Visakhapatnam

Green City Action Plan

Step towards achieving Eco-Vizag

IN PARTNERSHIP WITH

DEVELOPED USING

About this Document

This report, the Eco-Vizag Green City Action Plan (GCAP), presents an overview of the city's green ambitions and prioritized actions. The GCAP was developed using Advanced Practices for Environmental Excellence in Cities (APEX), an innovation of International Finance Corporation (IFC), a member of the World Bank Group.

This project is co-funded by the European Union. Its content does not necessarily reflect the views of the European Union.

We would like to extend our heartfelt gratitude to the European Union for their funding and support of the Eco-Vizag Green City Action Plan project under the Accelerate Climate-Smart, Inclusive Infrastructure in South Asia (ACSIIS) program.

We are also grateful for the funding and support of the UK Government under the Market Accelerator for Green Buildings (MAGC) program.

Disclaimer Notice

September 2024

Cover Image: istockphoto.com

Table of Contents

Acknowledgments

The Eco-Vizag Green City Action Plan (GCAP) is the result of a collaboration between the Greater Visakhapatnam Municipal Corporation (GVMC) officials and the International Finance Corporation (IFC). The diagnostic leverages a new IFC initiative, Advanced Practices for Environmental Excellence in Cities (APEX), which is supported by the APEX Online App, a tool that helps quantify and prioritize policy and investment solutions across four key sectors: energy, transportation, waste, and water.

The GCAP was initially steered by the Ex-Commissioner, Saikanth Varma, Indian Administrative Service (IAS), Ex- Additional Commissioner Development KS Viswanathan IAS, Additional Commissioner Finance SS Varma IAS, and Ex-Additional Commissioner Public Health Dr. V Sanyas Rao. The GCAP team would like to thank the present GVMC city commissioner, Sampath Kumar, IAS, for his cordial leadership and perseverance in taking this forward.

The GCAP development was coordinated by Dr. N Srinivasa Rajamani, head of the Sustainability and Resilience Unit, GVMC working together with the technical team including Dr. Swapna Kota, Vivek Varma D, D Sai Meghana, Sri Akshata, G Prasanthi Kumari, and E Sasikala. This GCAP was prepared with technical input from the following officials from the energy distribution, transmission, and generation service provider Samba Shiva Rao, Energy conservation cell, Andhra Eastern Power Limited (APEPDCL), Mahendranath, Superintendent Engineer, Distribution and Supply, Andhra Eastern Power Limited (APEPDCL), and the following officials at GVMC who led the development of the plan as Sector Leads: P Ravi Krishna Raju, (ex-City Chief Engineer), M Vinay Kumar (present City Chief Engineer), Ram Kumar (AP Road, Traffic and Transport Department), Damodar Rao (Parks and Gardens Department), B Suresh Kumar, Chief City Planner, (Town Planning Department), Dr EMV Naresh Kumar (Chief Medical Officer, Public Health), Lakshmoji Rao (Engineering Department - Electrical), KVN Ravi (Underground Drainage and Water Department), and S Srinivas Rao (Revenue Department). The teams also acknowledge the contributions of various organizations and entities that have played a pivotal role in the GCAP's development. The teams would also like to thank reviewers and workshop participants for their valuable input.

IFC's team was led by Prashant Kapoor, working closely with Faiza Solanki, Lorraine Sugar, Kelvin Tagnipez, Varun Bhandari, Bhawna Prakash, and Sahlla Abbasi.

This GCAP is part of the broader strategic collaboration between the Government of Andhra Pradesh and IFC to support urban infrastructure projects that promote sustainable and low-carbon growth in the state. It is a component of the advisory support provided by IFC to GVMC to develop a comprehensive approach for reducing greenhouse gas emissions and implementing environmentally sustainable solutions in Vizag.

Acronyms & Abbreviations

AP	Andhra Pradesh
APEPDCL	Andhra Pradesh Eastern Power Distribution Company Limited
APERC	Andhra Pradesh Electricity Regulatory Commission
APEX	Advanced Practices for Environmental Excellence in Cities
APIIC	Andhra Pradesh Industrial Infrastructure Corporation
APSRTC	Andhra Pradesh State Road Transport Corporation
AMRUT	Atal Mission for Rejuvenation and Urban Transformation (*AMRUT*)
BAU	Business-As-Usual
BEE	Bureau of Energy Efficiency
BEM(S)	Building Energy Management (*System)*
BRT(S)	Bus Rapid Transit (*System*)
BSES	Bharat Stage Emission Standards
BLDC	Brushless Direct Current
CAGR	Compound Annual Growth Rate
CAPEX	Capital Expenditures
CFA	Central Financial Assistance
CMP	Clean Mobility Plan
CNG	Compressed Natural Gas
CO_2	Carbon Dioxide
DBFOOT	Design-Build-Finance-Own-Operate-Transfer
DEFP	Domestic Efficient Fans Program
DELP	DSM based Efficient Lighting Program
DFI	Development Finance Institutions
DISCOM	Power Distribution Company
DSM	Demand Side Management
DPR	Detailed Project Report
ECBC	Energy Conservation Building Code
EDGE	Excellence in Design for Greater Efficiencies
EE	Energy Efficiency
EEFP	National Efficient Fans Program
EETL	Energy Efficient Tube Lights Program
EPR	Extended Producer Responsibility
ESCO	Energy Service Company
ESG	Environmental, Social and Governance
ETC	Evacuated Tube Collectors
ETS	Emissions Trading System
EV	Electric Vehicles
FAME	Faster Adoption and Manufacturing of Hybrid and Electric Vehicles
FF	Fossil Fuels
FY	Financial Year
FPC	Flat Plate Collectors
GCAP	Green City Action Plan
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GO	Government Order

GRESB	Global Standards for ESG Benchmarking of Real Assets
GVMC	Greater Visakhapatnam Municipal Corporation
GWh	Gigawatt Hour
ICCC	Integrated Command and Control Centre
ICE	Internal Combustion Engine
ICM	Indian Carbon Market
IFC	International Finance Corporation
JRMRWA	JR Nagar Residents Welfare Association
kg	Kilogram
kl	Kiloliter
km²	Square Kilometers
KPI	Key Performance Indicator
ktCO$_2$e	Kilotonnes of Carbon Dioxide Equivalent
kWh	Kilowatt Hour
L	Liter
LFI	Local Financial Institutions
LiFE	Lifestyle for Environment
LULC	Land Use/Land Cover
m²	Square Meters
m³	Cubic Meters
MBBR	Moving Bed Biofilm Reactor
MLCP	Multi-Level Car Parking
MLD	Million Liters Per Day
MoEFCC	Ministry of Environment, Forest, and Climate Change of India
MoHUA	Ministry of Housing and Urban Affairs
MRF	Material Recovery Facilities
MSW	Municipal Solid Waste
MtCO$_2$e	Million Tonnes of Carbon Dioxide Equivalent
Mtoe	Million Tonnes of Oil Equivalent
MWp	Megawatt Peak
NDVI	Normalized Difference Vegetation Index
NGO	Non-Governmental Organization
NMT	Non-Motorized Transport
OBF	On-Bill Financing
OEM	Original Equipment Manufacturers
OPEX	Operational Expenditures
OSR	Open Space Reservation
PAT	Perform, Achieve, and Trade
PLI	Production Linked Incentive
PPP	Public-Private Partnerships
PTC	Pendurthy Transit Corridor
PV	Photovoltaic
RE	Renewable Energy
RDSS	Revamped Distribution Sector Scheme
RTA	Road Transport Authority
RTO	Regional Transport Office

RWA	Residents Welfare Association
SDGs	Sustainable Development Goals
SLA	Service Level Agreement
SLB	Sustainability-Linked Bond
SLL	Sustainability-Linked Loan
SLF	Sustainability-Linked Financing
SRU	Sustainability and Resilience Unit
STC	Simhachalam Transit Corridor
STP	Sewage Treatment Plant
SPV	Special Purpose Vehicle
t	Tonnes
tCO_2e	Tonnes of Carbon Dioxide Equivalent
TOR	Terms of Reference
TOT	Training of Trainers
TOTEX	TOTal EXpenditure (OPEX + CAPEX)
TRANSCO	Transmission Corporation
UGD	Underground Drainage and Water Department
VISCO	Visakhapatnam Industrial Water Supply Company
VMRDA	Visakhapatnam Metropolitan Region Development Authority
VKT	Vehicle-Kilometers Travelled
VUDA	Visakhapatnam Urban Development Authority
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant


VIZAG

Executive Summary

Visakhapatnam is the largest and most populous city in the state of Andhra Pradesh, India with a population of around 2.8 million people (projected 2023 population) and an area of 620 square kilometers (km^2). Known as Vizag, the city is the commercial center of the state and is located along the coast of the Bay of Bengal, where geographic significance, nature, trade, industrial ports, and connectivity are key to the city's growth.

In 2023, the Greater Visakhapatnam Municipal Corporation (GVMC) launched the Eco-Vizag campaign, which has a focus on five components: Eco-Clean to maintain ecological balance, Eco-Green to increase urban greenery, Eco-Blue for enhanced water conservation, Eco-Zero Plastic for the elimination of plastic waste, and Eco-Zero Pollution for improved environmental quality in Vizag.

The Eco-Vizag Green City Action Plan (GCAP) aims to mainstream the climate mitigation lens within the Eco-Vizag campaign by identifying a roadmap to help Vizag meet its vision for environment and development. The Eco-Vizag GCAP identifies and prioritizes green city actions—including city-level policies, investments, and planning strategies—based on greenhouse gas (GHG) savings, sector benefits, indicative costing, and potential funding sources. It leverages a new platform developed by the International Finance Corporation (IFC) called APEX (Advanced Practices for Environmental Excellence in Cities), an online software tool that helps quantify and prioritize city-based policy and investment solutions in the energy, transport, water, and waste sectors, which aims to increase the pipeline of public and private climate-related investments that can be influenced by city-level policies and plans.

Using the year 2023 as its baseline and projecting to the year 2034, this GCAP prioritizes and quantifies the impacts of 42 selected solutions, called *measures*, across the four key sectors of built environment and energy, transport, solid waste, and water and wastewater, as illustrated in *Table 1*. The GCAP identifies and outlines a green investment pipeline totaling INR 80 thousand crore (equivalent to USD 9,510 million) that would be required to implement all measures across the four key sectors. All measures with their associated costs are listed in *Table 2,* which includes the estimated total capital cost as well as the direct costs to GVMC.

Direct costs total approximately INR 50 thousand crore (USD 5,990 million) and include actions where the city can leverage sources of finance, such as through municipal finance or public-private partnerships (PPPs) for capital investments.

Bird's eye view of Vizag city from Kailasagiri.

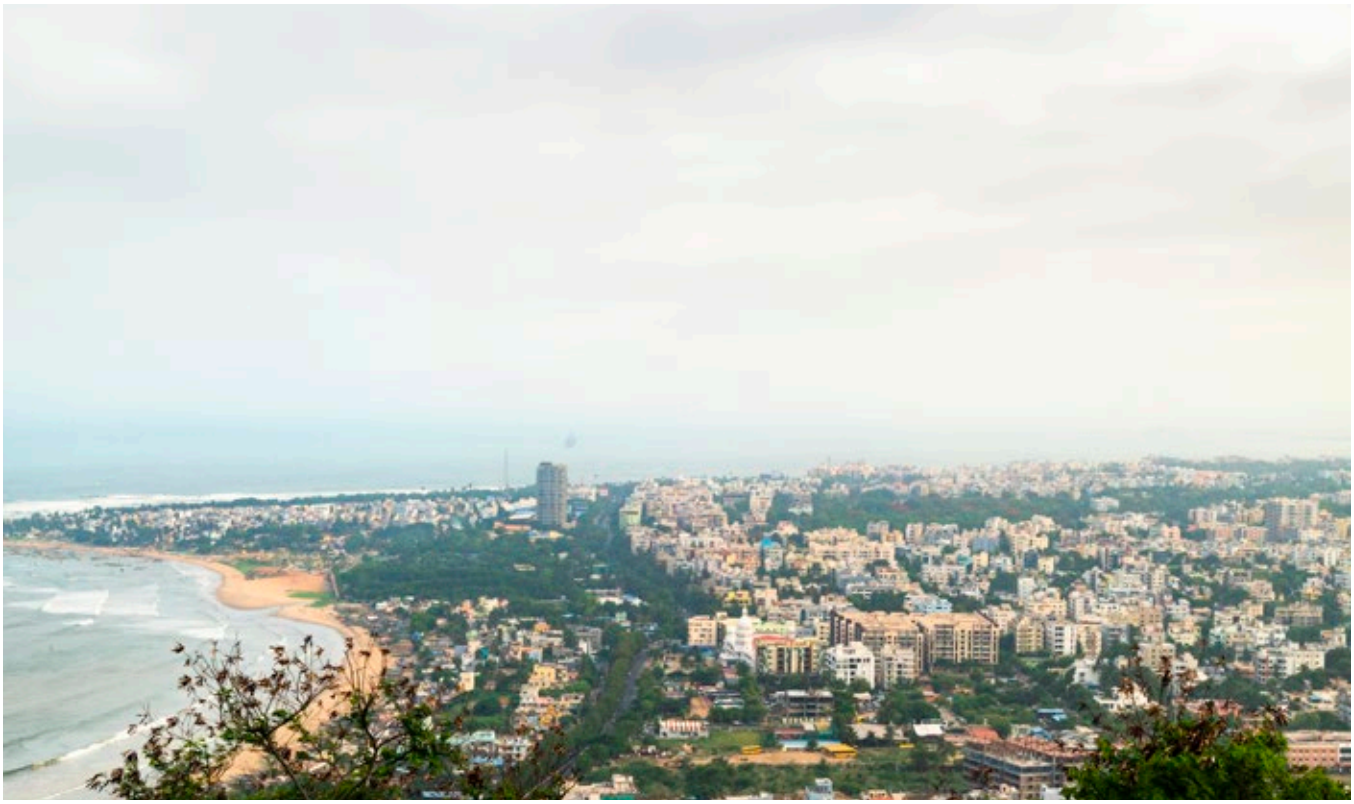


Image: IFC

For indirect cost actions of around INR 30 thousand crore (USD 3,520 million), the city can enable or incentivize the private sector to invest in green measures, by implementing policy, for example. *Figure 1* represents that if all these direct and indirect investment opportunities are implemented, they are expected to deliver a 30 percent GHG reduction for Vizag by 2034, eequivalent to 2.0 $MtCO_2e$ in GHG emissions.

In terms of GHG impact, 8 measures stand out with the highest contributions. High-impact solutions in the built environment and energy sector include an improved green building code, a city-wide solar photovoltaic (PV) program, and energy efficiency (EE) upgrades for private buildings, all of which can be accelerated through private sector financing. In the transport sector, incentives for private EVs, extending subway systems and expanded public bus transport can encourage the shift toward sustainable mobility. Taken together, these high **impact measures will result in 25 percent GHG savings or 85 percent of the total emissions reduction.**

Strong private sector engagement would support successful execution of the GCAP. Vizag can accelerate climate action by building a broad network of climate-smart businesses, industries, and financial institutions committed to achieving climate targets and a green city vision.

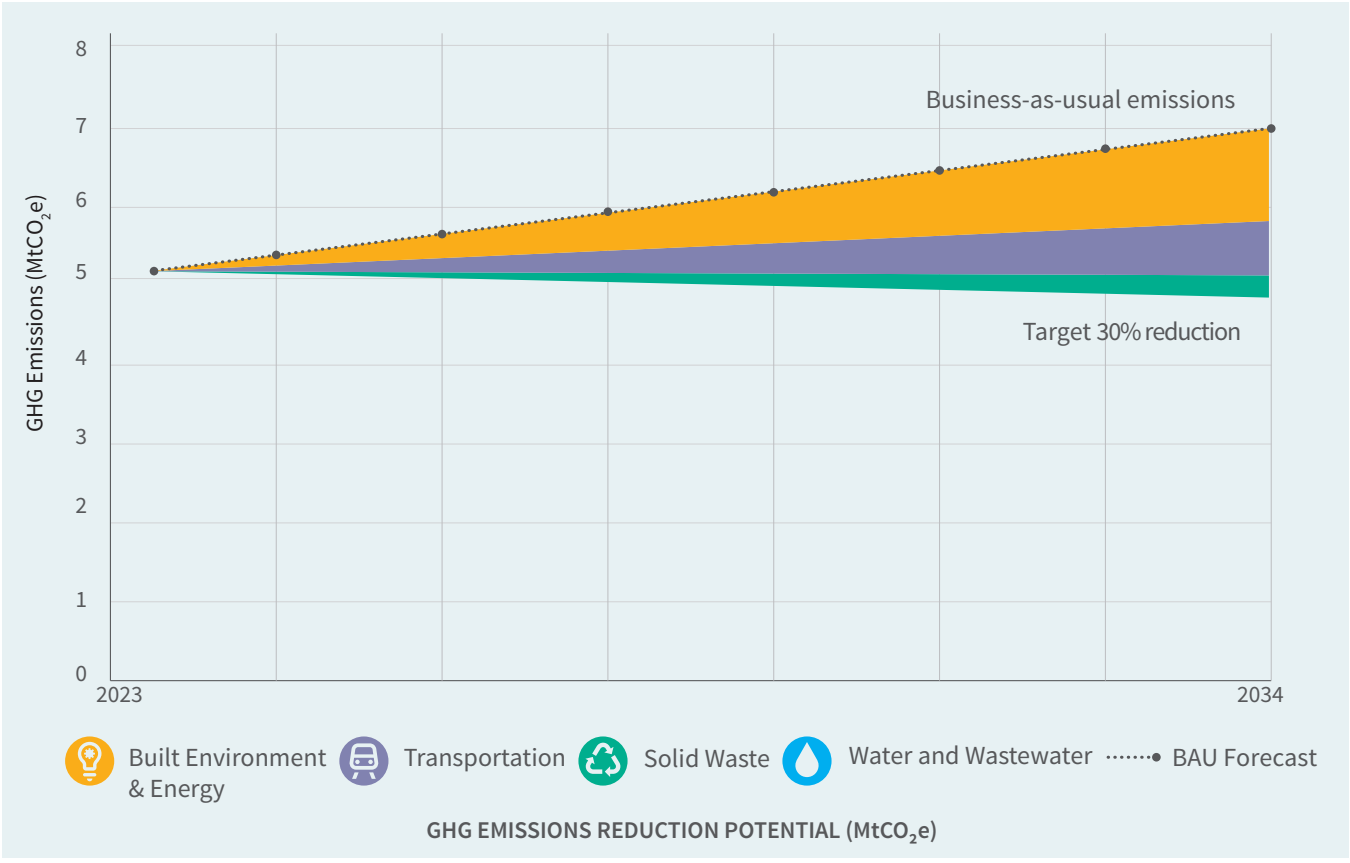


Figure 1: *Implementing the 42 measures is expected to deliver a 30 percent GHG reduction, equivalent to 2.0 $MtCO_2e$ in GHG emissions. Note: $MtCO_2e$ = million tonnes of carbon dioxide equivalent; BAU = business-as-usual; GHG = greenhouse gas.*

Table 1: Selected measures, benefits, and GHG savings across the four APEX sectors.

APEX Sector	Measures	Sector Indicator	GHG Reduction Compared to Business-as-Usual (%)	GHG Reduction Compared to Business-as-Usual ($ktCO_2e$)
Built Environment & Energy	Rooftop Solar PV Program for Private Buildings	20% Fossil Fuel Energy Savings	16%	1,134
	Improve Building Code			
	Smart Energy Display Meters			
	Incentivize Green Building Certification			
	Energy Efficiency Refurbishment in Private Buildings			
	Rooftop Solar Hot Water for Private Buildings			
	Implement Emissions Trading System			
	Promote Cool Roofs			
	Rooftop Solar PV on Municipal Buildings			
	Municipal Energy Efficiency Refurbishment			
	Green Municipal Buildings			
	Energy Efficient Street & Traffic Lights			
	Increase Urban Forestry			
Transportation	Extend Subway System	64% Less Private Fossil Fuel Vehicle Travel	11%	758
	Expand & Electrify Public Bus System			
	Expand & Electrify BRT System			
	Designate Street Lanes as Green Lanes			
	Add Park-and-Ride to Transit Stations			
	Electrification of the Municipal Fleet			
	Promote Private Electric Vehicles			
	Electric Vehicle Charging Infrastructure			
	Electrification of Auto-Rickshaws			
	Retirement of Inefficient Cars & Motorcycles			
	Street Parking with Dynamic Pricing			
	Car-free Zones			

APEX Sector	Measures	Sector Indicator	GHG Reduction Compared to Business-as-Usual (%)	GHG Reduction Compared to Business-as-Usual ($ktCO_2e$)
Solid Waste	Expand Materials Recovery Facilities	52% Less Waste Sent to Landfill	2%	145
	Decentralized Composting			
	Improve Waste Collection			
	Extended Producer Responsibility for Packaging			
	Ban Single-Use Plastics			
Water & Wastewater	Reuse Wastewater at the Municipal Scale	24% Water Security Improvement	0.2%	11
	Reduce Water Losses			
	Develop Ponds & Lakes for Rainwater Storage			
	Mandate Efficient Fittings in Buildings			
	Smart Water Meters			
	Mandate Rooftop Rainwater Harvesting			
	Mandate Rooftop Greenery			
	Incentivize Local Water Retention			
	New Centralized Wastewater Treatment Facilities			
	Local Scale Wastewater Treatment Plant			
	Improve the Efficiency of Existing Treatment Plants			
	Biogas Recovery at Existing Treatment Plants			
Total			**30%**	**2,048 $ktCO_2e$**

Table 2: Green investment pipeline for Vizag, including costs and potential funding sources.

APEX Sector	Measures	Total Cost (INR Crore)	Direct Cost (INR Crore)	Potential Financing Options			
				Own Revenue	Central Govt Transfer / Loan	PPP	Private Finance
Built Environment & Energy	Rooftop Solar PV Program for Private Buildings	**2,667**	-				✓
	Improve Building Code	**1,429**	-				✓
	Smart Energy Display Meters	**660**	-				✓
	Incentivize Green Building Certification	**357**	-				✓
	EE Refurbishment in Private Buildings	**1,388**	-				✓
	Rooftop Solar Hot Water for Private Buildings	**2,965**	-				✓
	Implement Emissions Trading System*	-	-				
	Promote Cool Roofs	**766**	-				✓
	Rooftop Solar PV on Municipal Buildings	**178**	**178**			✓	
	Municipal Energy Efficiency Refurbishment	84	84	✓		✓	
	Green Municipal Buildings	12	12	✓		✓	
	Energy Efficient Street & Traffic Lights	269	269	✓		✓	
	Increase Urban Forestry	386	386	✓			
Transportation	Extend Subway System	38,702	**38,702**		✓	✓	
	Expand & Electrify Public Bus System	2,402	**2,402**		✓	✓	
	Expand & Electrify BRT System	2,451	**2,451**		✓	✓	
	Designate Street Lanes as Green Lanes	641	**641**				
	Add Park-and-Ride to Transit Stations	**101**	**101**	✓	✓	✓	
	Electrification of the Municipal Fleet	1,678	-		✓	✓	
	Promote Private Electric Vehicles	10,904	-		✓		✓
	Electric Vehicle Charging Infrastructure	481	-		✓	✓	
	Electrification of Auto-Rickshaws	403	-			✓	✓
	Retirement of Inefficient Cars & Motorcycles	1,466	-				✓
	Street Parking with Dynamic Pricing*	-	-				
	Car-free Zones*	-	-				

APEX Sector	Measures	Total Cost (INR Crore)	Direct Cost (INR Crore)	Potential Financing Options			
				Own Revenue	Central Govt Transfer / Loan	PPP	Private Finance
Solid Waste	Expand Materials Recovery Facilities	38	38		✓	✓	
	Decentralized Composting	203	203		✓	✓	
	Improve Waste Collection	6	6		✓	✓	
	EPR for Packaging*	-	-				
	Ban Single-Use Plastics*	-	-				
Water & Wastewater	Reuse Wastewater at the Municipal Scale	662	662		✓	✓	
	Reduce Water Losses	252	252		✓	✓	
	Develop Ponds & Lakes for Rainwater Storage	1,153	1,153	✓			
	Mandate Efficient Fittings in Buildings	4,254	-				✓
	Smart Water Meters	15	-				
	Mandate Rooftop Rainwater Harvesting	6	-				✓
	Mandate Rooftop Greenery	86	-				✓
	Incentivize Local Water Retention*	-	-		✓	✓	
	New Centralized Wastewater Treatment Facilities	231	231		✓	✓	
	Local Scale Wastewater Treatment Plant	59	59		✓	✓	
	Improve Efficiency of Existing Treatment Plants	131	131		✓	✓	
	Biogas Recovery at Existing Treatment Plants	2,282	2,282		✓	✓	
Total		**79,859**	**50,333**				

**Policy-based measure that is currently not costed in APEX .*

Introduction

Objective and Vision of the GCAP

Vizag, home to around 2.8 million people and thriving on a diverse economy in the state of Andhra Pradesh, is increasingly vulnerable to climatic risks. The city has recently witnessed increasing seasonal extremes, changing rainfall patterns, and increasing temperatures with heat stroke-related health impacts among its citizens. In this context, the GVMC launched a campaign called Eco-Vizag, focusing on key adaptation components to reduce coastal risks and make the city clean and green.

The Eco-Vizag campaign is structured around five themes:

- Eco-Clean: Clean surroundings with effective waste management
- Eco-Green: Urban greenery, community gardening, home composting
- Eco-Blue: Rainwater harvesting, clean beaches, water conservation
- Eco-Zero Plastic: Environmentally friendly alternatives, recycling of plastic
- Eco-Zero Pollution: Pollution control

To enhance climate change mitigation efforts and for technical advice, GVMC requested the support of IFC to develop a green city action plan (GCAP) for the city. To address the impacts of climate change and in alignment with the Eco-Vizag campaign, the Eco-Vizag GCAP recognizes that actions must be prioritized across four key sectors: built environment and energy, transportation, waste, and water.

The vision of the GCAP is to create a robust roadmap and strategize an emission reduction pathway for the city that is achievable by 2034. It leverages a new platform developed by IFC called APEX, an online software tool that helps quantify and prioritize policy and investment solutions. An evidence-based, data-driven approach has been adopted for conducting the analysis. The GCAP has prioritized alignment and convergence with the city's ongoing initiatives as well as mainstreaming both the national and state government schemes and climate goals. This GCAP complements these efforts and aims to identify actions—including city-level policies, investments, and planning strategies—that can help the city meet its climate mitigation and sustainability targets. As such, it aims to increase the pipeline of public and private climate-related investments, influenced by city-level policies and plans.

This work is a collaborative exercise to determine the potential impact of various actions. It is meant to assist with the city's internal planning processes by providing a framework to prioritize the possible measures and does not obligate the city to proceed with the actions. Furthermore, climate is just one of many factors to be considered in any investment decision being made by the city. Assumptions used in calculations are specified herein.

This report begins with a background on Vizag and the GCAP development process. It presents an overview of Vizag's sectoral context and alignment of the GCAP to the goals of the Eco-Vizag campaign. Then, the prioritized measures across four key sectors (built environment and energy, transport, solid waste, and water and wastewater) are described in detail, including overall performance on future GHG emissions, costs, as well as sector-by-sector impacts on fossil fuel energy consumption, private fossil fuel vehicle kilometers traveled, waste diverted from landfill, and water security. The prioritized measures are then presented as a green investment pipeline, along with potential financing approaches Vizag may consider in the future. Finally, the report closes with a summary and recommendations to consider for implementation.

Background

The city of Visakhapatnam, otherwise known as Vizag, is the commercial capital of the state of Andhra Pradesh, India with an urban density of 2.8 million population and an annual growth rate of 3.5 percent. The city has the country's second-longest coastline and is well known for its port and beaches along the Bay of Bengal. The largest city in the state and the ninth richest city in the country, Vizag has the highest statewide gross domestic product (GDP) contribution (USD 43.5 billion) and has nearly 83 percent of its revenue coming from its own municipal sources of a satisfactory tax collection efficiency, thus positioning itself in strong liquidity[1]. The key economy of the city is from the service sector which contributes to around 55 percent of the GDP of Vizag, with 55 percent from the industrial sector like the Vizag steel plant, port trust, Bharat heavy electricals, and 10 percent from agricultural and allied sectors.

In Vizag, the following entities are responsible for various aspects of the city's infrastructure and services:

- **Greater Visakhapatnam Municipal Corporation (GVMC):** GVMC is the civic body that governs the Visakhapatnam Municipal Corporation boundary limits with an area of 620 km^2. It is responsible for parks maintenance and development, urban development, and maintenance of the city's infrastructure like streetlights and facilities. This includes services like water supply, sewage treatment, and solid waste management. It also handles property tax collection and maintenance of city facilities. The GVMC is led by the Commissioner and four senior IAS officers (as additional commissioners), spearheading revenue and development projects in the city.
- **Visakhapatnam Metropolitan Region Development Authority (VMRDA):** The Visakhapatnam region covering an area of 7,329 km^2 is administered by the VMDRA, which is the urban planning and town planning control agency in the state. VMRDA coordinates the development activities of municipal corporations, municipalities, and local authorities.
- **Andhra Pradesh Road Development Corporation (APRDC):** APRDC is the agency for maintaining and managing roads throughout the state. They are the designated agencies for the collection of toll tax on state highways.

In line with the Government of India's roadmap of achieving net zero emissions by 2070 and reducing carbon intensity to less than 45 percent by 2030[2], the state of Andhra Pradesh has set an energy savings target of 6.68 million tonnes of oil equivalent (Mtoe) of energy savings by 2030[3]. The state has urged all its cities to integrate climate action into policy and planning and develop local climate action plans with ambitious targets. Being a non-attainment city in the state, Vizag has been focused on reducing city-wide emissions and becoming a greener city[4]. Key strategic priorities of the city include upscaling renewables in the city, introducing an EV policy and parking policy, increasing urban green cover, focusing on climate-smart waste collection, and conserving urban biodiversity.

[1] GVMC credit rating, Care Edge Career ratings, 2022 https://www.careratings.com/upload/CompanyFiles/PR/31012022070608_Greater_Visakhapatnam_Municipal_Corporation.pdf

[2] India net zero emission target 2070, Government of India, 2023, https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1961797

[3] Andhra state energy conservation policy, Government of Andhra Pradesh, 2024, https://www.apsecm.ap.gov.in/copy2_of_awards/ap-state-energy-efficiency-energy-conservation-policy.pdf

[4] GVMC Clean air action plan, Central Pollution Control Board https://cpcb.nic.in/Actionplan/Visakhapatnam.pdf

Eco-Vizag GCAP Development Process

The GCAP development process followed four main steps:

1) Data collection and baseline setting;
2) Selection and prioritization of measures by conducting a baseline and measures workshop;
3) Analysis using APEX; and
4) Identification of high-level potential investments, business models, and financing approaches for the GVMC (using APEX) to consider in the future.

