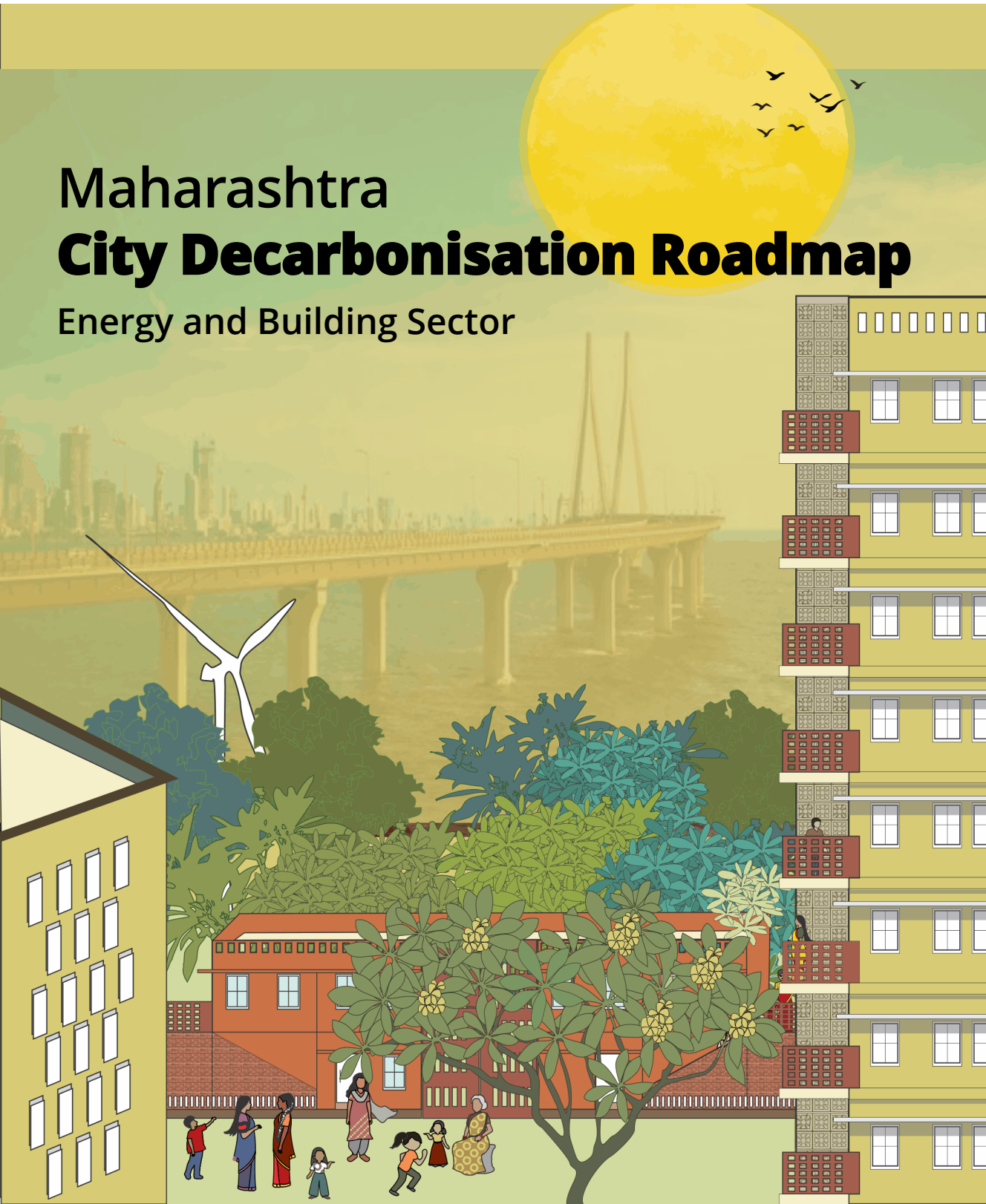
सत्यमेव जयते
Goverment Of India

Majhi Vasundhara

Maharashtra
City Decarbonisation Roadmap
Energy and Building Sector



About

India has been on a steady path to urbanization over the last seven decades, with over 35% of its current population residing in cities. It is estimated that, by 2050, the urban population of India would have doubled (from 467 to 877 million)[1]. The building stock in India is expected to double in the next fifteen years and buildings are expected to emerge as the largest electricity consuming sector in the country. Residential and commercial buildings account for 31% of the electricity consumption, and it is rising at 10-12% annually.

Population growth combined with increasing electricity demand and affordability are expected to exponentially increase the energy consumption in buildings. India, in August 2022, updated its Nationally Determined Contribution (NDC) under the Paris Agreement in-line with its pledge at COP26 to achieve Net Zero Emissions by 2070. Cities will play an important role when considering India's Net Zero Commitments. They are at the centre of climate change and therefore climate action; cities will need to play a leading role in embedding climate actions in long term economic and land use planning through data driven climate action plans for mainstreaming.

With a population of 112 million, Maharashtra is India's second most populated state. In the year 2021-22, while India's per capita electricity consumption stood at 1,255 kWh, Maharashtra's per capita electricity consumption was above the national average at 1,588 kWh (Refer Figure 1).

Maharashtra being the third most urbanised state in the country, only after Tamil Nadu and Kerala, experiences high energy demands from urban built environments which can be attributed to cooling or heating, lighting, and appliances. The building sector is a significant contributor to greenhouse gas emissions due to energy consumption. Reducing energy consumption aiming at zero emissions is essential to achieving India's climate targets.

