



WWF

IND

2020



© FARIANTHEPHOTOPIHLE

Working Paper

1.5°C ALIGNMENT FOR INDIAN CITIES

A CASE STUDY OF NAGPUR



ACKNOWLEDGEMENT

© WWF-India 2020

Published by WWF-India

Any reproduction of this publication in full or part must mention the title and credit the above-mentioned publisher as the copyright owner.

Acknowledgements

WWF-India is grateful to all experts and specialists for providing insights during the preparation of this working paper. We would like to acknowledge the support from Nagpur Municipal Corporation, Nagpur Smart and Sustainable City Development Corporation Limited, National Environmental Engineering Research Institute, Nagpur and associated government partners; who were instrumental in providing useful insights for the report. We would also like to thank Mr. Anit Kolhe, OPCC Nodal Officer, Nagpur Municipal Corporation, for his inputs and contribution. The support from Mr. Tabaré A. Currás, Technical Lead, WWF Cities and our colleagues in WWF-India is appreciated.

Team

Climate Change and Energy Programme:

Saurav Chowdhury, Senior Programme Officer | schowdhury@wwfindia.net

Suchismita Mukhopadhyay, Associate Director | smukhopadhyay@wwfindia.net

Sakshi Gaur, Assistant Manager- Communications | sgaur@wwfindia.net

This report has been prepared by WWF-India with inputs based on conversations, publicly available information and information gathered from different organizations. WWF-India disclaim any and all liability for the use that may be made of the information contained in this report. While the key organizations and experts listed in the Acknowledgements and Appendix have provided significant inputs for the development of this report, their participation does not necessarily imply endorsement of the report's contents or conclusions.

1. INTRODUCTION

1.1 CITIES- A 'CAUSE OF' AND 'SOLUTION TO' CLIMATE CHANGE

Over 54 percent of the global population lives in cities, which is projected to be 60 percent by 2030. Cities currently account for more than half of the global greenhouse gas (GHG) emissions and about two thirds of global energy use.[1] Rapid urbanization has posed challenges such as higher energy demand, pollution, unmanaged waste, unsustainable use of natural resources, leading to adverse impacts on the quality of life and sustainability of cities. On the other hand, millions of people residing in cities and urban areas are heavily vulnerable to the impacts of climate change.

India has witnessed rapid urbanization in recent years and the trend will continue in the future. The country has an urban population of more than 30 per cent currently, which is expected to be 40 per cent in 2030. As Indian cities cater to growing populations, they would also be faced with the challenges related to the provision of basic necessities such as housing and transport, which would further lead to increased demand for energy and water, higher emissions and waste generation, deteriorating air quality and, associated health impacts. Nearly 44 percent of India's rapidly growing carbon emissions have urban origins, emanating from transport, industry, buildings, and waste contributing towards climate change.[2]

It is therefore imperative for cities to play a larger role in countering the challenges of climate change by integrating low carbon actions and sustainable energy use into local development goals, and simultaneously strive towards climate resilient growth and planning. Climate smart planning in cities will determine the extent and impact of climate change, and the ability to achieve emission reductions, as well as the capacity to adapt to changing circumstances. Several cities are driving change by integrating low carbon actions into local development goals, and simultaneously mainstreaming climate resilient growth. Indian cities are also a part of this transition and have exemplified their role in addressing climate change. Globally, the significance of integrating sustainability in cities' actions and plans has been recognized.

The need to strengthen the response to climate change in cities is discussed across major global agendas such as Sustainable Development Goals, Paris Agreement, and the New Urban Agenda. Non-party stakeholders (cities, businesses, sub-national regions, investors, and civil society) came together to lend momentum to the Paris agreement in 2015 with commitments to act on climate change.



[1] United Nations (2016), The World's Cities in 2016

[2] TERI (2015); Draft Report on the "Study on quantification of the Greenhouse Gas mitigation potential of the various development initiatives undertaken by Government of India"

At the UN Climate Conferences in Marrakesh in 2016 and Bonn in 2017, countries restated their understanding that success on climate change will require greater ambition on the part of non-state actors. The UN's 2015 Sustainable Development Goals included an explicit urban goal for the first time - Goal 11 (Sustainable Cities and Communities). Similarly, Goal 7 (Energy) and Goal 13 (Climate Action) are also relevant to cities. Over two-thirds of the submitted Nationally Determined Contributions (NDCs) show clear urban references and content, establishing the relationship between sustainable urbanization and climate action. The New Urban Agenda, adopted at Habitat III, resolves to enable national, sub-national and local governments along with other stakeholders to achieve sustainable urban development.

India is focussing on the transformation and rejuvenation of cities through various schemes and programmes which have a thrust on promoting smart solutions that can make cities climate resilient. The ambitious Smart Cities Mission and the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) were launched to address the issue of infrastructure gap in urban areas, besides enhancing the business and investment climate for the benefit of the poor. The aim was to develop 100 smart cities that are ahead of the curve in decision making, problem solving, as well as ease of living of citizens, and improve infrastructure in another 500 cities, under the AMRUT scheme.

The “Solar Cities” mission was designed to support Urban Local Bodies (ULBs) to prepare a road map to guide cities in becoming 'renewable energy cities' or 'solar cities'. There have been various other initiatives where cities have a central role such as the target of installing 40 GW of grid-connected rooftop solar PV capacity by 2022, and the National Electric Mobility Mission 2020 which aims at promoting electric mobility in cities. The Mission on Sustainable Habitat under the National Action Plan on Climate Change (NAPCC) aims at encouraging sustainable urban planning in India with the help of policy, infrastructural and research interventions in sectors such as buildings, waste management, water resources and transportation.

In 2019, the Ministry of Housing and Urban Affairs (MoHUA), Government of India initiated the “ClimateSMART Cities Assessment Framework” (CSCAF) for the 100 Smart Cities which is a first-of-its-kind cities assessment framework on climate relevant parameters such as energy and green buildings, urban planning, green cover & biodiversity, mobility and air quality, water resource management, and waste management. The objective was to provide a clear roadmap for the cities and in effect, urban India as a whole, towards combating climate change while planning and implementing their actions including investments. CSCAF serves as a tool for cities to assess their present situation and facilitate cities to adopt, implement and disseminate the best practices and further to set standards in comparison to the international efforts towards the green, sustainable and urban resilient habitats. Further, in July 2020, a first of its kind Climate Centre for Cities (C-Cube) was launched at the National Institute of Urban Affairs (NIUA) with a vision to build climate action in cities. Instituted by the MoHUA, under its Smart Cities Mission, C-Cube will serve as a one-stop shop for climate informed actions to ensure a sustainable urban future for India.

In 2018, the Intergovernmental Panel on Climate Change (IPCC) published the Special Report on Global Warming of 1.5°C (SR1.5) to explain the pathways to and impacts of limiting global warming to 1.5°C compared with 2°C on ecosystems, human health and well-being. It shows that to retain global warming within 1.5°C, global emissions must peak by 2020 and reduce to net zero by 2050. The report emphasized that strengthening the capacities for climate action of national and sub-national authorities, civil society, the private sector, indigenous people and local communities can support the implementation of ambitious actions implied by limiting global warming to 1.5°C.[3] It also identifies cities and urban areas as one of four critical global systems that can accelerate and upscale climate action, but also recognizes that this will require major transitions in how both mitigation and adaptation/resilience are undertaken.[4]

[3] IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.

[4] Global Covenant of Mayors - Summary for Urban Policymakers – What the IPCC Special Report on 1.5C Means for Cities.

Cities can lead the way by adopting and ensuring access to renewable energy and energy efficiency measures, and recognizing the importance of sustainable, integrated urban planning to facilitate this transition. Energy and space-efficient building standards as well as retrofitting are priorities along with design for material reuse and recycling and, shifting to renewables. Cities have the opportunity to shift to sustainable urban planning and transportation, thereby facilitating low-carbon, energy-efficient development and physical greening of cities. Prioritizing pedestrians and bicycles, public transportation, support for e-vehicles and car-sharing,

over private vehicles has multiple benefits such as addressing air pollution and congestion, improving equity through accessibility, and enhancing biodiversity in cities. Cities need to act within their administrations, and with stakeholders and citizens.[5]

Urban infrastructure system transition consistent with limiting global warming therefore requires policy makers and associate stakeholders to be informed regarding a science-based approach towards aligning climate action with the 1.5°C goal.

WWF CITIES PROGRAMME - ONE PLANET CITY CHALLENGE

Vision: Cities are recognized as central actors in a climate-resilient and equitable future where people live in harmony with nature. Cities have adequate resources and capacity and are integrated into national and international planning and policy which empower them to not only act, but to innovate and lead towards a 100% renewable, equitable and sustainable future.

Commitment: To increase local political leadership, capacity, entrepreneurship, public engagement and resources to transform cities and support the creation and development of thriving and prosperous cities and empowered citizens, while respecting the ecological limits of our one planet.

Goal: By 2025, cities worldwide act as transformation catalysts, implementing integrated and inclusive action plans in line with 1.5°C, while ensuring urban resilience and unlocking individual and collective climate actions.

WWF's global initiative for cities, One Planet City Challenge (OPCC) is a biennial challenge that is designed to highlight, reward and inspire cities that are willing and prepared to make substantial long-term efforts towards sustainability and resilience. Created in 2011, the platform aims to highlight the power of cities to advance international climate and sustainability agendas, demonstrating cities' potential to help close the climate ambition gap. The OPCC assesses and guides cities towards a 1.5°C compliant pathway – contributing to the Paris Agreement, the UN Sustainable Development Goals and the conservation agenda. Since its inception in 2011, more than 500 cities have joined the OPCC, reporting over 5,700 actions that have the potential to reduce total GHG emissions by 3.9 GT by 2050. During the OPCC 2019-2020 cycle, 255 cities from 50+ countries were assessed on 1.5 °C alignment and their plans were reviewed based on their evidence in climate action.[6]

Since 2012, the India chapter of OPCC has been providing increased support and capacity building to cities in scaling up their climate actions by addressing the barriers for integration of a climate focus into the cities' policies, action plans and urban planning. So far, 26 cities across 16 states have been part of the city challenge in India. WWF-India engages with multiple stakeholders including the policy makers, city corporations as well as citizens to sensitize on climate change issues and mobilize climate actions. The programme aims to strengthen networking, both at the local and national level, to foster knowledge sharing, highlight best practices, and facilitate partnerships to mainstream climate action in city-level development planning.