The plan was then finalized following stakeholder review (by the commissioner and the Sustainability and Resilience Unit (SRU) of GVMC) and released for public comment in September 2024. *Figure 2* illustrates the GCAP development process. IFC collaborated with representatives from GVMC, Andhra Pradesh Eastern Power Distribution Limited (APEPDCL), and Andhra Pradesh State Road Transport Corporation (APSRTC) to compile data and review current plans, identify, and prioritize solutions using the APEX software, and develop a roadmap for green city action.

During an APEX analysis, the APEX software uses information for the baseline year and projects forward to the target year using anticipated population growth rates. It evaluates actions relative to the Business-As-Usual (BAU) case—that is, the scenario where the city government does not take any specific actions, and municipal operations and resident behaviors are the same as in the baseline year. APEX then helps quantify the impact of investment, planning, and policy solutions—referred to as measures—in the target year. There are over 100 measures preloaded into APEX, and there is an option to create custom measures. Each measure has an engine that quantifies its impacts and costs based on the specific city context. The methodology behind each measure is based on prevailing engineering calculations, existing studies in literature, and/or case studies from other cities.

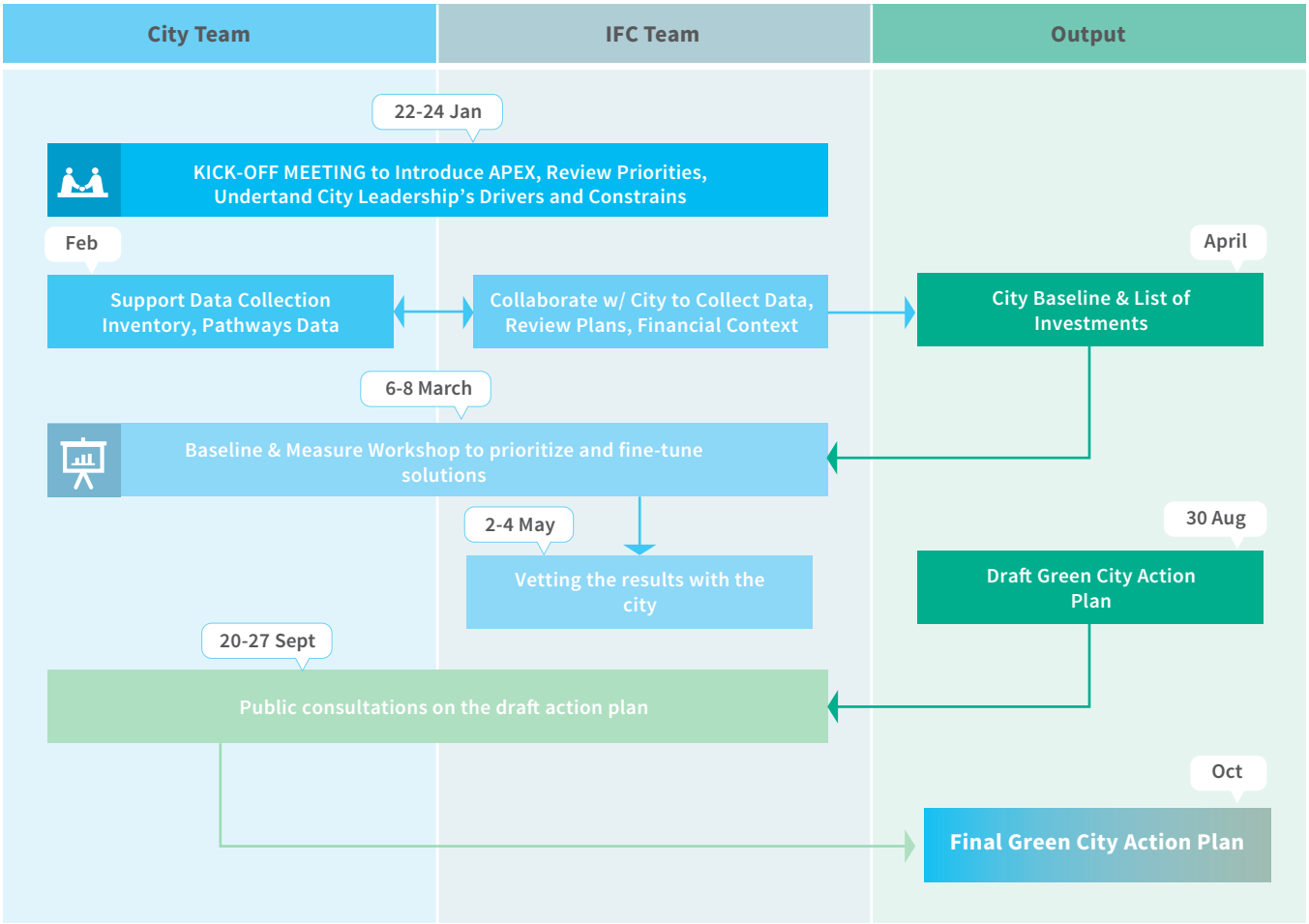


Figure 2: *Eco-Vizag GCAP Development Process, IFC.*

IFC collaborated with GVMC officials and the SRU team to compile data, review current plans, and identify and prioritize solutions through a data-gathering mission/workshop in January 2024 (images below). The workshop was led by the ex-commissioner Saikanth Varma, IAS.

Kick-off meeting for data gathering exercise with the ex-Commissioner, Saikanth Varma, IAS.

Image: GVMC

Stakeholder consultation and baseline data collection workshop - Building and Energy Sector.

Image: GVMC

Data were gathered from 14 internal departments of GVMC and 6 line agencies, as well as retrieved from publicly available sources. To select measures, the team reviewed the GVMC sectoral and departmental plans for key measures that could be assessed using the APEX platform. Finally, workshops were held with sector representatives to verify data and discuss the context and priorities of different measures.

The workshops took place at the GVMC council hall in the zonal main office, Jail Road on March 6-9, 2024, led by the additional commissioners of development, additional commissioner of public health and additional commissioner of revenue and finance. Representatives from the relevant departments attended workshops specific to each of the four APEX sectors. For built environment and energy, participants joined from APEPDCL, Department of Environment & Sciences & Management, Andhra University, Pollution Control Board, VMRDA, officials from GVMC Electrical department and Mechanical department, GVMC Parks and Gardens department, GVMC Revenue department, public health department, Underground Water and Drainage department, Visakhapatnam Industrial Water Supply Company (VISCO) and non-governmental organizations (NGOs) like City Terrace Garden group (CTG) involved in citizen green cover activities. For the transportation sessions, officials from the Road Transport Authority, Andhra Pradesh State Road Transport Corporation (APSRTC), the Department of Civil Engineering from Andhra University, and GVMC zonal heads attended. The second day of the workshop focused on the solid waste sector, which was attended by the GVMC Public Health and Sanitation Department led by the city chief medical and health officer along with all zonal health officers and representatives from the waste management plant. Next was the water and wastewater session led by department head KVN Ravi along with work inspectors of all zones, GVMC Underground water supply and drainage (UGD) department, pollution control board, industrial board, and water experts and professors from Andhra University. The main objectives of these workshops were to:

- Present the city baseline scenario using IFC's APEX software.
- Obtain agreement on GHG emissions and sectoral targets in alignment with the GCAP.
- Identify and prioritize investments, policies, and planning actions based on costs, financial models, and GHG emissions savings using APEX.
- Consult with key sector leads, including fine-tuning solutions and working out viable financial instruments to implement climate actions.

Presentation on APEX overview during the Baseline & Measures Setting Workshop.

Image: Kelvin Tagnipez, IFC

The workshops were key to understanding the urban, environmental, and social dynamics of the GVMC, as well as its ongoing schemes and alignment with the national and state schemes and targets. Following the workshops, the APEX team finalized the GCAP measures as picked up by the city and with the information received from the technical teams. The draft of the shortlisted measures and action items with the scoping and impact was shared with the GVMC commissioner and SRU team. The revisions were then incorporated, and the list of measures was finalized. Possible financing options and delivery models were identified taking into consideration the national and state standard benchmarking costs for implementation of each action item, currency exchanges, and financial context, all of which would require further feasibility studies to ensure viability. Going forward, the GVMC will continue to have access to the APEX online software to conduct further analyses, monitor implementation, and track results.

A meeting was held with the present new commissioner Sampath Kumar IAS on August 28th, to brief him and finalize the on the Eco-Vizag GCAP, post which was released for public consultations.

Technical session on measures setting for the Built Environment and Energy sector.

Image: Authors

Wrap-up summary meeting with the ex-Additional Commissioner, K.S. Viswanathan.

Image: Authors

Meeting with present GVMC commissioner Sampath Kumar IAS.

Image: GVMC

Technical session on measures setting for the Solid Waste and Water sectors.

Image: Authors

Meeting with the Mayor, Shri. Golagani Hari Venkata Kumari.

Image: GVMC

City Sector Context and Baseline Data

This section presents a summary of the city data underlying the APEX analysis across the four main sectors: built environment and energy, transportation, waste, and water. Further details and data references are available in Appendix A.

Built Environment and Energy

The electricity sector presents the biggest opportunity for a city to transition to clean energy at the grid by tapping into decentralized renewable energy solutions and energy-efficient retrofitting. Vizag's energy pie is dominated by electricity consumption at 88 percent and local heating sources at 12 percent. Cooking, cooling, and heating water are the key activities in the building sector that consume a high amount of energy. Four agencies, who are the key stakeholders responsible for the electricity and building sector in Vizag have been mapped as per the *Figure 3* below.

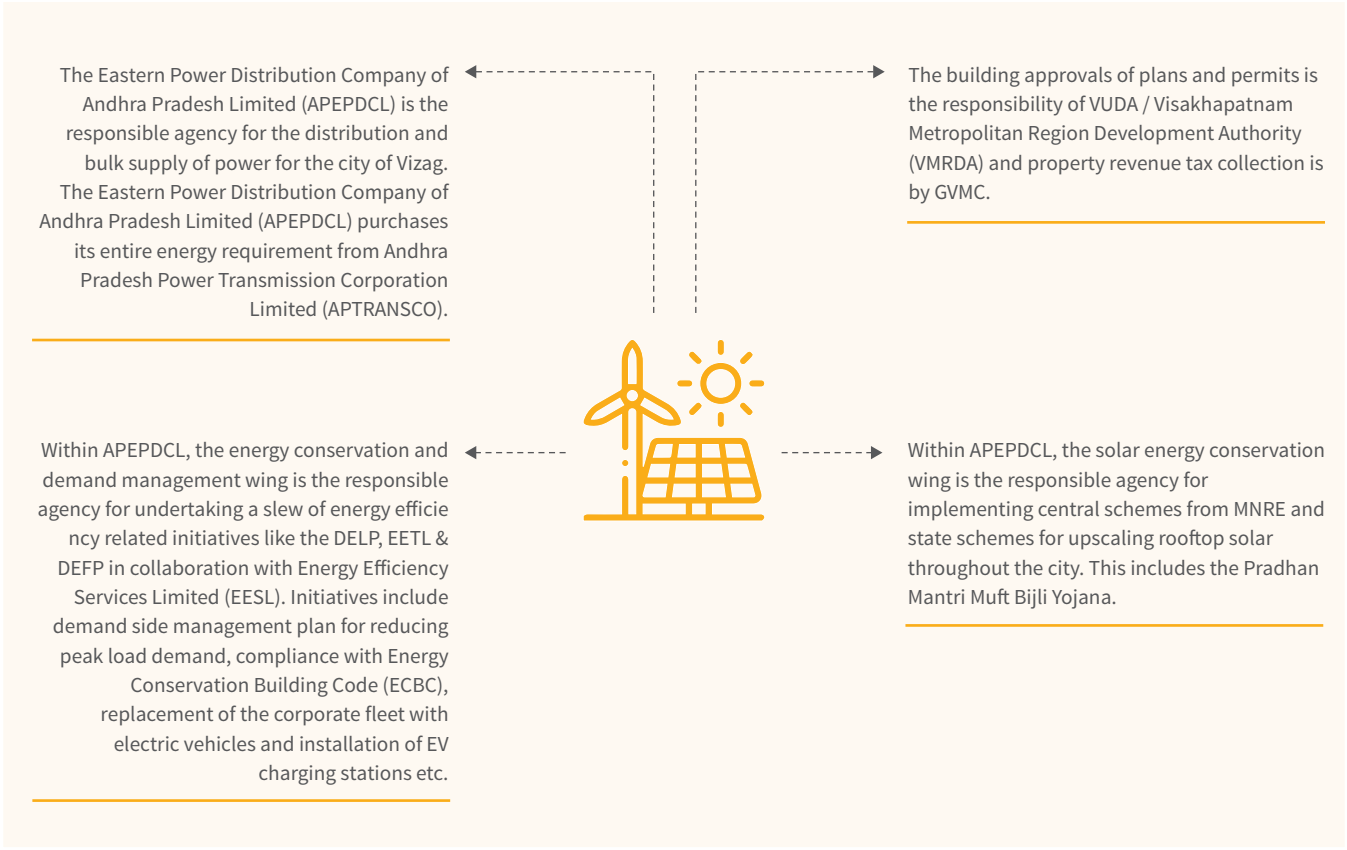


Figure 3: *Landscape of the building and energy sector in Vizag.*

The result of the baseline analysis, as shown in *Figure 4*, highlights that 74 percent of Vizag's buildings are dedicated to residential use, which includes houses and apartments. A further 15 percent are institutional buildings, including municipal-owned buildings and facilities. The remaining 9 percent is allocated for mixed-use properties including commercial retail, offices, and hospitals. And 2 percent of industries are within the city's municipal boundary limits.

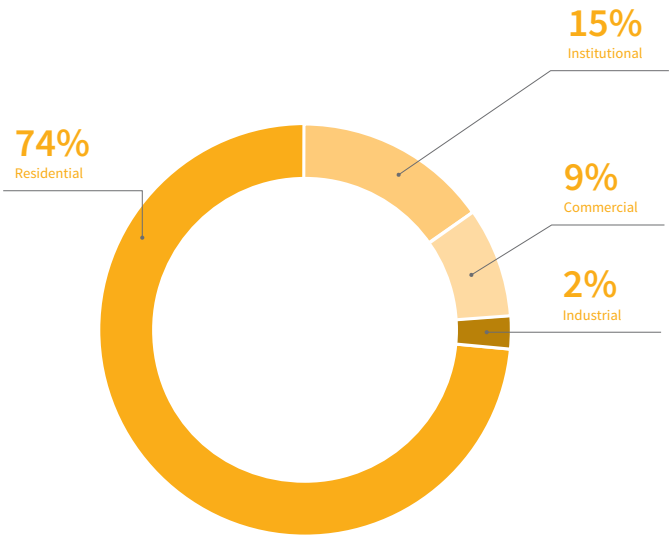


Figure 4 *shows the type of building typology in the city by building area, Source: Calculated from property tax data, and GIS data from the GVMC planning department and revenue department.*

The power distribution company, DISCOM, has observed a 3.82 percent load growth in consumers with an increase in energy demand from FY 2020-2021 to December 2023. *Figure 5* below highlights the energy usage by building type in the city.

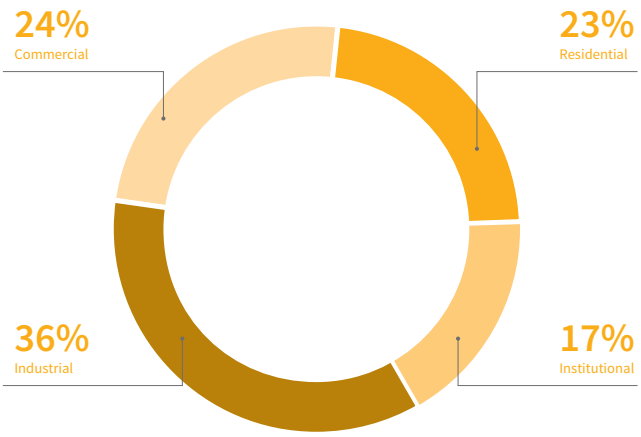


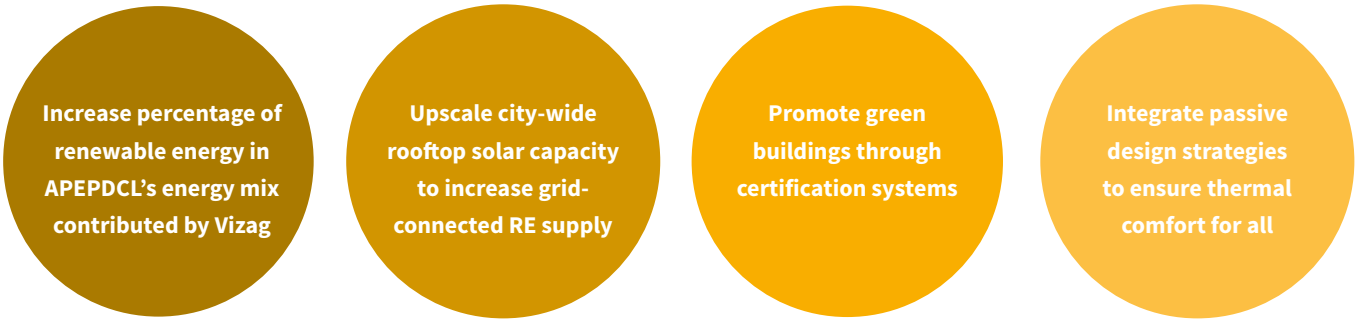
Figure 5 *shows the estimated energy use by type of building, the majority of which is industrial followed by residential and commercial consumption. Source: Calculated with 2024 electricity consumption data provided by APEPDCL, property tax data from the GVMC revenue department, and GCOM data portal for cities for local heat sources.*

The sector can be bucketed under three broad sub-categories for ongoing supply and demand side management initiatives in the city. *Table 3* lists the ongoing measures taken by APEPDCL and GVMC to reduce carbon emissions and energy consumption through promotion of renewable energy sources and Demand Side Management (DSM) measures.

Table 3: *Ongoing initiatives in the Built Environment and Energy sector.*

Renewable Energy	Energy Efficiency	Green Buildings
• Upgrading municipal buildings with rooftop solar. • 1 MW and 2MW capacity floating solar at Mudarsarlova reservoir and Meghadri Gedda reservoir • GVMC has also upgraded 100% LED streetlights throughout the city after HUDHUD cyclone. • Along PM Surya Ghar scheme, APEPDCL has also identified the list of empaneled vendors[5] for the implementation of one lakh households throughout the city until 2027.	• DSM-based Efficient Lighting Program (DELP): AP State has initiated an LED bulbs scheme first in the Country. In APEPDCL 86 Lakh LED Bulbs of 7W/9W were distributed to each domestic consumer through EESL. The estimated energy savings under this scheme is 639MU per annum. • Implementation of Domestic Efficient Fans Program (DEFP): 66,215 energy-efficient fans were sold through EESL. The estimated energy savings under this scheme is 12.7 MU per annum. • Retrofitting of BLDC 5 – star rated fans and lights at all APEPDCL offices.	• APEPDCL and the Andhra Pradesh State Energy Conservation Mission (APSECM) along with the Bureau of Energy Efficiency (BEE) has planned for a super ECBC building in Vizag for a training institute by APEPDCL.

For Vizag, energy decarbonization should ideally be related to grid decarbonization at the source. However, the GCAP is centered around the ownership and capacities of GVMC to execute and implement measures at the city level in close coordination with APEPDCL and Transmission Corporation of Andhra Pradesh (AP TRANSCO). Based on the above baseline, the identified need for the sector is a four-pronged approach as below to overcome the above challenges:



[5] APEPDCL, PM Surya Ghar vendor list, 2024 https://www.apeasternpower.com/MqKfcSkRsjsSlg0NlDDHYCT7dKQ=

Transportation

Vizag's transport sector is handled by APSTRC who manages and operates the bus fleet. The state Road Transport Authority (RTA) is responsible for vehicular registrations and the GVMC traffic police department manages the policy implementation and enforcement of traffic congestion, traffic fines, and parking policies.

Data on the number of vehicles registered with the Regional Transport Office (RTO) by fuel type from 2000 until 2024 was considered to assess the total vehicular registrations and understand vehicle usage trends and per passenger vehicular kilometers traveled in the city.

The city has a fleet of 605 standard buses (all diesel Bharat stage emission standards (BSES) IV) run by APSRTC on 32 routes covering 22,000 km. Vizag has 54 percent mode share for private vehicles (2-wheelers and 4-wheelers). Two-wheelers grew with a CAGR of 66 percent and four-wheelers with a compound annual growth rate (CAGR) of 59 percent between FY 2011-2021. The city currently has less than 1 percent of electric vehicles in its total private passenger transport fleet.

Figure 6 highlights the modal split of Vizag in which a share of 40 percent by motorcycles (2-wheelers), 14 percent by automobiles (4-wheeler cars), and 20 percent by IPT modes like auto-rickshaws (moto-taxis). Public transportation mode by bus seems to be only 13 percent while walking is 9 percent. The modal share by bicycling seems to be as low as 1 percent in the city.

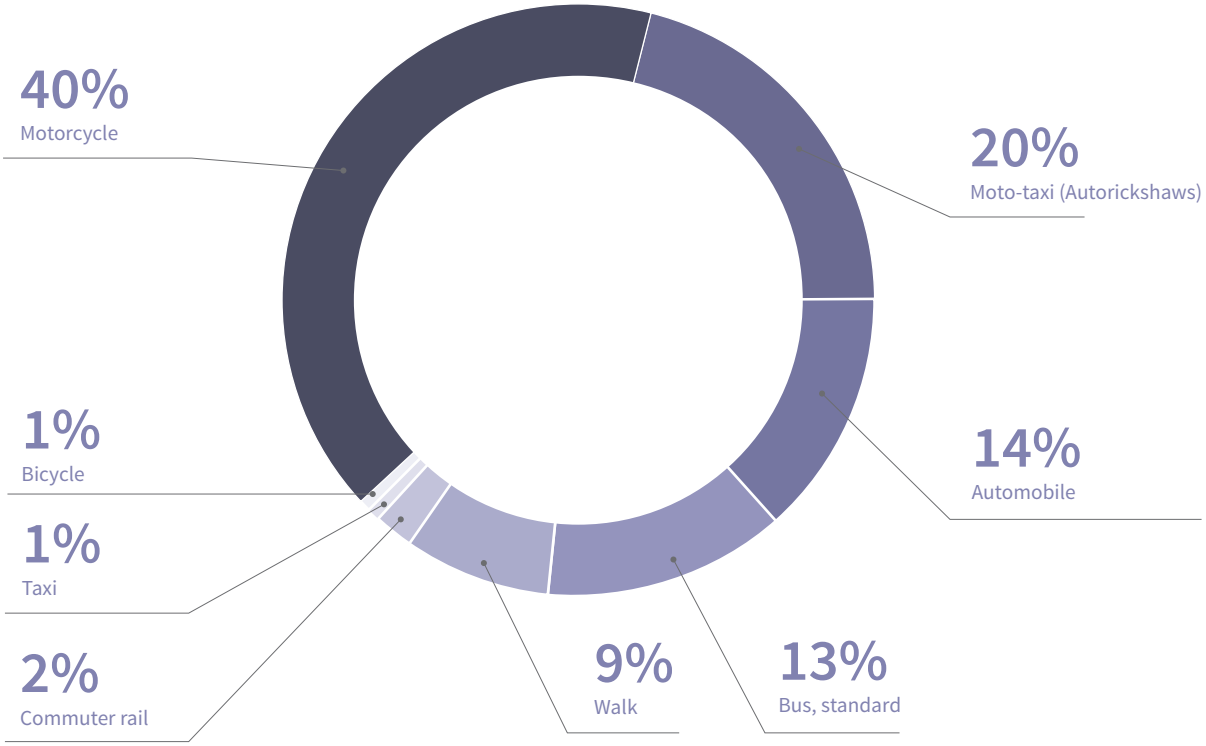


Figure 6: *Modal Split of Urban Transport Options by Passenger Distance Traveled; Source: Calculated with 2021 data provided by APSRTC, RTA. Data and sources are shown in Appendix A.*

The number of public buses available per capita is <0.01 (only 605 public busses for a population of 28.5 lakh), as shown in *Figure 7* is very low compared to the national service level benchmarks for Indian cities[6].

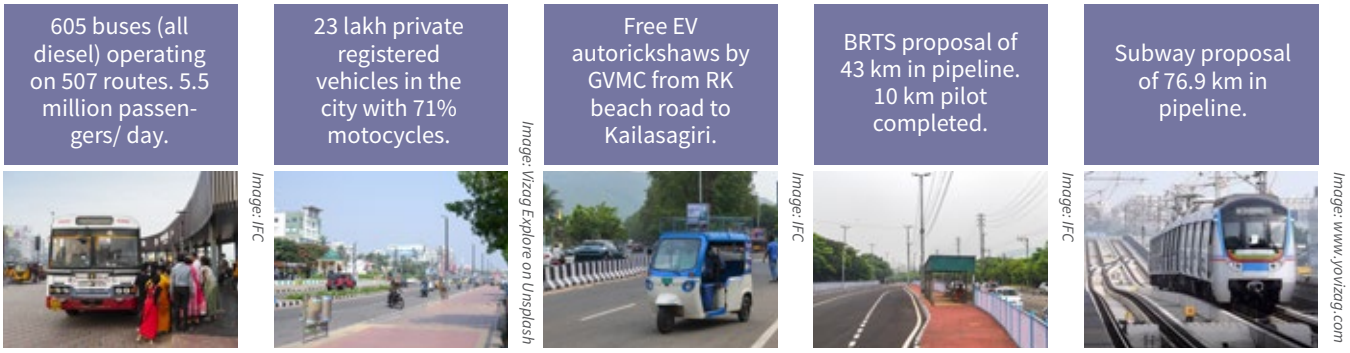
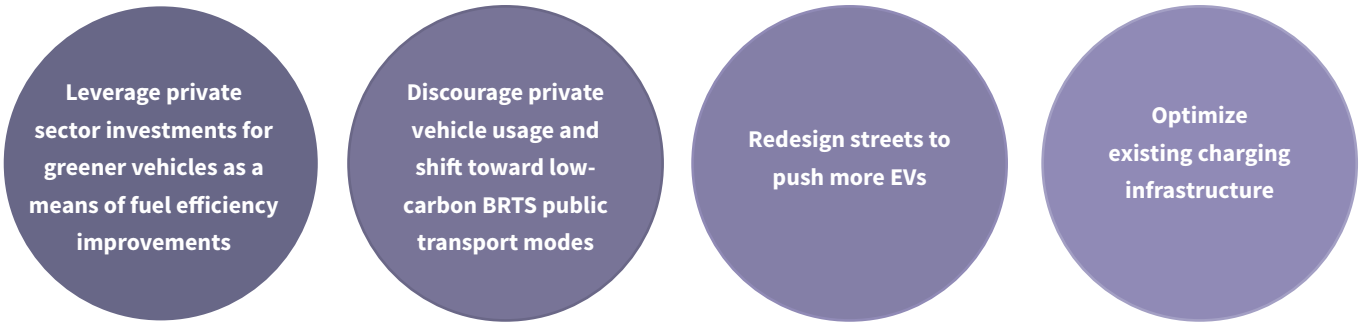


Figure 7: *Snapshot of the transport sector landscape in Vizag.*

Based on the above baseline, a four-pronged approach is recommended to reduce emissions from the transport sector, both to directly reduce private fossil fuel vehicle-kilometers traveled (VKT) and increase the passenger VKT by public transport.

Greening private mobility, by pushing private investments and coupling with policies is an urgent need for the city to shift toward zero emission fuels as well as improved fuel efficiency.[6]



[6] Service Level Benchmarking (SLB) in Urban transport , NIUA, https://smartnet.niua.org/sites/default/files/resources/SLB%202B.pdf

Solid Waste

The Greater Vishakhapatnam Municipal Corporation (GVMC) manages, on average, 848 MT of municipal solid waste per day, including approximately 80 tonnes per day of construction and demolition waste. *Figure 8* shows that the generated waste composition is high in food and organic waste (26 percent), garden and debris plant waste (26 percent) followed by paper waste (21 percent), and textiles waste (15 percent).

Almost 45 percent of the municipal waste is from domestic households, commercials, and bulk waste contributes 30 percent, construction debris contributes 2 percent, while street sweeping and drain silt contribute 23 percent. This waste from sweeping and drain silt is a challenge for the city.

GVMC is responsible for the door-to-door collection of segregated waste and transferring the collected waste to the transfer stations. Currently, there is 70 percent door-to-door collection, and the waste is not 100 percent segregated by the residents. The mixed waste from the transfer stations is then tipped to the 15 MWh waste-to-energy plant at Kapuluppuda with 2000 TPD capacity, for processing the non-recyclable waste. GVMC has initiated the waste-to-biogas and power plant project with a capacity of 30 TPD in the existing dumpsite at Kapuluppada. *Figure 9* represents the Waste treatment methods in the city which include waste-to-energy through biological processes (39 percent), incineration (22 percent), and composting (39 percent).

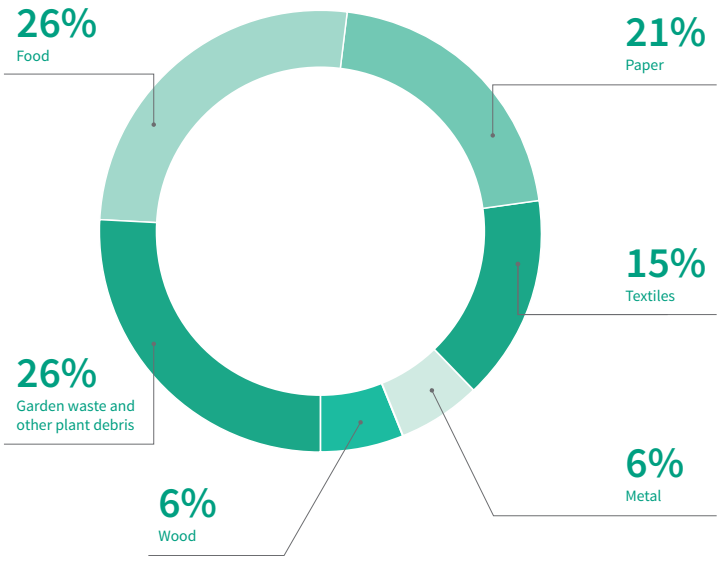


Figure 8: *SWM composition in GVMC, Source: data from the GVMC Public Health Department.*

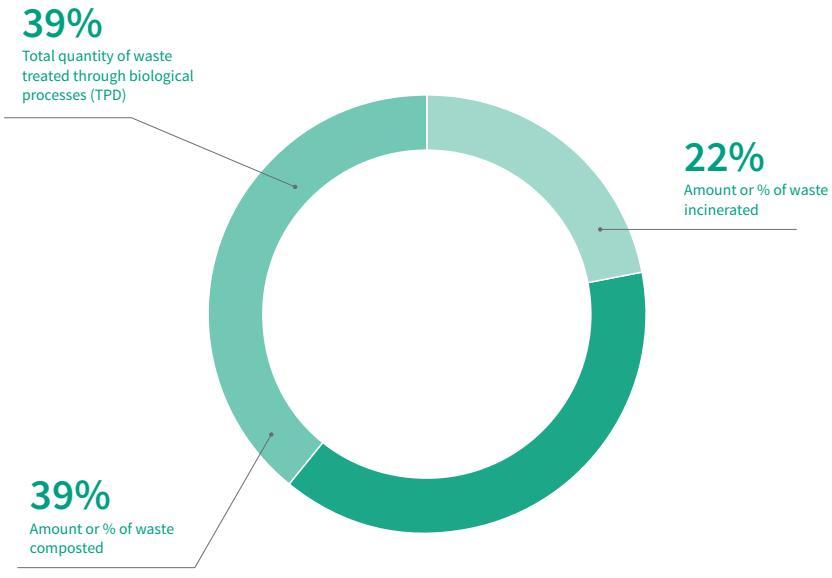


Figure 9: *Waste management and treatment, Source: data from the GVMC Public Health Department.*

Based on the above baseline, a three-pronged approach is emerging to promote sustainable waste management, which includes composting and recycling by enhancing decentralized waste management and enhanced segregation.

