-term water security. A city-wide rainwater harvesting program at the ward and household level can unlock a sustainable solution. The D2 - Gujarat Development Control Regulation (GCDCR) already provides a framework for rainwater harvesting in Jamnagar. This regulation mandates:

- Permeable surfaces: Buildings must maintain at least 50% of their open space unpaved to facilitate rainwater infiltration and groundwater recharge.
- Rainwater harvesting systems: All buildings exceeding 80 square meters in ground coverage require implementation of rainwater harvesting systems. The captured rainwater can be used for non-potable purposes.
- Storage capacity: Buildings larger than 1,000 square meters necessitate dedicated rainwater storage tanks to maximize water utilization throughout the year.

However, current implementation of GCDCR remains low (0.063% of buildings from 2017 to 2024). To address this, educational campaigns at all levels, from schools to communities, are required to foster awareness and encourage widespread adoption of rainwater harvesting. Community collaboration can leverage rooftops in apartment and row house buildings for rainwater capture into shared storage tanks. At city level, the captured rainwater can be utilized for city maintenance activities like park landscaping and dust suppression. At individual buildings, harvested rainwater can be used for non-potable purposes like gardening, vehicle washing, laundry, or toilet flushing, thereby reducing their dependence on groundwater resources.

Recommendations

Description	Aspect	Responsible Agency
1. At City Level: Review and potentially strengthen existing GCDCR regulations regarding Rainwater Harvesting (RH), with city level incentive such as, ● Mandatory to incorporate RH systems for both existing and new constructions as follows, ❖ For existing constructions : RH mandate to continue receiving municipal services such as water supply, door-to-door waste collection, sanitation maintenance services, etc. ❖ For new constructions : RH mandate to obtain 'Building completion certificate'. ● Offer subsidies of 50-50 cost installation sharing (or water bill rebate up to 50%) for incorporating rainwater harvesting systems in new and existing buildings will be explored. ● Demonstration successful RH implementations projects in public buildings, parks, and community centres. Organize tours and workshops to educate the public and encourage replication. ● Launch citywide campaigns through various media channels (radio, social media) to educate residents about the benefits of RH for both individual households and the city's overall water security. ● Establish a system to track the number of RH systems installed and the volume of rainwater captured. This data can be used to measure the program's effectiveness and guide future strategies.	Policy Short Term	*JADA , JMC – Water Works department*

2. At Neighbourhood Level: ● Community Mobilization: Organize workshops and training sessions for residents on the design, installation, and maintenance of RH systems. ● Community-Based Projects: Encourage collaboration between residents to develop shared RH systems for parks, community gardens, or common areas in apartment buildings. ● Neighbourhood Recognition Programs: Implement awards or recognition programs for communities demonstrating leadership in RH adoption.	**Policy** **Short Term**	*JADA , JMC – Water Works department*
3. At Building Level: ● Implement tiered regulations : For smaller buildings simplify system such as rooftop harvesting with storage tanks, while larger buildings will have systems with filtration and reuse capabilities. ● Allow flexibility in storage solutions beyond underground tanks. Consider above-ground tanks or integrated storage within building structures for space-constrained locations. ● Develop clear guidelines and recommendations for testing the quality of harvested rainwater for different intended uses (e.g., gardening, toilet flushing, vehicle washing, laundry). ● Organize training sessions for building managers and maintenance personnel on operating and maintaining RH systems.	**Policy** **Short Term**	*JADA , JMC – Water Works department*

Intervention A 6: Treatment of Used Water and its management

The city is committed to addressing its current 25 MLD used water treatment gap. Construction of four STPs with a combined capacity of 70 MLD is underway. These STPs will have varying capacities of 20 MLD, 30 MLD, 10 MLD, and 10 MLD. Upon completion, they will serve an estimated 175,516 households, representing 87.75% of the total in JMC. This initiative is being undertaken concurrently with the expansion of the underground drainage network under the AMRUT 2.0 scheme.

As per Gujarat's "Policy for Reuse of Treated Waste Water (TWW)" , the policy lays out a time-bound and systematic plan for cities to reuse TWW fully by 2030. This plan includes a target to reuse at least 25% of total fresh water consumption from TWW within the time limit set under the policy by every municipal body, followed by further increases to 70% and 100% by 2025 and 2030, respectively.

For Jamnagar city, with both a UGD collecting system and STP available, the timeframe to implement a minimum 25% fresh water reuse of treated wastewater is one year. Adhering to which, JMC has already begun processing tenders for TWW use with different sectors.