[5,6] WWF Cities Policy Paper Series - Cities in the Climate Crisis: Energy and urban planning to support 1.5°C alignment

1.2 OBJECTIVE OF THE WORKING PAPER

1. To map the climate related initiatives (mitigation and adaptation/resilience) undertaken by the city and analyse the alignment with the national as well as the state level climate goals.
2. To conduct a deep dive assessment of climate actions in Nagpur to analyse the alignment with global climate goals using WWF's One Planet City Challenge (OPCC) assessment framework based on the SR1.5 findings.
3. To provide recommendations for strengthening city level climate actions in line with 1.5°C goals, as well as to achieve greater alignment with the national climate agenda including the NDCs, state climate action plans, and CSCAF.



1.3 STUDY AREA

The city of Nagpur in the state of Maharashtra is the selected study area. As emerging growth centres, cities like Nagpur are crucial in the achievement and enhancement of the state as well as the national climate agenda. But it has been observed that the peak or maximum temperature occurrences in Nagpur have increased considerably in the recent years, and such extremities have been causing severe damages. Nagpur has also witnessed erratic precipitation in recent times, which has further impacted the city's water supply. Due to the variations in precipitation patterns, climate uncertainties can be a norm in the coming years. Therefore, it's important to assist cities like Nagpur in adopting a science-based approach towards aligning with the target of limiting global warming below 1.5°C by ensuring a smooth transition to a low-carbon economy, along with improving adaptive capacity. With rapid urbanisation, the city is undertaking several urban development projects, which can potentially mainstream climate and sustainability aspects. Some significant steps for mainstreaming climate initiatives in new as well as ongoing missions/schemes, and action plans have already been initiated. This paper attempts to provide recommendations for the city to further align its development targets with the climate goals to achieve an integrated and holistic climate smart future.

ABOUT NAGPUR

Nagpur is a fast growing metropolis and the third largest city in Maharashtra after Mumbai and Pune. With a population of 24,05,665 (2011), Nagpur Metropolitan Area is the 13th largest urban conglomeration in India. Nagpur was ranked as India's Best City in Innovation & Best Practices under Swachh Survekshan 2018. Nagpur was also ranked 1st in the Smart City Rankings 2019. In addition to being the seat of the annual winter session of Maharashtra state assembly, Nagpur is also a major commercial and political centre of the Vidarbha region of Maharashtra, and known as "Orange City" for being a major trade centre of oranges that are cultivated in the region. Nagpur is also called the "Tiger Capital of India" as it connects many tiger reserves in India to the world. It is among the important cities for the IT sector in Maharashtra after Pune. It is believed that Nagpur lies precisely at the centre of the country with the Zero Mile Marker indicating the geographical centre of India. The city has an area of 227.38 square kms, and a population of 24,05,665 as per Census 2011. The population of the city was projected to increase to 28,80,000 by 2020.

CLIMATE IN NAGPUR

Nagpur has tropical savannah climate with dry conditions prevailing for most of the year. It receives rainfall ranging from about 160 - 278 mm between June to September. The highest recorded daily rainfall was 304 mm on 14 July 1994. Summers are extremely hot, lasting from March to June, with May being the hottest month. Winter lasts from November to January, during which temperatures drop below 10 °C. The highest recorded temperature in the city was 48 °C on 19 May 2015, while the lowest was 3.5 °C on 29 December 2018.[7]

ADMINISTRATION

Nagpur Municipal Corporation (NMC), established in 1951, is the key administrating body for the city of Nagpur. The NMC primarily provides basic urban services related to sectors like water supply, sanitation, waste, roads, parks and gardens etc. in coordination with organizations like NMRDA, MHADA, MSRTC. The mission statement of the NMC focuses on achieving 100 percent coverage in water supply and sewerage collection, as well as solid waste collection & disposal, and improved road safety and better traffic management through provision of flyovers, bridges, parking facilities, etc.[8]

The Nagpur Smart and Sustainable City Development Corporation Limited (NSSCDCL), established in 2016, was created as a Special Purpose Vehicle, which aims to make Nagpur a Super smart city. The key objectives of NSSCDCL are to plan, design, carry out technical and financial appraisals, structure, construct, execute, maintain, manage and operate the projects envisaged under Smart City Proposal (SCP) of Nagpur Municipal Corporation (NMC) approved by the Central Government under the Smart Cities Mission. The city has chosen for itself formula of “e3i”, where the three “E” stands for making it an eco-friendly, edu-city, electronically connected city while “I” is chosen to make it inclusive. The Nagpur Smart and Sustainable City Development Corporation Limited (NSSCDCL) is responsible for driving the implementation of the smart city projects in the city.

NSSCDCL's sustainability policy is committed to:[9]

- Improve the lives by transforming India's heart Nagpur into SMART & SUSTAINABLE CITY
- Promote mixed land use in area based developments— planning for unplanned areas' containing a range of compatible activities and land uses
- Apply Smart Solutions to infrastructure and services in area-based development in order to make them better
- Housing and Inclusiveness - expand housing opportunities for all
- Create walkable localities - reduce congestion, air pollution and resource depletion
- Preserve and develop open spaces-parks, playgrounds, and recreational spaces in order to enhance the quality of life of citizens
- Promote a variety of transport options - Transit Oriented Development (TOD), public transport and last mile para-transport connectivity
- Making governance citizen-friendly and cost effective
- Maintain achieve continual improvement while following all applicable statutory & regulatory requirements.

The assessment of the city vision, perceived by the NMC and the NSSCDCL, highlights the key priority areas that should be addressed in order to achieve holistic development in the city. These priorities can be further categorized in the form of actions and/or policy interventions. The sectors/themes identified from the combined city vision would further guide us towards planning various interventions in order to mainstream climate change in Nagpur and aligning the city's climate action to align with the goal of 1.5°C.

[7] Regional Meteorological Centre. (2011). Climate of Nagpur.

[8] https://www.nmcnagpur.gov.in/mission_statement1539777979

[9] <https://nsscdcl.org/documents/Policy/Sustainable%20Policy%20Certificate.pdf>

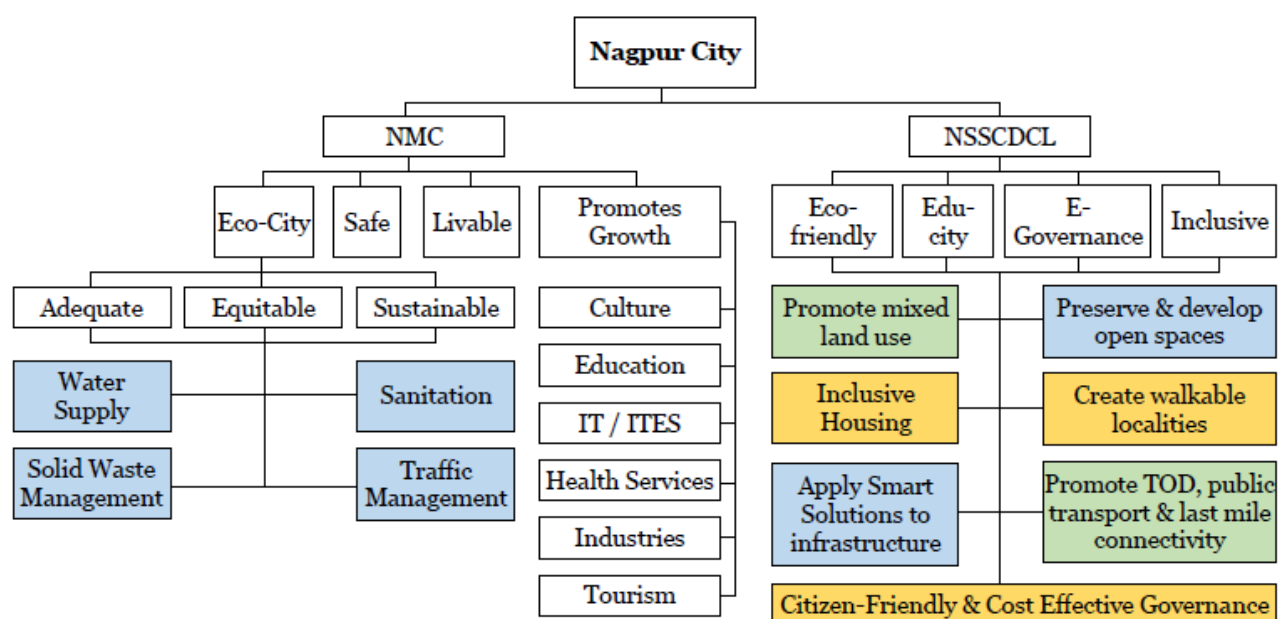


Figure 1: Combined vision of NMC and NSSCDCL for the city's development.

2. MISSIONS/SCHEMES AND PLANS IN NAGPUR

Several missions and schemes of the Government of India are being implemented in Nagpur with an impact on the overall development of the urban areas. In addition, the city has initiated several actions and plans to provide better services to its citizens. These programmes/schemes/missions and initiatives cover the key sectors such as energy, transport, buildings, waste and water. In addition to addressing the development needs of the city, most of these actions and plans also have climate mitigation, resilience and environmental co-benefits. This section provides a snapshot of some of the key initiatives (both national and local) being implemented or planned across different sectors.

2.1 NATIONAL MISSIONS / SCHEMES IMPLEMENTED

The ongoing national-level missions/schemes in Nagpur have been mapped along with their relevant sectors covered under the city's limits. Most of the missions/schemes related to urban development, have focused primarily on the sectors like Energy, Buildings, Mobility, Water & Sanitation and Waste. Green Cover & Biodiversity has witnessed lesser focus despite having the potential for climate mitigation and resilience, as well as co-benefits of addressing local environmental issues such as air pollution.