GVMC garbage trucks transferring the collected waste at the waste management plant for incineration processes.

Image: IFC

Water & Wastewater

Rapid urbanization and industrial growth have recently led the city and the region to become water stressed. About 75 percent of residents of Vizag have access to safe and potable water, mostly in the core, semi-urban, and periphery areas. Ecologically, the city is rich in biodiversity and has 218 natural *geddas* / tanks and ponds. Vizag's water demand needs are met by 70 percent surface water and 30 percent groundwater with a distribution network of 2600km. There are 7 main sources (Yeleru / Godavari, Raiwada, Thatipudi, MGR, Gosthani, Ghambiram, and Mudasarlova), which supply about 395.5 MLD (87MGD) water to the city for both domestic and industrial usages. The Yeleru / Godavari is most significant source, supplying 60 percent of the city's water demand. The water supply network includes 8,224 hand-drilled borewells.

The per capita water supply, on average, is about 105 to 110 LPCD against the standard of 135 LPCD.[7] Eleven water treatment plants with a total capacity of 489 MLD (107.46 MGD) exist for treating the raw water. The GVMC Underground Water and Drainage department is responsible for the drinking water supply as well as for sewage and wastewater treatment and management. Visakhapatnam Industrial Water Supply Company, a special purpose vehicle (SPV) with GVMC and Andhra Pradesh Industrial Infrastructure Corporation (APIIC) supplies almost 60 percent of its drawn water to the GVMC by 11,000 tankers over a 150 km distance via Malleshwaram, Rajamundry, and Godavari at average bulk water consumption of 140 liters (L) per person per day and a cost of INR 2 per kiloliter (kl). The Kannati balancing reservoir is the tail-end point delivery for transmission. The domestic water supply average of the city is 81.8 million gallons per year (about 4.5 MLD). It also supplies about 40-48 million gallons daily to the industrial areas. There are nearly 30 percent unaccounted water losses in the city, which equates to a revenue loss of 11 lakh per day for GVMC and an average annual loss of INR 40 crore.

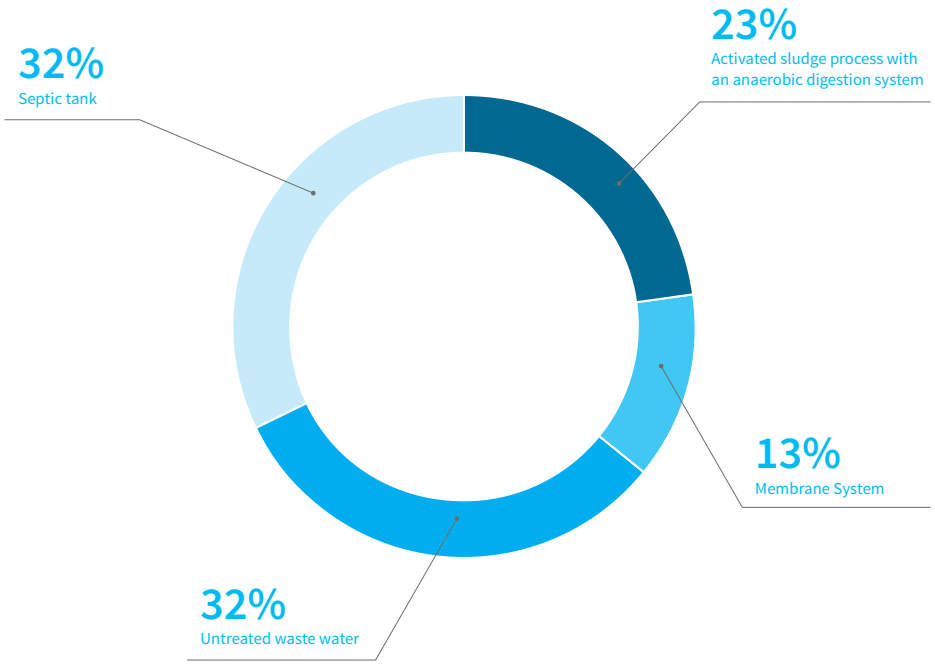
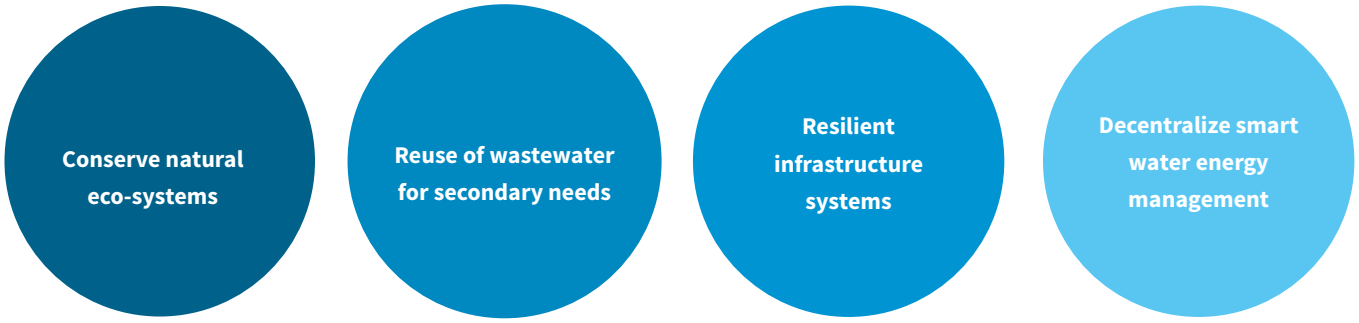


Figure 10: *Wastewater treatment by type in the city.*

[7] National per capita availability standard, https://pib.gov.in/PressReleasePage.aspx?PRID=1604871

In terms of wastewater management and sewerage systems, almost 60 percent of residential households are covered with a sewerage network. The flow of wastewater is approximately 181.4 MLD with a total STP capacity of 233 MLD. *Figure 10* highlights that almost 32 percent is discharged directly into the water sources without any type of treatment. The remaining wastewater is treated with centralized technologies including an activated sludge process with an anaerobic digestion system (23 percent), a membrane system (13 percent), and septic tanks (32 percent).

Based on the above baseline, a four-pronged approach is recommended to ensure a resilient water management system as a resource to reduce coastal flood risk, as well as ensure water security to meet future demand



Greenhouse Gas Emissions

Using the APEX Online App to develop a GHG baseline for 2023, the GHG inventory showed that Vizag produces over 5.1 million tonnes of carbon emissions across the energy, transportation, waste, and water sectors. As shown in *Figure 11*, the largest contributor to GHG emissions is the built environment and energy sector (78 percent), followed by transportation (19 percent), solid waste (3 percent), and water and wastewater (<1 percent). The per capita emissions are around 1.8 tCO_2e per person.

The emissions from the energy sector are significant due to the dependency of electricity consumption from a predominantly fossil-fuel-dominated grid to meet the lighting and heating demand needs of the city. The DISCOM has less than 1 percent of the renewable energy (RE) grid-connected supply. The transport sector is the second highest GHG contributor due to the high proportion of on-road internal combustion engine (ICE) passenger private vehicles. The emissions from the waste sector are predominantly due to a lack of biogas capture systems at the landfill site.

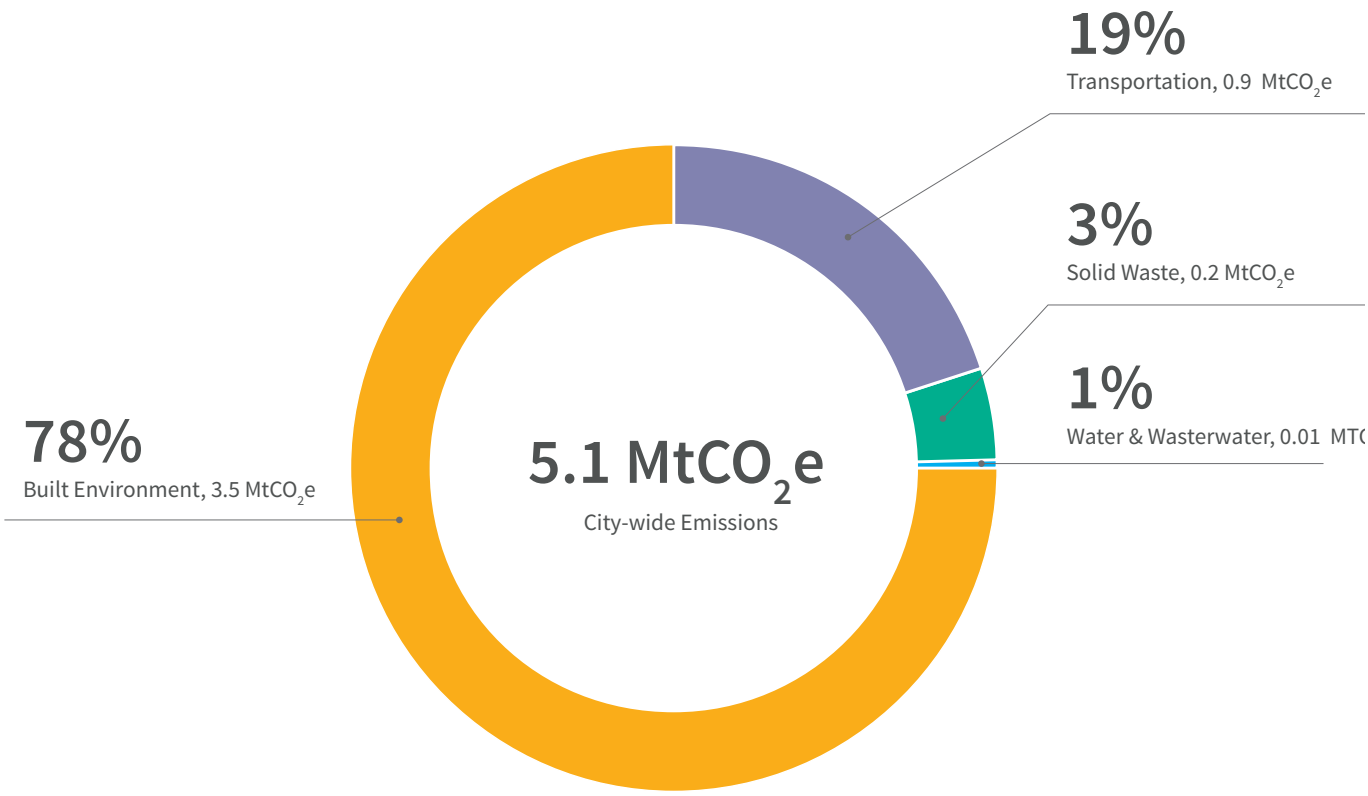


Figure 11: *City-wide GHG Baseline emissions breakdown by key sector.*

Eco-Vizag Campaign

The Eco-Vizag campaign was launched by GVMC in Andhra Pradesh to promote public participation in combating air and plastic pollution. It focuses on five Eco components: maintaining ecological balance, increasing urban greenery, enhancing water conservation, eliminating plastic waste, and reducing pollution.

The Eco-Vizag campaign actions are aimed toward strengthening climate adaptation and resilience in the city. The campaign has established actions that will contribute to meeting the 2030 Sustainable Development Goals (SDGs) that are structured around encouraging citizen engagement and sensitization to achieve climate adaptation.

To conduct the APEX analysis, the Eco-Vizag campaign actions were aligned with measures in the APEX software. APEX includes actions in the four key sectors of built environment and energy, transportation, solid waste, and water and wastewater, with a focus on climate change mitigation. Therefore, the APEX analysis is primarily related to the mitigation component of the Eco-Vizag measures and its strategic objectives, as well as other priorities identified by city officials during the workshops. The alignment between the Eco-Vizag and APEX measures included in the GCAP is shown in *Table 4*.

Table 4: *Strategic Objectives and Actions from the Eco-Vizag Action Plan for the GVMC, Aligned with APEX Sectors and Measures.*

APEX Sector	Strategic objective of Eco-Vizag	Strategic actions	Prioritized GCAP measures[8]
Built Environment & Energy	Making Vizag a greener city	1. Improve green cover to 50% in all zones of the city (Vertical Gardens development along the geddas, under flyovers, at government buildings/ schools) 2. Parks Development with 90% of canopy planned 3. Amend Bylaws to ensure 70% of residential buildings' terraces shall be developed as Green Terrace 4. Layout open spaces – 50% parks and 50% playgrounds – Action plan preparation 5. Coastal Shelter Belts development with Casuarina plantations, etc., in association with the Forest department (3 years) 6. Development of mangrove plantations in marshy areas to control coastal erosion. These plantations can be considered for carbon credits for further funding (3 years) 7. Develop green patches in coastal areas, by growing sand binders through the vegetative propagation method, with the support of volunteers 8. Urban Biodiversity Conservation in association with the Forest Department and AP State Biodiversity Board (APSBB) and action plan to ensure the propagation of these species 9. Green scaping of the city (hills, roads, forest, open spaces, etc.)	1. Increase urban forestry

[8] Each APEX measure has a number that corresponds to the 32 measures selected for the Vizag GCAP for the 4 study sectors, the order of the measure may change according to its correspondence with the Strategic Objectives (SO) and Strategic Actions (SA) of the Eco-Vizag mission.

APEX Sector	Strategic objective of Eco-Vizag	Strategic actions	Prioritized GCAP measures
Built Environment & Energy	A holistic and inclusive planning towards greening the city	1. Plantation Drives at the ward level by involving stakeholders 2. Promotion of community gardens (Terrace Gardens, Kitchen Gardens) at household level 3. Stakeholders involvement through 'Adopt a park' (Conference/Meetings with stakeholders)	2. Municipal green certification or labeling
			3. Municipal energy efficiency refurbishment
			4. Rooftop solar PV on municipal buildings
			5. Energy efficient streetlights
			9. Industrial energy efficiency
			6. Green building certification
			7. Finance for private energy efficiency refurbishment
			8. Rooftop solar PV on private buildings
Solid Waste	Make Visakhapatnam a Garbage-Free City	1: Increase monitoring of garbage vulnerable points and commercial centers 3. Swachh Dhoot (Indore) model replication with the help of volunteers/SHG 4. Decentralization of SWM, wherever possible	19. Decentralized composting
		1: Weekly drives for specific places – community toilets monitoring/ open spaces/parks, etc. 2. Collect waste two times a day at high waste generation areas 3. Identification of hotspots 4. Conduct community needs assessment to identify WASH problems in slums 5. Provide proper infrastructure (Water supply, drainage system, SWM facilities, roads, etc.) 6. Involvement of Self-Help Groups (SHGs), NGOs and volunteers in WASH activities	20. Ban single-use plastics
			21. Improve waste collection
		1. Complete (100%) recycling of waste 2. Identification of hotspots	22. material recovery facilities
			23. Centralized composting facilities
			24. Landfill with gas capture

APEX Sector	Strategic objective of Eco-Vizag	Strategic actions	Prioritized GCAP measures
Water & Wastewater	Promoting a green and cool city, encouraging sustainable use of water and conservation of ecosystem	1. Restoration of natural drains catchment areas (2024-25) 2. Revival of creeks, lakes, ponds, and tanks including inlet, and outlet maintenance – periodically 3. Clear demarcation of existing water bodies and development of bunds to prevent future encroachments (Aug 2024) 4. Cascading of Tanks – Network development (Study to be conducted) 5. Vaisakhi Jala Vudyana Vanam (Re-development) (Peerla Koneru) (March 2025) 6. Natural drains/geddas management (Identification of problem areas and control of encroachments 7. Sponge parks development to increase the groundwater table: Select 2 locations in each zone for the development of 16 sponge parks (6 months target – based on success may scale up) 8. Construction of rainwater harvesting pits at government buildings and schools	25. Install new desalination plants 27. Reduce water losses 31. Efficient fittings in new buildings 32. Efficient fittings in existing buildings 28. Smart water meters 30. Recovery of urban rivers
		1. Use of treated wastewater in public toilets – Special drives on Saturdays 2. Develop a UGD system in uncovered areas. 3. Provide removable sewer covers for open drains (prevent throwing of garbage/ plastic) 4. Develop UGD system in uncovered areas 5. Provide removable sewer covers for open drains (prevent throwing of garbage/ plastic) 6. Improve the performance efficiency of STPs 7. Increase the usage of treated water to 50%	29. New wastewater treatment facilities 26. Wastewater reuse

Source: *Adopted from the Eco-Vizag Review meeting in May 2024.*

Note: APEX = Advanced Practices for Environmental Excellence in Cities; BRT = bus rapid transit; PV = photovoltaics; and WWTP = wastewater treatment plant; The Eco-Vizag campaign does not cover mobility and transport and RE in buildings, refurbs, or EE improvements.

Green City Actions and Savings

The 42 measures in the Eco-Vizag GCAP are anticipated to result in a 30 percent reduction of the city's BAU GHG emissions across the built environment, transportation, solid waste, and water sectors. The current BAU and Improved Case emissions are shown in *Figure 12* by sector; the potential emission savings pathway in each sector is shown in *Figure 13*. Additional reductions may be achieved in sectors outside the scope of APEX (and outside the city's direct mandate), notably in the power grid and industrial sector.

The measures include a mix of direct-cost measures, where the cost is the responsibility of the city and its agencies, and indirect-cost measures that are mobilized by policies, regulation, and outreach programs (or the responsibility of other levels of government). This section provides an overview of the prioritize measures and results of the APEX analysis, including GHG emissions savings, cost, energy savings, and other indicators. Appendix B shows the full list of key assumptions for measures underlying the results calculations.

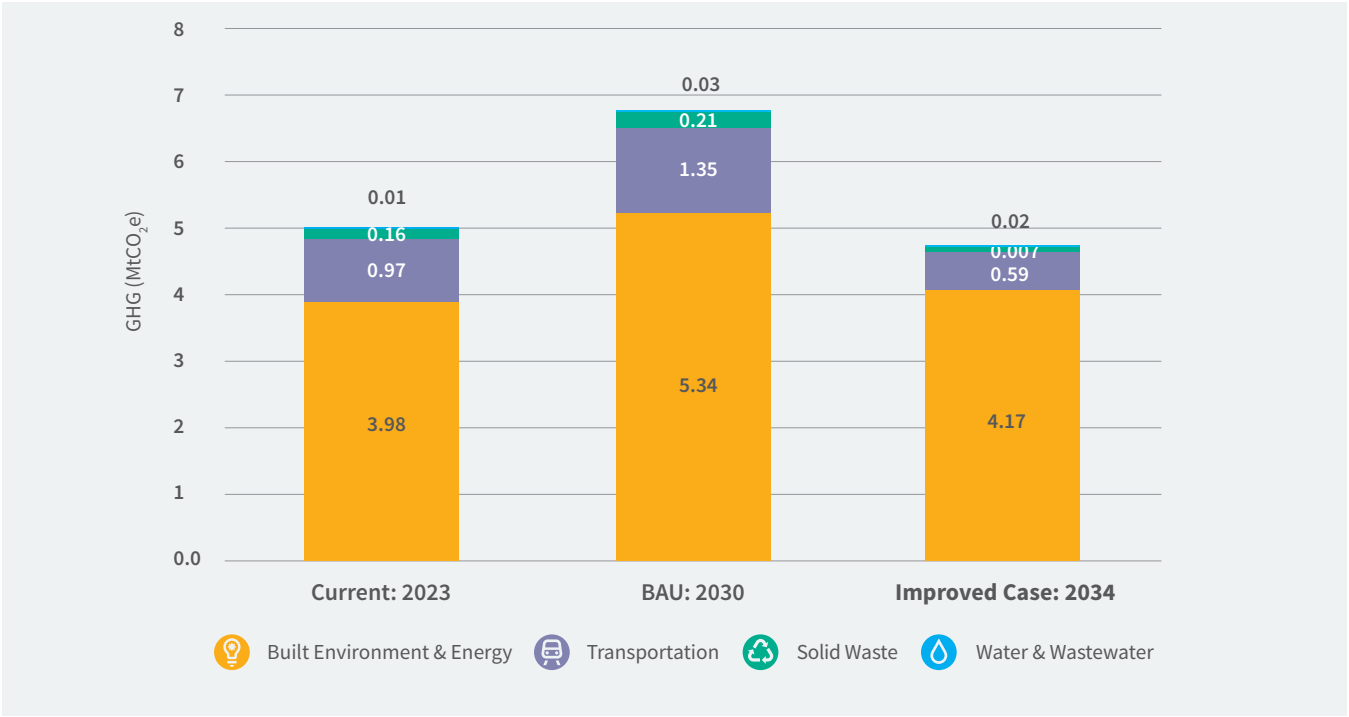


Figure 12: *Current BAU and Improved Case for GHG emissions ($MtCO_2e$/year). The 42 measures are expected to reduce the 2.0 $MtCO_2e$, representing a savings of 30 percent compared to the BAU case.*

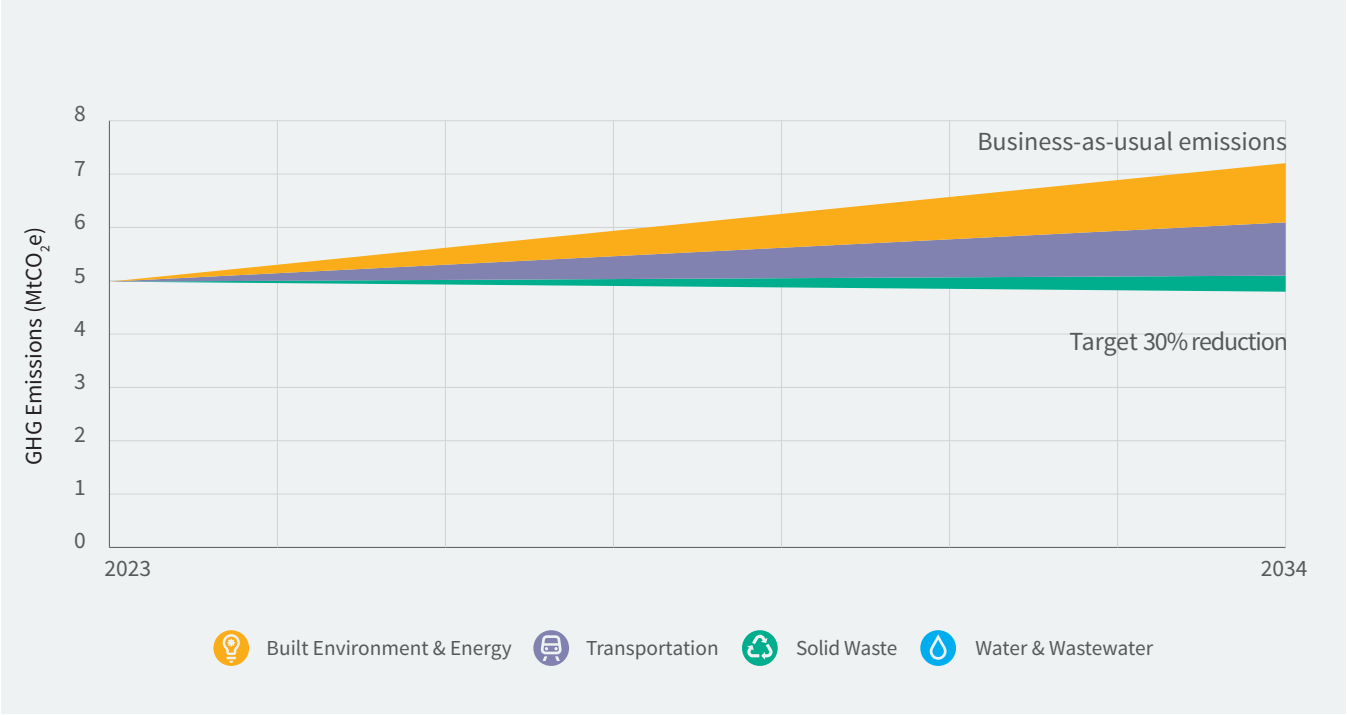


Figure 13: *Potential GHG reductions resulting from selected measures across the four APEX sectors. Implementing the 42 measures is expected to deliver a 30 percent GHG reduction, equivalent to 2.0 $MtCO_2e$ in GHG emissions. Note: $MtCO_2e$ = million tonnes of carbon dioxide equivalent; BAU = business-as-usual; GHG = greenhouse gas.*

GVMC urban green lung at Tenneti Park, GVMC.

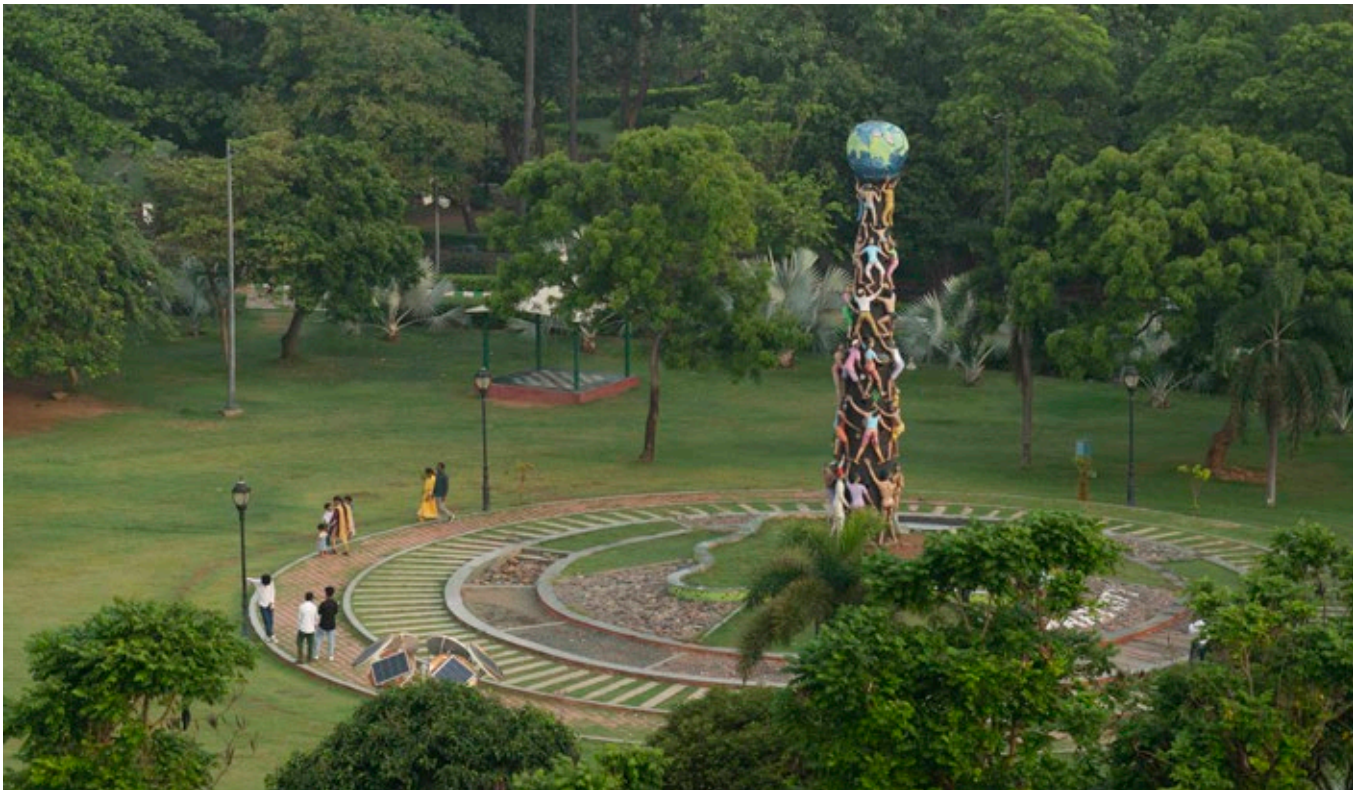


Image: IFC

Built Environment & Energy

To tackle the city's energy sector emissions, the analysis has considered both the supply side (increasing RE) and the demand side (improving energy efficiency in buildings). The recommended actions in the built environment and energy sector include upgrades to both private and municipal buildings (including improving energy efficiency in existing buildings), constructing new green buildings, and increasing solar electricity generation. Energy savings are defined as reductions in fossil fuel energy consumption, which encompasses reducing demand for fossil fuel-generated electricity, as well as replacing energy sources with renewables.

The 13 recommended prioritized measures in the built environment and energy, and their expected impacts, are shown in *Table 5.* Considering all built environment and energy measures combined, the improved case scenario represents a **20 percent fossil fuel energy savings and 16 percent GHG savings compared to the BAU scenario** *Figure 14.*

The most significant GHG savings are anticipated to arise from indirect measures. Such measures include a rooftop solar PV program, the construction of energy-efficient buildings compliant with a green building code, and the energy-efficiency refurbishment of existing buildings.

Total fossil fuel energy savings: 1,581 GWh/year.