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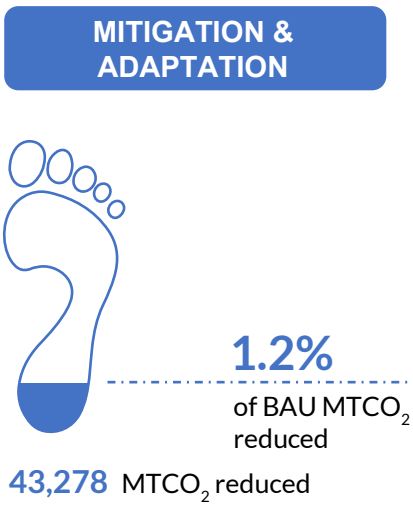
Project	Planning	Policy	Research Study	Institutional Mechanism

Action A6.1 : Treated used water (TUW) for industry



About

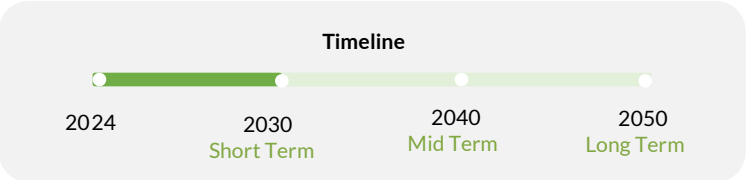
TUW use is mandated for all GIDC estates, industrial units within Special Investment Regions (SIRs) and industrial parks, along with large industrial users consuming at least 100,000 liters of fresh water daily for non-potable purposes, as per the aforementioned policy. The policy applies to these entities if they are located within 50 km of a STP or city limits. However, TUW use is not mandatory for processes involving direct human contact or production of goods for human consumption.

In Jamnagar, discussions regarding water reuse are ongoing with several industries. The JMC has proposed a cost model for industrial TUW use, offering two options. The first option, a 50/50 network coverage model, incurs a 45% surcharge on existing water supply charges. The second option, a door-to-door network model, comes with a 60% additional charge.

Recommendations

Description	Aspect	Responsible Agency
1. TUW for various non-potable applications in the Brass Industry ● Cooling: A substantial amount of water is used in cooling processes during brass production. Properly treated TUW can be a viable alternative to freshwater for cooling machinery and equipment. ● Boiler Feedwater: After appropriate treatment, TUW can be used for supplementing boiler feedwater, particularly in low-pressure boilers. ● Process Water: Certain stages of brass production may utilize water for cleaning or rinsing purposes. TUW can be a suitable replacement for freshwater in these applications.		*JADA , JMC – Water Works department*

Action A6.2 : TUW for Horticulture and Commercial sector



ADPATATION

About

JMC is also exploring potential applications for treated used water. A tender is being prepared to propose supplying 5 MLD to a Waste-to-Energy plant and 4 MLD to nearby farmers for irrigation purposes.

Intervention A 7: Ecosystem restoration of local biodiversity

Healthy ecosystems play a crucial role in climate change adaptation. Forests and wetlands act as carbon sinks, absorbing and storing greenhouse gasses. Additionally, diverse plant life helps regulate local temperatures and provides natural flood control.

Restoring local biodiversity involves initiatives like tree cover expansion, promoting native plant species, and wetland protection. This not only enhances the city's natural beauty but also strengthens its ecological resilience in the face of climate change. A healthier ecosystem also supports a wider variety of wildlife, contributing to a more balanced natural environment.

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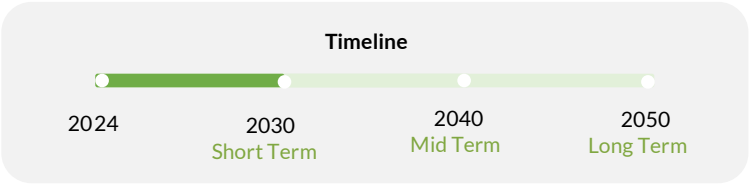
Project	Planning	Policy	Research Study	Institutional Mechanism

Action A7.1 : Documentation of biodiversity hotspots



ADPATATION

About

Jamnagar has established a Biodiversity Management Committee (BMC). However, the city's biodiversity initiatives have been inadequate. Given that the city's industrial zone is situated within an eco-sensitive area, it is imperative to take comprehensive actions towards biodiversity management and conservation.

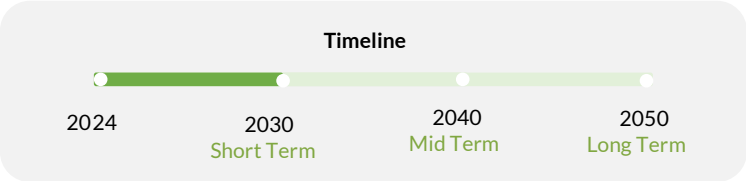
Documentation of biodiversity involve cataloguing existing plant and animal life, creating a baseline for future monitoring and conservation efforts.