43 cities in Maharashtra committed towards achieving net zero carbon emissions through the UNFCCC-backed Cities Race to Zero (CRtZ) campaign in 2021. Some of these cities have also committed to "Develop Zero Carbon Buildings", a theme in the CRtZ. In March 2022, Mumbai launched its first ever Paris Agreement Aligned Climate Action Plan (MCAP) - a strategic document with a tangible list of actions for mitigation and adaptation. MCAP highlights Energy and Buildings as a major sector contributing to the GHG emissions of a city which is a common situation in almost all the cities in Maharashtra. Following MCAP, cities like Nashik, Chhatrapati Sambhajinagar (Aurangabad) and Solapur too are progressing to develop their Climate Action Plans.

Building on the commitment of the State of Maharashtra on climate actions, C40 in coordination with the Department of Environment and Climate Change, Government of Maharashtra and Environmental Design Solutions as technical assistance has developed a city-level template roadmap. The roadmap outlines a pathway to decarbonisation that supports the energy transition at the city and state level while serving as an essential part of the process for cities to scale-up energy efficiency, reduce GHG emissions, reduce reliance on fossil fuels and lower energy operation costs.

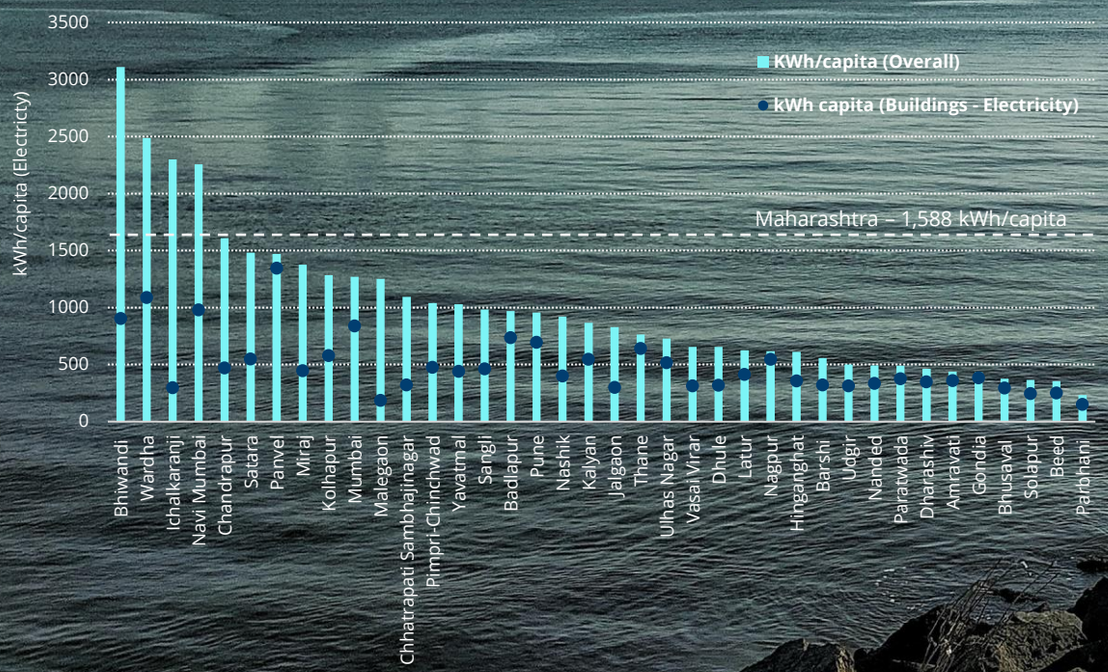


Figure 1. Electricity Consumption of cities in Maharashtra for the year 2021-22

[1] ORF. Managing India's urban transition in 2021

Roadmap Development Process

Roadmap development is a participatory process, involving engagement with relevant stakeholders at various levels both at state and cities. Five steps outlined below were followed while developing the roadmap and further deep dive was conducted with six cities. The cities may follow these steps to develop a comprehensive and collaborative roadmap to decarbonise both public and privately owned buildings within their city. Industrial buildings, although a significant source of emissions in many cities in Maharashtra are not included in the scope of the roadmap template, although many of the steps could be applicable to that sector.

1

Stakeholder Mapping and Landscape Analysis

a) Identify stakeholders.
b) Review governance structure, policies, programs and initiatives.
c) Review national, state and city actions, commitments, and plans for clean energy transition.

2

Development of Baseline

a) Define the baseline year.
b) Identify the scope and boundary for baseline assessment.
c) Define baseline indicators.
d) Collect, validate and analyse data
e) Incorporate stakeholders and expert feedback.