Table 5: *Built Environment & Energy measures and individual impacts.*

	Measures	Fossil Fuel Energy Savings (%)	GHG	Total Cost (INR Crore)
Indirect (Private)	+ Rooftop Solar PV Program for Private Buildings	5.5%	4.6%	2,667
	+ Improve Building Code	4.7%	3.9%	1,429
	+ Smart Energy Display Meters	2.8%	2.3%	660
	+ Incentivize Green Building Certification	2.5%	2.1%	357
	+ Energy Efficiency Refurbishment in Private Buildings	2.2%	1.9%	1,388
	Rooftop Solar Hot Water for Private Buildings	0.6%	0.5%	2,965
	Implement Emissions Trading System*	0.3%	0.2%	-
	Promote Cool Roofs	0.3%	0.2%	766
Direct (Municipal)	Rooftop Solar PV on Municipal Buildings	0.4%	0.3%	178
	Municipal Energy Efficiency Refurbishment	0.2%	0.2%	84
	Green Municipal Buildings with Certification or Labeling	0.2%	0.1%	12
	Energy Efficient Street & Traffic Lights	0.1%	0.1%	269
	Increase Urban Forestry	<0.1%	<0.1%	386
	Total	**20%**	**16%**	**11,162**

+ Measures with the highest impact in terms of GHG savings

**Policy-based measure that is currently not costed in APEX*

Note: GWh = gigawatt-hour; GHG = greenhouse gas; PV = photovoltaics; USD = United States dollar

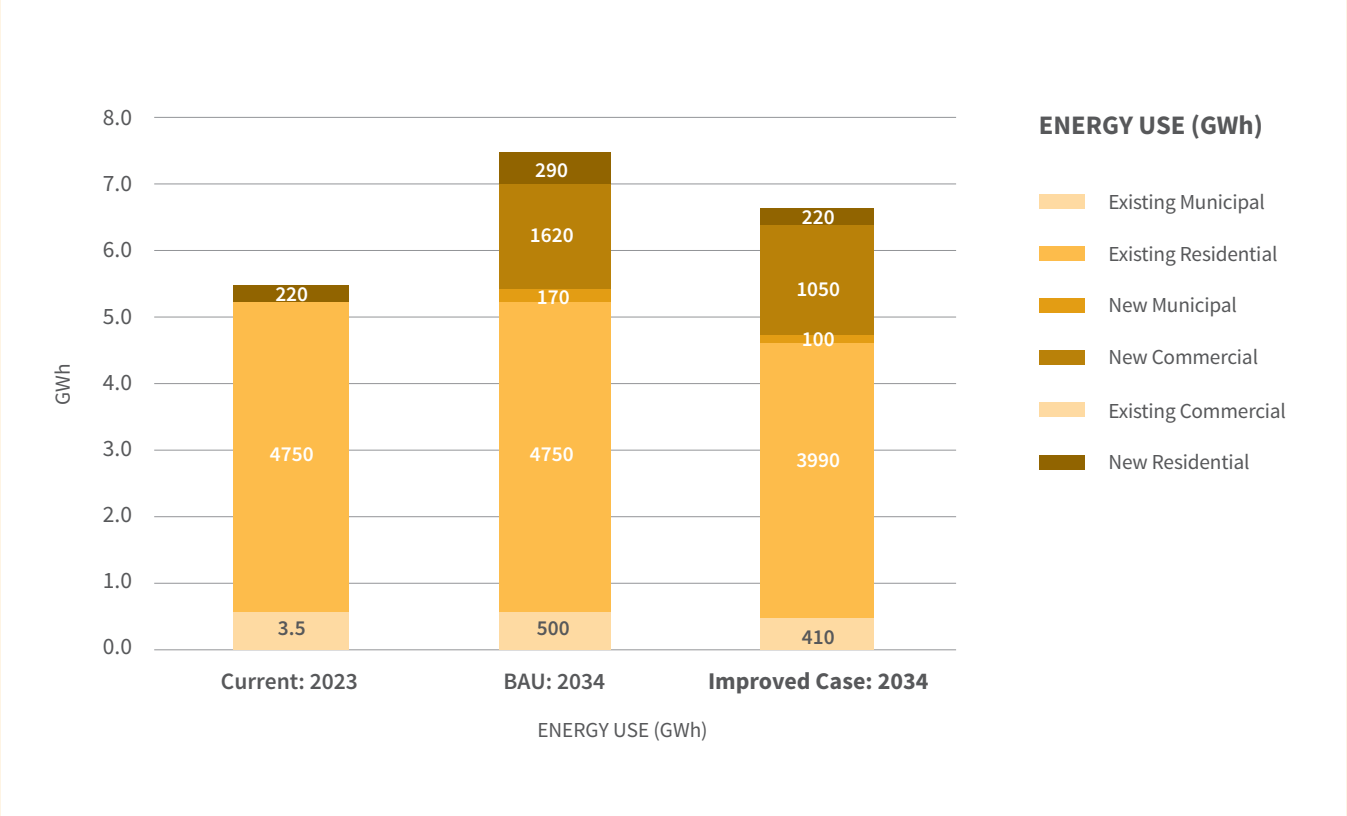


Figure 14: *Current, BAU, and Improved Case for fossil fuel energy use in gigawatt-hours per year (GWh/year).*

Installed rooftop solar panels at GVMC main office at Jail Road.

Image: IFC

Prioritized Measures: Built Environment and Energy

Rooftop Solar PV Program for Private Buildings

With this measure, the city implements a program to install solar panels on 50 percent of the privately owned new and existing residential buildings by 2034. This is expected to add a capacity of 300 MWp. The panels could be either rooftop or ground mounted.

The city plans to incentivize this action via existing government rooftop solar subsidy programs like the Pradhan Mantri Muft Bijli Yojana, which aims to achieve 40 GW of national rooftop solar capacity by 2026. The city will install solar PV rooftops in 1 lakh households across all zones in the city, which means 1,000 houses with sufficient rooftop area per ward secretariat will run on green solar power. Other cities have upscaled rooftop solar from private buildings, as described in *Box 1.*

Residential consumers installing grid-connected rooftop solar systems can avail central financial assistance directly from the Pradhan Mantri Muft Bijli Yojana national portal for rooftop solar. The subsidy[9] will cover up to 60 percent of the cost of the solar panels. The subsidy for installation from 1kW to 2kW capacity is INR 30,000/ Kw, For 3kW capacity: INR 30,000/ kW till 2kW and an additional INR 18,000 per kW up to 3kW capacity. For systems over 3kW capacity, a subsidy of INR 78,000 is fixed.

Box 1: *Case study for rooftop solar PV program for private buildings in Diu and Delhi.*

CASE STUDY

In 2018, The Diu smart city became the first smart city in India to run on 100 percent renewable energy during the day by generating 1.3 MW annually[10]. The city offers a subsidy of INR 10,000 – 50,0000 to install 1-5KW of rooftop solar panels, which is over and above the central and state subsidies. As part of Delhi's solar policy, the city of Delhi also allows a community solar rooftop policy through a RESCO model for consumers who do not have feasible rooftop space to set up solar panels. In this model, the solar private developer would bear the costs for installation and surcharges with a fixed fee[11]. A net-metering agreement between the consumers and DISCOM would be combined with the power purchase agreements between DISCOM and solar developers. Consumers pay DISCOM and receive net metering benefits on their electricity bills, whereas DISCOM would choose the developer and the criteria of the tariff. This would be a feasible model for both DISCOM and consumers.

Image: istockphoto.com

[9] Pradhan Mantri Muft Bijli Yojana Scheme, https://www.myscheme.gov.in/schemes/pmsgmb#benefits

[10] Diu smart city 100 percent RE power, Government of India, Press Information Bureau, 2018, https://pib.gov.in/newsite/PrintRelease.aspx?relid=178853

[11] Delhi community-led solar policy , Mongabay, 2023, https://india.mongabay.com/2023/01/delhi-proposes-community-solar-rooftops-to-encourage-renewable-growth/

Improve Building Code

With this measure, the city aims to achieve 20 percent of energy savings in the construction of all new buildings (residential and non-residential) by 2034.

To accelerate the effective implementation of the Energy Conservation Building Code (ECBC) and Eco-Niwas Samhita, the state of Andhra Pradesh has set a dedicated 'Energy Conservation and Energy Efficiency Policy 2023-2028'[12]. This policy has an energy savings target of 6.68 Mtoe of energy savings by 2034 and aims to leverage the potential of using local energy sources and energy-efficient measures in heating, cooling, and maintaining thermal comfort in buildings. To mainstream the state targets, the city aims to mandate and implement a Green Building Code by introducing additional requirements to the state Energy Efficiency and Energy Conservation Policy, and by developing a city-specific building energy conservation code, which is mandatory and applicable to the construction of new buildings.

Smart Energy Display Meters

With this measure, the city and the DISCOM would implement the execution of national and state targets that mandate smart net metering systems and installing Building Energy Management Systems (BEMS) at the consumer level for 100 percent of residential, and 100 percent of non-residential buildings by 2034.

As per the national Smart Meter Program, the Ministry of Power has a target to replace 25 crore conventional meters with smart meters by 2025, a critical component of the Revamped Distribution Sector Scheme (RDSS). The state also had a target to replace 27,000 smart meters across the state electricity meters with smart prepaid digital meters in the first phase. The implementation model for smart metering is TOTal EXpenditure (TOTEX), which is capital expenditure (CAPEX) plus operational expenditure (OPEX) under the Design-Build-Finance-Own-Operate-Transfer (DBFOOT) model, with OPEX payments linked to the Service Level Agreement (SLA). Few cities have successfully implemented smart meter installation, as described in *Box 2*.

Box 2: *Case study for implementation of smart energy meter in Delhi and Bangalore.*

CASE STUDY

The New Delhi Municipal Council (NDMC) with a population of 20 million citizens has achieved 100 percent smart metering by replacing more than 50,000 conventional electricity meters, serving more than 57,000 consumers within the NDMC area.[13] By partnering with Energy Efficiency Services Limited (EESL) and with a private vendor for their meter data management systems (MDMS) and consumer-facing redressal systems, NDMC deployed the implementation in three months.

Image: istockphoto.com

In Bangalore, Bangalore Electricity Supply Company (BESCOM) along with two private vendors has also completed the replacement of 17 lakh conventional meters to smart meters free of cost to the citizens within the Bengaluru Metropolitan Area Zone.[14] This is under the central government's Revamped Distribution Sector Scheme on a turnkey basis.

[12] Draft Andhra Pradesh Energy Efficiency and Energy Conservation Policy 2023-2028 https://www.apsecm.ap.gov.in/news/final-draft-ec-policy.pdf

[13] NDMC 100 percent smart metering project, 2019 https://fluentgrid.com/case-studies/first-indian-municipality-to-go-for-100-ami/

[14] BESCOM meter replacement program , 2022 https://www.thehindu.com/news/cities/bangalore/bescom-close-to-completing-meter-replacement-project-in-bengaluru/article68421274.ece#:~:text=The%20meter%20replacement%20programme%20began,meters%20on%20a%20turnkey%20basis.

Incentivize Green Building Certification

For this measure, the city requires new developments to take advantage of green building incentives. The measure aims for 30 percent of new buildings to receive green building certification, equating to an estimated 2.8 million m^2. Certain green building certification programs, such as IFC's EDGE program, include savings in water use and embodied energy in materials in addition to energy savings. IFC's EDGE certification is well-suited to be tied into municipal policy due to its ease of use, low cost, and scalability. The city can pair the regulatory policy with incentives to support developers to pursue green buildings.

While the investment will be undertaken by the private sector, the GVMC can encourage developers to build green by offering various incentives, such as expedited permitting for green buildings, awareness raising and promotion, technical trainings about green building certification, among others.

Andhra Pradesh has positioned itself as a frontrunner in implementing the ECBC with over 1,000 buildings conforming to its standards and more than 3,000 trained stakeholders. This measure is also aligned with the PM Surya Garha scheme and has a target to make 100 houses per secretariat become green either through EE retrofitting or solar rooftop solutions. The city plans to train the ward secretariat officers with the planning secretariats and town planning officers in each zone to implement this action. An approach for additional incentives for consumers can be based on building performance based on energy, water, and material savings instead of the rating level.

Energy Efficiency Refurbishment in Private Buildings

This measure targets private buildings for energy efficiency improvements, aiming for upgrades in 15 percent of residential buildings and 10 percent of commercial buildings for a total building area of 5 million m^2. Upgrades may include efficient lighting and appliances, improved windows and building envelopes, upgraded heating, ventilation, and cooling systems, energy-efficient ceiling fans, and others. This action will need to tap the private sector investments, primarily through offering financing programs for building refurbishment through local banks.

The action leverages the ongoing initiatives by the city DISCOM APEPDCL on business models for their DSM. Under the DSM program, the DISCOM has plans to develop a DSM-based Efficient Lighting Program (DELP), as well as to implement both the Energy Efficient Tube Lights Program (EETL) and the Domestic Efficient Fans Program (DEFP).

The DISCOM has considered two approaches for the replacement of conventional fans with Brushless Direct Current (BLDC) motor fans: the vendor-empaneled model and an on-bill financing approach. These will be executed under the APEPDCL BLDC Fan Replacement Scheme 2024.

The DISCOM has also identified the list of empaneled vendors for procurement and installation. The DSM has targeted a 41.85 MW reduction in demand while replacing the fans, 31.32 MW while retrofitting tube lights, and 34.83 MW while retrofitting air conditioners.

With EDGE infrastructure and networks already in place in India, the next step is to develop the regulatory approach and incentive structure that works for all green building rating systems.

Image: edgebuildings.com

Rooftop Solar Hot Water for Private Buildings

For this measure, the city aims to install solar hot water systems on 40 percent of habitable building rooftops, including hotels, health, and residential buildings. This measure also aligns with the Andhra Pradesh Solar Energy Policy of 2019, MNRE.[15] The state provides soft loans and capital subsidies for property owners installing solar water heating systems.

The applicable Central Financial Assistance (CFA) is INR 3300 per m^2 in the case of Flat Plate Collectors (FPC), INR 3000 per m^2 in the case of Evacuated Tube Collectors (ETC), or 30 percent of the system cost, whichever is lower. The state had issued a notification in 2004, mandating the installation of solar water heaters in all buildings with a height of above 15 meters. A demand of capacity of 30 lakh LPD was generated. The mandate has recently been amended and is now optional. According to a survey in 2018, the city has seen a high rate of acceptance of solar water heaters among hotels and hospitals.[16] Moving forward, the residential sector presents a prime opportunity to implement this measure. Other cities in India have issued mandates for solar hot water, as described in *Box 3*.

The city can develop partnerships with solar technology providers and educational institutions, as well as collaborate with local utilities to seamlessly integrate these systems into the existing energy infrastructure. This could be funded through central sector schemes or state sector schemes, municipal/utility budgets, loans from financial institutions, or private-sector financing models such as Energy Service Companies (ESCOs), and through PPPs. A database on the incentives used by citizens and the relative increase in the percentage of households with rooftop solar PVs can be monitored via the Integrated Control and Command Centre (ICCC) at the GVMC office.

Box 3: *Case study for solar water heater mandates in Thane, Rajkot, Bengaluru, and Pune.*

CASE STUDY

Cities such as Thane and Rajkot have issued a mandate for all new commercial buildings to have in-built solar water heaters. BESCOM in Bengaluru is also an example of the successful implementation of such a plan through a bylaw that requires developers to install solar water heaters in dwellings with a floor space of 600 square feet or more if they are built on parcels of land measuring at least 1,200 square feet. This mandatory solar thermal capacity is linked to room size, and increases based on the interior space. Pune also provides a 5 percent rebate on property tax for one energy efficiency initiative out of solar water heater.[17]

Image: istockphoto.com

[15] Andhra Pradesh Solar Energy Policy of 2019, https://nredcap.in/SolarEnergy.aspx

[16] Market Assessment of Solar Water Heating Systems in Five Potential States/NCR Region, https://www.gkspl.in/wp-content/uploads/2018/10/REI7b.pdf

[17] Pune solar water heater property tax rebate, https://www.pmc.gov.in/en/solar-tax-benefits#:~:text=The%20government%20also%20provides%20an,at%20the%20respective%20ward%20offices.

Implement Emissions Trading System

This measure will promote the city's commercial sector for emissions trading systems (ETS), targeting 10 percent of the commercial and industrial buildings by 2034. Emissions trading systems are market-based instruments that create incentives to cost-effectively reduce emissions; emissions targets can be decreased over time to result in more carbon savings. The government of India has recently passed the Energy Conservation (Amendment) Bill, 2022, which envisions a provision to develop an Indian Carbon Market (ICM)[18]. The ICM is expected to include a national ETS for sectors and entities that are already part of the Perform, Achieve, and Trade (PAT) scheme, including power and energy-intensive industry sectors. Other cities in India have implemented ETS, as described in *Box 4.*

Under this measure, both the city and state pollution control boards will coordinate to implement a policy mandate for adopting ETS in selected industrial clusters, with each industrial unit having set a science-based target. The city will encourage the industrial units to achieve their set targets through energy efficiency improvements for emissions reduction, by purchasing carbon credits, or through a combination of both. If a building's emissions are less than its target, the units are granted carbon credits they can then sell. This measure is initially targeted at non-residential buildings, but the city aims to include municipal buildings and facilities in the long term, with a focus on reducing emissions and encouraging cleaner production processes, thus ensuring a healthy city and a better quality of life for its citizens.

Box 4: *Case study for the implementation of ETS in industrial clusters of Surat and Ahmedabad.*

CASE STUDY

Surat, a city in the state of Gujarat conducted a successful large-scale pilot program for industrial plants in Surat for the implementation of ETS across 355 industries. This saw a 20 percent reduction in particulate matter compared to industries where it was not implemented.[19] In 2023, the state expanded the scheme in Ahmedabad for textile industries and has installed continuous real-time emission monitoring systems in 118 industries.[20]

Image: Abhay Prajapati on Unsplash

[18] The Energy Conservation (Amendment) Act, 2022
https://powermin.gov.in/sites/default/files/The_Energy_Conservation_Amendment_Act_2022_0.pdf
[19] Implementation of emission trading system, Ahmedabad TP Scheme
https://sites.google.com/view/tp-scheme-ahmedabad-download-
[20] Lessons from India's ETS market
https://www.weforum.org/agenda/2023/11/indian-city-first-pollution-market-cop28/

Promote Cool Roofs

With this measure, the city will promote cool roofs for 25 percent of residential and commercial buildings, covering 1.5 million m^2 of rooftop area by 2034.

Cool roofs reflect more sunlight and absorb less heat than conventional roofs, which can help reduce air conditioning loads and mitigate local urban heat islands. As part of the Eco-Vizag campaign, the city will promote cool roof solutions using lime-based whitewash, white tarp, white China mosaic tiles, and acrylic resin coating, or by solar reflective white paint on the rooftops of buildings in the city, first piloting commercial and institutional buildings. Local native species like vetiver (Vetiveria zizanioides - a tall perennial grass) is proposed by the city as an indigenous solution. Best practices from other cities in India have adopted cool roof programs, as described in *Box 5*.

Box 5: *Case study for the adoption of cool roofs in Ahmedabad, Hyderabad, Surat, and Indore.*

CASE STUDY

The city of Ahmedabad, Gujarat under its Ahmedabad Heat Action Plan, 2019,[21] and the Greater Hyderabad Municipal Corporation, Telangana as part of their state-building energy efficiency program, have adopted cool roofs.[22] Telangana aims to install 300 sq km of cool roofs throughout the state by 2028, in which 200 sq km of cool roofs will be implemented in the Greater Hyderabad area.[23] Similarly, Surat and Indore had also embarked upon the cool-roof project in which over 100 households were coated with low-cost techniques and green cool-proofing materials such as lime concrete, helping to reduce temperatures and the costs of electricity and water.[24]

Image: istockphoto.com

[21] Ahmedabad heat action plan, 2019 https://www.c40knowledgehub.org/s/article/Ahmedabad-Heat-Action-Plan-2019?language=en_US

[22] Telangana cool roof policy, 2023 https://www.nrdc.org/bio/prima-madan/telangana-announces-groundbreaking-cool-roof-policy

[23] Hyderabad cool roofs, 2023 https://www.newindianexpress.com/states/telangana/2023/Apr/04/telangana-govt-makes-cool-roofs-a-must-for-buildings-2562486.html

[24] Cool roof projects in Surat and Indore, 2019 https://iiphg.edu.in/images/pdfs/NRDC/cool-roofs-2018.pdf

Rooftop Solar PV on Municipal Buildings

With this measure, the city aims to add 20 MW of solar capacity to its municipal buildings and facilities. This will include rooftop solar PV integration for new municipal projects, and zonal offices showcasing a forward-looking approach to sustainable energy practices. The city aims to install PV systems on the roofs of all new and existing public buildings, such as schools, hospitals, offices, all public facilities/utilities like sewage treatment plants (STPs), water treatment plants (WTPs), and community centers. This will help the city to reduce its electricity bills, GHG emissions, and dependence on fossil fuels, while also creating local jobs and promoting renewable energy awareness. Other cities in India have installed rooftop solar PVs in municipal buildings, as described in *Box 6*.

The city currently generates less than 1 percent of renewable electricity with solar photovoltaic (PV) panels on rooftops of municipal buildings and water reservoirs. The average renewable energy generated from the 2MW grid interactive solar floating power plant on the Mudasarlova reservoir is 250 million units. The GVMC has also recently commissioned a 1 MW solar floating plant near Mudasarlova and a 3 MW floating solar power project on Meghadri Gedda reservoir. Solar rooftops have been installed on institutional buildings of GVMC, including the main office on Jail Road. The installation of rooftop PVs have also been piloted in a few GVMC-owned schools and universities. The city has floated a terms of reference tender document for the proposed installation of solar PVs with a capacity of about 215 kW mounted on the rooftops of 144 schools located within the limits of GVMC.

Box 6: *Case study for the implementation of solar rooftops in all municipal buildings.*

CASE STUDY

The Delhi Municipal Corporation (DMC) has adopted a revenue-sharing model (RESCO model) and has tendered for the installation of 50 MW solar PV in all 645 municipal buildings (an area larger than 500 sq meters) where revenue is shared between the agency and DMC over 25 years minimum[25]. This is for the implementation of the Delhi Solar Energy Policy 2023 which targets 750MW of rooftop solar capacity by 2026-27[26]. The city provides a subsidy of INR 2,000 to a maximum of INR 10,000 per consumer, which will be over and above the capital subsidy of the central government. Special budget allocations are also provided in budget FY 2024-25.

Image: Jeroen Van deWater by Unsplash

[25] Delhi Municipal Corporation to install solar PVs on municipal buildings, https://timesofindia.indiatimes.com/city/delhi/50mw-solar-systems-to-be-installed-on-645-govt-buildings/articleshow/108445325.cms

[26] Delhi Solar Energy Policy 2023, https://eerem.delhi.gov.in/sites/default/files/eerem/circulars-orders/notified_delhi_solar_energy_policy_2023_english_version.pdf

Municipal Energy Efficiency Refurbishment

With this measure, the city aims to retrofit 100 percent of its municipal buildings and facilities with energy efficiency improvements like retrofitting with EE appliances by 2034. The city commits to building green for nearly 20 percent of its new upcoming municipal buildings, as well as retrofitting existing buildings to be more energy and water-efficient through an EE refurbishment program.

The DISCOM along with EESL and Bureau of Energy Efficiency (BEE) has been upscaling an EE retrofitting program throughout 5 districts in the state. This aligns with the National Electricity Policy, the Energy Conservation Act, and the National Efficient Fans Program (EEFP). All the appliances in the APEPDCL corporate office were replaced with star-rated appliances, viz., 800nos LED Lights, 250nos 5-star energy efficient fans, and 77nos 5-star rated air conditioners. This has resulted in 9200MU* per month of energy savings.

Green Municipal Buildings with Certification or Labeling

With this measure, the city commits to building green for all new municipal buildings, as well as retrofitting existing buildings to be more energy and water efficient. The results are based on all new municipal buildings being constructed according to green building principles, resulting in at least a 20 percent reduction in their energy and water use.

The city will mandate adoption of ECBC building codes (or similar certification) for all new institutional buildings to be constructed according to green building principles. Under Eco-Green and Eco-Clean the city aims to initiate a green building certification program for retrofitting the municipal buildings in compliance with ECBC 2018 guidelines. Other cities in India have piloted green municipal buildings with certification systems like EDGE, as described in *Box 7.*

Box 7: *Case study for EDGE-certified municipal buildings in Chennai..*

CASE STUDY

Tamil Nadu Infrastructure Fund Management Corporation, an independent investment company (regulated by the Securities & Exchanges Board of India and the government of Tamil Nadu along with public and private financial institutions) has developed an IFC EDGE-certified government affordable housing project, having ~1.1mn Sq. ft of saleable area and 2,736 units targeting Economically Weaker Sections, Low-Income Groups, and Medium Income Group customers like Working Women, Long Term Rental Housing, Industrial Housing, Senior and Assisted Living, and Housing for Migrant Construction Workers.[27]

Image: Tamil Nadu Shelter Fund.

[27] Tamil Nadu Infrastructure Fund Management Corporation: Case study on green government affordable housing https://tnifmc.com/about-us/

Energy Efficient Street and Traffic Lights

With this measure, the city will ensure that all streetlights and traffic lights use energy-saving bulbs. Utility assets like traffic signals and traffic lights are owned and maintained by the city's Police Department. As per the secondary data from 2020, there are already 50 traffic signals within the city, and another 50 will be added as a part of the Smart City project[28]. Of the 50 additional signals, 25 have been installed and the trial run has been completed at 23 traffic junctions.

The city also plans to upgrade to signal-free roads and roundabouts for all traffic junctions. At present, 4 junctions are upgraded to signal-free roads. Lighting upgrades could be funded through central sector schemes or state sector schemes, and municipal/utility budgets, including through lease-to-own models, ESCOs, and/or PPPs.

Increase Urban Forestry

Currently, the city's urban green cover is 35 percent as shown in *Figure 14*. With this measure, the city seeks a 20 percent increase in its urban green cover from the existing baseline by adding a 12.6 km^2 of green canopy area by 2034, as shown in *Figure 15*. With this measure, the city aims to increase the extent of urban forestry by planting more trees and creating more green spaces along the non-motorized transport (NMT) infrastructure. *Figure 16* shows the layout of open spaces (OSRs) identified within GVMC for increasing green cover.

Image: IFC

Installed energy efficient traffic lights at Railway Station road.

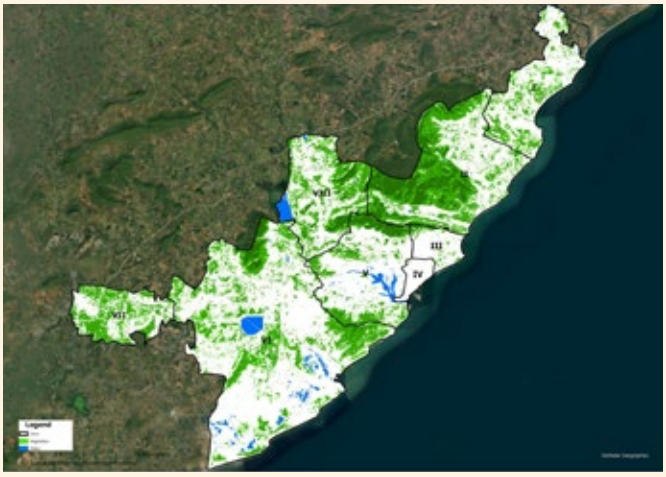


Figure 15: *Vizag Green cover map, Source: GVMC.*

[28] Traffic Lights in Vizag to have EE, https://www.thehansindia.com/news/cities/visakhapatnam/visakhapatnam-gets-new-traffic-signals-646983

With the Eco-Green and Eco-Clean tranches of the Eco-Vizag campaign, the city aims to increase community gardens (terrace gardens, kitchen gardens) with the support of Resident Welfare Associations and women's groups involved in social forestry. Through Eco-Green 'Green my street' the city aims to implement a mass planting program that targets greening around the city's major sub-arterial and local road corridors. The city also aims to plant alongside 35-38km of new roads to be laid as connecting roads. GVMC is also planning to initiate a zone-wide Normalized Difference Vegetation Index (NDVI) analysis to help understand land use/land cover (LULC) and implement the planting scheme. The costing analysis from the GCAP will be used for planning the activities and GCMC is willing to budget the expenditure from its municipal budget to implement this initiative. The city is also looking at the coastal belt, aiming to plant Casuarina trees to reduce beachside temperature.

Shelterbelt planting is also planned to control erosion by introducing sand binders. Mulching activities are planned to retain soil moisture and reduce evaporation losses from the albedo effect, as well as to reduce the urban heat island effect. Other than the planting activities, the city is collaborating with the Ministry of Environment, Forest, and Climate Change of India (MoEFCC) to explore carbon credits from establishing a mangrove plantation along the coastline. As part of this measure, the city also commits to developing an urban biodiversity index. This measure will help curb emissions and reduce the urban heat island effect.

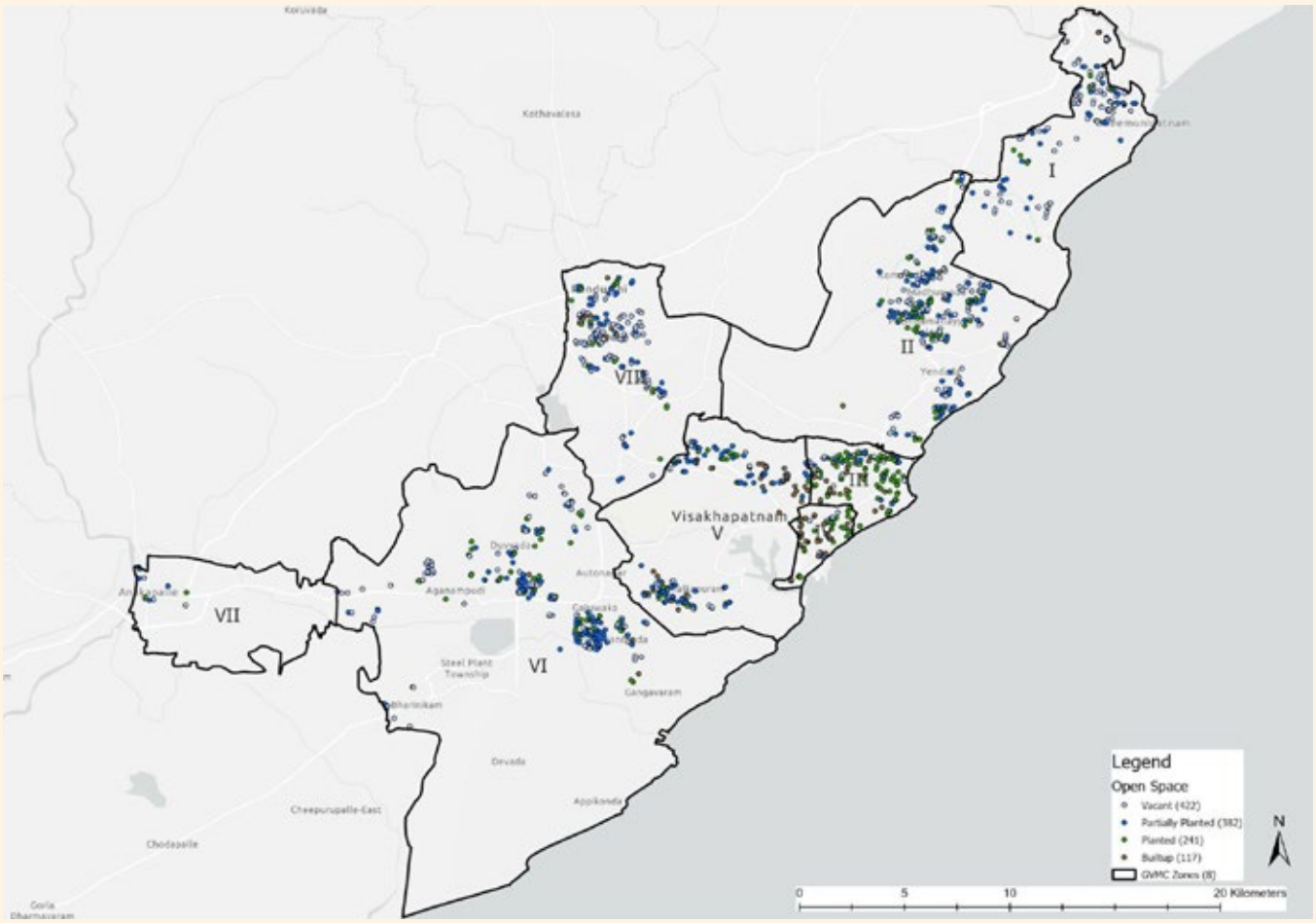


Figure 16: *Layout of open spaces identified within GVMC, Source: GVMC.*

Implementation Considerations

The table below explores the implementation considerations for the built environment and energy prioritized measures in terms of their GHG savings potential, ease of implementation, and implementation timeline.