Table 1: Ongoing Missions/Schemes in Nagpur

Schemes	Sectors Covered								Relevant Sectors
	Energy	Buildings	Transport	Water & Sanitation	Waste	Urban Planning	Green Cover & Bio-diversity	Industry	
SBM-U				✓	✓				2
PMAY (U)		✓		✓		✓			3
NCAP	✓		✓			✓	✓	✓	5
PMUY	✓								1
Make in India								✓	1
Digital India								✓	1
Total Schemes	2	2	1	2	1	1	0	3	

SBM-U: Swachh Bharat Mission - Urban , PMAY (U): Pradhan Mantri Awas Yojana (Urban), NCAP: National Clean Air Programme, PMUY: Pradhan Mantri Ujjwala Yojana

2.2 PROJECTS UNDER SMART CITIES MISSION

Key projects under the NSSCDCL:

- About 1256 e-rickshaws, 5 e-Buses, about 200 e-Cars, and 50 CNG buses are introduced to reduce the emissions from traditional diesel-based local transportation vehicles. In addition, the city is set to procure 40 Electric Buses Under FAME and the RTO is giving tax exemptions to e-vehicles.
- In the area based development (ABD) area, ICT based solid waste management system for efficient solid waste management will be incorporated. Home composting and segregation of waste at the source is being encouraged.
- In the ABD area, rain water harvesting system will be incorporated in all the construction projects to improve ground water level.
- In the ABD area, rain water harvesting system will be incorporated in all the construction projects to improve ground water level.
- In the ABD area, green spaces will be developed and local or adaptive species will be planted to maintain local biodiversity.
- All the streetlights are being replaced by energy-efficient LED. Full moon day is celebrated in the city by switching off unessential lights at a particular location in the city.
- NMC initiated a 15-day campaign focussed on cleaning of the Nag river (de-silting of some of the important stretches). NMC has already prepared a rejuvenation plan for all the water bodies and will implement it under state and central funded programmes.

The Smart City projects in Nagpur have a strong focus on the transport sector. Additional focus on waste related projects may be recommended in the smart city ABD area (along with the initiatives under SBM) since both transport & waste sector contribute significantly to the city's GHG emissions.

Table 2: Projects undertaken by Nagpur Smart and Sustainable City Development Corporation Limited (NSSCDCL)

Projects	Sectors Covered								Relevant Sectors
	Energy	Buildings	Transport	Water & Sanitation	Waste	Urban Planning	Green Cover & Bio-diversity	Industry	
Suyojit Pardi-Bharatwada-Punapur (Town Planning Scheme)		✓	✓			✓	✓		4
Building Efficiency Accelerator (BEA)	✓	✓				✓			3
Urban-LEDS II[SC1]	✓		✓	✓	✓	✓			5
Design and construction of Roads, Bridges, Culverts, Sidewalks, MEP works on TenderSURE Concept for ABD area			✓						1
MOVE PEOPLE Initiative (E-Buses) ^a	✓		✓						2
Smart Bus Shelters			✓						1
Share a Bike			✓						1
E-Rickshaws ^a	✓		✓						1
Automated MLCP at Pardi			✓						1
Home Sweet Home (Improved living conditions for the urban poor)		✓				✓			2
Shikshat & Niramay Pardi Bharatwada & Punapur (School & Hospital in ABD area)		✓				✓			2
Kaushal PBP area (Skill Development Centre)								✓	1
Public Market Place						✓			1
Public Gardens and Landscaping ^d						✓	✓		2
Zero Garbage Society ^b					✓				1
Smart Trash Bins ^b					✓				1
Project Green Light							✓		1
Rainwater Harvesting ^c				✓					1
Project "Attractive Public Realm" and public art installation						✓			1

2.3 CLIMATE RESILIENCE INITIATIVES IN NAGPUR

The climate of Nagpur city is characterized by hot summers and is located in the arid zone. As per City Development Plan for Nagpur – 2041, the following figure shows the various parameters that constitutes Nagpur's climate & disaster resilience index.[10]

The resilience index shows that the city is characterized by strong physical (good condition of roads, access & availability of electricity, and water) and social resilience (capable and prepared health facilities, good social capital and cohesion) to climate-related disasters.

The institutions are in good shape and mostly prepared for such events. The economic resilience could be improved by increasing income through the availability of more employment, especially targeting the youth. Existing environmental policies are expected to protect the city from potential harm of striking hazards and may improve the current quality of the ecosystem. Nagpur is currently conducting the city's Climate Vulnerability Assessment, which would contribute towards the preparation of City Resilient Climate Action Plan (including Adaptation and Mitigation strategies).

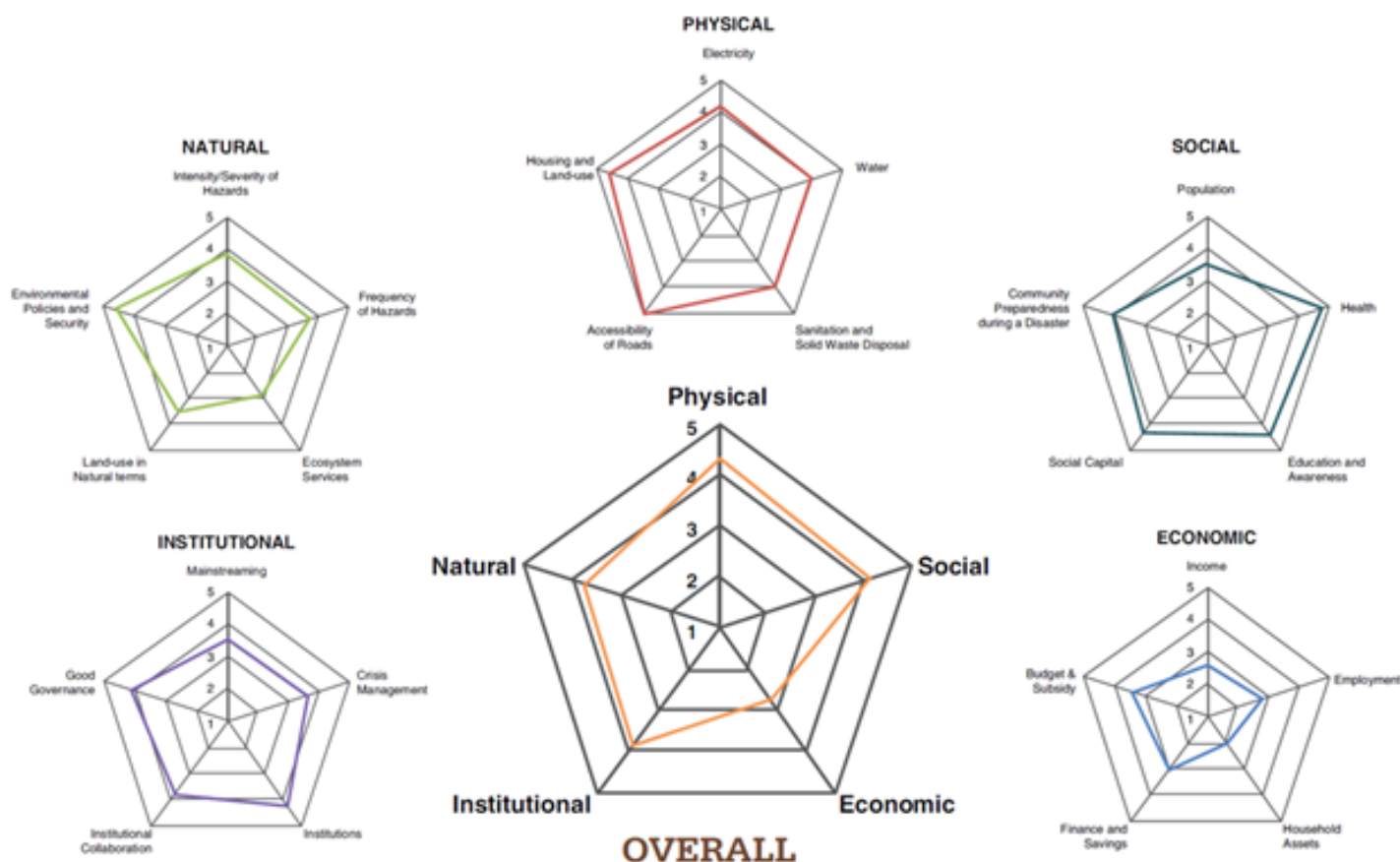


Figure 2: Climate and disaster resilience index for Nagpur

[10]Report, F. (2015). City Development Plan for Nagpur, 2041 Ministry of Urban Development , Government of India Capacity Building for Urban Development. 2041(March).

RESILIENCE INITIATIVES IN NAGPUR (AS PER CITY DEVELOPMENT PLAN)

Under the Jawaharlal Nehru National Urban Renewal Mission (JNNURM), NMC had undertaken several initiatives, which had environmental co-benefits. In addition, several climate resilience initiatives were also undertaken in partnership with NSSCDCL.

WATER SECURITY



1. 24 x 7 water supply, water audit and water monitoring cell
2. Diversifying water supply (including new sources): New bore wells in the city are being dug to match the requirement of water. 303 bore wells were dug until 2019, and the target of 347 is likely to be achieved in 2020
3. NMC will clean 755 public wells for use, of which about 502 public wells were cleaned in 2019
4. Rejuvenation of lakes: NMC's master plan for rejuvenation of water bodies also focuses on the city's lakes, which are considered as the heritage of the city. Rejuvenation project for 2 lakes is under implementation. It will ensure recharge of the water table, control the surface temperature of areas near the water bodies and to some extent preserve bio-diversity.

1. Earlier only 28 percent of the sewage generated in the city was treated and the rest was discharged into the city rivers leading to Gosikhud dam resulting in contamination of water bodies. Now about 340 MLD of sewerage water is treated every day at four Sewerage Treatment Plants (STPs) of capacity 130 MLD, 200 MLD, 5 MLD and 5 MLD, respectively. Out of this recycled water, 130 MLD treated water is being sold to Mahagenco, a thermal electricity generation company, reducing the requirement of fresh water. For this Mahagenco pays Rs. 15 Crores to NMC per year.
2. Recycle and reuse of wastewater.

WASTE WATER



WASTE MANAGEMENT



1. Covering of the old dumping sites and treatment and recycling of the solid waste: In order to prevent emissions from the existing waste management practices, old dumping yard was scientifically closed as per the MSW Rules, 2000.
2. NMC is treating majority of the waste on a daily basis for recycle and reuse.

3. ALIGNING WITH 1.5°C TARGET

The Paris Agreement was signed by nearly 200 nations in a joint commitment to reduce GHG emissions in order to check the increase in the global average temperature to well below 2°C above pre-industrial levels, and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels. In order to support these objectives, the One Planet City Challenge – WWF’s global platform for cities has been redesigned to provide guidance towards achieving this goal. The OPCC framework evaluates cities based on publicly available climate data, voluntarily reported through CDP and ICLEI’s Unified Reporting System. The key components of the framework are aggregated under the dimensions of Vision, which represents Political Commitments, Emissions Reporting and Mitigation & Adaptation Targets; and Impact, which represents Climate Risk Assessment, Mitigation Actions and Adaptation Actions. The framework tests whether mitigation actions align with the main emissions sectors and whether adaptation actions map effectively to the climate risks. Furthermore, the framework reviews the quality & co-benefits of the schemes/projects/actions in relation to their ability to catalyze long-term action or change.