Recommendations

Description	Aspect	Responsible Agency
1. Mandatory functioning of the Biodiversity Management Committee (BMC) *(The Biodiversity Act, 2004 (Section 41) empowers Municipal Corporations and Gram Panchayats to establish BMCs within their jurisdictions. These BMCs can then undertake activities relevant to overall biodiversity management in their respective areas)* As outlined in Rule 22 of the Biodiversity Rules, 2004, BMCs have several key functions: ● The main function of the BMC is to prepare People's Biodiversity Register in consultation with the local people. ● Advice and provide technical support on any matter referred to it by the State Biodiversity Board or Authority for granting approval. ● Levy charges from any person for accessing/collecting any biological resource for commercial purposes ● Eco-restoration of the local biodiversity, management of sacred groves and sacred water bodies, conservation of traditional varieties/breeds of economically important plants and animals.	**Project** **Short Term**	*JADA , JMC, Forest Dept.*
2. Preparation of the People's Biodiversity Register (PBR) *(PBR contains comprehensive information on locally available Bio-resources, including landscapes and city demographics)* Preparation Stages : ● Identifying Biodiversity Hotspots for study and documentation. ● Public Awareness and Participation about the PBR process and encouraging to share their knowledge. ● Capacity Building for Data Collection and documentation. ● Data Analysis and Validation in consultation with technical support groups and the BMC. ● Documentation in Various Formats, including booklets, digital asset maps, photographs, drawings, audio/video recordings, and printed materials.[6]	**Project** **Short Term**	*JADA , JMC, Forest Dept.*
3. Preparation of the Local Biodiversity Strategy and Action Plan (LBSAP) *(LBSAPs serve as local government blueprints for optimal biodiversity and ecosystem management. These guiding strategies, mirroring National Biodiversity Strategy and Action Plans (NBSAPs) at the local level, outline city specific actions)* Preparation Stages : ● Baseline Assessment: Identify natural resources, ecological zones, and biodiversity changes. ● Review Existing Plans: Incorporate relevant departmental plans for biodiversity benefits. ● Land Use Integration: Identify potential green habitats based on land use patterns. ● Action Plan Development: Prioritize areas and species, develop species/habitat strategies. ● Development Plan Integration: Integrate LBSAP with development plan, outlining implementation details.	**Project** **Medium Term**	*JMC*

[6]National Biodiversity Authority, 2013 Revised PBR guideline available at : http://nbaindia.org/uploaded/pdf/PBR%20Format%202013.pdf

Action A7.2 : Implementing Sustainable Livestock Management and Wildlife Conservation Strategies



ADPATATION

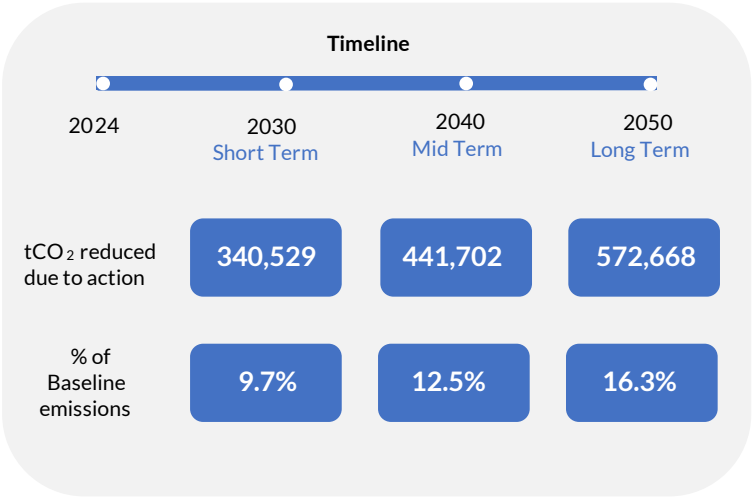
About

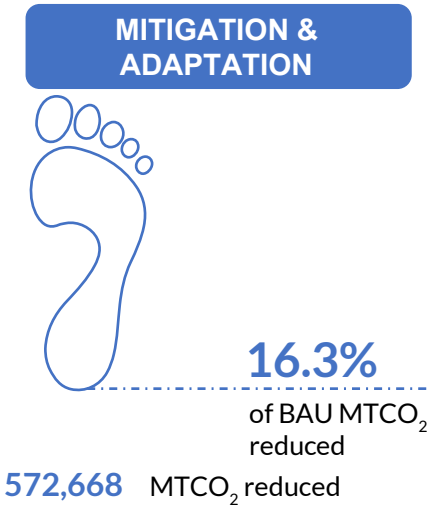
Wildlife conservation plays a crucial role in maintaining ecological balance. Protecting natural habitats within and around Jamnagar, especially those identified as biodiversity hotspots, will safeguard vital ecosystem services. Similarly, sustainable livestock practices will protect cattle and capture methane emissions for sustainable use.