Measures	GHG Savings Potential[1]	Ease of Implementation[2]	Timeline[3]
Rooftop Solar PV Program for Private Buildings	High	Medium	Long
Improve Building Code	High	High	Medium
Smart Energy Display Meters	High	High	Medium
Incentivize Green Building Certification	High	High	Short
Energy Efficiency Refurbishment in Private Buildings	High	Medium	Medium
Rooftop Solar Hot Water for Private Buildings	Medium	Medium	Medium
Implement Emissions Trading System	Medium	Low	Long
Promote Cool Roofs	Medium	High	Short
Rooftop Solar PV on Municipal Buildings	Medium	High	Medium
Municipal Energy Efficiency Refurbishment	Medium	Medium	Long
Green Municipal Buildings with Certification or Labeling	Medium	High	Short
Energy Efficient Street & Traffic Lights	Medium	Medium	Short
Increase Urban Forestry	Low	High	Medium

[1] ***GHG Savings Potential***

High	*More than 1% savings from BAU*
Medium	*0.1-1% savings from BAU*
Low	*Less than 0.1% savings from BAU*

[2] ***Ease of Implementation***

Low	*The city is interested in delving into the particular action but is yet to initiate the necessary groundwork and further scoping is needed to identify land availability or technical feasibilities and identify a network of stakeholders, which might require additional technical and financial support, which would impact the chances of uptake implementation*
Medium	*The city has identified the policies, undertaken potential feasibility studies, identified locations and land availability, and has identified the network of stakeholders for implementation, however, might require additional financial support from the private market, which would impact the chances of effective implementation*
High	*With the needed infrastructure, policies, and network of stakeholders already in place, the city has initiated necessary actions for implementation of the measure, which would deliver a high impact and quick chances to uptake implementation.*

[3] ***Timeline***

Short	*1-2 years (By 2026)*
Medium	*3-5 years (By 2029)*
Long	*5-10 years (By 2034)*

Transportation

Transportation measures focus on shifting travel from private cars to public transit, as well as electrifying cars, buses, and autorickshaws. The measures primarily focus on new infrastructure and vehicles, but there is an important balance between the supply and demand of public transportation; that is, increasing the supply of public transportation must be balanced with policies that discourage private vehicles and make driving less convenient. It is important that new infrastructure is well-connected, safe, and accessible to make it easy for public transport riders to transition between modes.

The 12 prioritized transport measures and individual impacts are shown in *Table 5*. With all measures combined, the *Figure 17* represents an Improved Case scenario of **64 percent reduction in private fossil fuel vehicle-kilometers traveled (VKT) and 11 percent GHG savings** compared to 2034 BAU.

Achieving this vision requires a focus on public transportation and electrification. The measures with the greatest impact include expanding and electrifying bus systems, extending the subway system, and promoting electric vehicles.

Total reduction in private fossil fuel vehicle travel: 10,543million VKT/year.

Table 5: Transportation measures and individual impacts.

	Measures	Reduction in Private FF Vehicle Travel (%)	GHG Savings (%)	Total Cost (INR Crore)
Direct (Municipal)	+ Expand & Electrify Public Bus System	22.7%	2.9%	38,702
	+ Extend Subway System	11.1%	1.3%	2,402
	Expand & Electrify BRT System	0.7%	0.1%	2,451
	Designate Street Lanes as Green Lanes	0.1%	<0.1%	641
	Add Park-and-Ride to Transit Stations	0.1%	<0.1%	101
	Electrification of the Municipal Fleet	0.4%	0.1%	1,678
Indirect (Private)	+ Promote Private Electric Vehicles	20.5%	4.7%	10,904
	Electric Vehicle Charging Infrastructure	2.3%	0.2%	481
	Electrification of Auto-Rickshaws	0.7%	0.2%	403
	Retirement of Inefficient Cars & Motorcycles	-	0.2%	1,466
Policy	Street Parking with Dynamic Pricing*	5.0%	1.1%	-
	Car-free Zones*	0.4%	<0.1%	-
	Total	**64%**	**11%**	**59,230**

+ Measures with the highest impact in terms of GHG savings

**Policy-based measure that is currently not costed in APEX*

Note: BRT = bus rapid transit; FF = fossil fuel; GHG = greenhouse gas; USD = United States dollar

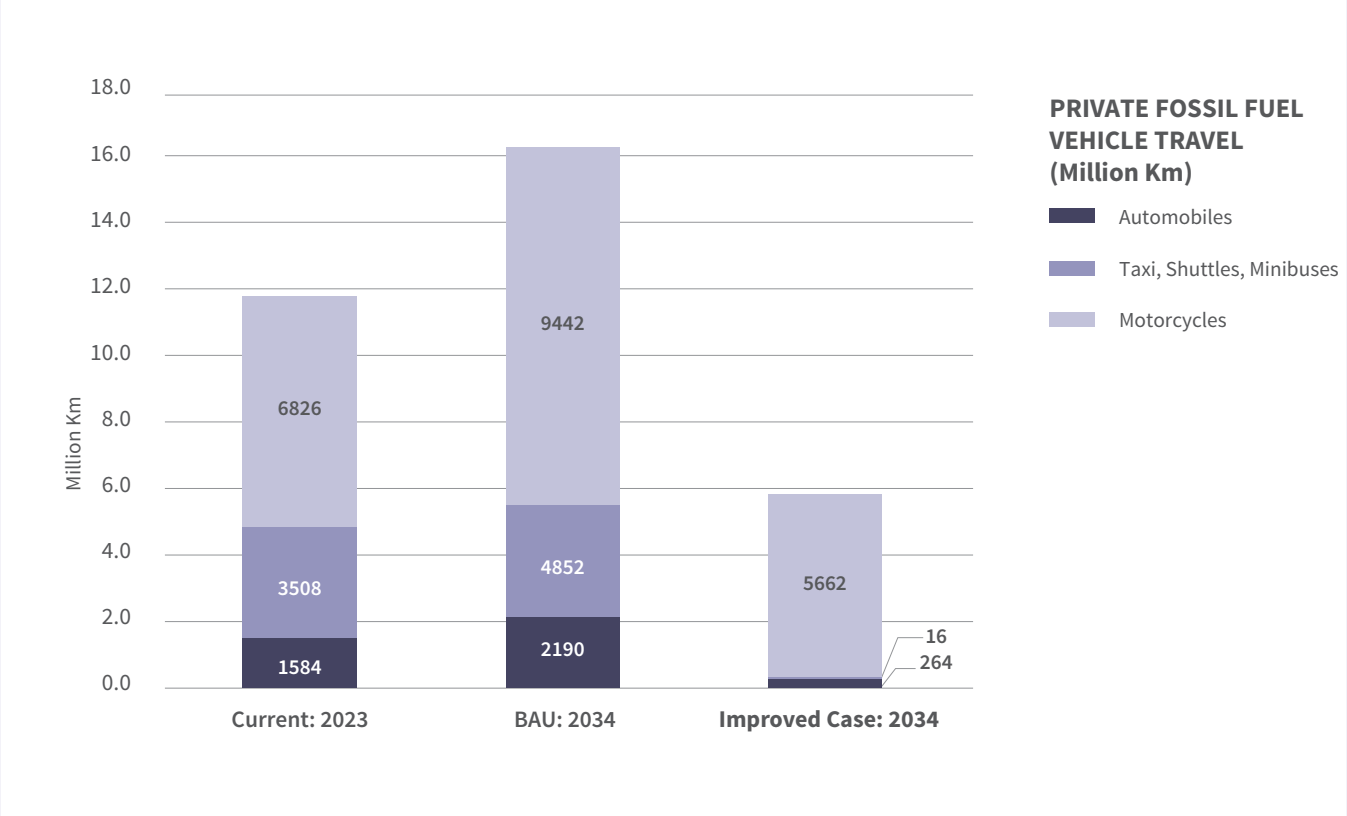


Figure 17: *Current, BAU, and Improved Case for Private Fossil Fuel Vehicle Travel (Million km/year).*

GVMC bus bay at RTC Complex.

Image: IFC

Prioritized Measures: Transportation

Extend Subway System

This measure includes the implementation of the Andhra Pradesh state government's proposal to develop a 76.9 km metro rail project in Vizag at an estimated cost of INR 14,309 crore, as shown in Figure 18 . The city will implement the provision of e-bikes, charging points, and shared electric auto-rickshaws at metro stations, along with the opportunity for commuters to bring bicycles on the trains. To further support ridership, the city will enhance pedestrian-friendly pathways around metro stations, ensure convenient accessibility, and establish parking facilities near major junctions.

The metro rail will consist of 4 corridors and connect the Steel Plant Jn. to Kommadi on NH-16 (34.23 km), Gurudwara to Old Post Office (5.28 km), Thatichetlapalem to Chinna Waltair (RK Beach) (6.91 km), and Kommadi to Bhogapuram Airport (30.48 km).

The project has been estimated to generate direct and indirect employment for about 8,000 people during construction and permanent employment for 5,000 workers. The Detailed Project Report (DPR) along with all necessary reports and documents has been submitted to the Ministry of Housing and Urban Affairs (MoHUA) for approval. In the financial model approved by the state government, 20 percent will be paid for by the center, 20 percent by the state, and the remaining 60 percent by the private developer. The state government has sought support from the center to bear the total government's share of 40 percent (both that of the state and the center). The target is to cater to a passenger capacity of 5-6 lakhs daily by 2024 and to gradually increase the carrying capacity to more than 20 lakhs per day by the year 2054. Though this action will not have a direct high impact on GHG savings, it will create demand for public transport and help achieve the goal of reducing the total passenger private VKT traveled.

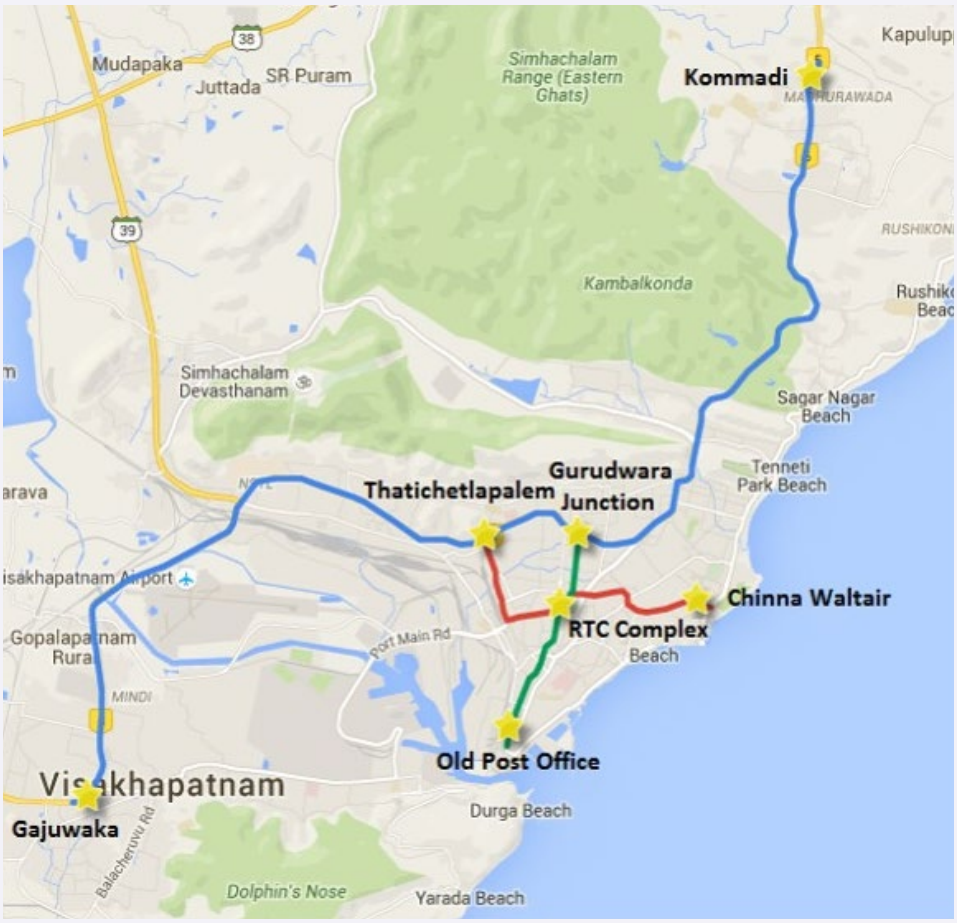


Figure 18: Vizag proposed metro route map, Source: AP Cabinet.

Dedicated BRTS corrdior at Mudasarlova road.

Image: IFC

Expand & Electrify Public Bus System

The city aims to increase and electrify its bus fleet by a 50 percent increase with 1,200 new electric buses.

As per the Andhra Pradesh State EV policy 2018-2018, the target is to convert 100 percent of the APSRTC bus fleet of over 11,000 buses into either battery electric vehicles or fuel cell electric vehicles) by 2029, with the first phase of 100 percent conversion of the bus fleet in the top 4 cities by 2024. The FAME-II Scheme allows a subsidy of INR 20,000 per kWh for e-buses with a cap of 40 percent of the vehicle's cost and a maximum ex-factory price limit of INR 2 crores.[29] APSRTC has already sought the subsidy and aims to electrify its fleet across its service for 5 districts of Andhra Pradesh. This, however, seems to be insufficient.

The electrification of the municipality-owned bus fleet could be financed through mechanisms such as the Public Asset Corporation model, municipal debts, or PPP contracts. Other cities in India have set targets and identified business models, as described in *Box 8.*

Box 8: *Case study for the expansion and electrification of public electric buses in Kolkata.*

CASE STUDY

The West Bengal Transport Corporation (WBTC), the state-owned enterprise (SOE) in charge of Kolkata's state government-owned bus, tram, and ferry services, has plans to consider a clean public transportation system by identifying viable business models for EV transition in two-wheelers and four-wheelers segment.[30] In this, battery-operated electric buses are 50 percent more cost-effective than diesel buses.

Image: newssense.in

[29] FAME II Subsidy, Business Standard, 2023, https://www.business-standard.com/economy/news/centre-to-announce-incentive-scheme-for-private-electric-buses-in-works-123080900617_1.html

[30] WBTC electrification of private vehicles , https://documents1.worldbank.org/curated/en/479341609914443074/pdf/India-Transition-to-Electric-Vehicles-Puts-Kolkata-on-the-Road-to-Clean-Transport.pdf

Extend & Electrify BRT System

This measure includes the already constructed BRTS network and the proposed 19 km extension to the current bus rapid transit (BRT) system by adding another 108 new electric BRT buses which will be run and managed by GVMC in terms of a business model with private operators, charging station manufacturers and bus operators.

By 2030, according to Clean Mobility Plan (CMP) projections, a total of 108 standard BRT buses are required to migrate the bus fleet to electric fuel and reduce dependence on fossil fuels.

BRT systems are bus networks that operate on purposely constructed, dedicated lanes, like those of rail networks. Extending the BRT system includes building new service corridors, as well as building new stations. The results are based on a daily ridership increase of over 2 lakh passengers. Figure 19 shows the route map, where over 41km of the BRT corridor is proposed to cut across Vizag, separated from vehicular traffic, connecting Pendurthy to Dhwaraka Nagar through two major routes.

The Pendurthy Transit Corridor (PTC) cuts across the city, running through Gopalapatnam, Kanchanapalem, and the city railway station, while the Simhachalam Transit Corridor (STC) traverses the path of Maddilapalem, Hanumanthwaka, and Vepagunta. GVMC completed the development of two BRTS corridors in 2023, which are currently non-operational.

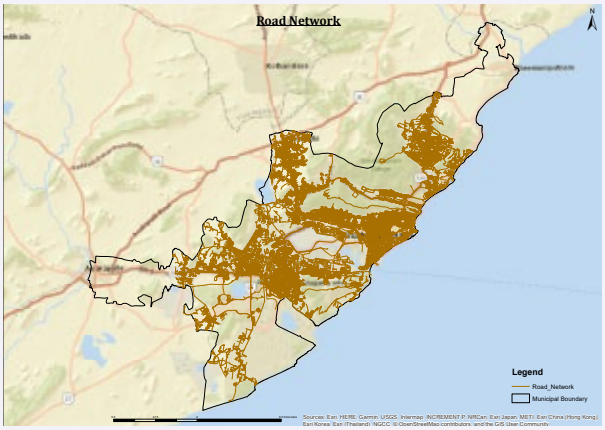


Image: GVMC

Figure 19: *Road network in Vizag.*

BRTS dedicated bus lane system at Gopalapatnam.

Image: IFC

Designate Street Lanes as Green Lanes

This measure designates 250 km of city streets to include a green lane. A green lane can be a priority lane for buses, electric cars, electric two-wheelers, and electric auto-rickshaws. The non-green vehicles plying on this designated lane could be charged fines and the revenue would be used for incentivizing more EVs and charging infrastructure. The green lane can help improve bus service and reduce travel times, as well as encourage the shift to electric transportation. Green lanes would help create demand and shift people from private transport to public transport and electric vehicles due to increased connectivity and reliability. The city needs to identify the corridors in which the feasibility of green lanes can be implemented based on the right of way (ROW) for three-lane and four-lane roads. Other cities in India have planned for specific inter-city EV green lanes, as described in *Box 9.*

Box 9: *Case study for the implementation of green lanes for electric vehicles in Kolkata.*

CASE STUDY

The state of West Bengal, India has planned to develop two special inter-city green corridors only for EVs – one from Kolkata city – Asansol (215 km) and Kolkata to Digha (185km) with EV charging stations at every 25km.[31] This is to promote 10 lakh battery powered EVs by 2030 in the state. The National Highways Department is also working on building EV-ready highways along 6000km[32] on golden quadrilateral to promote the adoption of PM Public Transport Sewa Vision 2030.

Image:https://earthbuddies.net/green-lane-solution-road-pollution/

[31] Kolkata to have green lanes for EVs, 2023 https://auto.economictimes.indiatimes.com/news/industry/west-bengal-proposes-green-lanes-for-e-vehicles/83277820

[32] EV ready highways , 2024 https://economictimes.indiatimes.com/industry/renewables/govt-to-build-6000-km-of-electric-vehicle-ready-highways-on-golden-quadrilateral/articleshow/106680883.cms?from=mdr

Add Park-And-Ride to Transit Stations

In this measure, the city builds a park-and-ride lot next to a transit station. A park-and-ride lot is a parking facility for public transport users, where they can leave their private vehicles to avoid driving into the city. Park-and-ride lots can help increase public transport ridership in areas without adequate feeder buses, such as suburban and peri-urban areas. The results consider an additional 3,000 new parking spaces (2,000 for two-wheelers and 1,000 for four-wheelers) added near metro and BRT bus stations.

The Visakhapatnam Metropolitan Region Development Authority (VMRDA) plans to build a multi-level car parking (MLCP) facility for 500 cars and 800 bikes at Siripuram Junction, which is a key Vizag business district. A 100-car capacity MLCP is also proposed at the Jagadamba junction. It is also proposed that the planned metro rail stations are provided with a park-and-ride lot. Another MLCP is to be constructed at the New Visakhapatnam Urban Development Authority (VUDA) park. The proposed measure of adding 3,000 new spaces will accommodate 4,950 new transit passengers. Though this action will not directly impact GHG savings, it will create demand for public transport and help achieve the goal of reducing the total passenger private vehicle transport kilometers (VKT) traveled.

The city will encourage the PPP model by developing a revenue-sharing framework for building, operating, and managing the park-ride facilities next to the transit stations. GVMC and VMRDA along with APSRTC will need inter-departmental coordination and dedicated task forces to aggregate land or utilize open GVMC-owned Open Space Reservation (OSR) lands for the construction.

Electrification of the Municipal Fleet

In this measure, the city will move to a cleaner transition for service vehicles, such as garbage trucks, utility vehicles, passenger vehicles, and other municipal service vehicles, to shift from conventional internal combustion engines to electric power. This shift aims to reduce GHG emissions, lower operating costs, and decrease dependency on fossil fuels. It involves not only acquiring EVs but also establishing the necessary charging infrastructure at municipal depots, maintenance facilities, and other service areas to support the new fleet. This transition supports environmental sustainability and can contribute to cleaner air and reduced noise pollution in urban areas. The measure will be replacing 10,000 municipally owned vehicles with EVs.

As per the Andhra Pradesh State EV policy, the target was to convert all forms of government vehicles, including vehicles owned by government corporations, boards, government ambulances, etc., to EVs by 2024. GVMC has already procured 50 EV cars for official purposes at GVMC headquarters, as well as 64 EVs for solid waste collection. The city has also developed an AI-based vehicle monitoring app for fuel saving, trip management, and emissions monitoring, integrated within the Integrated Command and Control Centre (ICCC) for municipal-owned vehicles. The city has proposed the ambition to upscale this effort and procure additional EVs for all zonal and divisional offices and to reduce emissions in its door-door solid-waste collection.

Electric Vehicles for solid waste collection.

Image: Faiza Solanki / IFC

Private electric vehicle at Siripuram.

Image: IFC

Promote Private Electric Vehicles

This measure aims to increase privately owned EVs in the city, adding 5.5 lakh electric two-wheelers and 20,000 electric cars to the city-wide fleet.

The state's target is to position Andhra Pradesh as the lighthouse state and attract investments to the tune of USD 4 billion for the electric vehicle segment[33]. The city along with the Road Transport Authority (RTA) needs to devise an EV Readiness Plan, which outlines various strategies and actions to facilitate the transition to EVs. Some of the key initiatives could include providing preferential parking spaces for EVs, mandating EV-ready parking spaces in existing and upcoming residential and commercial establishments, offering free charging for employees in industrial working set-ups as an incentive, directing fleet aggregators to switch to EVs in a phased manner.

The financing can be paired with other incentives offered by the city in consultation with private partners and financial institutions, such as access to public charge points, expedited or discounted vehicle registration, discounts on electricity at private charge points, mortgage EV discounts on home loans, and other innovative business models.

[33] CEO-ministerial dialogue on E-mobility
https://economictimes.indiatimes.com/industry/renewables/andhra-pradesh-seeks-to-attract-4-bn-investment-in-electric-vehicle-segment/articles-how/93361547.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst

Electric Vehicle Charging Infrastructure

This measure encourages residents and businesses to switch from vehicles with internal combustion engines to EVs by providing publicly accessible charging infrastructure. The measure aims for 5,000 public chargers installed throughout the city.

As per the Andhra Pradesh State EV policy, the target is to establish approximately 400 EV charging stations across the state, at least every 50 km on highways, other major roads, etc. Currently, 266 are operational throughout the state. The measure is amplifying the state targets to make Vizag an EV-ready city in the state. Few cities in India have planned and identified business models for upscaling EV charging infrastructure, as described in *Box 10.*

DISCOM will plan to set up 100 DC public charging stations in each of these cities. The state EV policy provides a capital subsidy of 25 percent of the value of the charging station equipment/machinery for the first 100 stations up to a maximum subsidy of INR 10 lakh. GVMC has already installed EV charging infrastructure within the main office in 2018.

Even if EV two-wheeler sales did not pick up in Vizag, the EV-car sales are increasing. The city proposes to implement a policy mandate that all future and existing apartment buildings consisting of 20 or more flats should install EV charging stations within the premises. The city also seeks to enable private developers and financing through multilateral and bilateral agencies. Given that the city aims to increase its EV vehicle sales, there would be a surge in demand for additional charging infrastructure, hence this action tries to mitigate the challenge. Though this action has a limited direct impact on GHG savings, it will create demand for decarbonizing the transport sector with more public infrastructure to support the increased uptake of private EV vehicle sales in the city.

Box 10: *Case study for the upscaling EV charging infrastructure in Delhi.*

CASE STUDY

Delhi has adopted a PPP model for setting up charging points at 100 locations with tariffs of INR 2 (US 3 cents) per unit for users.[34] The city has aggregated 100 land parcels from different agencies to be rented on a concessional basis to private players. The understanding of the above EV charging business model is developed in consultations with the land-owning agencies like the transport department, DISCOM, Delhi Metro Rail Corporation (DMRC), Delhi State Industrial and Infrastructure (DSIDC), along with private fleet operators, charging point operators, battery swapping operators, and vehicle and battery manufacturers. The city has leveraged the private sector with the flexibility in determining the charging combinations on 70 percent of the space. A working task force was formed including the heads of departments of all relevant government departments for smooth inter-agency coordination and standardization. As costs associated with leasing/purchasing of land and augmentation of electrical infrastructure are often the biggest economic viability gaps, the city linked the lease to revenue and provided 100 KW of electrical connection to each site to bridge the initial gaps.

Image: energy.economictimes.indiatimes.com

[34] Delhi EV charging infrastructure business model , https://oecd-opsi.org/innovations/delhis-model-of-ev-charging-infrastructure-ensuring-the-cheapest-ev-charging-rates-in-the-world/

Electrification of Auto-Rickshaws

This measure aims to add 20,000 new electric auto-rickshaws (e-moto taxis), based on the target to phase out 10 percent of inefficient conventional diesel/petrol motor vehicles (autos) by 2034, replacing them with new EVs or Compressed natural gas CNGs autorickshaws, as set by the state. Moto-taxis or autorickshaws form an integral part of the public transport system in Vizag, with a 20 percent modal split, and hence a high contributor to transport sector emissions. By adopting the e-auto policy and encouraging the transition to electric rickshaws, the city can reduce emissions and achieve the EV target.

The city has been practicing retiring conventional three-wheelers (moto-taxis or auto-rickshaws) and providing free-cost EV auto rides along the beach road. The financing cost assumption for retrofitting the autorickshaws is calculated to be INR 2 lakh (USD 2,400) per vehicle.

Retirement of Inefficient Cars and Motorcycles

In this measure, the city aims to retire older, inefficient private vehicles, including both cars and motorcycles, from city streets. The measure targets 15 percent of the most inefficient cars and 10 percent of the most inefficient two-wheelers to be scrapped or removed from use. This policy can be enforced through several methods, such as requiring vehicles to pass minimum efficiency tests for registration renewal or limiting street access to vehicles below a certain age threshold. The policy should be paired with incentives designed to motivate vehicle owners to transition toward more efficient and sustainable mobility options.

The government of India Vehicle Scrappage Policy, 2022 mandates that passenger vehicles older than 20 years, and commercial vehicles older than 15 years, should pass a 'fitness and emissions test' to continue their services.[35] This policy launched incentives to scrap old vehicles through discounts on the purchase of vehicles against a scrappage certificate. The incentives included a 5 percent discount for purchasing new vehicles and a registration fee waiver for new vehicle purchases. The vehicle owners can get a scrap value equivalent to 4-6 percent of the ex-showroom price of the new vehicle. Along with this policy, the state can provide up to 25 percent and 15 percent road-tax refunds for personal and commercial vehicles, respectively. With this measure, the city road transport authority is targeting the use of around 10 percent of scrap materials like copper and iron for recycling. The city aims to promote the livelihood of the informal sector dependent on scrap metals.

Street Parking with Dynamic Pricing

With this measure, the city will work in close coordination with the AP traffic police to mandate 85 percent occupancy in street parking with dynamic pricing, considering 1 empty space per 40m. Dynamic pricing systems adjust the price of parking based on the real-time supply and demand for parking spaces in certain areas of the city. Dynamic pricing can help promote vehicle turnover, carpooling, and public transportation instead of private vehicle travel.

The city does not have a dedicated city parking policy yet. However, parking fee guidelines and regulations have been implemented. Vizag city police have launched an initiative against illegal parking on roads, and encroachment of roads and footpaths, which lead to road congestion. The city has introduced dedicated parking spots, and illegally parking a vehicle will impose a fine of either INR 1,000 or wheellock. GVMC is currently charging parking fees at commercial establishments where parking exceeds 30 minutes.

[35] National Vehicle Scrappage Policy , 2024 amendment , Ministry of Road transport and Highways, https://morth.nic.in/sites/default/files/circulars_document/GSR-815(E)-dt-03-11-2023.pdf

Car-Free Zones

With this measure, the city will implement 5 km^2 of car-free zones in key commercial areas to incentivize pedestrianization and NMT.

Following the Eco-Clean Vizag campaign, in 2022 the city announced a GVMC campus-wide, car-free zone policy, mandating GVMC officials to commute from their residences to offices using either public vehicles or bicycles. Vizag has plans to upscale this action city-wide and has floated proposals to create vehicle-free zones in key commercial and public zones like Jagadamba, Dwaraka Nagar, Allipuram, and RK Beach Road. Few cities in India like Chennai have implemented dedicated car-free zones, as described in *Box 11.*

Box 11: *Case study for the implementation of car-free zones in Chennai.*

CASE STUDY

Learning from best practices from Times Square, New York, and La Rambla, Barcelona, the city of Chennai transformed one of its busiest commercial area – Pondy Bazaar, T Nagar.[36] At a project length of 1.4 km and a project cost of INR 39.6 crores, the city implemented its first-ever pedestrian plaza which restricts the entry of cars within the commercial area and prioritizes shopping by pedestrian experience. The city aims to transform 100 km of its streets to complete streets with pedestrian plaza and car free zones at Nungambakkam, and sections of heritage locations like Mylapore, Triplicane and George Town.

Image: c40.org

[36] Chennai car free zones at pedestrian plaza , ITDP, 2020 , https://itdp.org/wp-content/uploads/2020/09/ITDP_From-Pilot-to-Permanent_Sept2020.pdf

Implementation Considerations

The table below explores the implementation considerations for the prioritized transport measures in terms of their GHG savings potential, ease of implementation, and implementation timeline.