OPCC’s approach for science-based target setting internalizes the latest findings of IPCC SR1.5. The latest IPCC evidence suggests that the most effective approach for achieving targets is to focus on setting the direction of emissions reductions by defining a clear end goal and interim target. For this reason, the OPCC encourages cities to have a mid-term (against the baseline target of 2018) and a long-term target for Scope 1 and 2 emissions:

- 2030: Reduce per capita emissions in-line with a global reduction of 50%,
- 2050: Reduce total emissions to Net-Zero.

The OPCC stretches city ambitions and builds in an additional layer of equity using the Human Development Index (HDI), which allows cities to reduce per capita emissions at different rates. HDI is a composite index that ranks nations based on several national development metrics like life expectancy, education, per capita income etc.[11]

As a result, forecasted 2030 target ranges between 25-65 percent reductions depending on development levels as

determined by the HDI of the nation. The emission reduction targets derived by aggregating the HDI with the population leads to 50 percent global emissions reduction by 2030.

- Clear commitment to tackle the effects of climate change, including the backing of the mayor or council, and dedicated resources for climate action;
- Evidence-based action planning that shows engagement with a broad set of stakeholders, capacity to implement plans, and integrating them in future decision-making.[12]

3.1 OPCC EVALUATION OF NAGPUR’S PLANS & ACTIONS

After evaluating Nagpur on the above-mentioned aspects, it was observed that it scored well on strong political commitments, comprehensive risk/vulnerability assessment, strong adaptation actions, and emissions reporting. However, Nagpur did not define targets for emission reduction, which is crucial for aligning with 1.5°C goal. Although Nagpur has specific initiatives, towards the decarbonisation of its energy systems, the reporting lacked tangible commitments towards energy efficiency targets. Similarly, Nagpur has also not reported any targets for climate adaptation despite having an existing assessment of future risks/hazards (as per CDP 2041). Hence, the city was not found to be aligned with the goal of 1.5 °C yet.

In order to facilitate the city towards achieving this goal, the initial step would be to set the mid-term and long-term targets for emissions reductions, which would be further supported by holistic mitigation actions based on the sector-wise trend of city’s emissions inventory. The alignment with the 1.5 °C goal would be further enhanced by setting targets for climate adaptation, which would enable the cities to tackle future climate risks.

3.2 EMISSIONS REDUCTION TARGET SETTING, BASED ON OPCC METHOD

It is important to set a mid-term target for per capita emission reduction by 2030. The first step for calculating the emission reduction target involves the creation of an annual population series, which would indicate the projected population for the years 2018, 2030 and 2050. As per the population series of Nagpur, the projected

[12] One Planet City Challenge Candidates Booklet - Guidance for local government representatives on WWF’s 2019-2020

population for 2018, 2030 and 2050 are 2,805,700, 3,523,300 and 4,995,950, respectively (Annexure A.3). The total GHG emission for Nagpur city in the year 2017-18 stands at 2.85 million tonnes of CO₂ equivalent (tCO₂e) which translates to a per capita emission of 1.02 tCO₂e. In order to derive the required per capita emissions for the year 2030, it is crucial to equate it with the HDI reduction factor, which is 44 percent in case of Nagpur. Since the city does not have a per capita target for 2030, science-based 2030 emissions were calculated as per the projected population of 2030, adjusted as per the HDI reduction factor. Therefore, Nagpur should reduce the per capita emissions to the interim goal of 0.57 tCO₂e/capita by 2030, in order to align with the 1.5°C goal.

3.3 ALIGNMENT WITH 1.5°C TARGET

The SR1.5 recognizes cities as one of four critical global systems that can accelerate and upscale climate action but the alignment with the 1.5°C goal will further require the major holistic transitions in how both mitigation and adaptation are undertaken for i) Energy Systems, ii) Urban & Infrastructure Systems, iii) Industrial Systems and iv) Land & Ecosystems.

In order to ensure smooth transition to low carbon development, the mitigation pathways should focus on the four priority sectors: [13]

- **BUILDINGS (Urban & Infrastructure Systems Transitions)** : Along with being responsible for over a third of global energy consumption, they also possess large energy saving potential, e.g. Efficient buildings and compact urban planning including the optimization of energy efficiency in buildings and appliances
- **ENERGY (Energy Systems Transitions)**: Since energy consumption goes well beyond buildings, focus should be towards decline of carbon intensity of electricity and increase in electrification of energy use, e.g. Sustainable energy use and clean energy supply including the decarbonisation of the electricity grid, and promoting renewable energy
- **MOBILITY (Urban & Infrastructure Systems Transitions)**: Such initiatives along with reducing the carbon intensity of transit systems would also reduce

air pollution, congestion and road fatalities, and improve health, e.g. Low-carbon urban transportation including electric vehicles, better public transport and local shared mobility, and non-motorized transport

- **WASTE (Land & Ecosystems Transitions)** : Increased rates of recycling and the substitution/reduction of high-carbon or organic items could further reduce individual carbon footprint, e.g. Efficient waste management and reduced food wastage
- **OTHERS**: Few of the above initiatives may lead to decrease in ecosystem services, hence there should be additional measures should also be undertaken, e.g. Ecosystem restoration, Nature-based solutions, sustainable land use and urban planning (including policies, technology standards, efficiency regulations etc.), use of ICT/ IoT/ AI for emission reduction

Besides strengthening the mitigation options, the alignment with the 1.5 °C goal further depends on the enhancement of both adaptive capacity and resilience.[13] For ensuring enhanced adaptive capacity/ resilience, actions should reduce exposure to climate risks through the use of local knowledge, climate projections, and an understanding of vulnerabilities based on social, cultural, political and economic factors. The following actions may be undertaken in order to enhance adaptive capacity:

- **DISASTER RISK MANAGEMENT (DRM)**: Efficient and integrated climate action planning, including risk and vulnerabilities assessment (Ecosystem-based Adaptation);
- **EDUCATION AND LEARNING**: Involvement, Collaboration & Co-ordination between all stakeholders including government, academia, CSOs/NGOs, and Industry for sharing risk and vulnerabilities data research and evidence-based decision-making.
- **RISK SHARING**: Mainstreaming and embedding climate risk in all infrastructure, budget and urban planning decisions.
- **INDIGENOUS KNOWLEDGE & DISASTER RISK MANAGEMENT (DRM)**: Nature based solutions such as enhancing green infrastructure, increase green cover and conserving biodiversity, use of natural systems to sequester carbon, manage water, and reduce urban heat island effect.

[13] Global Covenant of Mayors - Summary for Urban Policymakers – What the IPCC Special Report on 1.5C Means for Cities.

4. STRATEGIES & RECOMMENDED ACTIONS

There are multiple approaches for sustaining climate action in cities, which are generally based on various frameworks and indices. While some frameworks are designed in accordance to sectors or thematic areas, others are based on the indicators of resilient city like exposure, sensitivity, adaptive capacity. In order to align the city with the goal of limiting global warming below 1.5°C, the focus should be on strategically aligning the recommendations (including both mitigation & adaptation), with the sector-wise trend of GHG emissions.

An assessment of Nagpur's GHG emission inventory (baseline year 2017-2018), prepared under the Urban-LEDS II program, shows that buildings (including residential, and commercial & institutional) are predominant source of emission in the city, with a total share of 61 percent, an obvious corollary due to its highest share in energy consumption within the city. The residential settlements along with commercial and institutional sector cover more area than other sectors like manufacturing/industrial sectors and energy-intensive industries that are situated outside NMC's jurisdiction area. Transportation sector is the second highest contributor to GHG emissions in the city with an 18 percent share followed by emissions from the waste sector at 17 percent.

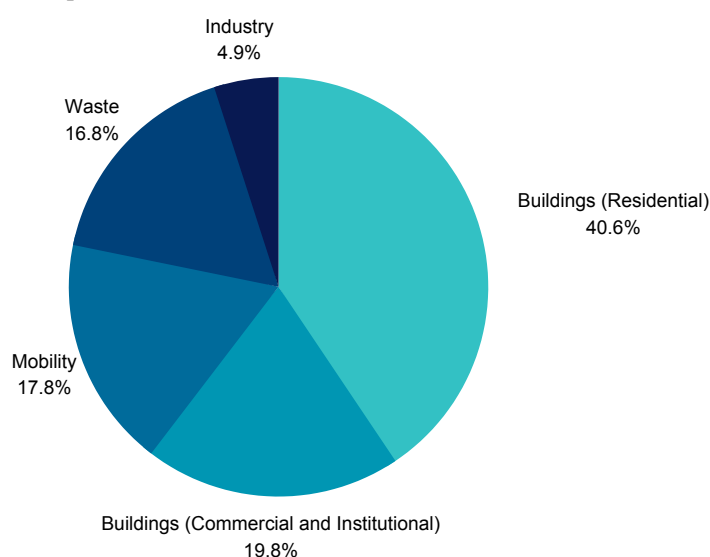


Figure 3: Sector-wise Trend of GHG Emission in tCO₂e for 2017-18

Based on the sector-wise GHG emission trend, the proposed prioritisation of sectors for mitigation action should be buildings (energy), followed by transport, waste, and industry. Even within the buildings sector, the priority should be towards emission reduction in residential buildings, through initiatives based on the uptake of renewable energy and energy efficiency.

The formulation of adaptation actions should address potential hazards and changes in their frequency and impact in near future. Since extreme hot temperatures leading to heat waves and droughts are the most potent hazards for Nagpur currently, the adaptation targets & actions should focus on these, along with the wider goal of achieving city-wide resilience.

The feasibility of mitigation and adaptation actions defined in SR1.5 (Refer Annexure A.7) across the dimensions of economic, technological, institutional, socio-cultural, environmental/ecological, and geophysical, were referred to recommend actions for Nagpur.