3

Identification of actions for decarbonisation

Actions for -
a) Decarbonising buildings,
b) Decarbonising energy supply,
c) Management and Institutional strengthening

4

Prioritisation of Actions

Evaluation Criteria –
a) Emission reduction potential
b) Co-benefits such as health-wellbeing, economic and environmental benefits
c) Feasibility of implementation

5

Development of Roadmap

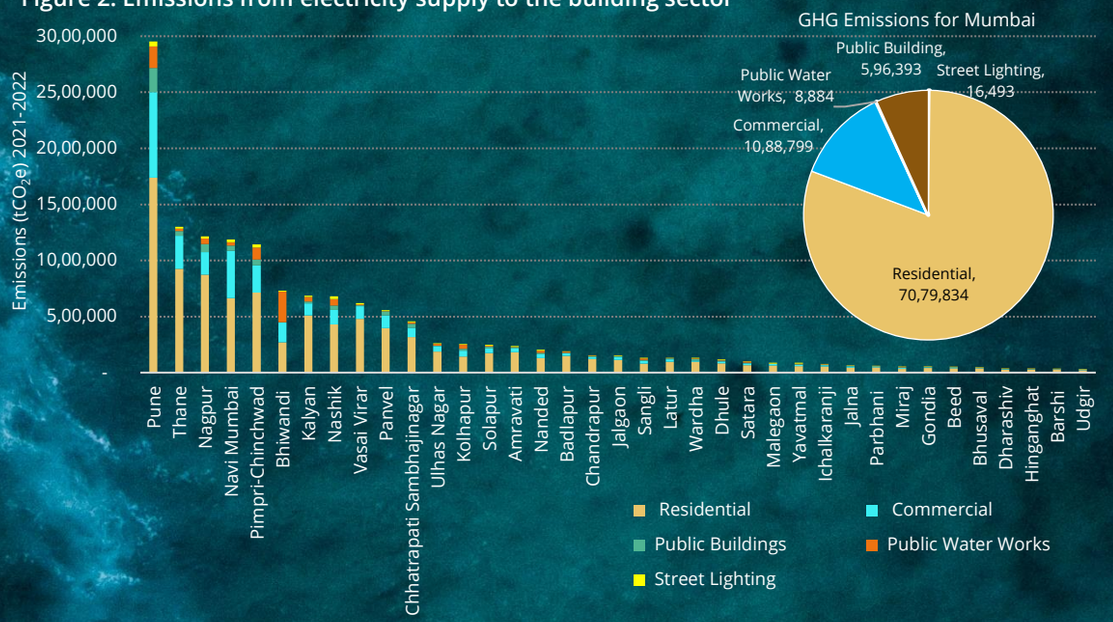
a) Emission trend analysis,
b) Define timelines for actions
c) Set overall goal
d) Map actions and sub-actions
e) Assessment of impact (Business as usual and Decarbonised Scenario)
f) Finalise interim targets and goals

Cities of Maharashtra: Baseline

Baseline Year	FY 2021-2022
Scope and Boundary	Includes emissions from a) Electricity use in residential, commercial, and institutional, public buildings and municipal infrastructure such as public water works and streetlighting. b) Fuel (LPG and /or PNG) for cooking. Excludes emissions from transportation, industries, waste, agriculture etc.
Baseline Indicator	**Primary Indicator** – Per capita emissions (kg CO_2e/ capita) covered in the scope above. **Secondary Indicators** – a) Per capita emissions (kg CO_2e/ capita) for the building electricity sector b) Per capita emissions (kg CO_2e/capita) for overall electricity supply to city (including all sectors – industries, transport, agriculture and buildings). (In the future, when cities monitor and track the growth of the built-up footprint, emission intensity per square meter can be an additional indicator, especially from the building sector perspective)
Data Points	City officials from the departments (Town Planning Department, Tax Department, Environment Department, Public Works Department and Electrical Department) of the Municipal Corporation, electricity and gas utilities were engaged with, for data collection to develop the baseline. Data collected, validated and analysed for development of the baseline: **a)** **Population** for FY2021-22 (Source – City reported population to MVA) **b)** **Built-up area in square meters** for FY2021-22 (Source – Property Tax Departments of Municipal Authorities) **c)** **Sectoral Electricity Consumption** from 2017-2022. (Source – All DISCOMs in Maharashtra - Maharashtra State Electricity Distribution Co. Ltd. (MSEDCL), TATA Power, Adani Power and BEST Undertaking) **d)** **Cooking Fuel** (both LPG and PNG) consumption from 2017-2022 (Source – Mahanagar Gas Limited, (MGL), Bharat Petroleum Corporation Limited (BPCL), Hindustan Petroleum Corporation Limited (HPCL), Indian Oil Corporation Limited (IOCL). **e)** **Emission Factors** - Electricity (Source – Central Electricity Authority) - Cooking Fuels (Source IPCC Guidelines for National Greenhouse Gas Inventories)

Mumbai ranks first in emissions from electricity supply to buildings and public infrastructure (87,90,403 tCO_2e) followed by Pune. Residential sector contributes to 60-80% of the building sector electricity demand across all cities. Decarbonisation of the residential electricity demand is crucial for all cities. In cities like Pune, Navi Mumbai and Thane, the commercial sector electricity consumption too can be prioritized from a decarbonisation perspective.

Figure 2. Emissions from electricity supply to the building sector



The following figure represents both overall (industrial, agriculture, buildings, transport and public infrastructure) and the building electricity specific emissions per capita of the individual cities. Bhiwandi, Wardha, Ichalkaranji and Navi Mumbai have a higher emissions per capita (above 1500 $kgCO_2e$/capita) which can be attributed to mixed land use, industrial development; whereas majority of the cities have overall emissions lesser than 1000 $kgCO_2e$/capita.