Recommendations

Description	Aspect	Responsible Agency
1. Wildlife conservation strategies : ● Demarcation of wildlife zones as : Establish buffer zones with reduced human activity around wildlife corridors ❖ Intensive management zone ❖ Administrative zone ❖ Tourist zone ● Identify and map potential wildlife corridors connecting fragmented habitats. Consider construction of wildlife passages such as underpasses, overpasses, and culverts at critical points to reduce human wildlife conflict.	Project Short Term	*JADA , JMC, Forest Dept.*
2. Livestock Management Strategy : ● Livestock Identification and Registration : Implement a mandatory livestock tagging program linked to an ownership registration database. ● Deterrence of Cattle Abandonment : Impose a financial penalty of at least ₹ 15,000 for abandoning cattle. ● Management of Abandoned Cattle : Abandoned cattle will be impounded and managed in government Gau-Shala (cow shelters). ● Cost Recovery for Management : A one-time fee equivalent to the average cost of sheltering and caring for an abandoned animal will be levied on the owner to recover management expenses. ● Installation of decentralized Biogas Plants at Gaushalas to convert waste into biogas and bio-fertilizers. Fuel can be used in anganwadis, EWS housing, and government school kitchens, and bio-fertilizer to nourish urban forests, city green cover, and other landscaping projects in city.		

Action A7.3 : Protecting and enhancing urban green spaces



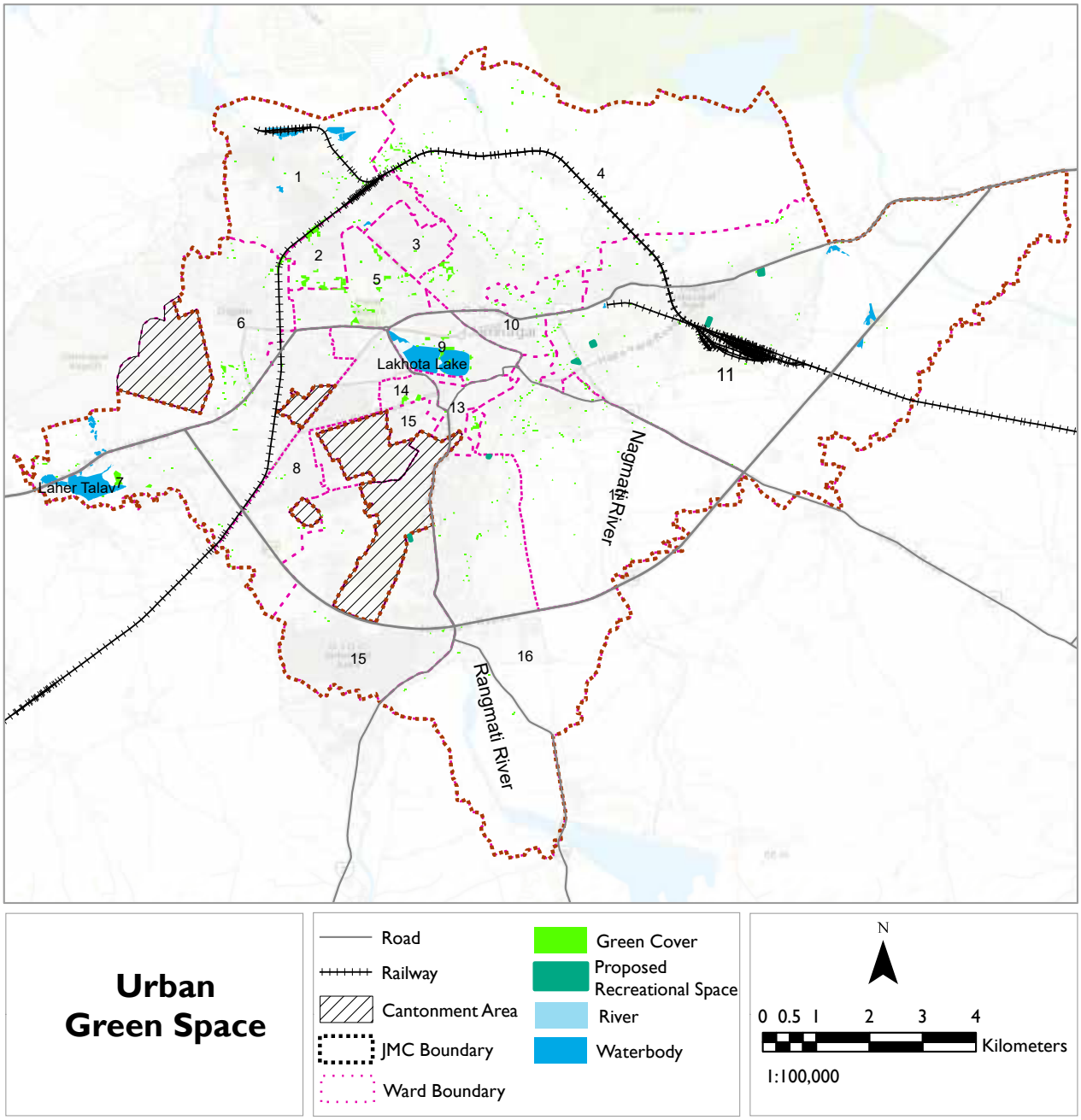


About

The city's per capita urban green space is 0.98 sqm, falling short for both the URDPFI guidelines (10-12 sqm) and WHO standards (9 sqm). This translates to 0.09 hectares of green space per 1,000 population in comparison to the URDPFI recommendation (1.2-1.4 Ha). While these figures suggest less progress, the distribution of green cover remains uneven (as shown in Map 11), limiting accessibility for some residents.