Further, to guide Nagpur towards achieving required emission reductions by 2030, a predictive analysis was applied to identify priority opportunities for mitigation action. This was based on C40 & McKinsey predictive analysis of six city typologies for climate action. Following this approach, Nagpur was assigned a specific action pathway in coherence with its GDP per capita, population and emissions inventory information. As a result, the analysis identified a set of key opportunities for Nagpur, based on emissions reduction potential. [15]

The GDP of Nagpur in 2018 was USD 16.9 billion and the population in 2018 was estimated to be 2,805,700. Therefore, the GDP per capita for Nagpur in 2018 is estimated to be USD 6,045. As per the 2030 emission city typology, based on the per capita GDP and population, a city like Nagpur with the GDP per capita in the range of USD 4,500 to 11,000 falls in the category of Low Income Megacity (Refer Annexure A.4).



The priority opportunities for Low Income Mega City, based on their emission reduction potential are: Distributed renewables (40%), Ultra high-efficiency new building standards (22%), Next-generation vehicles (15%), Mass transit, walking and cycling infrastructure (14%), Transit-oriented development (13%) (Refer Annexure A.5).

By undertaking these priority actions at the city level, Nagpur would be closer to achieving the 2030 target of

reducing the emissions to half and would be aligned to the trajectory of Net-Zero Emissions by 2050.

In terms of adaptation actions, since Nagpur reported heat wave and drought as the main hazards at the city-level, the top five most common actions, which were identified by the OPCC Assessment Framework for each climate hazard are as follows:

Table 4: Identified hazards and potential adaptation actions

 Heat Wave	 Drought
<ul style="list-style-type: none"> • Heat mapping and thermal imaging • Tree planting and/or creation of green spaces • Projects and policies targeted at those most vulnerable • Cooling centers, pools, water parks/plazas • Incorporating climate change into long-term planning 	<ul style="list-style-type: none"> • Water use restrictions and standards • Community engagement/education • Awareness on reducing water use • Diversification of water supply • Tree planting and/or creation of green space

In this section, the actions and initiatives that would support Nagpur in the enhancement of climate action in line with 1.5°C goals, and better alignment with the national climate agenda will be explained.

4.1 MITIGATION ACTIONS



Actions marked in cyan are in progress in Nagpur, and require scaling up in future



Actions marked in white - As prescribed by the SR1.5, to be undertaken in order to align with 1.5°C goal

Table 5: Selected mitigation actions for Nagpur to align with the target of 1.5°C

SYSTEM	SECTOR	1.5°C ALIGNMENT ^[16] ACTION	OPCC (Annex. 1)	NDC ALIGNMENT (Annex. 8)	SAPCC ALIGNMENT (Annex. 9)	CSCAF ALIGNMENT (Annex. 10)	ALIGNMENT WITH SCHEMES
Energy System Transitions	Energy	Renewable Energy - Solar PV- Decarbonization of the electricity grid	OPCC2	NDC-4	ENERGY-1 / ENERGY-2	ENERGY-2	JNNSM
Energy System Transitions	Energy	Strengthened energy governance & Urban Smart Grids		NDC-3 / NDC-4	ENERGY-1 / ENERGY-3 / ENERGY-4	ENERGY-1	JNNSM
Urban & Infra Structure System Transitions	Buildings	Building Retrofit Incentives (Residential, Institutional & Commercial)	OPCC6	NDC-3	ENERGY-5	ENERGY-5,6	NMEEE
Urban & Infra Structure System Transitions	Buildings	Energy efficiency improvements in technical installations	OPCC 2,3	NDC-3	ENERGY-5	ENERGY-4	SEEP
Urban & Infra Structure System Transitions	Buildings	Efficient heating and cooling through improved building design		NDC-3 / NDC-1	ENERGY-5	ENERGY-5,6	SCM
Urban & Infra Structure System Transitions	Buildings	Efficient equipment, lighting and appliances	OPCC 2,3	NDC-3	ENERGY-5	ENERGY-4	SEEP
Urban & Infra Structure System Transitions	Buildings	Establishing Building Energy Codes (new & existing)		NDC-3 / NDC-1	INFRA-3	ENERGY-5 / ENERGY-6	NMEEE
Urban & Infra Structure System Transitions	Transport	Providing incentives for uptake of improved fuel efficiency vehicles & phasing out of fossil fuel passenger vehicle by 2035–2050				MOBILITY-1/4	

[16] IPCC, 2018: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press.

Urban & Infra Structure System Transitions	Transport	Enable modal shifts		NDC-3	UD-7	MOBILITY-3	AMRUT/SCM
Urban & Infra Structure System Transitions	Transport	Faster Electrification of all modes of transport	OPCC 1	NDC-3	UD-7	MOBILITY-2/ MOBILITY-1	FAME
Urban & Infra Structure System Transitions	Transport	Low-emissions Transit Zones & Corridors & Mass Transit Systems	OPCC 1	NDC-3	UD-7	MOBILITY-1/3	SCM
Urban & Infra Structure System Transitions	Transport	Operational NMT Modes (Bike-share schemes Pedestrianization)		NDC-3	UD-7	MOBILITY-3	SCM
Urban & Infra Structure System Transitions	Urban Planning	Accelerate slum upgrading by new approaches and technologies		NDC-1	INFRA-1		PMAY(U)
Urban & Infra Structure System Transitions	Urban Planning	Changes in urban design that encourage NMT and facilitate TOD		NDC-2 / NDC-3	UD-7	MOBILITY-3	SCM
Urban & Infra Structure System Transitions	Waste	Improved recyclables collection & Circular economy programme	OPCC 7	NDC-2 / NDC-3	UD-8	WASTE-1	SBM(U)
Urban & Infra Structure System Transitions	Waste	Education & awareness programmes for source segregation/ better consumption/ household composting	OPCC 7	NDC-1	UD-8	WASTE-1	SBM(U)
Urban & Infra Structure System Transitions	Waste	Waste management system cost monitoring		NDC-7	UD-8	WASTE-1 / WASTE-4	SBM(U)

Urban & Infra Structure System Transitions	Waste	Dumpsite Closure / Landfill Management		NDC-3	UD-8	WASTE-5 / WASTE-6	SBM(U)
Land & Ecosystem Transitions	Urban Planning	Monitoring and management of urban trees		NDC-3	UD-8	URBAN-1/2/3	SBM(U)

Proposed actions in the building sector are focused on energy governance & smart grids, retrofitting for old buildings, energy efficiency measures in buildings & equipments, improved heating, cooling & lighting along with strengthening building codes & standards. The transport sector needs to focus on phasing out fossil-fuel powered vehicles and mainstreaming electric vehicles along with encouraging better transportation planning and non-motorized modes of transport. The actions related to the waste sector should focus on awareness, facilitating circular economy and better waste management practices in and outside the city limits including closure of dumpsites.

4.2 ADAPTATION ACTIONS



Actions marked in cyan are in progress in Nagpur, and require scaling up in future



Actions marked in white - As prescribed by the SR1.5, to be undertaken in order to align with 1.5°C goal

Table 6: Selected adaptation action for Nagpur to align with the target of 1.5°C

SYSTEM	SECTOR	1.5°C ALIGNMENT ^[17] ACTION	OPCC (Annex. 1)	NDC ALIGNMENT (Annex. 8)	SAPCC ALIGNMENT (Annex. 9)	CSCAF ALIGNMENT (Annex. 10)	ALIGNMENT WITH SCHEMES
Urban & Infrastructure System Transitions	Drought	Drought early warning systems		NDC-6	DRM-3	URBAN-4/5	
Urban & Infrastructure System Transitions	Urban Planning	Mainstreaming climate risk in infrastructure, budget and urban planning decision-making	OPCC 12	NDC-6	DRM-1 / DRM-2	URBAN-4/5	SCM (CSCAF)
Urban & Infrastructure System Transitions	Urban Planning / Green Cover & Bio-Diversity	Green Infrastructure and Ecosystem-based adaptation: Use of natural systems to sequester carbon in areas, manage water, and reduce the urban heat island effect	OPCC 9, 10	NDC-5 / NDC-6	DRM-5 / FOREST-1	URBAN-1,2,3	
Land & Ecosystem Transitions							

[17] IPCC, 2018: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press.

		Collaboration & co-ordination between stakeholders for sharing risk and vulnerabilities data, research		NDC-8	DRM-4		
		Citizen engagement / behavior change programmes related to climate change		NDC-1	DRM-4		
		Membership in climate networks, (local, national and transnational)			DRM-4		

As Nagpur has already undertaken some major initiatives to counter the present hazards in the city, the adaptation actions for aligning city goals with the 1.5°C target have been designed in terms of the future hazards, which the city may face due to the changing climatic condition and associated anthropogenic activities. The actions focus on better early warning systems, as well as mainstreaming climate risk and ecosystem-based adaptation practices in city infrastructure development. The alignment of city-goals with the 1.5°C target also depend heavily on the collaboration and coordination between multi-stakeholder groups in order to have better synergy for identifying opportunities to support long terms climate goals.

5. SUMMARY & CONCLUSION

Cities are envisioned as nodes of climate action due to their significant contribution to GHG emissions, and energy consumption. Cities are also vulnerable to several climate risks and hazards. Therefore, cities have a pivotal role in addressing climate change as mitigation solution providers, as well as in terms of building climate resilience. India, as a nation, has made multiple commitments towards addressing climate change and achieving sustainable development. While there are multiple initiatives at the national & sub-national level, cities can also have their own apportionment at the local level towards delivering these commitments. City level plans like Development plans/Masterplans, and central government missions like AMRUT, SBM(U), Smart Cities Mission, PMAY(U) etc., can provide direction and support to cities in mainstreaming climate action.

IPCC research highlights the urgency of limiting global warming to 1.5°C compared with 2°C, since the latter would have a more adverse impact on ecosystems, human health and well-being. Cities can play an important role in achieving the target of limiting global warming to 1.5°C by aiming for net-zero emissions in the year 2050. This calls for equitable climate action, based on the sectors emphasized by the city's emission inventory. In order to further align with the target of limiting global warming to 1.5°C, cities should demonstrate science-based emission reductions, which can be achieved by planned mitigation actions.

There are multiple ways or methodologies for a city to align its emission reduction with the trajectory of limiting global warming to 1.5°C. IPCC SR1.5 lays down the detailed assessments towards aligning with the 1.5°C target.