Measures	GHG Savings Potential[1]	Ease of Implementation[2]	Timeline[3]
Expand & Electrify Public Bus System	High	Medium	Medium
Extend Subway System	High	High	Long
Expand & Electrify BRT System	Medium	Medium	Long
Designate Street Lanes as Green Lanes	Low	Medium	Medium
Add Park-and-Ride to Transit Stations	Low	Medium	Medium
Electrification of the Municipal Fleet	Low	High	Short
Promote Private Electric Vehicles	High	Medium	Medium
Electric Vehicle Charging Infrastructure	Medium	Low	Long
Electrification of Auto-Rickshaws	Medium	Medium	Medium
Retirement of Inefficient Cars & Motorcycles	Medium	Low	Long
Street Parking with Dynamic Pricing	Medium	High	Medium
Car-free Zones	Low	High	Short

[1] ***GHG Savings Potential***

High	*More than 1% savings from BAU*
Medium	*0.1-1% savings from BAU*
Low	*Less than 0.1% savings from BAU*

[2] ***Ease of implementation***

Low	*The city is interested in delving into the particular action but is yet to initiate the necessary groundwork and further scoping is needed to identify land availability or technical feasibilities and identify a network of stakeholders, which might require additional technical and financial support, which would impact the chances of uptake implementation*
Medium	*The city has identified the policies, undertaken potential feasibility studies, identified locations and land availability, and has identified the network of stakeholders for implementation, however, might require additional financial support from the private market, which would impact the chances of effective implementation*
High	*With the needed infrastructure, policies, and network of stakeholders already in place, the city has initiated necessary actions for implementation of the measure, which would deliver a high impact and quick chances to uptake implementation.*

[3] ***Timeline***

Short	*1-2 years (By 2026)*
Medium	*3-5 years (By 2029)*
Long	*5-10 years (By 2034)*

Solid Waste

Measures in the waste sector aim to divert waste from landfill and extract value from waste materials, including through recycling and composting. The city has ambitions to have nearly zero waste sent to landfills, as well as reduce the legacy waste sitting in landfills. The treatment measures are complimented by actions like reducing waste generation through a single-use plastic ban and extended producer responsibility, as well as expanding waste collection services to accommodate a rapidly growing city population.

The 5 prioritized waste measures and their individual impacts are shown in *Table 7*. With all measures combined, the *Figure 20* represents an Improved Case scenario of **52 percent reduction in waste sent to landfill** and a **2 percent GHG savings compared to 2034 BAU.**

The most impactful measures are to expand materials recovery facilities to promote recycling, decentralizing composting, and extending producer responsibility policy. Extending waste collection services to the growing city population is also important to enable recycling.

Landfilled Waste Reduction: 93 kt/year.

Table 7: *Waste measures and individual impacts.*

	Measures	Waste Diverted from Landfill (%)	GHG Savings (%)	Total Cost (INR Crore)
Direct (Muni)	+ Expand Materials Recovery Facilities	25.9%	1.2%	38
	Decentralized Composting	11.2%	0.4%	203
	Improve Waste Collection	3.3%	<0.1%	6
Policy	Extended Producer Responsibility for Packaging*	11.1%	0.8%	-
	Ban Single-Use Plastics*	0.1%	<0.1%	-
Total		**52%**	**2%**	**247**

+ Measures with the highest impact in terms of GHG savings Note: kt = kilotonnes; GHG = greenhouse gas; USD = United States dollar
**Policy-based measure that is currently not costed in APEX*

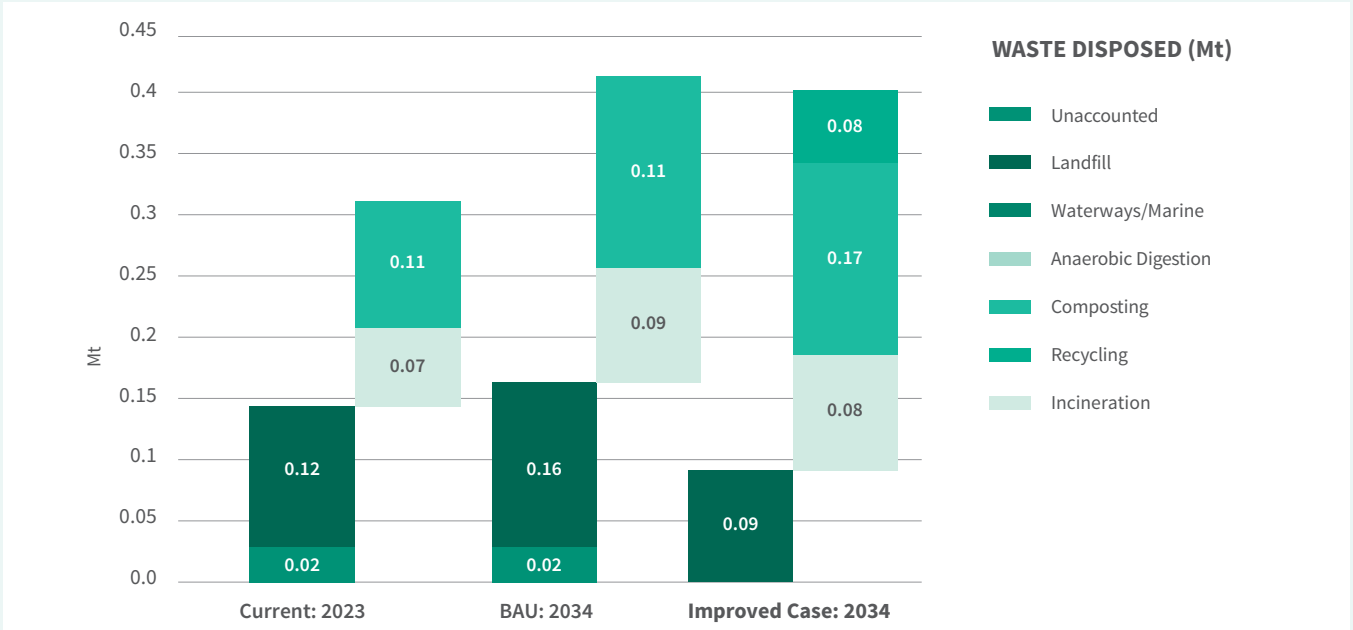


Figure 20: *Current, BAU, and Improved Case for waste disposal in million tonnes per year (Mt/year).*

Prioritized Measures: Solid Waste

Expand Materials Recovery Facilities

This measure implements material recovery facilities (MRFs) with a capacity of 150 t/day to divert 50 percent of recyclable waste from landfills, so that, overall, 50 percent of paper, cardboard, plastic, glass, and metal waste is recycled. An MRF sorts recyclable materials into separate components (such as plastics, metal, glass, and cardboard), and then packages and prepares them to be sold to recycling companies. A new MRF would complement GVMC's existing waste management infrastructure.

Related to this measure, the city is seeking to adopt an innovative approach to reuse the end products of the MRF-recovered waste as well as that from other non-revenue generation waste like road silt, stone particles, etc. The city faces challenges in handling the residual waste coming from the recycling facilities and other waste like road silt, sweeping dust, and stone, which is not high in revenue generation.

Plastic waste in cities.

Image: Nick Fewings on Unsplash

Decentralized Composting

In this measure, the city mandates decentralized composting facilities in housing societies, apartment complexes, and buildings used for commercial purposes. The aim is to convert 10 percent of domestic waste and 15 percent of organic commercial waste into compost.

The total waste generated in the city is 848 tonnes /day, out of which 380.7 tonnes /day is organic waste. Most of the organic waste (340.11 tonnes /day) is currently composted, which represents 39 percent of the total generated waste. Currently, the wet waste that is collected from households, commercial establishments, and various markets in the city is treated at composting yards at 5 different locations in the city: Gajuwaka, Bhimunipatnam, K.R.M. Colony, Mudasarlova, and Kapuluppada. The collected waste is taken to the nearest compost yard and is treated through two techniques: windrow composting and vermicomposting. Currently, the compost produced by GVMC is being used by the GVMC horticulture department. With this measure, the city is considering requiring decentralized composting, considering the assumption that the new decentralized composting facilities would process 60 t/day of organic waste. The city aims to reduce organic garbage collection and encourages citizens to participate in home composting of waste produced in their respective households.

As part of the Eco-Vizag campaign, the city plans to target citizen engagement and sensitization with key stakeholders in housing societies, such as resident associations and management committees.

Improve Waste Collection

This measure targets 100 percent of future waste generated to be collected or treated onsite. The city has implemented a highly efficient solid waste management system that has 70 percent door-to-door collection and processes almost all waste generated by residents. With this measure, the city aims to achieve 100 percent door-door waste collection.

The city has achieved a high level of efficiency in its solid waste management system with the waste-to-energy plant that processes mixed waste, thereby reducing unaccounted waste. However, almost 39 percent of the waste is currently sent to a managed landfill without gas capture.

The city employs a house-to-house operation, wherein waste collectors are contracted by GVMC to visit each household to collect and transport waste to the Kapulpada waste management plant. The collected waste is outsourced to private contractors under a PPP model, with the city paying a fixed amount per tonne of waste collected. To encourage waste diversion from landfills, the city provides incentives to collectors, such as allowing them to sell recyclable materials and paying a tipping fee for collecting additional waste and delivering it to processing plants.

In 2021, the state Municipal Administration and Urban Development Department initiated the statewide program called ‘’CLAP - CLEAN ANDHRA PRADESH” with the target of systemizing the ongoing efforts to ensure bin-free, litter-free, and garbage-free cities as well as to implement 100 percent door-to-door waste collection. Hence, this measure aims at convergence of the state’s initiatives at the local level. The Swachh Andhra Corporation has taken up an initiative to purchase auto tippers with 3 compartments for dry, wet, and hazardous waste. To do so, GVMC has deployed 522 waste collection vehicles across all wards of GVMC.

With improved waste collection, the city will monitor and evaluate the quality of waste sent to the landfill to increase efficiency at the treatment plant. Currently, mixed waste is brought to the waste-to-energy plant, which provides energy returns of 1KW used for internal plant operational purposes with the rest sent to the grid. Incorporating stringent measures for waste segregation at the household level can improve the calorific value of incinerated waste and enhance combustion. Organic waste from temples and markets will be pooled to create a recycled product market for marginalized self-help groups to contribute to their livelihoods.

Extended Producer Responsibility for Packaging

This measure targets Extended Producer Responsibility (EPR) of 20 percent for plastics and 25 percent for cardboard packaging by 2028.

The Ministry of Environment, Forest, and Climate Change of India (MoEFCC) has mandated the EPR on plastic packaging under the amended 2022 plastic waste management rules.[37] Among the 75 actions identified in the national Lifestyle for Environment (LiFE) mission, there is an emphasis on reducing and reuse of plastic packaging and biodegradable cardboard.[38] To align with the national targets, the city aims to implement the EPR policy for packaging. EPR puts the responsibility for packaging collection and disposal back on the company that originally sold the product.

The city is incentivizing manufacturers to design their products by introducing an Eco-Vizag certification for each consumer type. This will be continued as it will help maximize recycling and reuse, thus strengthening circular economy practices and moving toward sustainable packaging business in the city.

[37] EPR Portal for Plastic packaging, MoEFCC, CPCB
https://eprplastic.cpcb.gov.in/#/plastic/home
[38] LiFE Mission - Lifestyle for Environment
https://www.niti.gov.in/sites/default/files/2022-10/Brochure-10-pages-op-2-print-file-20102022.pdf

Ban Single-Use Plastics

This measure includes a ban on single-use plastic waste, which is estimated to account for 2 percent of plastic waste generated in the city. The ban is accompanied by awareness campaigns, imposing fines on violators, promoting alternatives like cloth bags, and collaborating with businesses, industries, and community organizations.

The National Plastic Waste Management rules, amended in 2022, prohibits the manufacture, import, stocking, distribution, sale, and use of plastic carry bags having a thickness of less than 120 microns, effective since December 31, 2022.[39] The AP state has also set a target to become plastic-free by 2027.[40]

Along with the Eco Clean and Eco Zero Plastic of the Eco-Vizag campaign, the city has been organizing 'Clean My Premises' and ward-level neighborhood cleanliness awards once a month. To ensure a zero-plastic ban, 10 enforcement vehicles and teams have been deployed in all 8 zones of the city. The plastic seized and collected from waste is being used in the construction of roads – nearly 30 plastic roads have been laid in the city. The city has declared several tourist places around RK Beach, VMRDA Central Park, Zoo Park, Tenneti Park, and Kailasagiri as plastic-free zones. With this measure, the city aims to continue its ongoing initiatives around plastic waste reduction.

Implementation of the plastic ban with enforcement teams.

Image: GVMC

[39] National Plastic Waste Management Amended Rules, 2022, Central Pollution Control Board, https://cpcb.nic.in/uploads/plasticwaste/2-amendment-pwmrules-2022.pdf

[40] AP state state plastic target , Deccan Chronicle, 2022, https://www.deccanchronicle.com/nation/current-affairs/270822/jagan-announces-plastic-free-ap-by-2027-as-mou-signed-with-parley.html

Implementation Considerations

The table below explores the implementation considerations for the prioritized waste measures in terms of their GHG savings potential, ease of implementation, and implementation timeline.

Measures	GHG Savings Potential[1]	Ease of Implementation[2]	Timeline[3]
Expand Materials Recovery Facilities	High	Low	Medium
Decentralized Composting	Medium	High	Short
Improve Waste Collection	Low	High	Short
Extended Producer Responsibility for Packaging	Medium	Low	Medium
Ban Single-Use Plastics	Low	High	Short

1 GHG Savings Potential

High	*More than 1% savings from BAU*
Medium	*0.1-1% savings from BAU*
Low	*Less than 0.1% savings from BAU*

2 Ease of implementation

Low	*The city is interested in delving into the particular action but is yet to initiate the necessary groundwork and further scoping is needed to identify land availability or technical feasibilities and identify a network of stakeholders, which might require additional technical and financial support, which would impact the chances of uptake implementation*
Medium	*The city has identified the policies, undertaken potential feasibility studies, identified locations and land availability, and has identified the network of stakeholders for implementation, however, might require additional financial support from the private market, which would impact the chances of effective implementation*
High	*With the needed infrastructure, policies, and network of stakeholders already in place, the city has initiated necessary actions for implementation of the measure, which would deliver a high impact and quick chances to uptake implementation.*

3 Timeline

Short	*1-2 years (By 2026)*
Medium	*3-5 years (By 2029)*
Long	*5-10 years (By 2034)*

Water & Wastewater

Actions in the water sector focus on improvements to water security, which includes both reducing demand for water and diversifying sources of water supply. The measures target water security at the building level with efficient fittings and rainwater capture, as well as system-wide with actions such as water reuse at the municipal scale and reducing water losses. This sector also includes the expansion and improvement of wastewater treatment facilities.

The 12 priority measures and individual impacts are shown in *Table 8*. With all measures combined, the Figure 21 represents an Improved Case scenario of a **24 percent improvement in water security** compared to 2034 BAU. There is a modest **0.2 percent GHG** savings from avoided energy in water pumping and improving wastewater facilities.

The most impactful measures include the reuse of wastewater at the municipal scale, reduction in water losses, and efficient water fittings in buildings. Several measures can contribute to managing flood risk, including rooftop rainwater harvesting, rooftop greenery, and incentivizing local water retention.

Total water security improvement: 252 MLD.

Table 8: Water measures and individual impacts.

	Measures	Water Security Improvement (%)	GHG Savings (%)	Total Cost (INR Crore)
Direct (Muni)	Reuse Wastewater at the Municipal Scale	10.4%	<0.1%	662
	Reduce Water Losses	7.9%	<0.1%	252
	Develop Ponds & Lakes for Rainwater Storage	1.0%	<0.1%	1,150
Indirect (Private)	Mandate Efficient Fittings in New & Existing Buildings	3.2%	<0.1%	4,254
	Smart Water Meters	1.4%	<0.1%	15
	Mandate Rooftop Rainwater Harvesting	-	-	6
	Mandate Rooftop Greenery	-	-	86
	Incentivize Local Water Retention*	-	-	-
Direct (WW)	New Centralized Wastewater Treatment Facilities	-	<0.1%	231
	Local Scale Wastewater Treatment Plant	-	<0.1%	59
	Improve the Efficiency of Existing Treatment Plants	-	<0.1%	131
	Biogas Recovery at Existing Treatment Plants	-	<0.1%	2,282
	Water Savings from Green Buildings Measures	2.7%	-	-
Total		**24%**	**0.2%**	**9,120**

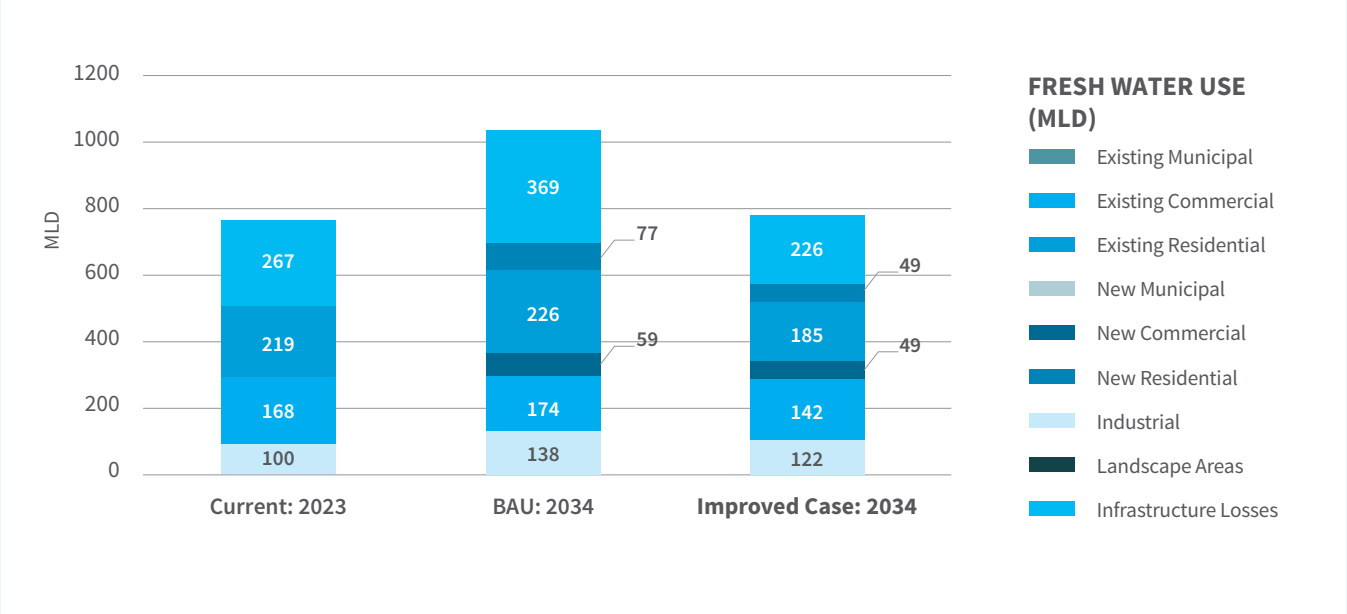


Figure 21: *Current, BAU, and Improved Case for freshwater use (MLD).*

Water Treatment Plant at Aganampudi.

Image: IFC

Prioritized Measures: Water & Wastewater

Reuse Treated Wastewater at the Municipal Scale

In this measure, the city aims to expand the reuse of treated effluent from its centralized wastewater treatment plants considering 110 MLD of municipal wastewater to be treated for non-potable reuse. Wastewater treatment technology is available that can treat effluent to various standards of use. Non-potable water is suitable for both irrigation and industrial purposes, and some cities are even treating wastewater to potable standards suitable for domestic consumption. Few cities in India have adopted successful reuse of treated wastewater, as described in *Box 12*.

The city has initiated a Visakhapatnam Sewerage and Recycled Water Project for INR 942 crore (USD 112 million).[41] Under this project, the proposal aims to develop a sewerage system in two phases, the first phase in Pendurthi, and the second in the Gajuwaka and Malkapuram areas. The construction of a wastewater treatment plant with recycling capacity is also planned to increase the supply of treated water for industrial purposes. The project proposes about 655 km of sewerage network in Zone 2 of the city, which would provide 60,000 households with an improved sewerage network. The proposal also considers a 108 MLD STP at Narava and a 79 MLD ultrafiltration and reverse osmosis wastewater treatment plant (WWTP). The operations and maintenance are estimated over15 years.

Engaging stakeholders, including local businesses, industries, and residential communities, is crucial for participatory planning sessions for the consumption of treated wastewater use for domestic and commercial usage.

Box 12: *Case study for the reuse of wastewater in Nagpur.*

CASE STUDY

The Nagpur Municipal Corporation (NMC) has signed a 30-year agreement with a private thermal power plant for reuse of wastewater to run the operational wastewater treatment plants in the city.[42] NMC provides the company with the generated wastewater for treatment and the private company pays a subsidized cost of INR 3.4 instead of INR 9.6 per cubic meter to NMC. The treated water is used to run the treatment plant and the remaining plants of the city.

Image: Ivan Bandura on Unsplash

[41] Visakhapatnam Sewerage and Recycled Water Project, https://www.apurban.com/projectdetail.php?pdid=85

[42] Wastewater: From Waste to Resource, A case study from Nagpur, India, Water Global Practice, World Bank Group, 2019 https://documents1.worldbank.org/curated/en/847531576610020104/pdf/Wastewater-From-Waste-to-Resource-The-Case-of-Nagpur-India.pdf

Reduce Water Losses

This measure aims to implement a program to reduce unaccounted water losses to 25 percent by 2034. Unaccounted water losses are calculated as the bulk system input less the authorized consumption. Such unaccounted water losses include apparent losses (i.e., unauthorized consumption, metering inaccuracies) and real losses (i.e., leakage on transmission and/or distribution mains, leakage and overflows of utility storage tanks, and leakage on service connections up to the point of customer metering). Strategies to reduce water losses include repairing and replacing leaking water pipes and tanks, improvements to metering systems, and accounting of unauthorized connections.

Currently, the water losses in the city stand at 35 percent. With this measure, the city aims to improve its water losses by 2034 by implementing actions such as pipe replacement, variable speed drives, fixing pipeline leaks, and pressure management.

To leverage private sector finance to address water losses, the following next steps are proposed:

- Coordinate with VISCO and UGD department to analyze water supply and consumption data.
- Focus on water-stressed areas in all zones based on the vulnerability hotspot.
- Develop a non-revenue water action plan, bill of quantities, and financial assessment.
- Determine a deployment model to attract private sector expertise, for example through a performance-based contract or bond.

Water losses due to pipe and tap leakage.

Image: Luis Quintero on Pexels

Develop Ponds & Lakes for Rainwater Storage

This measure aims to develop about 5 lakh m^3 in additional water storage capacity. The city has been focusing on the redevelopment of lakes, ponds, and tanks. Under Atal Mission for Rejuvenation and Urban Transformation (AMRUT) 2.0, around 10 ponds/tanks have been selected by the city for rejuvenation as follows: Mindhi Tank, Jaggarajupeta Tank, Akkireddypalem Tank, Chingantyada Tank, Chillapeta Tank, Lankelapalem Tank, Kranthi Nagar Tank, Narava Tank, Kommadi Tank, and the Natayyapalem Tank.

The city has plans to build a protective wall around Lankelapalem Tank to create a walking track, open gym equipment, a children's play area, and an arrangement of a channel to streamline rainwater from hills to the pond. The city also has other reservoirs such as Meghadrigedda Reservoir, Mudasarlova Reservoir, Gangavaram Lake, Peddacheruvu, and NAD Lake. The city has various ponds, including Citivalasa Chilapetta Cheruvu, one of the biggest GVMC water bodies. Other ponds include Chirapsia Cheruvu, Gayathrigudi Cheruvu, Kaladapalem Cheruvu, Nathipaidaiyu Cheruvu, Tadi Gedda, Boyapalem, Bodlapalem Cheruvu, Padradesipaleam Cheruvu, Khambala Cheruvu, Nerla Cheruvu, Borapetta Pond, Kondaa Tank, etc. The present condition of these ponds requires major desilting work and restrengthening of bunds.

Vizag will focus on rejuvenating ponds and lakes within water-stressed areas; treated wastewater can be injected back into the lakes and used for domestic supply. Vizag can consider the best practices from few cities in India like Chennai that have adopted successful practices of using lakes to store treated wastewater and supply to local domestic and industrial uses, as described in *Box 13.*

To do this, a spatial mapping exercise to identify the ponds and lakes to an STP for potential pilots. Following that, wastewater reuse revenue models can be explored with the potential to be implemented via PPP arrangements, from which the city utility and UGD could generate revenue from the sales. Though this measure will not have major GHG savings compared to the BAU, it will contribute to improving water security in the city.

Box 13: *Case study for the development of ponds and lakes for storage and domestic supply in Chennai.*

CASE STUDY

The Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB) has been tertiarily treating eight million liters of secondary wastewater at its Nesappakkam plant and is releasing it into the Porur Lake[43] and supplies the treated water to nearby domestic household use for secondary purposes and to the industries.

Image: newindianexpress.com

[43] Porur lake water reuse, Chennai, World Bank, 2021 https://documents.worldbank.org/en/publication/documents-reports/documentdetail/737251622708324921/water-in-circular-economy-and-resilience-wicer-the-case-of-chennai-india

Mandate Water-Efficient Fittings in Existing and New Buildings

With this measure, the city mandates the installation of water-efficient fittings in 40 percent of new buildings and 50 percent of existing buildings equipped with water-efficient fittings. Efficient fittings consume 25 to 35 percent less water than traditional fittings. For new construction, developers are required to equip buildings with water-saving taps, showers, and toilets; they will bear the primary cost but also potentially receive incentives from the city or national government.

The city will ensure that the use of water-efficient fittings is reflected in the building bylaws and codes to mandate implementation. Vizag will alternatively explore requirements at the building level, such as mandatory water performance ratings or minimum water performance requirements. Alongside the Eco-Vizag campaign, the city aims to incorporate a push toward water-efficient fittings at the community level. A list of approved vendors with market compliance ratings can be provided with a training of trainers (TOT) manual for ease of upscaling the action at the grassroots level.

EE fittings in existing buildings.

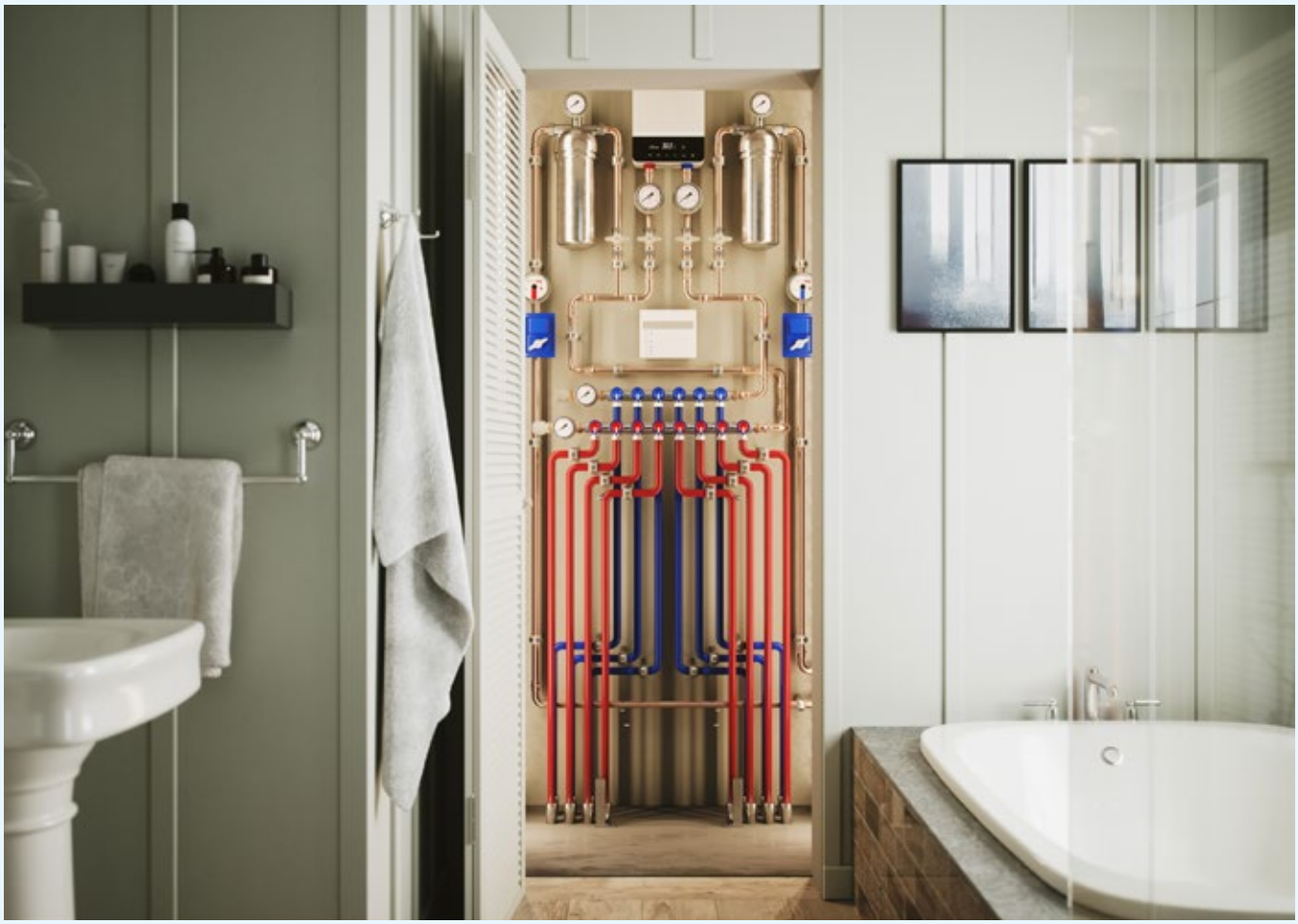


Image: Istockphoto

Smart Water Meters

In this measure, the city and the DISCOM implement smart water meters in 30 percent of buildings, including hotels, hospitals, large new residential developments, and schools. Smart water meters will provide DISCOM with real-time data on water use, send notifications when there is a leak or burst in the distribution network, and help ensure fair billing. Results for this measure consider a program that targets Smart meters can help reduce water use and leakage in these buildings by 10 percent.

Traditionally dependent on mechanical water meters, Vizag aims to mandate all residential apartment buildings with more than 25 flats to monitor the withdrawal of groundwater through bore wells, and by measuring the bore well usage or time taken to fill the overhead central tank. The smart meter will also help monitor electricity consumption, and the city plans to introduce municipal tax incentives for residential apartment owners/ occupants at the ward level who have more energy and water savings. Other cities in India have implemented smart water metering, as described in *Box 14.*

- DISCOM has identified implementing smart meters in their DSM plan, so the next steps should include developing deployment models to expand and build on current efforts. It will also be important to gain community support through awareness campaigns, incentives, and community-tailored solutions.
- The city will conduct a water energy audit throughout the city to improve water conveyance, reduce water losses, and reduce electricity for water consumption.