Recommendations

Description	Aspect	Responsible Agency
1. For carbon sequestration, 2.5 trees/ capita is required by 2050 to mitigate the climate change effect. This could involve creating new parks and green areas in underserved neighbourhoods and improving pedestrian connections to existing green spaces.	**Project** **Long Term**	*JADA , JMC, Forest Dept.*
2. Tree Census and Annual Survival Audit of Sapling: ● Conducting the census every 10 years for monitoring changes in the tree population over time. Data Collection to include, ● Species Identification: Record the scientific name of each tree, along with any common names used locally for better identification by the public. ● Typology: Classify trees based on various parameters like: ❖ Growth Habit ❖ Canopy Cover ❖ Fruiting/Flowering ● Location Data: Utilize GPS technology or a Geographic Information System (GIS) to accurately map the location of each tree. ● Size Measurements: Measure tree parameters like diameter at breast height (DBH) and total height to estimate biomass and track growth over time. ● Health Assessment: Evaluate the overall health of each tree, noting any signs of disease, pest infestation, or damage. ● An annual audit specifically focuses on tracking the survival rate of newly planted saplings to assess the effectiveness of plantation drives and identify areas for improvement. ❖ Methodology: Revisit the planting sites from the previous year's plantation drives. Count the number of surviving saplings to determine the survival rate. ❖ Analysis: Identify factors that may have contributed to sapling mortality (drought, pests, improper planting techniques). ❖ Action: Based on the findings, refine planting practices, improve aftercare measures (watering, mulching), and potentially replant failed sites.	**Project** **Medium Term**	*JADA , JMC, Forest Dept.*



Urban Green Space

Road
Railway
Cantonment Area
JMC Boundary
Ward Boundary
Green Cover
Proposed Recreational Space
River
Waterbody

N
0 0.5 1 2 3 4
Kilometers
1:100,000

Map 12: Urban Green Space in Jamnagar City

URDPFI guidelines emphasize accessibility, recommending green spaces within walking distances of 300-500 meters (5-15 minutes). The current distribution in Jamnagar lack this level of accessibility for all its citizens. Moving forward, efforts will focus on increasing per capita urban green space and ensuring equitable distribution of green spaces throughout the city.

ANNEXURE I: GHG Methodology

Emission Factors to Estimate Emissions from Various Sources

The emission factors used to estimate the carbon emissions from various sources are listed in Table 1. The Global Warming Potential (GWP) of gases is listed in Table 2.

Table 1 : Emission factors for India 2021-22

S.No.	Electricity/ Fuel	Emission Factor	Unit	Emission Factor	Unit
1	Electricity	0.815	tCO2/MWh	815	tCO2/kWh
2	Electricity (including RE)	0.715	tCO2/MWh	715	tCO2/kWh
3	Petrol	2.20307	tCO2/kL	2203.07	tCO2/L
4	Diesel	2.62694	tCO2/kL	2626.94	tCO2/L
5	CNG	0.48066	tCO2/kL	480.66	tCO2/L
6	LPG	1.51906	tCO2/kL	1519.06	tCO2/L
7	PNG	0.48066	tCO2/kL	480.66	tCO2/L

Source: https://cea.nic.in/wp-content/uploads/baseline/2023/01/Approved_report_emission__2021_22.pdf

Table 2 : Global Warming Potential of Gases

S.No.	Name	Formula	GWP
1	Carbon Dioxide	CO2	1
2	Methane	CH4	28
3	Nitrous Oxide	N2O	265
4	Sulphur hexafluoride	SF6	23,500
5	Carbon tetrafluoride	CF4	6,630
6	Hexafluoroethane	C2F6	11,100
7	HFC-23	CHF3	12,400
8	HFC-134a	-	1,300

Source: IPCC 5th Assessment Report

Formulas and Calculations

For most of the emissions sources, GHG emissions are estimated by multiplying activity data by an emission factor associated with the activity being measured as mentioned in Eq. Activity data is a quantitative measure of a level of activity that results in GHG emissions taking place during a given period of time. An emission factor is a measure of the mass of GHG emissions relative to a unit of activity.

Emissions = Activity data x Emission Factor (1)

Emissions from consumption of grid-supplied energy within the city boundary

For estimating CO_2 emissions from consumption of grid-supplied energy the data on kilowatt-hours (kWh) of electricity used is multiplied by the emission factor (tCO_2/kWh) for electricity, which will depend on the technology and type of fuel used to generate the electricity. The emission factors considered for electricity are shown in Table 1.