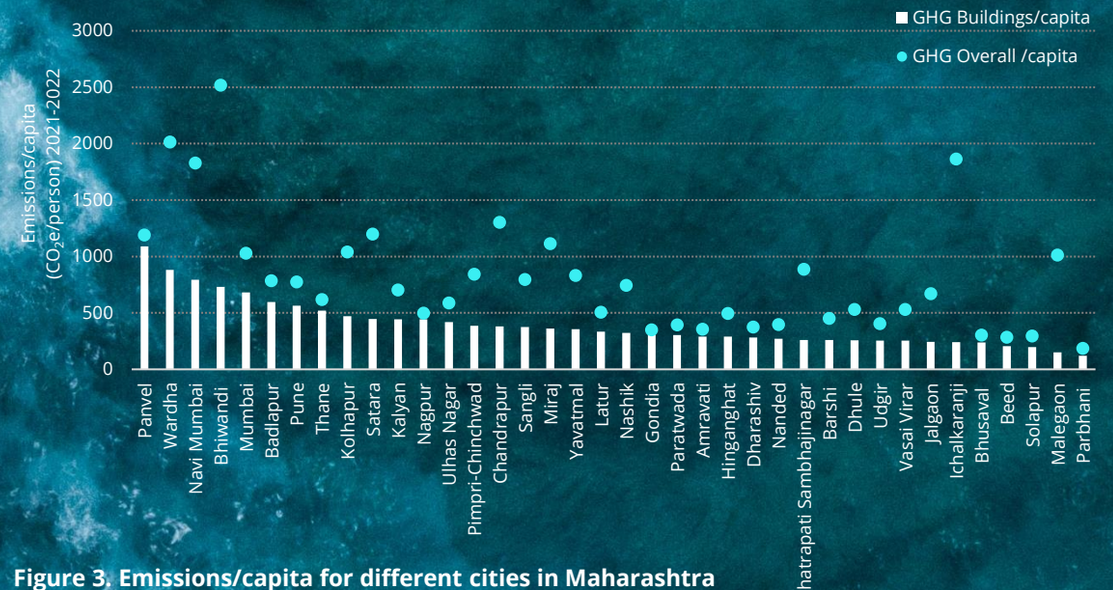


Figure 3. Emissions/capita for different cities in Maharashtra

Baseline

Cities can use the baseline information to:

a) Draw comparisons and lessons from other cities that have a similar profile and sectoral split.

b) Develop their own detailed roadmaps.

c) Monitor and track performance of the actions against the baseline.

Cities can refer to the following city-specific baselines as a starting point to embark on their journey towards decarbonization.

Name of the City	Emissions / capita (CO_2e/person) (overall electricity supply to city)	Emissions / capita (CO_2e/person) (building electricity)	Emissions / capita (CO_2e/person) (building electricity and cooking fuel)
Amravati	356	291	419
Badlapur	786	597	738*
Barshi	452	260	329*
Beed	286	204	256*
Bhiwandi	2,519	732	815*
Bhusaval	304	238	306*
Chandrapur	1,202	381	637
Chhatrapati Sambhajinagar	887	260	313*
Dharashiv	374	283	343*
Dhule	530	258	318*
Gondia	351	310	70*
Hinganghat	495	289	353*
Ichalkaranji	1,863	240	301*
Jalgaon	671	243	303*
Jalna	5,171	147	182*
Kalyan	702	443	531*
Kolhapur	1,041	470	563*
Latur	506	334	403*
Malegaon	1,012	151	199*
Miraj	1,114	362	443*
Mumbai	1,030	680	774*
Nanded	98	271	324*
Nagpur	499	442	517*
Nashik	745	324	437
Navi Mumbai	1,827	794	881
Parbhani	187	121	153*
Paratwada	395	305	386*
Panvel	1,191	1,090	1,246
Pimpri-Chinchwad	843	386	453*
Pune	774	563	654*
Sangli	795	374	456*
Satara	1,199	445	556*
Solapur	296	198	244*
Thane	617	520	571
Udgir	405	255	314*
Ulhas Nagar	89	418	489*
Vasai Virar	531	254	317*
Wardha	2,015	881	1,075*
Yavatmal	833	357	433*

* Cooking fuel is calculated based on population and typical household cooking fuel consumption in India. This value needs to be verified with gas suppliers to the city.

Actions for Decarbonisation

Energy Code Compliance for all new buildings (residential, commercial, public)

Decarbonise Building Construction (Low embodied energy material and technology)

Offset residual emissions from embodied energy due to construction activities.

Grid-Interactive Buildings, Smart Metering and Real-time tariffs

RE Generation / supply of clean energy (by electricity suppliers)

Retrofit for existing buildings (residential, commercial, public)

Increase Distributed Renewable energy generation and storage capacity

Increase penetration of efficient cook stoves

Formation of a Climate Cell at Municipal Corporation

Building Energy Consumption Database and Benchmarking

Training and capacity building

Transition to clean fuels for cooking

Retrofit streetlights and Public Water Works for energy efficiency and grid-interactivity