Box 14: *Case study for the smart water meters in Pune, Panaji.*

CASE STUDY

The Pune Municipal Corporation (PMC) has installed one lakh smart water meters in the city and has a target of 3.25 lakh consumer installation meters across the city.[44] Panaji, Goa has also fitted around 3,000 homes with smart meters through an on-bill finance model where the cost of installation is later added to the consumer water bill.[45]

Image: Sugarman Joe by Unsplash

[44] Pune smart water meters, Times of India, 2023, https://timesofindia.indiatimes.com/city/pune/pune-municipal-corporation-to-restart-fitting-water-meters/articleshow/97186363.cms

[45] Panalji IOT-based smart water meters, Times of India, 2024, https://timesofindia.indiatimes.com/city/goa/iot-smart-meters-bring-down-water-use-leakages-in-panaji-pilot-project/articleshow/112270711.cms

Mandate Rooftop Rainwater Harvesting

For this measure, the city aims at mandating rooftop rainwater harvesting on 25 percent of habitable buildings, including residential buildings, hotels, and healthcare facilities. Rainwater captured on rooftops can be stored in cisterns for later use or filtered through the soil as groundwater recharge. Capturing rainwater on rooftops prevents it from entering the stormwater drainage system, which can also help with flood mitigation.

The state government has mandated rainwater harvesting in all municipal corporation buildings with a footprint of 300 sqm or more. Alongside the Eco-Blue tranche of the Eco-Vizag campaign, the city aims to construct rainwater harvesting collection pits at residential buildings, educational institutions, and commercial buildings. A few residential colonies in the city such as the JR Nagar Residents Welfare Association (JRMRWA) have already achieved 100 percent water demand through effective rainwater harvesting.

Mandate Rooftop Greenery

With this measure, the city aims to amend the building development bylaws to encourage a 30/30 green rooftop concept and introduction of a city-wide green roof policy.

The city aims to conduct a study of the potential rooftop area in the city, which can be converted to a green terrace with 30 percent of the rooftop area installed with solar panels and the area beneath used for terrace gardening, or that 30 percent used as part of the community kitchen gardens initiative. Regarding the latter, the ambition is to increase community garden green cover by 2-3 percent in each zone. Other cities in India have incentivized green rooftops, as described in *Box 15*.

The city plans to conduct citizen outreach campaigns to promote, accelerate implementation, and sustain the residential green roof guidelines through educational outreach as well as public collaboration. This initiative can help reduce urban heat island effects, reduce cooling needs in buildings, slow stormwater runoff, and improve air quality for a healthy city.

Box 15: *Case study for the mandating rooftop greenery.*

CASE STUDY

The city of Madurai is selling subsidized terrace garden kits to citizens.[46] The kits contain 10 seed varieties, bags, and manure. The government of Tamil Nadu also provides a 50 percent subsidy for procuring materials to start a green terrace under the “do it yourself” kit program. Each buyer can avail themselves of the subsidy five times. Bihar Chhat Par Bagwani Yojana is a program by the state government to provide financial assistance of 75 percent subsidy for every 300 sq feet gardening cost and encourage residents to transform rooftops into vibrant urban green lungs in the city.[47]

Image: CHUTTERSNAP on Unsplash

[46] Madurai subsidized green terrace gardening kit, 2016 https://timesofindia.indiatimes.com/city/madurai/subsidy-on-terrace-garden-kits/articles-how/50969959.cms

[47] Bihar green rooftops , Sarkari Yojana, 2024, https://banglawikibio.com/bihar-chhat-par-bagwani-yojana/#:~:text=The%20Bihar%20government%20has%20launched,and%20flowers%20on%20urban%20rooftops

Incentivize Local Water Retention

With this measure, the city enables water retention systems in 10 percent of Vizag's available open spaces. The city will conduct a comprehensive study to understand retention potential and identify available open spaces suitable for catchment-area development.

The city has used its municipal budget to develop local water retention in 11 parks, with plans for 30-40 more ponds near 100 parks. The city also plans to devise a sponge city plan, under which it will develop 1 acre sponge parks in 62 open spaces. This equates to 2 sponge parks in each of the 8 zones, (16 parks total) by FY 2024-2025. The city plans to integrate all these parks and overlay them on the master plan for Sponge City development.

The city can integrate local developers and Residents Welfare Associations (RWAs), creating incentives for these groups to construct local water retention ponds, lakes, and/or reservoirs in undeveloped, open spaces. This measure can help slow stormwater drainage and capture surface water runoff for future use, which can help increase water supply and reduce water stress during drought periods. This will also help reduce urban flooding and reduce the urban heat island effect.

New Centralized Wastewater Treatment Facilities

With this measure, the city is exploring innovative PPP models, inviting the expertise and investment of the private sector in the construction and operation of these new treatment facilities. This measure includes the construction of 110 MLD of additional centralized wastewater treatment facilities.

At present, UGD covers only 198 km^2 (out of 620.36 km^2 including Anakapalli & Bheemili) of the GVMC area, which is 32 percent network coverage. There are 5 major and 12 mini STPs with a total capacity of 233 MLD (2 mini STPs remain under construction).

At present, the city treats 233 MLD of sewage in various treatment facilities. With increasing population and demand, the city would face a deficit of 230.18 MLD by 2031 as shown in *Table 8.* Thus, the measure of an additional 110 MLD will help cater to the demand. Below is the projection for sewage generation and deficit surplus.

Table 8: *Water measures and individual impacts.*

Census Year	Population	Sewage Generation at 115 LPCD in MLD (City as a Whole) 85% of 135LPCD	Existing STPs Capacity in MLD	Present Generation in network connected area in MLD	Deficit / Surplus
Year 2021	24,00,000	276.10	226 MLD	181.40	+50.10
Year 2031	36,80,000	463.68	226 MLD	-	-230.18
Year 2041	49,20,000	619.92	226 MLD	-	-386.42

The city plans to implement the below Infrastructure projects in a phase-wise manner.

UGD Ongoing Projects: Sewerage System in Pendurthi, Gajuwaka & Malkapuram area in two packages taken up under smart city.

- Package-II (Pendurthi area) Sewerage network of 226KM and TTP of 46MLD Capacity with an estimated cost of INR 412 crores including O&M for a period of 15 years.
- Package-II (Gajuwaka and Malkapuram areas) Sewerage network of 429Km and TTP of 33MLD capacity with estimate cost of INR 530 crores including O&M for a period of 15 years.
- Diversion of dry weather flow drains and streams to near STP (i.e. from coastal battery to Rushikonda-1st stretch) with a cost of INR 3 crore.

Sanctioned and Under Tender Stage:

- Diversion of dry weather flow drains and streams, which includes gaps in the sewerage network, house service connections and construction of an additional 25MLD STP at Appughar with a cost of INR 90 crore.

Detailed Project Report (DPR) Submitted for Sanction (Loan by GVMC):

- Providing comprehensive sewerage system in Zone 2 (Madhurwada Zone) of GVMC with a loan from IFC of INR 553 crore.

The city needs to identify private investments using the revenue models for 110 MLD of additional centralized wastewater treatment facilities. Other cities in India have leveraged innovative financial models for setting up wastewater treatment plants at a municipal scale, as described in *Box 16.*

Box 16: *Case study for the centralized wastewater treatment facilities in Delhi, Indore, and Ghaziabad.*

CASE STUDY

Delhi Jal Board has commissioned an 80KLD project on a solar-powered sewage treatment plant at a capital cost of 55 lakh to treat 5000 liters of sewage water to 4000 liters of drinking water per hour.[48] Indore Municipal Corporation has issued rupee-dominated masala bonds worth INR 720 crore for floating solar projects to power pumping stations.[49] Ghaziabad Municipal Corporation has also raised green municipal bonds of INR 150 crore to partially fund the setting up of a tertiary treatment plant worth INR 320 crore through the Hybrid Annuity Model (HAM) – a public-private partnership (PPP) model.[50]

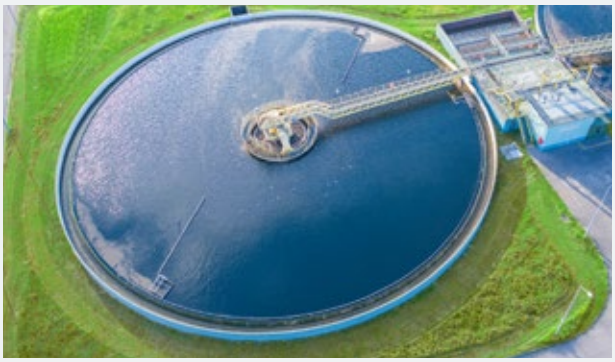


Image: mercomindia.com

[48] Planet Custodian, Delhi's first solar-powered plant will recycle 'sewage into drinking water', July 2015 https://www.planetcustodian.com/delhis-first-solar-powered-plant-will-recycle-sewage-into-drinking-water/4286/

[49] Indore Green Bonds for solar plants, the Print, 2023, https://theprint.in/india/governance/indore-countrys-cleanest-city-gets-rs-720-crore-on-green-bonds-to-build-largest-solar-plant/1371439/

[50] Ghaziabad Municipal Corporation Green Municipal Bond, Brick Work Credit Ratings, 2024 https://www.brickworkratings.com/Admin/PressRelease/Ghaziabad-Nagar-Nigam-19April2024%20(1).pdf

Local-Scale Wastewater Treatment Plant

With this measure, the city expands its wastewater treatment capacity by an additional 22 MLD. A localized wastewater treatment (WWTP) plant can provide treatment capacity to the new developments, industrial areas, or communities previously unserved by the existing wastewater treatment network.

The city aims to add a new, localized wastewater treatment plant with moving bed biofilm reactor (MBBR) technology to provide treatment capacity to the upcoming development areas in the city like VUDA Harshitha and Maraikavalasa. The city will aim to mandate decentralized WWTPs during building approvals.

The city needs to strategize a decentralized water treatment plan by conducting a spatial mapping exercise that overlays hotspots near the lakes and ponds for the most effective wastewater treatment and reuse for industrial and domestic use. However, there needs to be a special task force within the UGD to monitor the quality of the treated water discharged into the lakes for reuse.

Improve the Efficiency of Existing Treatment Plants

With this measure, the city improves the efficiency of the existing WWTPs. This measure targets improvement of 30 MLD of installed capacity.

Planned upgrades at the WWTPs at Laksmi Talkies and Appugarh, which are operational at 22MLD serving the Pandurangapuram Santhiasharam pumping stations, include the installation of fine screens and primary sedimentation tanks. The city is also planning to improve the network from where sewage currently discharges into the sea, by introducing artificial wetlands and laying a network connecting the wetlands to the Narava STP of 54 MLD.

Sewage Treatment Plant at Narava.

Image: IFC

Biogas Recovery at Existing Treatment Plants

The city does not capture biogas as an end-use product from the wastewater treatment process. With this measure, the city aims to add a new biogas recovery facility to the existing WWTP and collect 1.5 lakh m^3 of biogas per day.

Wastewater sludge management is an economic and environmental challenge for the city, and biogas recovery is a way of adding value to operations. It consists of digesting the sludge to reduce its volume and produce biogas, which can create renewable energy. Vizag is in the position to explore new innovative models and alongside revenue models such as trading and carbon credits for these sorts of climate-smart projects. Other cities in India have successfully set up bio-gas plants at the existing wastewater treatment facilities, resulting in revenues, as described in *Box 17.* Such models can be considered as a successful case of circular economy.

Biogas is produced during the decomposition of organic materials in wastewater by microorganisms. Captured biogas is used to produce heat and power to meet local energy demands, such as to heat and power the WWTP. The produced biogas can also be used to meet the local heat demand for agricultural and industrial purposes and as an operational source of energy for fuel-switch in public transport. Vizag can explore new innovative revenue models such as trading and carbon credits for climate-smart projects.

Box 17: *Case study of the production of biogas at wastewater treatment plants in Indore, Surat, Chennai, Bangalore, and Ahmedabad.*

CASE STUDY

Cities like Indore have set up decentralized bio-CNG plants using segregated wet waste and wastewater at a local scale like a 20 TPD bio-CNG plant attached to a vegetable market (mandi) at Choithrom[51] and a 200TPD Bio CNG plant at Kabit Kheri and two bio-CNG plants at Gobardhan using PPP model.[52] The produced energy is used to run buses. It is estimated that 15 buses consume nearly 1400 kg of bio CNG gas per day and run more than 3000 km per day. Total municipal earnings of approximately 9 crores in the first two years of Carbon credit trading. Surat also has a 100 MLD secondary treatment system at Bamroli STP, which is supplied to the Pandesara Industrial estate and for plant operations.[53] Seven STPs of Chennai are generating biogas.[54] Bangalore also generates 1MW power from its 60 MLD plant.[55] Ahmedabad generates biogas from sewage, earning INR 2.75 crore each year.[56]

Image: istockphoto.com

[51] Indore Integrated Waste Management with Decentralized Approach Case Study, *Bio- CNG plant from segregated wet waste at Indore, 2019* https://ksp-cb.kerala.gov.in/assets/uploads/widget/wm_files/integrated_solid_waste_managementppt_on_26th_feb-converted.pdf

[52] Gobardhan Bio CNG Plant, Indore Case study, https://www.pppinindia.gov.in/bestpractices/best-practice-detail/gobardhan-bio-cng-plant

[53] Sewage Gas-based Power Generation at Bamroli, Surat, https://niua.in/innovation/home/project/50

[54] Chennai Sewage treatment plant, CNBC, 2016 https://www.cnbc.com/2016/10/13/how-india-is-turning-sewage-into-energy.html#:~:text=%E2%80%9CIn%20Chennai%20we%20have%2013,make%20the%20plant%20self%2Dsufficient.

[55] Bangalore Sewage treatment plant generates power, India Today, 2016 https://www.indiatoday.in/education-today/gk-current-affairs/story/sewage-treatment-plant-generates-power-977317-2017-05-16

[56] Environmentally sustainable sewage management – a case study of Ahmedabad, India, 2021, https://www.ijres.org/papers/Volume-9/Issue-7/Series-15/H09074656.pdf

Implementation Considerations

The table below explores the implementation considerations for the prioritized water and wastewater measures in terms of their water savings potential, ease of implementation, and implementation timeline.

Measure	Water Savings Potential (MLD)	Ease of Implementation[1]	Timeline[2]
Reuse Wastewater at the Municipal Scale	110	High	Medium
Reduce Water Losses	84	Medium	Medium
Develop Ponds & Lakes for Rainwater Storage	11	High	Medium
Mandate Efficient Fittings in Buildings	34	Medium	Medium
Smart Water Meters	14	Low	Long
Mandate Rooftop Rainwater Harvesting	-	High	Short
Mandate Rooftop Greenery	-	High	Short
Incentivize Local Water Retention	-	High	Short
New Centralized Wastewater Treatment Facilities	-	High	Medium
Local Scale Wastewater Treatment Plant	-	Low	Short
Improve the Efficiency of Existing Treatment Plants	-	Medium	Medium
Biogas Recovery at Existing Treatment Plants	-	Low	Medium

[1] ***Ease of Implementation***

Low	*The city is interested in delving into the particular action but is yet to initiate the necessary groundwork and further scoping is needed to identify land availability or technical feasibilities and identify a network of stakeholders, which might require additional technical and financial support, which would impact the chances of uptake implementation*
Medium	*The city has identified the policies, undertaken potential feasibility studies, identified locations and land availability, and has identified the network of stakeholders for implementation, however, might require additional financial support from the private market, which would impact the chances of effective implementation*
High	*With the needed infrastructure, policies, and network of stakeholders already in place, the city has initiated necessary actions for implementation of the measure, which would deliver a high impact and quick chances to uptake implementation.*

[2] ***Timeline***

Short	*1-2 years (By 2026)*
Medium	*3-5 years (By 2029)*
Long	*5-10 years (By 2034)*

Green Investment Pipeline

Solutions in the Eco-Vizag GCAP can be transformed into a pipeline for green investment in Vizag enabled by both public and private sector funding. The GCAP takes into consideration a high-level review of GVMC's financial context such as government revenues and expenditures, fiscal autonomy, and enabling PPP frameworks.

GVMC is a self-reliant entity with about 83 percent of the revenue coming from its own sources during FY 2021 in comparison with about 85 percent in FY 2020.[57] The budgetary estimate of the GVMC for the FY 2022-2023 was INR 4,320 crore, including an opening balance of INR 434.8 crore; major receipts included taxes at INR 573 crore, externally aided projects at INR 243.8 crore, water supply at INR 510 crore, finance commission funds at INR 276 crore, among others.[58] For FY 2024-2025, the budget was increased by 30 percent due to higher capital expenditure commitments.[59]

In 2020, the city implemented property tax reform to change the basis of tax calculation to capital value from an annual rental basis. The property tax collection is high from private properties at 76.80 percent[60] in FY 2021-2022 and the property tax revenue stood at INR 324 crore.[61] During the same period, the water charges collection was strong at 69.27 percent.

GVMC has a history of raising funds through bonds and bank loans and its debt instruments are rated consistently at AA/ Stable to A+/ Stable (2022, 2023).[62] The debt level for the city was INR 244 crore at the end of FY 2023.

The Government of Andhra Pradesh has set up a dedicated PPP cell under its Finance Department, which serves as the main department for PPP projects in the state.[63] The city has initiated many PPP projects leveraging the state guidelines.

Under the Smart City Mission, technology-enabled initiatives are implemented for area-based developments. The Greater Visakhapatnam Smart City Corporation Limited is jointly owned by the state government and GVMC at 50:50. With a total project cost of INR 940 crore, 61 projects were identified and 48 were estimated to be completed by April 2022. The completed projects include a city operations centre, solar power plant, solar rooftop, solar lighting, smart classrooms, and others.

Land value capture mechanisms have also been adopted by Indian cities[64] and include tools like property tax, charges for development rights, and betterment levies. In FY 2022-23, GVMC collected INR 416 crore through vacant land and property taxes.

Given the above context, potential financing approaches that Vizag could consider for the recommended GCAP investments include a mix of both direct-cost and indirect-cost measures,

[57] GVMC ratings, Care edge, 2022 https://www.careratings.com/upload/CompanyFiles/PR/31012022070608_Greater_Visakhapatnam_Municipal_Corporation.pdf

[58] GVMC Mudarsarlova project, Times of India, 2022 https://timesofindia.indiatimes.com/city/visakhapatnam/gvmc-set-for-4320-cr-budget-mudasarlova-project-gets-100-cr/articleshow/90022937.cms

[59] GVMC capital expenditure, Times of India, 2024, https://timesofindia.indiatimes.com/city/visakhapatnam/capital-expenditure-boosts-gvmcs-5614-crore-budget-for-2024-25/articleshow/106682128.cms

[60] Annual financial statement of GVMC, Revenue department

[61] GVMC revenue records, Hans India, 2022, https://www.thehansindia.com/news/cities/visakhapatnam/visakhapatnam-corporation-collects-record-revenue-736123

[62] GVMC India Ratings, 2023, https://www.indiaratings.co.in/pressrelease/62619

[63] GVMC PPP Cell, Finance department, https://ppptg.cgg.gov.in/AboutPPP1.aspx

[64] Land Value Capture - Towards Planning and Financing Equitable Cities in India, NITI Aayog, 2021, https://www.niti.gov.in/sites/default/files/2022-04/LVC&S_Workshop_Proceedings_25042022.pdf

as represented in *Table 9*. Where the cost falls within the city's mandate, the full cost is reflected as a direct cost. However, the city can leverage other funding sources, including private sources of financing for these investments, such as through PPPs and other business models. The investment pipeline is anticipated to reduce 30 percent of the city's GHG emissions across all sectors under analysis.

The total investment cost for all measures totals INR 80 thousand crore (equivalent to USD 9,510 million). Direct cost measures add up to INR 50 thousand crore (USD 5,990 million). The list of investments includes actions where the city can nudge behaviors through policy implementation such as an improved green building code, through pilot projects such as public EV charging stations, or through leveraging the private sector to invest in green municipal infrastructure through mechanisms such as sustainability-linked financing and PPPs. The potential for alternative sources of financing is visualized in the investment flow diagram shown in *Figure 22*.

The green investment pipeline points to key opportunities where the city can leverage complementary policies and investment actions to work together, including Green Building Upgrades Mobilized through On-Bill Financing; Ambitious Green Building Code Reinforced by EDGE; Low Carbon Mobility Driven by EVs and Expansion of Public Transport; and Green Municipal Infrastructure Enabled by Sustainability-Linked Financing. These opportunities are described in further detail below.

1MW floating solar panels at Mudasarlova reservoir.

Image: IFC

Table 10: Table 10 Summary of the 42 measures in the green investment pipeline, including costs, GHG savings, and potential financing options the city could consider in the future. The pipeline has both direct-cost and indirect-cost measures, including actions where the city can nudge (i.e., implement policy, pilot investments, etc.) or leverage (i.e., through PPP, etc.) the private sector to invest in green measures. The measures with the highest impact in terms of GHG savings are shown in green. Costs are indicative only; all would need further feasibility work.

APEX Sectors	Measures	Total Cost (INR Crore)	Direct Cost (INR Crore)	Potential Financing Options			
				Own Revenue	Central Gov't Transfer / Loan	PPP	Private Finance
Built Environment & Energy	Rooftop Solar PV Program for Private Buildings	2,667	-				✓
	Improve Building Code	1,429	-				✓
	Smart Energy Display Meters	660	-				✓
	Incentivize Green Building Certification	357	-				✓
	EE Refurbishment in Private Buildings	1,388	-				✓
	Rooftop Solar Hot Water for Private Buildings	2,965	-				✓
	Implement Emissions Trading System*	-	-				
	Promote Cool Roofs	766	-				✓
	Rooftop Solar PV on Municipal Buildings	178	178			✓	
	Municipal Energy Efficiency Refurbishment	84	84	✓		✓	
	Green Municipal Buildings	12	12	✓		✓	
	Energy Efficient Street & Traffic Lights	269	269	✓		✓	
	Increase Urban Forestry	386	386	✓			
Transportation	Extend Subway System	38,702	38,702		✓	✓	
	Expand & Electrify Public Bus System	2,402	2,402		✓	✓	
	Expand & Electrify BRT System	2,451	2,451		✓	✓	
	Designate Street Lanes as Green Lanes	641	641	✓			
	Add Park-and-Ride to Transit Stations	101	101	✓		✓	
	Electrification of the Municipal Fleet	1,678	-	✓		✓	
	Promote Private Electric Vehicles	10,904	-				✓
	Electric Vehicle Charging Infrastructure	481	-			✓	
	Electrification of Auto-Rickshaws	403	-				✓
	Retirement of Inefficient Cars & Motorcycles	1,466	-				✓
	Street Parking with Dynamic Pricing*	-	-				
	Car-free Zones*	-	-				

APEX Sectors	Measures	Total Cost (INR Crore)	Direct Cost (INR Crore)	Potential Financing Options			
				Own Revenue	Central Gov't Transfer / Loan	PPP	Private Finance
Solid Waste	Expand Materials Recovery Facilities	38	38		✓	✓	
	Decentralized Composting	203	203		✓	✓	
	Improve Waste Collection	6	6		✓	✓	
	EPR for Packaging*	-	-				
	Ban Single-Use Plastics*	-	-				
Water & Wastewater	Reuse Wastewater at the Municipal Scale	662	662		✓	✓	
	Reduce Water Losses	252	252		✓	✓	
	Develop Ponds & Lakes for Rainwater Storage	1,153	1,153	✓			
	Mandate Efficient Fittings in Buildings	4,254	-				✓
	Smart Water Meters	15	-				
	Mandate Rooftop Rainwater Harvesting	6	-				✓
	Mandate Rooftop Greenery	86	-				✓
	Incentivize Local Water Retention*	-	-		✓	✓	
	New Centralized Wastewater Treatment Facilities	231	231		✓	✓	
	Local Scale Wastewater Treatment Plant	59	59		✓	✓	
	Improve Efficiency of Existing Treatment Plants	131	131		✓	✓	
	Biogas Recovery at Existing Treatment Plants	2,282	2,282		✓	✓	
Total		**79,768**	**50,242**				

**Policy-based measure that is currently not costed in APEX.*

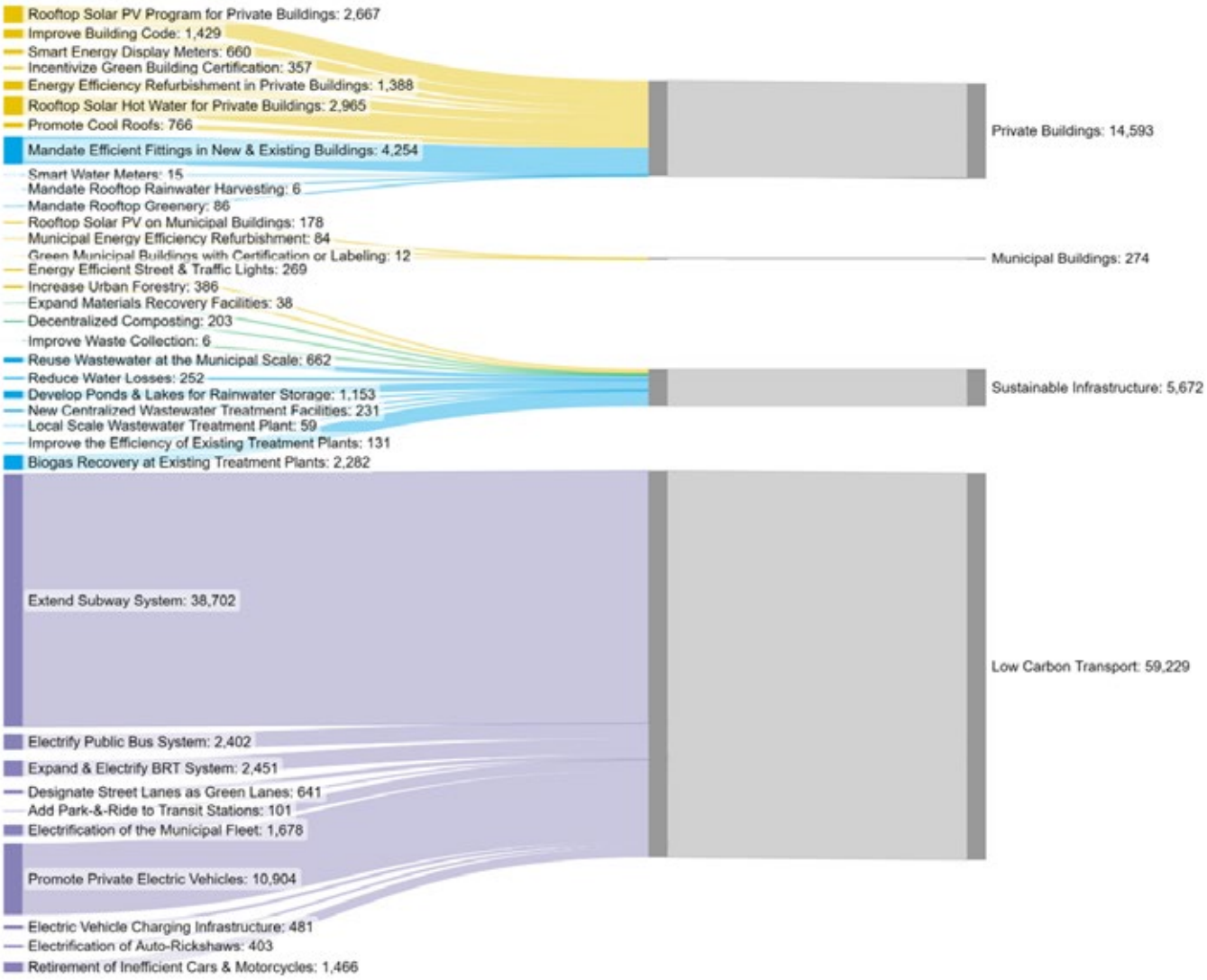


Figure 22: *Investment flow diagram showing the potential financing volumes aligned to measures in the green investment pipeline (shown in INR crore).*

Green Building Upgrades Mobilized Through On-Bill Financing

GVMC aims to accelerate more resource efficient green buildings to achieve energy-and-GHG savings through green upgrades and retrofits, and solar rooftop programs. The introduction of utility on-bill financing (OBF) programs presents an opportunity to facilitate consumer investments in efficiency upgrades. Collaboration with utility companies, third-party financial intermediaries, and local contractors can enhance the success of these programs, contributing to energy reduction and GHG emission goals.

OBF is a mechanism where financing repayments are made monthly through an existing utility bill. It enables loans for energy efficiency measures to be repaid over a more extended period via an additional line item on the recipient's utility bill, which decreases repayment risk for the lender. These improvements can deliver valuable efficiency to the utility, reduce customers' energy expenses, improve the value of properties, create jobs, and reduce harmful pollution. The near-term promise for OBF programs seems especially strong for customers whose access to conventional loans today can be difficult, such as city governments, schools, small businesses, and commercial tenants at the time of build-out. Many of these utility customers might have good credit risks for an on-bill loan.[65]

The potential areas of application could be energy and water efficiency through technology upgrades, renewable energy supply through rooftop solar, and electric mobility options. Vizag could pioneer OBF in partnership with the Andhra Pradesh Electricity Regulatory Commission (APERC) to introduce an OBF model to encourage the usage of modern EE appliances by domestic consumers.[66] For example, the demand aggregation programmes through OBF models like the UJALA (LED lighting) scheme can help in driving down the cost for the end users.[67] An indicative OBF structure is presented in *Figure 23.*

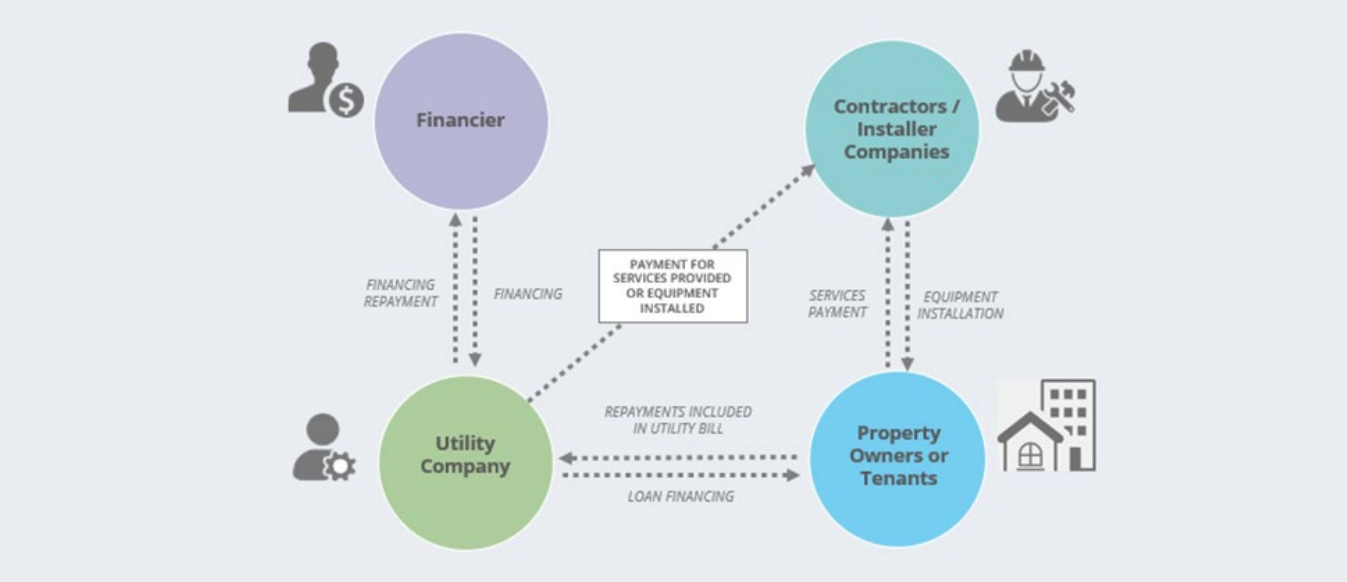


Figure 23: *Indicative on-bill financing structure.*

[65] On-Bill financing, On-bill financing, Natural Resources Defense, 2013, https://www.nrdc.org/sites/default/files/on-bill-financing-IB.p

[66] On-Bill financing, Andhra Pradesh Electricity Regulatory Commission, 2022, Introduce on-bill financing model, APERC advises Discoms (newindianexpress.com)

[67] Financing India's Sustainable Cooling Technology Transition, CEEW, 2022, https://www.ceew.in/blogs/financing-sustainable-cooling-technology-transition-in-india

Ambitious Green Building Code Reinforced by EDGE

An improved green building code could be introduced for Visakhapatnam along with a third-party verification for building approvals, such as IFC's Excellence in Design for Greater Efficiencies (EDGE). This approach could include policy incentives to promote green buildings in the city, including regulatory flexibility or benefits for green buildings (i.e., extra floor allowance), expediting or reduced permits, subsidies on property tax, and more.