WWF's One Planet City Challenge (OPCC) has been inspiring cities to raise their commitments towards climate goals along with enabling a smooth transition towards a sustainable future by supporting cities through various initiatives. The OPCC encourages cities to have a mid-term and a long-term target for the reduction of Scope 1 and 2 emissions. Cities are encouraged to reduce their per capita emissions in-line with a global reduction of 50% by the year 2030, and total emissions to net-zero by 2050.

In order to ensure equity, the required emission reduction factor is adjusted as per the national HDI, which forms the basis of mitigation targets.

This study is an attempt to analyze the alignment of Nagpur with the 1.5°C goal using the OPCC evaluation methodology. It further assesses the climate actions (mitigation and adaptation) undertaken by the city and emphasized that Nagpur will not achieve the 1.5°C goal with its current portfolio of climate actions and targets. Therefore in order to mainstream climate action in the city, recommendations have been provided for further alignment with the 1.5°C goal, the NDCs, SAPCC & ClimateSmart City Assessment Framework.

Nagpur, an OPCC finalist city in 2019-20 was selected for the study based on factors such as availability of GHG emissions inventory, existing sustainability initiatives in urban sectors like energy, transport, waste etc., and the overall intent demonstrated by the city towards holistic and climate smart growth.

It was estimated that Nagpur should reduce the per capita emissions to the interim goal of 0.57 tCO_{2e}/capita by 2030, in order to align with the 1.5 °C target. Along with transitioning to low carbon development, the city should also increase its adaptive capacity. As per IPCC SR1.5 report, the key mitigation pathways of focus are energy, buildings, mobility, and waste. The sector-wise trend of Nagpur's GHG emission inventory suggests that the largest source of emissions is the buildings sector, followed by mobility and waste. The mitigation actions to be undertaken in the city should be commensurate to sector-wise weightage of emissions. The city has also highlighted heat waves and drought as main climate hazards, to be addressed in order to build resilience.

After assessing the state of climate action in Nagpur, as per various missions, schemes and programmes and supported by evidence-based climate action planning, selective recommendations in terms of mitigation and adaptation were made for Nagpur. For mitigation, in addition to existing actions like solar PV, energy efficient lighting and

appliances, electrification of transport, and promotion of NMT, strengthened energy governance & urban smart grids, incentives for building retrofits, energy efficient heating and cooling, slum upgradation, encouragement of NMT through urban design, landfill management etc. were emphasized. The city has already highlighted the climate risk on infrastructure and decision-making, so the additional suggestions for enhancing resilience include early warning systems for identified hazards, green infrastructure and ecosystem-based adaptation, citizen engagement/behavior change programmes etc.

To conclude, this paper outlines the actions, which are important for the city of Nagpur in order to align with the 1.5°C target, in a manner that it coincides with the existing efforts of the policymakers and implementing bodies. Providing such recommendations increases the chances of better uptake among the desired stakeholders, which would enable them to plan urban development initiatives, which also have strong climate-co-benefits. Hence, the paper attempts to propose a convergence of urban planning & management with evidence-based climate action planning.

6. CALL FOR ACTION

WHY SHOULD WE ACT?

Tackling climate change is not a one-time activity, but a continuous effort towards a better world. In order to minimize the adverse impacts of climate change, we must limit global warming to 1.5°C. The process of achieving this target depends on multiple system transitions like energy, urban & infrastructure, land & ecosystem and industrial system transitions, among which urban & infrastructure plays a crucial role. There are no possible trajectories towards the 1.5°C, which do not involve local climate action in cities. Hence, it is crucial for cities to act immediately on the climate crisis. Since cities are expanding rapidly, a sustainable form of urban development also has the potential of huge economic savings due to the lesser energy consumption. The climate actions undertaken in cities also have strong health and wellbeing co-benefits, which are crucial towards ensuring lesser vulnerability towards future health hazards.

THE RACE WITH TIME

The 2018 IPCC Special Report on 1.5°C (SR 1.5) has asserted the fact that in order to limit global warming to 1.5°C, all the cities must be carbon-neutral by the year 2050. In order to have net-zero emissions by 2050, cities must form science-based emissions reduction targets, which are supported by evidence-based climate action planning. As per the IPCC framework, for a city, to achieve net-zero emissions in 2050, their per capita emissions should be reduced to half in 2030. Since we just have a decade to reduce our per capita emissions to half, cities should display robustness towards undertaking drastic but planned mitigation actions. In addition, it has been predicted that the intensity of climate-induced risks will increase in the coming decade, therefore the cities should also plan for actions to build adaptive capacity/resilience. Through the case study of one Indian city, the paper recommends immediate actions, which cities may undertake in the present scenario in order to ensure a smoother transition towards low-carbon, climate-resilient development.

SYNERGY BETWEEN STAKEHOLDERS

As the recommended climate actions directly align with various goals at national & sub-national level along with ongoing missions/schemes, this calls for wider cooperation and collaboration between various government departments and associated stakeholders. While the government departments are expected to amalgamate the recommendations with their ongoing initiatives or revisit the present initiatives towards climate-proofing, they should also be further supported by stakeholders from academia, corporates and civil society organizations. Since the key to limiting global warming to 1.5°C relies on the per capita emissions, hence every individual and household should play their role in achieving common climate goals. As residential consumption of energy is one of the largest sources of emissions in cities, it can be well tackled through household-level climate actions. Initiatives like opting for energy-efficient lighting & appliances, installation of solar PV systems, reducing & segregating waste, switching to low-carbon mobility, rainwater harvesting and plantation of trees at an individual level can pave the way for low-carbon, climate-resilient city.

7. ANNEXURES

A.1 Ongoing Projects / Actions listed by NMC for WWF's One Planet City Challenge (OPCC) 2019-20

Table 7: Actions reported by Nagpur for OPCC 2019-20

#	Sector	Initiatives	Brief details	Mission/Scheme covered
1	Transport	Cleaner Fuel	<ul style="list-style-type: none"> Promotion of CNG buses and production of CNG from waste is also encouraged E-Rickshaw use promoted and encouraged in the city There are about 1256 e-rickshaws and 50 CNG buses already running in the city. Nagpur is adopting Metro for local transportation 	<ul style="list-style-type: none"> SCM JNNURM FAME AMRUT
2	Energy (Buildings)	Installation of Rooftop Solar PV systems on NMC owned public buildings and LED lights in public buildings.	<ul style="list-style-type: none"> Estimated emissions reduction (metric tonnes CO₂e): 68985, Energy savings (MWh): 68985, renewable energy production (MWh): 68985. Nagpur was the first model solar city and has implemented projects with MNRE's support. 42 MW solar PV (SPV) systems will be installed every location where conventional energy is being consumed which includes streetlights, office buildings, hospitals, schools, water pumping stations, sewage treatment plants etc. 68985000 units /annum will be generated. Potential of over 27 MW of roof top solar system identified in government buildings. 3000 solar water heaters have been provided by NMC to citizens @50% subsidy which in turn have transferred the load of 9000 kW from conventional to non-conventional energy. NMC is also promoting wind-solar hybrids. Installation of solar panels in the Smart City's Area Based Development (ABD) region (affordable housing, public marketplaces, multilevel car parking etc.). Solar-based electric vehicle recharging station has also been started in Nagpur City. 	<ul style="list-style-type: none"> SCM JNNSM
		Installation of LED streetlights , energy efficient ceiling fans	<ul style="list-style-type: none"> Adopting energy efficient measures for lighting buildings and housing. 1,20,000 conventional streetlights and 8000 conventional lights in office buildings have been replaced by LED lights Ensuring 70 percent energy savings and reduction of 49950 T of carbon emissions. Ceiling fans in office buildings have been replaced with energy efficient ones. Setting up dedicated Energy saving cell to guide energy projects Installation of Energy efficient LED lights and fans in Nagpur smart city in ABD area 	<ul style="list-style-type: none"> SCM National Programme for LED-based Home and Street Lighting

#	Sector	Initiatives	Brief details	Mission/Scheme covered
		Public Awareness and Capacity Building	<ul style="list-style-type: none"> Energy saving through public awareness is being promoted through a unique programme called the Full Moon Day celebration. Every full moon, streetlights and unessential lights in different areas are switched off from 8.30 pm to 9.30 pm. This is a monthly ongoing activity and a total of 1,59,141.96 units were saved till February 2019. 	
		Tax Benefit on Solar /Renewable Energy	<ul style="list-style-type: none"> NMC provides an exemption of 5 percent on general tax for installing solar rooftop or solar water heater in homes. 	<ul style="list-style-type: none"> SCM
3	Buildings	Green Buildings	<ul style="list-style-type: none"> Green Building concept will be incorporated in projects like affordable housing, schools, hospitals etc. in ABD area Prepared guideline for Energy Efficient housing in Nagpur under BEA project. The intention is to adopt the guideline for upcoming Affordable Housing Project. 	<ul style="list-style-type: none"> SCM
4	Waste	Property Tax exemption on HH vermicomposting	<ul style="list-style-type: none"> Green Building concept will be incorporated in projects like affordable housing, schools, hospitals etc. in ABD area. 	<ul style="list-style-type: none"> SBM-U
5	Green space and / or biodiversity	Tree Plantation	<ul style="list-style-type: none"> About 80,000 saplings were planted in 2019, of which about 55,000 survived. 	
6	Water	Water Security in Nagpur	<ul style="list-style-type: none"> 24x7 water supply scheme will provide potable water to the city. Sewerage water is treated and supplied to the Thermal power station about 20 km away to reduce fresh water requirement for cooling purpose. 	<ul style="list-style-type: none"> JnNURM AMRUT
7	Water Scarcity / Drought	Rain Water Harvesting	<ul style="list-style-type: none"> In Nagpur City, there is tax exemption of 5 percent for household rainwater harvesting. There are plans for reservoir development in several areas. 	
8	Extreme hot temperature (HEAT WAVE)	Heat Action Plan & Disaster Management Plan	<ul style="list-style-type: none"> Nagpur has prepared a Heat Action Plan and Disaster Management Plan for the city. All the ten zones of the city are appointed with the Zonal in-charge related to health. Ongoing Climate Vulnerability Assessment under the Urban-LEDS II project. 	