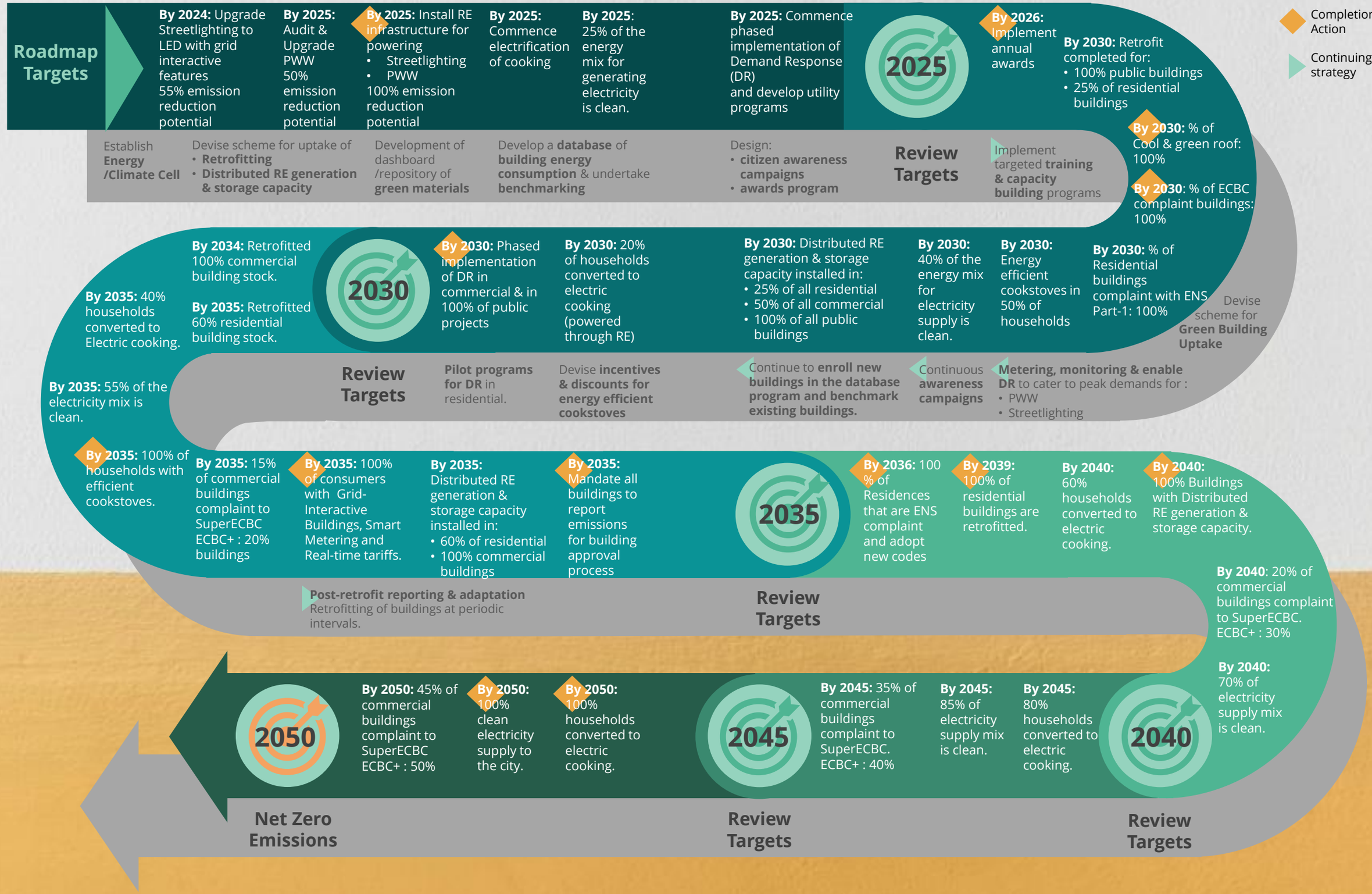
Design and implement annual awards

Citizen Awareness

RE powered public infrastructure

City Decarbonisation Roadmap

Example : Navi Mumbai



City Decarbonisation Roadmap

Example : Navi Mumbai

Trend Analysis

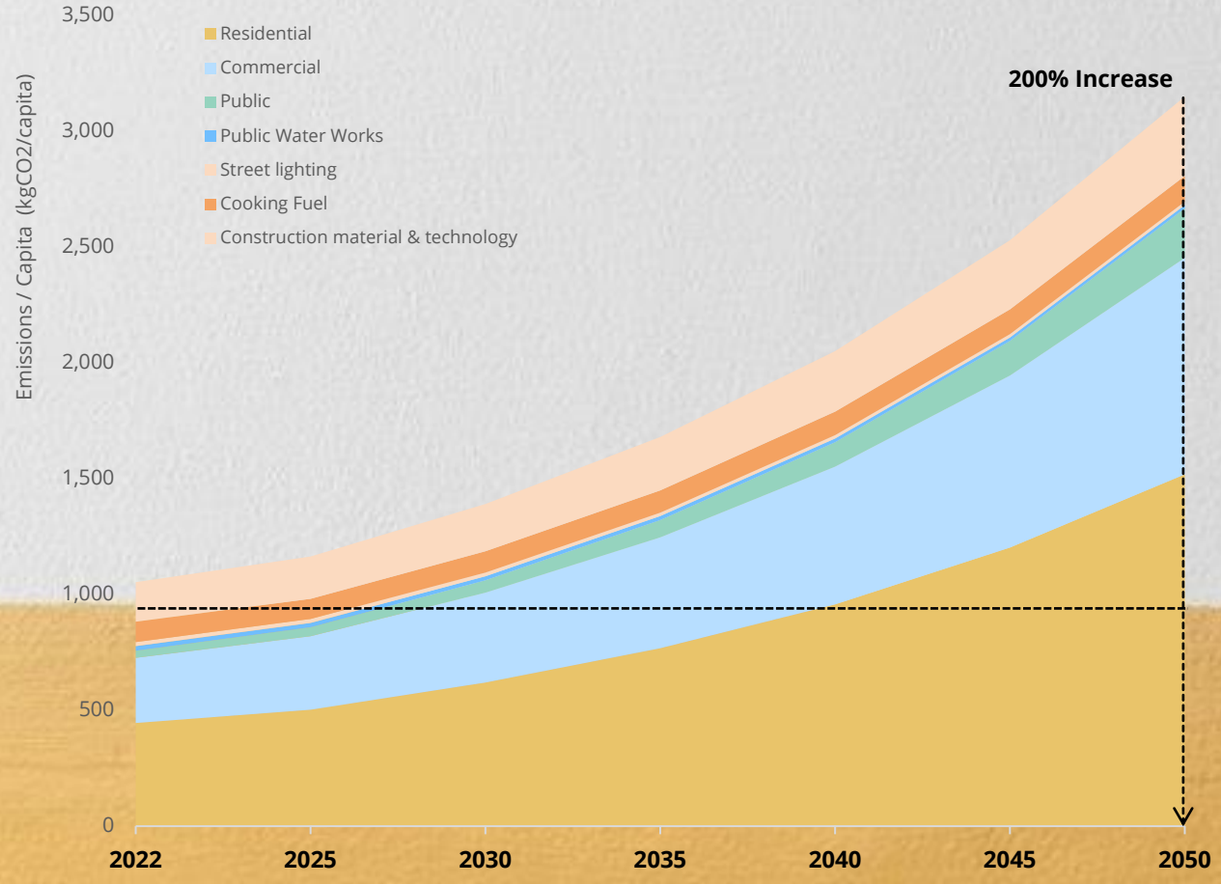
Emissions trends from the building sector of Navi Mumbai indicate largest emissions from the residential electricity use sector, followed by commercial electricity use and cooking fuel use (LPG). In a business –as-usual scenario, if no action is taken, Building and Energy sector emissions/capita