Emissions from fuel combustion within the city boundary

For estimating CO_2 emissions from fuel combustion, the data on Litres (L) of type of fuel sales (volume of fuel purchased within the city boundary) is multiplied by the respective emission factor (tCO_2/L) for Petrol, Diesel, CNG, LPG and PNG. The emission factors considered for all fuel type are mentioned in Table 1.

Emissions from in-boundary waste treatment

The IPCC methodology for estimating CH_4 emissions from SWDS is based on the First Order Decay (FOD) method. This method assumes that the degradable organic component (degradable organic carbon, DOC) in waste decays slowly throughout a few decades, during which CH_4 and CO_2 are formed. If conditions are constant, the rate of CH_4 production depends solely on the amount of carbon remaining in the waste. As a result, emissions of CH_4 from waste deposited in a disposal site are highest in the first few years after deposition, then gradually decline as the degradable carbon in the waste is consumed by the bacteria responsible for the decay.

The equations for estimating the CH_4 generation are given below. As the mathematics are the same for estimating the CH_4 emissions from all waste categories/waste types/materials, no indexing referring to the different categories/waste materials/types is used in the equations below.

First order of decay (FOD) model

- Methane Emissions

The CH_4 emissions from solid waste disposal for a single year can be estimated using Equation 2. CH_4 is generated as a result of degradation of organic material under anaerobic conditions. Part of the CH_4 generated is oxidised in the cover of the SWDS, or can be recovered for energy or flaring. The CH_4 actually emitted from the SWDS will hence be smaller than the amount generated.

$$CH_4\ Emissions = \left[\sum_x CH_4\ generated_{x,T} - R_T\right] X\ (1 - OX_T) \quad (2)$$

Where:

CH_4 Emissions = CH_4 emitted in year T, Gg
T = inventory year
x = waste category or type/material
R_T = recovered CH4 in year T, Gg
OX_T = oxidation factor in year T, (fraction)

The CH_4 recovered must be subtracted from the amount CH_4 generated. Only the fraction of CH_4 that is not recovered will be subject to oxidation in the SWDS cover layer.

- Methane Generation

The CH_4 potential that is generated throughout the years can be estimated on the basis of the amounts and composition of the waste disposed into SWDS and the waste management practices at the disposal sites. The basis for the calculation is the amount of Decomposable Degradable Organic Carbon (DDOCm) as defined in Equation 3. DDOCm is the part of the organic carbon that will degrade under the anaerobic conditions in SWDS. It is used in the equations and spreadsheet models as DDOCm. The index m is used for mass.

$$DDOC_m = W \; X \; DOC \; X \; DOC_f \; X \; MCF \tag{3}$$

Where:
DDOCm = mass of decomposable DOC deposited, Gg
W = mass of waste deposited, Gg
DOC = degradable organic carbon in the year of deposition, fraction, Gg C/Gg waste
DOCf = fraction of DOC that can decompose (fraction)
MCF = CH4 correction factor for aerobic decomposition in the year of deposition (fraction)

CH_4 generation potential (Lo) is defined as the product of DDOCm, the CH_4 concentration in the gas (F) and the molecular weight ratio of CH_4 and C (16/12) as mentioned in Equation 4.

$$L_0 = DDOC_m \; X \; F \; X \; \frac{16}{12} \tag{4}$$

Where:
Lo = CH4 generation potential, Gg CH4
DDOCm = mass of decomposable DOC, Gg
F fraction of CH4 in generated landfill gas (volume fraction)
16/12 molecular weight ratio CH4/C (ratio)

Using DDOCma (DDOCm accumulated in the SWDS) from the spreadsheets, the above equation can be used to calculate the total CH_4 generation potential of the waste remaining in the SWDS.

The IPCC Waste Model allows the user to change the default delay of six months to a different value. It is good practice to choose a delay time of between zero and six months. Values outside this range should be supported by evidence.

Emissions from in-boundary wastewater treatment

"Wastewater can be a source of methane (CH_4) when treated or disposed of anaerobically. It can also be a source of nitrous oxide (N_2O) emissions. Carbon dioxide (CO_2) emissions from wastewater are not considered in the IPCC Guidelines because these are of biogenic origin and should not be included in national total emissions. Wastewater originates from a variety of domestic, commercial and industrial sources and may be treated on-site (uncollected), sewer to a centralized plant (collected) or disposed untreated nearby or via an outfall. Domestic wastewater is defined as wastewater from household water use, while industrial wastewater is from industrial practices only."

Source 2006 IPCC Guidelines.