JNNSM: Jawaharlal Nehru National Solar Mission, NMEEE: National Mission for Enhanced Energy Efficiency, SEEP: Super-Efficient Equipment Program, SCM: Smart Cities Mission, FAME: Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India, NEMMP: National Electric Mobility Mission Plan, AMRUT: Atal Mission for Rejuvenation and Urban Transformation, PMAY(U): Pradhan Mantri Awas Yojana (Urban), SBM(U): Swachh Bharat Mission (Urban), GIM: National Mission for a Green India

A.2 Emissions Reduction Targets – Calculation Methodology

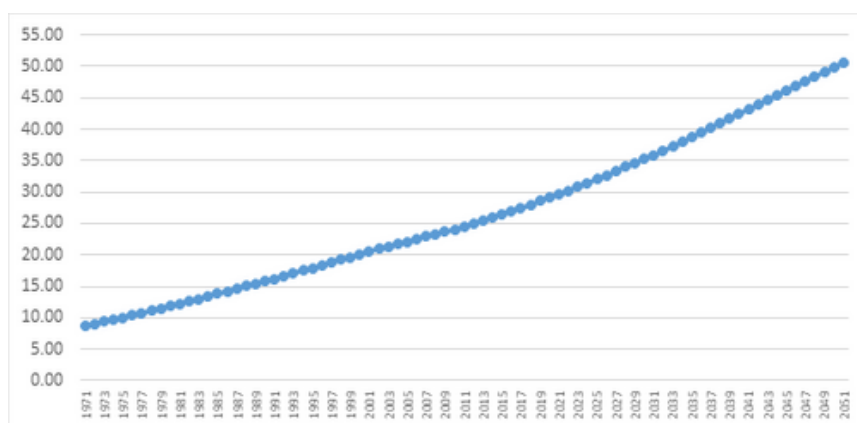
Table 8: OPEC Methodology for Emission Reduction

#	Step	Remarks
1	Creation of an annual population series (1990-2100)	Created (refer Annexure A.2)
2	Using population series to estimate the population in 2018, 2030 and 2050	
	Estimated Population in 2018	2,805,700
	Estimated Population in 2030	3,523,300
	Estimated Population in 2050	4,995,950
3	Creation of annual GDP growth series (1990 – 2025)	Created (refer Annexure A.3)
	Nagpur's GDP (in 2018) (in USD)	16,960,000,000
4	Estimation of 2018 emissions, as per GHG Emission Inventory (tCO ₂ e)	2,849,470.40[18]
5	Calculation of total emissions based on city targets	NO TARGETS
6	Calculation of HDI reduction factor and calculate the science-based 2030 emissions. Formula: $1 - (0.5 * (1 - ((HDI_{India} - HDI_{World}) / HDI_{World})))$ Where HDI _{India} : 0.647, HDI _{World} : 0.731	44%
7	Calculation of 'per capita' emissions in the 2018 & 2030 (tCO ₂ e/capita)	
	Per Capita Emission in 2018 (2018 Estimated Emissions / 2018 Estimated Population)	1.02
	Estimated Per Capita Emission in 2030 ((2018 Estimated Emissions / 2018 Estimated Population) X (1-HDI Reduction Factor) = Science-Based 2030 Emissions)	0.57
8	Testing of city targets by interpolating between the 'per capita' emissions in the reported target start and end year and comparing against the science-based 2030 and 2050 emissions	NO TARGETS

A.3 Annual Population Series

After comparing the population projections from the 1st generation City Development Plan, water supply project, sewerage project, SWD project, and traffic and transportation study (CMP) along with the population trends during the past four decades, the Incremental method of population projection was found to be most appropriate in case of Nagpur. The same method has been also used in the latest City Development Plan (CDP) and the GHG Emission Inventory for Nagpur (prepared under Urban LEDS Phase II). The decadal growth rate considered as per this method is about 20.9%, 21.2% & 20.7% for 2021, 2031 & 2041 & beyond respectively. [19]

Figure 4: Graph showing Population Growth from 1971 to 2051



[18] Covers Scope 1 and Scope 2 emissions from stationary energy and transportation, as well as Scope 1 and Scope 3 emissions from waste as per GHG Emission Inventory for Nagpur, prepared under Urban LEDS II

[19] Census of India 2011, Nagpur City Development Plan, GHG Emission Inventory of Nagpur

While the annual population series was created for the range of 1971 – 2051, the relevant population for the emission reduction target setting are for the year 2018, 2030 & 2050. The below mentioned table shows the estimate population projection of Nagpur from 2011-2050, in lakhs:

Table 9: Population range (in lakhs) from 2011 to 2050

Year	Population	Year	Population	Year	Population	Year	Population
2011	24.48	2021	29.59	2031	35.86	2041	43.28
2012	24.99	2022	30.22	2032	36.60	2042	44.02
2013	25.50	2023	30.84	2033	37.34	2043	44.76
2014	26.01	2024	31.47	2034	38.09	2044	45.51
2015	26.52	2025	32.10	2035	38.83	2045	46.25
2016	27.04	2026	32.73	2036	39.57	2046	46.99
2017	27.55	2027	33.35	2037	40.31	2047	47.73
2018	28.06	2028	33.98	2038	41.05	2048	48.48
2019	28.57	2029	34.61	2039	41.80	2049	49.22
2020	29.08	2030	35.23	2040	42.54	2050	49.96

A.4 GDP Series

GDP Growth created as per Nagpur's 2017 GDP (from CREDAI's report on 'The Dawn of India's Future Cities Special Focus: Nagpur') and Nagpur's 2035 GDP (from Oxford Economics' report on Global Cities).

Figure 5: Graph showing GDP (in Billion USD) growth from 2017 to 2035

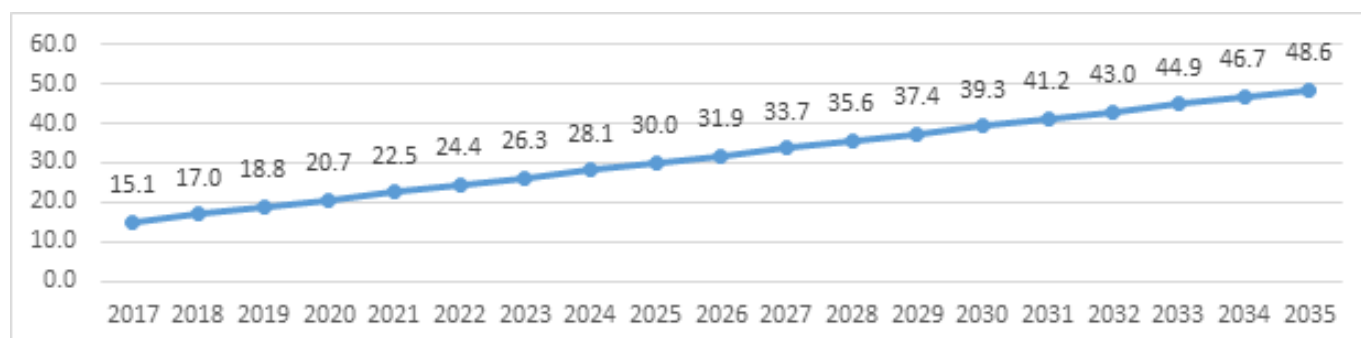


Table 10: GDP (in Billion USD) range from 2017 to 2035

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
GDP	15.1	17.0	18.8	20.7	22.5	24.4	26.3	28.1	30.0	31.9
Year	2027	2028	2029	2030	2031	2032	2033	2034	2035	
GDP	33.7	35.6	37.4	39.3	41.2	43.0	44.9	46.7	48.6	

A.5 City Typologies as per C40 & McKinsey

Table 11: City typologies as per GDP & Population

TYPOLGY	GDP PER CAPITA RANGE (USD)	POPULATION RANGE
Large Low Income Leapfrog City	0 - 4,500	NA
Low Income Megacity	4,500 – 11,000	NA
Large Semi-Dense Middle Income City	11,000 – 21,000	NA
Middle Income Megacity	21,000 – 37,000	NA
Large Dense City	>37,000	>1,000,000
Small High Income Innovator City	>37,000	<1,000,000

A.6 Priority action opportunities for typologies based on emission reduction potential

Table 12: Typology-wise priority actions

	LARGE, LOW INCOME, LEAPFROG CITY	LOW INCOME MEGA CITY	LARGE, MIDDLE INCOME, SEMI-DENSE CITY
1	Distributed renewables (36%)	Distributed renewables (40%)	Distributed renewables (24%)
2	Ultra-high-efficiency new building standards (23%)	Ultra-high-efficiency new building standards (22%)	Next-generation vehicles (23%)
3	Mass transit, walking and cycling infrastructure (18%)	Next-generation vehicles (15%)	Centralised renewables (10%)
4	Transit-oriented development (13%)	Mass transit, walking and cycling infrastructure (14%)	Ultra-high-efficiency new building standards (10%)
5	Appliances and lighting upgrades (11%)	Transit-oriented development (13%)	Mass transit, walking and cycling infrastructure (8%)
	MIDDLE INCOME MEGA CITY	LARGE, HIGH-INCOME, DENSE CITY	SMALL, HIGH-INCOME, INNOVATOR CITY
1	Ultra-high-efficiency new building standards (22%)	HVAC and water heating upgrades (24%)	Centralised renewables (54%)
2	Centralised renewables (21%)	Centralised renewables (18%)	HVAC and water heating upgrades (26%)

A.7 Feasibility Assessment of Urban-Relevant Adaptation and Mitigation Options^[20]

The Special Report on Global Warming of 1.5°C provided detailed feasibility assessments, using a similar frame and a common method. This is the first time that such a climate feasibility assessment has been attempted and is an important step forward to support implementation. When localised, this global feasibility assessment can assist national and local governments do the following: identify key options that can enable system transitions, begin prioritising implementation actions for feasible options, identify conditions that will enable accelerated implementation, and identify synergies and trade-offs between adaptation and mitigation, which can support a pragmatic action plan. It can also help define knowledge gaps and hence priorities for action research.

[20] Global Covenant of Mayors - Summary for Urban Policymakers – What the IPCC Special Report on 1.5C Means for Cities.

The feasibility assessment used three steps to assess the multi-dimensional feasibility of 1.5°C-relevant mitigation and adaptation options that have seen considerable development since 2014.

1. First, each mitigation and adaptation option was assessed along relevant indicators grouped around six feasibility dimensions: economic, technological, institutional, socio-cultural, environmental/ ecological, and geophysical.
2. Second, for each option, the overall feasibility for each of the dimensions was assessed as the mean of the combined scores of the relevant underlying indicators. These were classified into four groups, each with a distinctive color shading. Dark shading indicates few feasibility barriers; moderate shading indicates some barriers; and light shading indicates that multiple barriers may block implementation for a particular feasibility dimension. No shading means there is insufficient literature available to make an assessment. The context column indicates how the assessment might change if contextual factors are different.