EDGE certification is well-suited to be tied into municipal policy due to its ease of use, low cost, and scalability. EDGE is a free software, a green building standard, and an international green building certification system (*Figure 24*). It can help achieve requirements under global standards, such as GRESB (global standards for ESG benchmarking of real assets), and International Capital Markets Associations (in the context of green bond principles).[68] EDGE certification has been adopted across 60 cities in India and has provided 92 million square feet of certified building footprints.[69]

GVMC can create an ecosystem for private sector developers, accredited agencies, government officials, financiers, and enforcement agencies by way of policies, guidelines, bylaws, incentives, and other necessary regulations for green buildings codes under standards like EDGE.

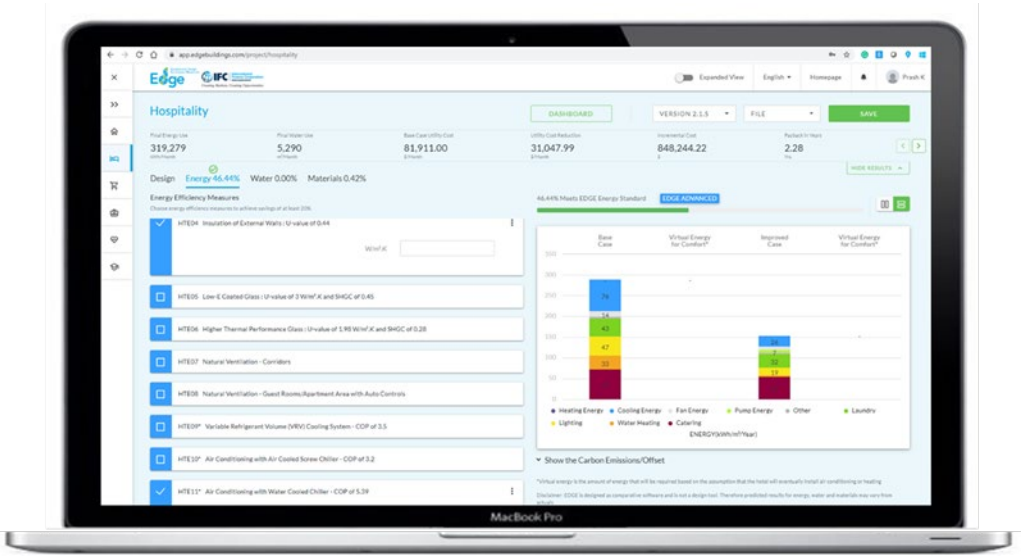


Figure 24: *EDGE Green Buildings Certification Application, available at www.edgebuildings.com.*

[68] Green Building Codes, IFC & Green Buildings - EDGE Buildings

[69] EDGE Certification – Leading India's green building transformation - Construction Week India (constructionweekonline.in) , 2021

Low Carbon Mobility Driven by EVs and Expansion of Public Transport

A systematic shift in passenger-travel demand from private vehicles to public transport and decarbonizing the transport sector by phasing out conventional fossil-fuel vehicles, are critical for achieving the climate-action goals. The city government can create lucrative incentives for adoption of cleaner modes of transport like electric vehicles (EVs). Though upfront costs of EVs are typically higher than internal combustion engine (ICE) vehicles, the operation and maintenance costs over their lifetime tend to be lower.[70]

The city is planning to phase out inefficient old vehicles including passenger cars, two-wheelers, and commercial vehicles. It also includes incentives for scrapping old vehicles, discounts on purchasing new vehicles, and refund of road taxes both for personal and commercial vehicles by up to 25 percent and 15 percent, respectively.

In addition, all municipal vehicles will be converted into EVs, and public charging infrastructure will be built by 2034. Exploring leasing options, especially operating leases, emerges as a viable strategy for financing the replacement of inefficient municipal vehicles. Careful evaluation of the advantages and legal aspects associated with both operating and finance leasing is crucial for informed decision-making.

Finally, the city is also leveraging government funds to improve parking planning and pricing, last-mile connection for public transport, creating car-free zones, building dedicated bicycle lanes, increasing the number of public transport buses, and expanding the BRT and metro systems.

The 2022 central budget proposed a battery-swapping policy for EVs to decouple battery costs from the upfront EV-purchasing costs, as well as to offer flexibility to EV users by promoting battery swapping as an alternative to charging facilities. Batter swapping also helps promote the idea of energy as a service, which, in turn will encourage EV adoption; it is popularly used for 2 and 3-wheelers that have small batteries.[71] This policy is promoted in addition to the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) and Production Linked Incentive (PLI) Scheme of the government of India. While the battery swapping policy is already operational in India, industry consultations are still held by NITI Aayog and others.

Municipal electric vehicles being charged at GVMC main office at Jail road.

Image: IFC

[70] Battery Swapping Policy, NITI Aayog, 2022
https://www.niti.gov.in/sites/default/files/2022-04/20220420_Battery_Swapping_Policy_Draft.pdf

[71] India's electric vehicle policy, TechCircle, 2023 https://www.techcircle.in/2023/07/04/a-timeline-proposal-of-battery-swapping-scheme-to-demand-for-redraft

Along similar lines, the city government can partner with local banks, Original Equipment Manufacturers (OEMs), and financial institutions to help launch an EV financing investment program. Banks can offer financing to car buyers to purchase EVs. Financing can also be paired with other policy measures offered by the city alongside state and national government incentives. A case study example of Pimpri Chinchwad's EV Readiness Plan is shown in *Box 18.*

Box 18: *Case Study for Pimpri Chinchwad Municipal Corporation City EV Readiness Plan 2023.*

CASE STUDY

Pimpri Chinchwad's EV Readiness Plan aims to make the city EV ready by 2025.[72] The measures include as dedicated EV cell within city's sustainability cell, electrification of public transport, deployment of EV charging stations, property tax rebate, EV cell as a knowledge repository and citizen grievance cell, e-auto-rickshaw (three-wheeler) incentive cell.

Image: IFC

With plans to reduce its petrol and diesel vehicles, in 2023 the city leased 79 EVs from Tata for 5 years to upgrade its fleet, which already included 22 existing EVs.[73]

EVs are capital-intensive investments and Pimpri Chinchwad Municipal Corporation plans to use funds from the 15th Finance Commission under the National Clean Air Program, engage financial institutions for EV buyers, and support first and last-mile connection providers in partnership with Maha-metro and public transport bus provider for Pune.

[72] Pimpri Chinchwad City Electric Vehicle Readiness Plan, PCMC, 2023 https://www.pcmcindia.gov.in/evcell/PDF/Publications-EV-Policy-GR-2022.pdf

[73] Electric vehicles, PCMC, Hindustan Times, 2023, https://www.hindustantimes.com/cities/pune-news/pcmc-leases-79-electric-vehicles-to-reduce-vehicular-emission-aims-to-remove-diesel-and-petrol-vehicles-from-fleet-101689441951493.html

Green Municipal Infrastructure Enabled by Sustainability-Linked Financing

Sustainability-linked financing (SLF) is designed to incentivize a borrower's achievement of environmental, social and governance (ESG) targets through price incentives. SLF mobilizes capital for sustainability in emerging markets. Its incentive structures can vary, including an increase (step-up) in the interest rate paid by the firm if the target is missed, a decrease (step-down) if the target is met, or both. The underlying instrument can be any financial product, including bonds, corporate loans, project finance loans, revolving credit facilities, derivatives, and others. The most popular ones are sustainability-linked bonds and loans, with 85 percent of the portfolio formed by sustainability-linked loans (SLLs) since its inception in 2017.[74] A case study for city-based sustainable-linked financing is shown in *Box 19.*

APEX can help cities provide data for the necessary Key Performance Indicators (KPIs) to underpin a sustainability-linked loan or bond. The APEX city-level accreditation monitoring system (under development) can track the city's overall year-on-year performance as well as progress toward the sustainability-linked targets.

Box 19: *Case study for city-based sustainable-linked financing from Helsingborg, Sweden.*

CASE STUDY

In January 2022, Helsingborg, Sweden, became the first city to issue a sustainability-linked bond[75] The framework underpinning the bond is the emission reduction target to be achieved by 2035. The performance indicator will be the trajectory of the municipal emission reduction rate in the coming years. The goal of the bond is to attract capital for carrying out and expanding green initiatives. Technical specialists will use the Swedish national emissions database to track emission reduction performance.

Image: istockphoto

[74] Sustainability-Linked Finance— Mobilizing Capital for Sustainability in Emerging Markets, IFC, 2022 https://www.ifc.org/content/dam/ifc/doc/mgrt/emcompass-note-110-sustainability-linked-finance-web.pdf

[75] Iolov, Tzvetozar Vincent. 2022. "Helsingborg is the first municipality to issue sustainability-linked bonds." TheMayor.eu. Available: https://www.themayor.eu/en/a/view/helsingborg-is-the-first-municipality-to-issue-sustainability-linked-bonds-9810. Image source: https://www.flickr.com/photos/tsaiproject/7095237743.

Summary & Conclusion

The Eco-Vizag GCAP identifies 42 measures across four key sectors: built environment and energy, transport, solid waste, and water and wastewater. These solutions also represent a green investment pipeline for Vizag totaling INR 80 thousand crore (equivalent to USD 9,510 million). If fully implemented, these measures could collectively contribute to a 30 percent GHG reduction for Vizag by 2034, equivalent to 2.0 $MtCO_2e$ in GHG emissions.

In terms of GHG impact, there are 8 measures that stand out with the highest contributions:

- Promote Private Electric Vehicles
- Rooftop Solar PV Program for Private Buildings
- Improve Building Code
- Extend Subway System
- Smart Energy Display Meters
- Incentivize Green Building Certification
- Energy Efficiency Refurbishment in Private Buildings
- Expand & Electrify Public Bus System

High impact items on the built environment and energy side include a city-wide solar PV program, an improved green building code, and EE upgrades for private buildings, all of which can be accelerated through private sector financing. In the transport sector, financing, and incentives for private EVs and an expanded subway and public bus transport can encourage the shift toward electric mobility and public transport. Taken together, these measures will result in 25 percent GHG savings, which is 85 percent of the total emissions reduction target.

The GCAP and green investment pipeline align with the Eco-Vizag campaign. It provides an integrated and analytical approach to implementing green projects in Vizag, reflecting GVMC's vision for a more sustainable and resilient future. The GCAP also highlights four key opportunities based on complementary policies and investment actions that work together:

- Green Building Upgrades Mobilized through On-Bill Financing
- Ambitious Green Building Code Reinforced by EDGE
- Low Carbon Mobility Driven by EVs and Expansion of Public Transport
- Green Municipal Infrastructure Enabled by Sustainability-Linked Financing

Given the importance of mobilizing private investment toward green city actions, GVMC will also play an important role in convening stakeholders, shaping public policy, and increasing awareness. GVMC can bring together key ingredients to accelerate climate action by building a broad network of ambitious and practical businesses, industries, and financial institutions committed to achieving climate targets and a green city vision for the city, businesses, and residents of Vizag.

Wall mural competitions at major roads to promote Eco-Vizag campaign awareness among citizens.

Image: IFC

Appendix A: Baseline Data

Table A.1. Population

Item	Value	Sources and Notes
Resident population	28,76,279	Projected based on Government of India Census data 2001a and Census data 2011b and annual growth rate.
Annual growth rate (%)	3.51%	Government of India Census data 2011 and 2021 and annual growth rate.
Employment rate (% of 15–74-year-olds)	96.6%	Estimated based on national and regional averages
Population at working age, 15-74 years old (%)	70.6%	Estimated based on national and regional averages
Persons per household in urban areas	2.1	Calculated based on property tax data provided by GVMC revenue department for building area and projected data of population for 2024
Population distribution by income (%)		
Low	21.9%	Estimated based on national and regional averages
Lower-middle	19.3%	
Upper-middle	25%	
High	33.8%	

a. Government of India: Census data, table N.10, page 8.
b. Article available at

Table A.2. Built Environment and Energy

Item	Value	Sources and Notes
City area (km^2)	620	Primary data provided by the city as on 2024 based on NDVI LAND-SAT
Length of streets (km)	4,231	Data populated on GIS by GVMC, by plotting on google earth with the rough estimates provided by each Sachivalayam WPR officer.
Number of streetlights	118,000	Primary data provided by the city as on 2024 as maintained by the GVMC electrical department
Number of traffic light sets	75	Data as provided in the article below a
Area of parks and green spaces (km^2)	1.66	Primary data provided by the city as of 2024 based on NDVI LAND-SAT
Area of forest canopy (km^2)	222.5	Primary data provided by the city as of 2024 based on NDVI LAND-SAT
Total building area (million m^2)	33.73	
Retail	0.14	Data as received from property tax department for floor wise built-up area and GIS data as received from GVMC planning department
Office	0.58	
Hotel	0.14	
Health	1.87	
Education	2.18	
Institutional or Assembly	0.59	
Warehouse	0.34	
Transport	0.06	
Residential		
Apartments	18.97	
Homes	8.86	
Average building area per person (m^2)	11.7	Calculated based on building areas and population
Area of municipal buildings (m^2)		Data as received from property tax department for floor wise built-up area and GIS data as received from GVMC planning department. Nonresidential have considered institutional assembly, mandapams and residential have considered affordable housing.
Nonresidential	2,62,012	
Residential	24,440	
Building energy consumption (kWh per m^2per year)		

Item	Value	Sources and Notes
Retail	180.63	Calculated based on property tax department for floor wise built-up area and GIS data as received from GVMC planning department and APEPDCL electricity consumption data 2024
Office	83.69	
Hotel	123.33	
Health	94.78	
Education	82.35	
Institutional or Assembly	131.65	
Warehouse	107.68	
Transport	118.4	
Residential		
Apartments	180.15	
Homes	198.17	
Energy source (%)		Calculated based on APEPDCL data and data as on GCOM Data portal for cities b for local heat sources
Grid electricity	92%	
Local heat sources	8%	
Energy emissions factors ($kgCO_2e$ per kWh)		
Grid electricity	0.716	Data from national grid emission factor by CEA c
Local heat sources	0.215	Estimates based on national and regional averages

a. Article available at https://www.thehansindia.com/news/cities/visakhapatnam/visakhapatnam-gets-new-traffic-signals-646983
b. Article available at https://dataportalforcities.org/
c. Article available at : CO2 Baseline Database for the Indian Power Sector , Government of India, Central Electricity Authority https://cea.nic.in/wp-content/uploads/baseline/2024/01/User_Guide__Version_19.0.pdf

Note: GCOM = Global Covenant of Mayor's; and GIS = geographic information systems.

Table A.3. Transportation

Item	Value	Sources and Notes
Average trips per day per resident	1.67	Calculated based on data from Low carbon comprehensive mobility plan 2014 a and APSRTC primary data 2024
Average trip distance (km)	14	Calculated based on data from Low carbon comprehensive mobility plan 2014 and APSRTC primary data 2024 and VMRDA master plan b
Working days per year	303	Estimated based on the global average
Total resident passenger travel (million km)	20,376	Calculated based on the model split by passenger kilometer travelled and average distance kilometers
Modal split by passenger in kilometers (%)		Data from low carbon comprehensive mobility plan 2014, Google vehicular kilometer travelled data 2024 and calculated based on passenger kilometers travelled
Automobile	14%	
Motorcycle	40.2%	
Taxi	0.67%	
Moto-taxi	20.31%	
Minibus, private	0%	
Minibus, public	0%	
Bus, standard	13%	
Bus, BRT	0%	
Subway	0%	
Bicycle	0.56%	
Walk	8.91%	
Transit ridership (passengers per day)		
Bus, standard	285,000	Data as provided by APSRTC, 2024
Bus, BRT	0	
Subway	0	

Item	Value	Sources and Notes
Transit infrastructure		
Length of bus lanes (km)	220	Data as provided by APSRTC, 2024
Number of conventional buses in fleet	605	
Length of BRT system (km)	24	
Number of BRT buses in fleet	0	
Length of subway system (km)	0	
Number of subway stations	0	
Number of subway trains	0	
Average occupancy rate (passengers)		Data from Low carbon comprehensive mobility plan 2014
Automobile	2	
Motorcycle	1.5	
Taxi	2	
Moto-taxi	2.5	
Minibus, private	0	
Minibus, public	0	
Bus, standard	30	
Bus, BRT	0	
Subway	0	
Number of vehicles in fleet		
Automobile	88,595	Data from RTA on vehicular registration from 1998 to 2024
Motorcycle	18,25,707	
Taxi	7000	
Moto-taxi	4,00,473	
Minibus, private	0	
Minibus, public	3277	

Item	Value	Sources and Notes
Annual growth in private vehicle ownership (%)		
Automobiles	7.08%	Calculated based on data from RTA on vehicular registration for two years 2022 and 2023
Motorcycles	3.38%	
Annual rate of vehicle retirement or obsolescence (%)		
Automobiles	5%	Estimated based on the global average
Motorcycles	3%	
Average vehicle efficiency (km per liter)		Data from Low Carbon Comprehensive Mobility Plan 2014
Automobile	16	
Motorcycle	49	
Taxi	12.39	
Moto-taxi	29	
Minibus, private	7	
Minibus, public	7	
Bus, standard	5	
Bus, BRT	5	
Parking		
On-street parking spaces	6,34,700	Estimated based on WB data c
Off-street parking spaces	1,166,715	

a. Available at : http://vmrda.gov.in/masterplan-2041/DPPreports.pdf
b. Available at : https://stg-wedocs.unep.org/bitstream/handle/20.500.11822/31402/LCCMPV.pdf?sequence=1&isAllowed=y
c. Available at : https://documents1.worldbank.org/curated/en/195691468042841007/pdf/732240WP0P09510reater0Visakhapatnam.pd

Table A.4. Solid Waste

Item	Value	Sources and Notes
Municipal solid waste (MSW) generation (tonnes per person per year)	0.108	Primary data received from the city public health department 2024
MSW composition (%)		Primary data received from the city public health department 2024
Organic waste	40%	
Paper and cardboard	16%	
Wood	5%	
Textiles	12%	
Rubber and leather	1%	
Plastics	5%	
Metal	5%	
Glass	0%	
Other	16%	
Organic waste composition (%)		
Food waste	60%	
Organic waste	40%	
Waste treatment (%)		Primary data received from the city public health department
Compost	35%	
Managed landfill without landfill gas system	39%	
Unaccounted for	5%	
Incineration	21%	
Recycling	0%	
Recycling composition (%)		
Paper and cardboard	50%	Primary data received from the city public health department
Rubber and leather	25%	
Plastics	25%	
Metal	0%	
Glass	0%	

Table A.5. Water and Wastewater

Item	Value	Sources and Notes
Municipal water consumption (MLD)	395.5	Primary data received from the city UGD department GVMC
Potable water (%)	65%	Primary data received from the city UGD department GVMC
Nonpotable water (%)	35%	
Average consumption per person (L/day)	105	Primary data received from the city UGD department GVMC
Industrial water consumption (MLD)	100	Primary data received from the city UGD department GVMC
Unaccounted-for water losses (%)	35%	Primary data received from the city UGD department GVMC
Water source (%)		
Groundwater	30%	Primary data received from the city UGD department GVMC
Surface water	70%	
Wastewater treatment		
Wastewater flow (MLD)	181.4	Statistics Yearbook 2022
Treatment type (%)		
Septic tank	32%	
Activated Sludge Process (ASP) With AD	23%	
Upflow Anaerobic Sludge Blanket (UASB) with biogas capture	0%	Primary data received from the city UGD department GVMC
Waste stabilization ponds, covered lagoons	0%	
Membrane System (MBR)	13%	
Untreated sewer (discharge into water)	32%	

Appendix B: Key Assumptions for Measures

Table B.1. Built Environment and Energy

No.	GCAP Measure	APEX Measure Code (Version 2023-05)	Measures Settings & Key Assumptions
1	Rooftop Solar PV Program for Private Buildings	• A.14 Implement Rooftop Solar PV Program	• Additional Rooftop Solar PV Capacity Installed (MWp): 300 • Panel Area (m^2): 3.5 million • Building Roof Area With Solar PV Systems: 57%
2	Improve Building Code	• A.5 Improve Building Code	• New Building Area: 100% • New Building Area (m^2): 11.3 million
3	Smart Energy Display Meters	• A.21 Smart Energy Display Meters	• Buildings with Smart Energy Display Meters: 100% • Building Area (m^2): 32 million
4	Incentivize Green Building Certification	• A.9 Incentivize Green Building Certification (e.g. EDGE) • D.17 Promote Voluntary Green Building Certification (EDGE)	• New Private Buildings Meeting Green Building Certification Standards: 30% • Building Area (m^2): 2.8 million
5	Energy Efficiency Refurbishment in Private Buildings	• A.10 Finance for private energy efficiency refurbishment	• Existing Building Area Receiving Energy Upgrades: 13% • Existing Building Area Receiving Energy Upgrades (m^2): 4.7 million
6	Rooftop Solar Hot Water for Private Buildings	• A.3 Mandate Roof-top Solar Hot Water	• Habitable Buildings with Collectors (%): 40% • Building Area (m^2): 16 million
7	Implement Emissions Trading System	• A.4 Implement City-wide Emissions Trading System (ETS)	• Non-Residential Buildings with ETS: 10% • Building Area (m^2): 789,000
8	Promote Cool Roofs	• A.7 Promote Cool Roofs	• Uptake of Cool Roofs (%): 25% • Roof Area (m^2): 1.5 million
9	Rooftop Solar PV on Municipal Buildings	• A.18 Install Rooftop Solar PV on Municipal Buildings	• Additional Rooftop Solar PV Installed on Municipal Buildings (MWp): 20 • Municipal Roof Area (%): 295%
10	Municipal Energy Efficiency Refurbishment	• A.17 Implement EE Refurbishment Program For All Municipal Buildings	• Existing Municipal Building Area Receiving Energy Upgrades (m^2): 286,452 • Existing Municipal Building Area Receiving Energy Upgrades (%): 100%
11	Green Municipal Buildings with Certification or Labeling	• A.16 Implement Green Certification/labelling For All Municipal Buildings	• New Municipal Building Area Meeting Green Certification Standards (m^2): 97,485 • New Municipal Building Area Meeting Green Certification (%): 100%
12	Energy Efficient Street & Traffic Lights	• A.19 Upgrade All Streetlights With Energy Efficient Bulbsa • A.20 Upgrade All Traffic Lights With Energy Efficient Bulbs	• Number of Streetlights Upgraded: 118,000 • % of Streetlights Upgraded: 100% • Number of Traffic Lights Upgraded: 75 • % of Traffic Lights Upgraded: 100%
13	Increase Urban Forestry	• A.8 Increase Extent of Urban Forestry	• % of Increase in Urban Forestry: 20% • Canopy Area (km^2): 12.6

Table B.2. Transportation

No.	GCAP Measure	APEX Measure Code (Version 2023-05)	Measures Settings & Key Assumptions
14	Expand & Electrify Public Bus System	• B.20 Expand Conventional Bus Fleet	• Buses Added: 800
		• B.22 Electrify Conventional Bus Fleet	• Buses Electrified: 1200
15	Extend Subway System	• B.26 Add / Extend Subway System	• Subway System Added/Extended (km): 76.9
16	Expand & Electrify BRT System	• B.23 Add / Extend BRT System	• BRT System Added/Extended (km): 19
		• B.25 Electrify BRT Bus Fleet	• BRT Buses Electrified: 108
17	Designate Street Lanes as Green Lanes	• B.18 Designate Street Lanes as Bus Lanes	• Corridors Designated As Bus Lanes: 25 • Length of Bus Lanes (km): 10
18	Add Park-and-Ride to Transit Stations	• B.31 Add Park-and-ride Lot to Transit Station	• Car Spaces Added: 1000 • Motorcycle Spaces Added: 2000
19	Electrification of the Municipal Fleet	• B.16 Finance Electric Vehicles Through Banks	• Number of Electrified Municipal Vehicles: 10,000
20	Promote Private Electric Vehicles	• B.16 Finance Electric Vehicles Through Banks	• Number of Electrified Two-Wheelers: 550,000 • Number of Electrified Private Cars: 20,000
21	Electric Vehicle Charging Infrastructure	• B.15 Provide EV Charging Infrastructure	• Public Chargers: 5000
22	Electrification of Au-to-Rickshaws	• B.16 Finance Electric Vehicles Through Banks	• Number of Electrified Autorickshaws: 20,000
23	Retirement of Inefficient Cars & Motorcycles	• B.1 Mandate Retirement of Inefficient Cars	• Most Inefficient Cars Retired: 15%
		• B.2 Mandate Retirement of Inefficient Motorcycles	• Most Inefficient Motorcycles Retired: 10%
24	Street Parking with Dynamic Pricing	• B.7 Reduce Street Parking With Dynamic Pricing	• Occupancy: 85%; Empty Spaces Per 40m: 0.9
25	Car-free Zones	• B.12 Create Car-free Zones	• Area with Car-free Zone (km^2): 5

Table B.3. Solid Waste

No.	GCAP Measure	APEX Measure Code (Version 2023-05)	Measures Settings & Key Assumptions
26	Expand Materials Reco-very Facilities	• C.13 Add / Expand Materials Recovery Facilities	• Recycling : 50% • MRF Facility (t/day): 150
27	Decentralized Compos-ting	• C.1 Mandate Decentralised Composting	• Domestic Food/Organics Composted: 10% • Commercial Food/Organics Composted: 15% • Capacity of Decentralized Composting Facility (t/day): 60
28	Improve Waste Collection	• C.9 Improve Waste Collection	• Waste Collection Rate: 100% • Increase in Collections (t/day): 50
29	Extended Producer Res-ponsibility for Packaging	• C.6 Mandate Extended Producer Responsibility For Packaging	• Plastics Avoided: 20% • Cardboard Avoided: 25%
30	Ban Single-Use Plastics	• C.5 Ban Single Use Plastics	• Single Use Plastics Banned: 2% of plastic waste

Table B.4. Water and Wastewater

No.	GCAP Measure	APEX Measure Code (Version 2023-05)	Measures Settings & Key Assumptions
31	Reuse Wastewater at the Municipal Scale	• D.7 Reuse Wastewater at Municipal Scale	• Reuse Capacity (MLD): 110
32	Reduce Water Losses	• D.14 Reduce Unaccounted-for Water Losses	• Improved Case Water Losses: 26% Water Losses Avoided (MLD): 83.6
33	Develop Ponds & Lakes for Rainwater Storage	• D.3 Harvest Rainwater at Municipal Scale	• Water Harvested (MLD): 4.76
		• D.5 Develop Ponds / Lakes For Rainwater Storage	• Volume of Ponds/Lakes (m^3): 503,000 • Water Supply Met (MLD): 5.83
34	Mandate Efficient Fittings in New & Existing Buildings	• D.18 Mandate Efficient Fittings in New Buildings	• New Buildings With Efficient Fixtures: 40% • Building Area (m^2): 4.58 million
		• D.19 Mandate Efficient Fittings in Existing Buildings	• Existing Buildings With Efficient Fixtures: 50% • Existing Building Area (m^2): 16.6 million
35	Smart Water Meters	• D.20 Install Smart Meters to Reduce Consumption And Leakage	• % of Buildings: 30% • Building Area (m^2): 13.5 million
36	Mandate Rooftop Rainwater Harvesting	• D.1 Mandate Rooftop Harvesting	• Roof Area Capture with Groundwater Recharge: 25% • Roof Area (m^2): 1.1 million
37	Mandate Rooftop Greenery	• D.2 Mandate Rooftop Greenery	• Roof Area Covered (%): 30%
38	Incentivize Local Water Retention	• D.4 [x] Implement Sustainable Urban Drainage Systems (SUDS)	• City Area with SUDS: 15% • Area (km^2): 25
		• D.8 Incentivize Local Water Retention in Lakes / Ponds / Reservoirs	• Available Open Space used for Local Water Retention: 10% • Catchment Area (m^2): 314,085
39	New Centralized Wastewater Treatment Facilities	• D.21 Add New Centralised Wastewater Treatment Facilities	• WWTP Type to Add: Moving Bed Bioreactor (MBBR) • Additional Capacity: 68% • Additional Capacity (MLD): 110
40	Local Scale Wastewater Treatment Plant	• D.24 Add Local Scale Wastewater Treatment Plant	• WWTP Type to Add: Moving Bed Bioreactor (MBBR) • Additional Capacity: 25% • Additional Capacity (MLD): 22
41	Improve the Efficiency of Existing Treatment Plants	• D.22 Improve The Efficiency of Existing WWTP	• Capacity Impacted: 25% • Impacted Capacity (MLD): 30
42	Biogas Recovery at Existing Treatment Plants	• D.25 Add Biogas Recovery to Existing WWTP	• Plant Capacity (MLD): 340 • Biogas Collected (m^3/day): 150,000 • Density of biogas (kg/m^3): 0.6 • Fraction of methane (%): 50%

APEX

An innovation of IFC, APEX supports cities in emerging economies to accelerate the implementation of ambitious and transformative policy actions and investments that significantly contribute to transitioning to low-carbon and resource-efficient growth pathways. The platform leverages the APEX Online App, which helps cities to quickly assess the most cost-effective ways to incorporate measures into their investment and policy pipelines.

www.apexcities.com

IFC

IFC is a member of the World Bank that focuses on private sector development. Working with partners in more than 100 emerging markets, IFC invests, advises, and mobilizes resources from others, creating opportunity for clients in a broad range of industries. Standing between the public and private sectors, IFC brings market-based solutions to respond to the challenge of creating low-carbon economic growth.

www.ifc.org