- CH4 emissions from domestic wastewater

$$CH_4\ Emissions = \left[\sum \left(U_i\ X\ T_{i\ j}\ X\ EF_j\right)\right](TOW - S) - R \quad (8)$$

Where:

CH_4 Emissions = CH_4 emissions in inventory year, kg CH_4/yr

TOW = total organics in wastewater in inventory year, kg BOD/yr

S = organic component removed as sludge in inventory year, kg BOD/yr

U_i = fraction of population in income group i in inventory year

$T_{i,j}$ = degree of utilisation of treatment/discharge pathway or system, j, for each income group fraction i in inventory year

I = income group: rural, urban high income and urban low income

J = each treatment/discharge pathway or system

EF_j = emission factor, kg CH4 / kg BOD

R = amount of CH4 recovered in inventory year, kg CH4/yr

- CH4 emissions factor for each domestic wastewater treatment/discharge pathway or system

The emission factor for a wastewater treatment and discharge pathway and the system is a function of the maximum CH_4 producing potential (Bo) and the methane correction factor (MCF) for the wastewater treatment and discharge system, as shown in Equation 9. The Bo is the maximum amount of CH_4 that can be produced from a given quantity of organics (as expressed in BOD or COD) in the wastewater. The MCF indicates the extent to which the CH_4 producing capacity (Bo) is realised in each type of treatment and discharge pathway and system. Thus, it is an indication of the degree to which the system is anaerobic.

$$EF_j = B_o\ X\ MCF_j \quad (9)$$

Where:

EFj = Emission factor, kg CH4/kg BOD

j = Each treatment/discharge pathway or system

Bo = Maximum CH4 producing capacity, kg CH4/kg BOD

MCFj = methane correction factor (fraction)

- Totally organically degradable material in domestic wastewater

The activity data for this source category is the total amount of organically degradable material in wastewater (TOW). This parameter is a function of the human population and BOD generation per person. It is expressed in terms of biochemical oxygen demand (kg BOD/year). The factor I values in Equation 10 expresses the BOD from industries and establishments (e.g., restaurants, butchers or grocery stores) that are co-discharged with domestic wastewater.

$$TOW = P\ X\ BOD\ X\ 0.001\ X\ I\ X365 \quad (10)$$

Where:
TOW = total organics in wastewater in inventory year, kg BOD/yr
P = country population in inventory year, (person)
BOD = country-specific per capita BOD in inventory year, g/person/day
0.001 = conversion from grams BOD to kg BOD
I = correction factor for additional industrial BOD discharged into sewers (for collected the default is 1.25, for uncollected the default is 1.00)

Carbon Sequestration from Trees and Forests

Carbon sequestration in plant biomass is determined using the above ground biomass (AGB) and below ground biomass (BGB) method. To calculate this, the girth at breast height (GBH) and height of the trees were obtained from scientific literature. The AGB and BGB were then calculated using following formulas:

Basal area (m^2) = $(GBH)^2/(4\pi)$
Bio-volume (m^3) = Basal area x Height of the tree
AGB (kg) = Bio-volume x Wood density (kg/m^3)
BGB (kg) = AGB x 0.26 (where 0.26 = Root to Shoot ratio)
Total Biomass (TB) in kg/tree = AGB + BGB
Total Carbon Sequestered (TC) = (in kg/tree) TB/2

The wood density of the individual tree species is considered from the literature. The CO_2 equivalent was calculated using the following formula:

$$CO2\text{-}eq. = (TC \times 44)/12$$

Where, 44 and 12 are the molecular and atomic weight of CO_2 and C, respectively.

Carbon sequestration is influenced by both the species and the girth at breast height (GBH) of trees. As plants age, their biomass accumulation increases until they reach death. It is important to note that both above and below ground biomass of plants play a significant role in sequestering terrestrial carbon.

ANNEXURE II: Flood Risk Assessment Methodology

In the study, the Analytical Hierarchy Process (AHP) is employed as a key method in the multi-criteria decision-making (MCDM) framework to determine the relative importance of various flood-controlling factors. This approach facilitates the assignment of weights to each factor, aiding in the identification and mapping of flood-prone areas. Weights were assigned based on the local physical characteristics of the study area and insights from previous research. Each factor received a value between 1 and 9, representing its relative importance, with 1 indicating equal importance and 9 indicating extreme importance, allowing for the construction of a pairwise comparison matrix. Following this, a normalized pairwise comparison matrix was generated to compute the weight of each factor. To ensure the validity of the comparisons, a consistency check was conducted using the equations provided. The Consistency Index (CI) was calculated as follows:

$$\mathbf{CI} = (\lambda_{max} - n) / (n-1)$$

where CI is the consistency index, n is the number of factors compared, and λ_{max} is the highest eigenvalue of the matrix. The maximum eigenvalue was then determined. The Consistency Ratio (CR) was calculated using:

$$\mathbf{CR} = CI / RI$$

where CR is the consistency ratio, CI is the consistency index, and RI is the random index, which varies based on the number of factors. A CR value below 0.10 indicates acceptable consistency; values of 0.10 or above suggest inadequate consistency, necessitating a repeat of the comparison process until an acceptable CR is achieved. After reclassifying each flood-controlling factor to a common scale of 1 (very low) to 5 (very high) using GIS software and applying the AHP-derived weights, the spatial layers were integrated using the weighted overlay technique. The flood susceptibility map of the study area was generated using the following equation:

$$\mathbf{FS} = \sum_{i=0}^{n} x_i * w_i$$

where FS represents flood susceptibility, n is the number of decision criteria, x_i is the normalized criterion, and w_i is the corresponding weight. The values of the raster layers were multiplied by their AHP-derived weights, and the results were summed to create the final flood risk assessment map.