is set to increase from 1,053 kg.CO_2/capita in 2022 to 3,150 kg.CO_2/capita in 2050 for Navi Mumbai, increasing by 200% between 2022 and 2050. This trend implies that programs and policies for demand reduction and increasing renewable energy production leveraging innovative technologies need to be implemented to reach the target of zero emissions.

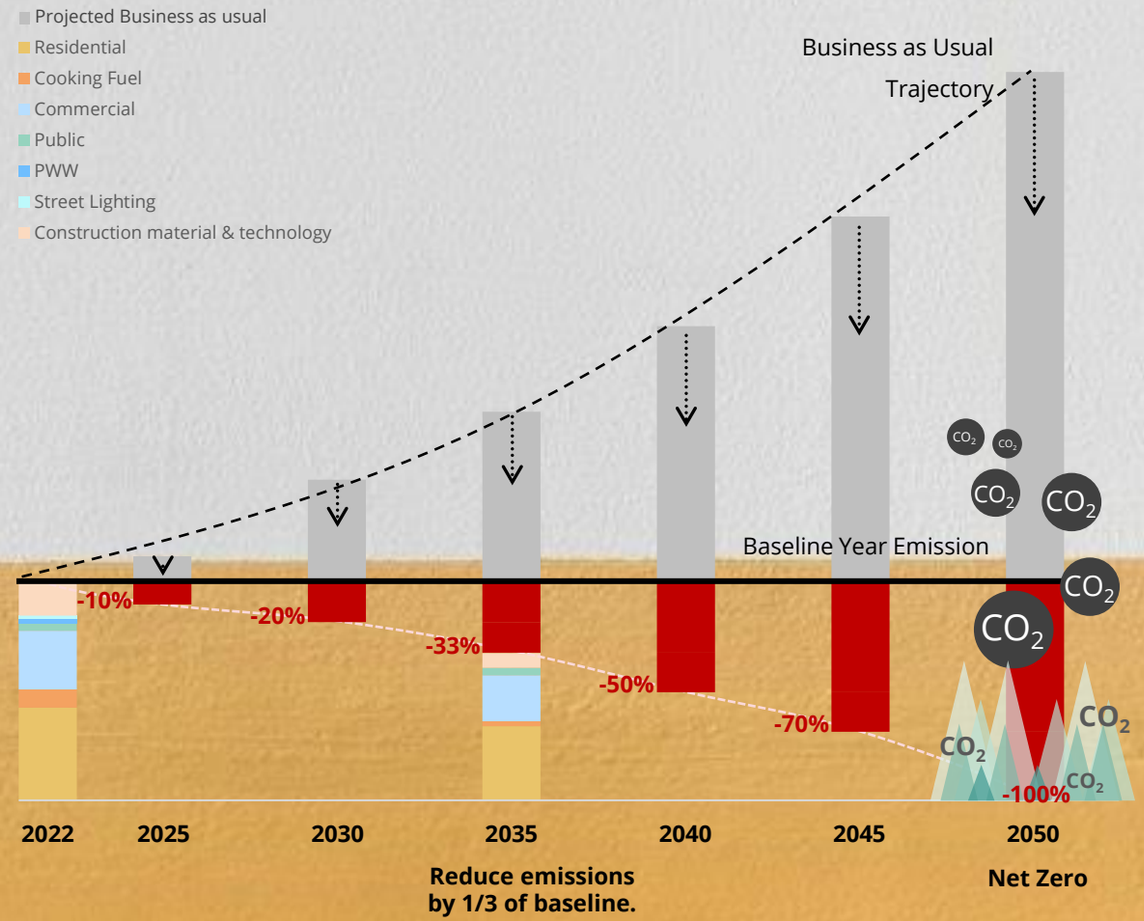
Roadmap

The aim of city decarbonization shall be achieved through a phased approach. The roadmap quantifies emissions reductions from the actions for 5 years interval until 2050. In 2022-2025.