ANNEXURE III: Stakeholder Consultation

City Official Consulted

S. No.	Name	Designation	Department
1	Mr K. K. Bishnoi	Chief Fire Officer	First Emergency Services
2	Mr Deepak Shingala	Dy. Ex. Engineer	House Tax
3	Mr Urmil Desai	Dy. Ex. Engineer	Town Planning Office
4	Mr Anil K. Bhati	Dy. Ex. Engineer	Town Planning Office
5	Mr A. G. Oza	Senior Officer	GPCB
6	Mr Ketan M Kateshiya	Dy. Ex. Engineer	Town Planning Office
7	Mr Naresh M. Patel	Ex. Engineer	Water Works
8	Mr Rushabh Mehta	Dy. Ex. Engineer	Light Branch
9	Mr Chetan Sangavi	Jr. Engineer	Project & Planning
10	Mr Haresh C. Vaniya	Jr. Engineer	Civil Branch
11	Mr B P Jadeja	ForestR.	Forest
12	Mr Nakum Hasmukh N.	Jr. Engineer	Civil Branch
13	Mr Nimesh V. Rathod	Jr. Engineer	Civil Branch
14	Mr G V Rathod	Jr. Engineer	Civil Branch
15	Mr Deepak Shukla	Jr. Engineer	T.P.D.P Branch
16	Mr Khant Ashvin S.	AAECCS	GMB

S. No.	Name	Designation	Department
17	Mr B N Janisir	CE & DMC	JMC
18	Mr A P Joshi	DE	Housing JMC (SBM Toilets)
19	Mr Rajiv B. Jani	DE (Project)	Project & Planning
20	Mr Manoj D. Rathod	Jr. Engineer (Project)	Project & Planning
21	Mr Himanshu H. Jethva	Jr. Engineer (Civil)	Civil West Zone
22	Mr Sanjay Khimsuriya	WA	Zone Head Work
23	Mr Ramesh G. Solanki	Jr. Engineer (Civil)	Civil Central
24	Mr D R Panchal	Maleria Officer	Health Branch
25	Mr Ramesh Rathva	Jr. Engineer	Underground
26	Mr Shubham Vekariya	W.A. (Civil)	JMC (Civil)
27	Mr Bhagirath Gondaliya	D.P.O.	Disaster Management Cell
28	Mr Paresh V. Rathod	P.O.	Disaster Management Cell
29	Mr Naresh Chaudhary	AIMV	RTO, Jamnagar
30	Mr V.P. Makwana	J.E. (Electrical)	JMC

NGOs Consulted

S. No.	Name	Designation	Department
1	Er. Himanshu R. Jani	NNC/ FAE (IPP)	FAE/ NCC
2	Mr Sharad M. Sheth	P.P RK Jam	Rotary Club of Jamnagar
3	Mr Dharmesh Patel	Member	Navanagar Nature Club
4	Mr Vijaysingh Jadeja	President	Navanagar Nature Club
5	Ms Kajal Pandya	Managing Trustee	Chaitnya Charitable Trust (NGO)
6	Mr Hitesh Pandya	Trustee	Chaitnya Charitable Trust (NGO)
7	Mr Milan Kantariya	Member	L.N.C.
8	Mr Malay Thaker	W.A.	JMC
9	Mr Mittal Patel	Project Consultant	SDG Trust
10	D D Joshi	Member	F.F.C.T.
11	Ms Vishakha Kakadiya	Project Manager	F.F.C.T.

S. No.	Name	Designation	Department
12	Mr Jay Bhayani	Member	NGO
13	Mr Kalpesh Hadiyee	V.P.	FAE
14	J C Jignesh Changani	President	NGO
15	Mr Dipakbhai Vataliya	President	NGO
16	Jil Jignesh Changani	Trustee	NGO
17	Er. Hardik A. Dave	President	Fed. of Architect & Engineer Association
18	Mr Dharmesh Sheth	ASM GUJARAT	JDMAGOLTD
19	Mr Kamlesh R. R	Trustee	Lakhota Nature Club
20	Mr Utpal Niranjan Dave	Member	Navanagar Nature Club
21	Er. Ashish B Asha	Secretary	Fed. of Architect & Engineer Association
22	Ms Pratibha Joshi	Intern	Chaitnya Charitable Trust (NGO)














KHIJADIYA BIRD SANCTUARY


Notes:

Photo Credit: Gujarat Tourism