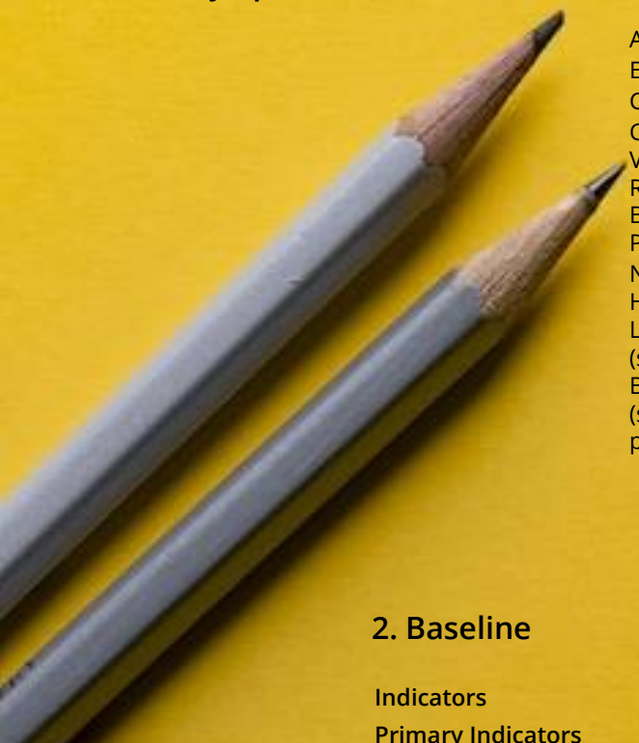
The following five actions are crucial to Navi Mumbai's decarbonisation roadmap.

a) Increase penetration of clean / renewable energy powered electricity supply to the city.
b) Energy Efficiency Code Compliance in all new buildings (especially residential)
c) Increase penetration of distributed renewable energy and storage in buildings.
d) Retrofit of existing buildings.
e) Decarbonise Building Construction (Materials and Technology with Low embodied energy)





City Decarbonisation Roadmap Template



1. City-Specific Information

Administration			
Economic base			
Climate Type			
Climate Vulnerability & Risk			
Baseline Year			
Population			
Number of Households			
Land Area (square km)			
Built-up area (square meter & percent)		sqm	(%)
	Residential		
	Commercial		
	Institutional		
	Public		
	Other		
	Total		100%

2. Baseline

Indicators	Baseline Value	Unit
Primary Indicators		
Emissions / capita (overall electricity supply to city)		CO_2e/person
Emissions / capita (building electricity)		CO_2e/person
Emissions / capita (building electricity and cooking fuel)		CO_2e/person
Emissions /capita (building electricity, fuel, embodied emissions)		CO_2e/person
Secondary Indicators		
Electricity / capita (Buildings)		kWh/person
Electricity /m^2		kWh/m^2
Emissions /m^2		kg CO_2e/m^2
Total Emissions		tCO_2e
Electricity – Residential Buildings		tCO_2e
Electricity – Commercial Buildings		tCO_2e
Electricity - Public Buildings		tCO_2e
Electricity – Public Water Works		tCO_2e
Electricity – Street Lights		tCO_2e
Cooking fuel		tCO_2e
New construction		tCO_2e

3. Assessment of Actions, Initiatives

Describe the current state of play projects, actions undertaken – potential, challenges and opportunities towards implementation of the actions in different sectors (as applicable).

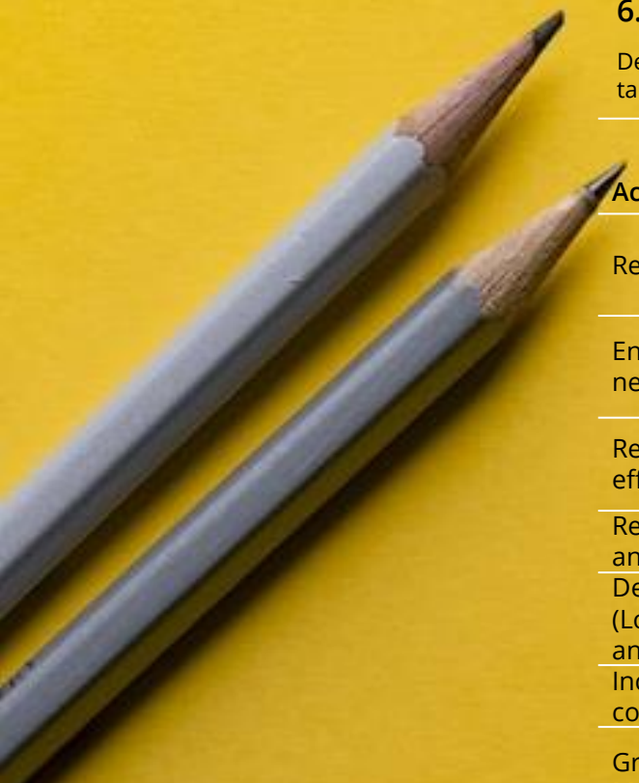
Action	Residential	Commercial	Public
Retrofit for existing buildings			
Energy Code Compliance for all new buildings			
Retrofit streetlights for energy efficiency and grid-interactivity	x	x	
Retrofit PWW for energy efficiency and grid-interactivity	x	x	
Decarbonise Building Construction (Low embodied energy material and technology)			
Increase penetration of efficient cook stoves			
Grid-Interactive Buildings, Smart Metering and Real-time tariffs			
Increase Distributed Renewable energy generation and storage capacity (in buildings)			
Renewable energy powered streetlighting	x	x	
Renewable energy powered PWW	x	x	
Offset emissions from balance embodied energy		x	x
Transition to clean fuels for cooking		x	x
RE Generation/ Supply of clean energy (by electricity suppliers)			
Formation of a Climate / Energy Cell at Municipal Corporation.			
Building Energy Consumption Database and Benchmarking			
Training and capacity building			
Design and implement annual awards			
Citizen Awareness			

4. Stakeholder Mapping

Name of Stakeholder	Type	Role and Responsibility	Type of Influence

5. Energy Consumption & Emissions: Trend Analysis

Add the observations from the energy consumption and emissions trend analysis to identify priority sectors and actions.



6. Roadmap Template

Detail the sub actions in each of the cells to meet the target provided and develop the final roadmap.

Actions	Sector	Target Emission Reduction % / Emissions /capita ($kg.CO_2$ /capita)
		10% · 20-25% · 30-35% · 50% · 70% · 100%
Retrofit for existing buildings	Residential Commercial Public	→
Energy Code Compliance for all new buildings	Residential Commercial Public	→
Retrofit streetlights for energy efficiency and grid-interactivity	Public	→
Retrofit PWW for energy efficiency and grid-interactivity	Public	→
Decarbonise Building Construction (Low embodied energy material and technology)	All	*Eg: Mandate emission accounting & disclosure system for buildings* →
Increase penetration of efficient cook stoves	Residential	→
Grid-Interactive Buildings, Smart Metering and Real-time tariffs	Residential Commercial Public	→
Increase Distributed Renewable energy generation and storage capacity (in buildings)	Residential Commercial Public	→
Renewable energy powered streetlighting	Public	→
Renewable energy powered PWW	Public	→
Offset emissions from balance embodied energy	All	→
Transition to clean fuels for cooking	Residential	→
RE Generation/ Supply of clean energy (by electricity suppliers)	All	→
Formation of a Climate / Energy Cell at Municipal Corporation.	All	●
Building Energy Consumption Database and Benchmarking	All	● →
Training and capacity building	All	→
Design, implement annual awards	All	→
Citizen Awareness	All	→

Maharashtra - City Decarbonisation Roadmap – Energy and Building Sector

Building on the commitment of the State of Maharashtra on climate actions, C40 in coordination with the Department of Environment and Climate Change, Government of Maharashtra and technical assistance from Environmental Design Solutions has developed a city-level template roadmap. The "Maharashtra - City Decarbonisation Roadmap – Energy and Building Sector" outlines a pathway to decarbonisation that supports the energy transition at the city and state level while serving as an essential part of the process for cities to scale-up energy efficiency, reduce GHG emissions, reduce reliance on fossil fuels and lower energy operation costs.

About State Climate Action Cell (SCAC)

State Climate Action Cell is a newly formed cell, that will focus on prevention, adaptation, and mitigation actions for climate change. The cell will provide guidance on implementation of the state Action Plan on Climate Change (SAPCC) and National Action Plan on Climate Change (NPACC) in the state. SCAC will also coordinate between the Union government, local governing bodies, NGOs, institutions working in the field of environmental research and development, international financial institutions, and other stakeholders. The climate cell will also work as the nodal agency in implementing the green initiatives.

About Majhi Vasundhara Abhiyan (MVA)

Majhi Vasundhara (My Earth) is a holistic initiative taken up by the Environment and Climate Change Department, Govt. of Maharashtra. This initiative focuses on all the five elements of nature i.e. "Panchamahabhuta". The aim of this initiative is to make citizens aware of the impacts of climate change and environmental issues and to encourage them to make a conscious effort towards improvement of the environment. It also aims to ensure sustainable development of Maharashtra and to take strong climate action at state level.

About C40 Cities Climate Leadership Group Inc. (C40)

C40 is a global network of nearly 100 mayors of the world's leading cities that are united in action to confront the climate crisis. Mayors of C40 cities are committed to using an inclusive, science-based and collaborative approach to cut their fair share of emissions in half by 2030, help the world limit global heating to 1.5°C, and build healthy, equitable and resilient communities.

About Environmental Design Solutions (EDS)

EDS is a sustainability advisory firm focusing on the built environment. EDS has worked on over 500 green building and energy efficiency projects worldwide. The diverse proficiencies of its team of experts converges on energy efficiency, climate change mitigation, decarbonization & Net-zero transition, and resource efficiency. The scope of EDS projects ranges from global and national level policy and code formulation to building-level integration of energy-efficiency parameters.

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