The objectives for Transition to Low Carbon Development may include:

- Global GHG emissions need to peak in 2020 and then begin declining, by following ambitious long-term decarbonisation pathways aligned with the Paris Agreement.
- By 2030, the cities should show progress in reducing their emissions to half.
- By 2050, the long-term objective of carbon neutrality must be reached, the recommendations and milestones of the Sendai Framework for Disaster Risk Reduction must be implemented
- Rapid adoption of tested and new technologies that reduce emissions.

Table 13: Feasibility of Mitigation options

System	MITIGATION Objective Options /	Feasibility						Context	General Scoring	Score for Nagpur
		E	T	I	SC	EE	GP			
Energy System Transitions	Solar PV	3	3	2	3	3	2	Cost-effectiveness affected by solar irradiation and incentive regime	16	15
	Bioenergy	2	3	1	2	1	2	Depends on availability of biomass such as municipal solid waste and capability to collect it. Distributional effects depend on the agrarian (or other) system used to produce feedstock.	10	6
	Electricity storage	1	1	1	1	1	1	Batteries universal but grid flexible resources vary with area's level of development.	6	6
Urban & Infrastructure System Transitions	Land-use & urban planning	2	2	2	2	3	3	Varies with urban fabric, not geography or economy; requires capacitated local government and legitimate tenure system	12	18
	Electric cars and buses	2	2	2	2	0	2	Varies with degree of government intervention; requires capacity to retrofit 'fuelling' stations.	10	15
	Sharing schemes	3	2	2	2	3	3	Historic schemes and universal new ones depend on ICT status; undermined by high crime and low levels of law enforcement.	15	15
	Public transport	3	3	3	3	3	3	Depends on presence of existing 'informal' taxi systems, which may be more cost effective and affordable than capital intensive new build schemes, as well as local government capabilities.	18	18
	Non-motorized transport	3	3	3	3	0	3	Viability rests on linkages with public transport, cultural factors, climate and geography.	15	15
	Smart Grids	2	2	1	2	3	2	Varies with economic status and presence or quality of existing grid.	11	12
	Efficient appliances	2	3	3	3	3	3	Adoption varies with economic status and policy framework.	17	15
Industrial System Transitions	Low/zero energy buildings	3	2	2	0	3	3	Depends on size of existing building stock and growth of building stock.	13	9
	Energy efficiency	2	3	3	2	2	3	Potential and adoption depends on existing efficiency, energy prices and interest rates, as well as government incentives.	15	15
Land Ecosystem Transitions	Bio-based circularity &	2	2	1	0	0	1	Faces barriers in terms of pressure on natural resources and biodiversity. Product substitution depends on market organisation and government incentivisation.	5	4
	Reduced food wastage & efficient food production	2	2	3	2	3	3	Will depend on the combination of individual and institutional behaviour.	15	12

E – Economic, T – Technological, I – Institutional, SC – Socio-Cultural, EE – Environmental / Ecological, G – Geophysical

Barriers of Feasibility	Absence of Barriers	No Effect	Potential Barriers	Insufficient Literature
-------------------------	---------------------	-----------	--------------------	-------------------------

As per the Mitigation Feasibility Matrix, it can be observed that in case of Nagpur the following options have a higher level of feasibility: Solar PV, Land-use & urban planning, Electric cars and buses, Sharing schemes, Public transport, Non-motorized transport and Efficient appliances & Energy efficiency.

The objectives for building Adaptive Capacity / Resilience may include:

- To increase our capacity to adapt to the inevitable effects of climate change locked-in by current levels of GHG emissions in our atmosphere and
- Strong cooperation among city government, businesses, and residents
- Leadership on climate education and awareness of climate risks and solutions to accelerate behaviour change
- Objectives of the New Urban Agenda and Sustainable Development Goals must be achieved

Table 14: Feasibility of Adaptation options

System	ADAPTATION Objective Options /	Feasibility						Context	General Scoring	Score for Nagpur
		E	T	I	SC	EE	GP			
Energy System Transitions	Power infrastructure, including water	3	3	2	3	3	2	Depends on existing power infrastructure, all generation sources and with intensive water requirements.	16	15
Urban & Infrastructure System Transitions	Sustainable land-use & urban planning	2	3	1	2	1	2	Depends on nature of planning systems and enforcement mechanisms.	9	15
	Sustainable water management	2	2	2	2	2	2	Balancing sustainable water supply and rising demand especially in low-income countries.	12	12
	Green infrastructure & ecosystem services	2	2	3	2	3	3	Depends on reconciliation of urban development with green infrastructure.	15	12
	Building codes & standards	0	2	0	2	3	0	Adoption requires legal, educational, and enforcement mechanisms to regulate buildings.	7	15
	Disaster risk management	2	2	2	2	3	3	Requires institutional, technical, and financial capacity in frontline agencies and government.	14	15
Industrial System Transitions	Intensive industry infrastructure resilience & water management	2	2	2	2	0	2	Depends on intensive industry, existing infrastructure and using or requiring high demand of water.	10	8

E – Economic, T – Technological, I – Institutional, SC – Socio-Cultural, EE – Environmental / Ecological, GP – Geophysical

Barriers of Feasibility	Absence of Barriers	No Effect	Potential Barriers	Insufficient Literature
-------------------------	---------------------	-----------	--------------------	-------------------------

As per the Adaptation Feasibility Matrix, it can be observed that in case of Nagpur the following options have a higher level of feasibility: Power infrastructure, including water, Sustainable land-use & urban planning, Sustainable water management, Green infrastructure & ecosystem services, Building codes & standards, Disaster risk management.

A.8 India's Nationally Determined Contributions (NDCs)^[21]

Table 15: List of India's NDCs

# NDC	Description
NDC-1	To put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation.
NDC-2	To adopt a climate friendly and a cleaner path than the one followed hitherto by others at corresponding level of economic development.
NDC-3	To reduce the emissions intensity of its GDP by 33 to 35 percent by 2030 from 2005 level.
NDC-4	To achieve about 40 percent cumulative electric power installed capacity from non-fossil fuel based energy resources by 2030 with the help of transfer of technology and low cost international finance including from Green Climate Fund (GCF).
NDC-5	To create an additional carbon sink of 2.5 to 3 billion tonnes of CO ₂ equivalent through additional forest and tree cover by 2030.
NDC-6	To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly agriculture, water resources, Himalayan region, coastal regions, health and disaster management.

[21] Union Environment Ministry. (2015). India's Intended Nationally Determined Contribution. Unfccc/Indc, October, 1–38.

NDC-7	To mobilize domestic and new & additional funds from developed countries to implement the above mitigation and adaptation actions in view of the resource required and the resource gap.
NDC-8	To build capacities, create domestic framework and international architecture for quick diffusion of cutting edge climate technology in India and for joint collaborative R&D for such future technologies.

A.9 Maharashtra State Action Plan on Climate Change (SAPCC)^[22]

Table 16: City-related Adaptation & Mitigation action from Maharashtra's SAPCC

# SAPCC	Sector/ Broader Actions	Priority (Very High / High/Medium/ Low)	Sectoral Strategies / Recommended Actions listed in Maharashtra SAPCC
FOREST	Forest and other Ecosystems		
FOREST-1	Enhance quality of forest cover in the State leading to enhanced overall ecosystem services.	High	Enhance tree cover in cities with high growth in peri-urban areas.
ENERGY	Energy		
ENERGY-1	Promote cleaner forms of energy with special focus on solar, wind and hybrid energy systems.	High	Introduction of policies for promoting usage of hybrid systems (solar and wind) in urban and rural areas.
ENERGY-2	Promote and mandate solar rooftop power generation in new constructions in urban areas, which have large potential in commercial, industrial and residential buildings.	High	Solar rooftop power generation in the urban areas which have large potential in commercial, industrial and residential buildings.
ENERGY-3	Promote innovative research and entrepreneurship on cleaner forms of energy.	High	
ENERGY-4	Introduce policies to encourage net metering.	High	Introduction of policies to encourage generation of renewable energy (one innovative measure is net metering).
ENERGY-5	Promote efficient energy systems for energy conservation.	Medium	Active promotion of waste-to-energy technologies.
WATER	Water Resources		
WATER-1	Conserve and re-naturalise rivers and water bodies.	High	Modify the current tree policy to retain the mature trees, mainly around the origin of rivers.
WATER-2	Maintain ecological flows in dammed rivers, High Construct K. T. Weirs at regular intervals along rivers.	High	Recharge underground aquifers through artificial recharge methods in scientifically demarcated zones.
WATER-3	Develop early warning systems for floods for communities residing near the banks of rivers.	High	Mandate water recycling and reuse by industries and utilities, and encourage early adoption through tax concessions.
WATER-4	Mandate water recycling and reuse to reduce demand for freshwater supply.	Very High	Mandate regular water audits by industries and utilities and raise the prices for fresh surface water.

[22] Action on Climate Today (ACT) (2018). Tackling climate change in Maharashtra.

			As a supplementary measure to reduce the costs of compliance, provide incentives to domestic wastewater treatment equipment manufacturers.
			Make rainwater harvesting mandatory in new and existing structures in all million plus population cities of Maharashtra.
			Mandate treatment and reuse of sewage water for gardening or flushing.
			Augment storm water drainage infrastructure in major cities to accommodate a 15% increase in flood magnitude.
HEALTH	Health		
HEALTH-1	Enhance monitoring & surveillance of different climate-sensitive diseases and develop health-related climate services and early warning system.	High	Develop early warning tools in collaboration with meteorological agencies for different end-users.
HEALTH-2			Develop and maintain a digital health database at fine spatial and temporal scales for climate-sensitive diseases.
HEALTH-3	Invest in research related to climate change and health	High	Study the regional pattern of climate-sensitive diseases and disease outbreaks to identify changing trends and trigger events, and provide regular feedback.
HEALTH-4			Increase investment in health research.
HEALTH-5	Improve overall health infrastructure and training.	High	Introduce additional training module on climate change risks and impacts for health sector staff.
HEALTH-6	Promote community surveillance programmes and awareness programmes.	Medium	Promote community surveillance programmes and awareness programmes
			Introduce norms for working hours for labourers to reduce their direct exposure to heat and construct shelters near farm areas.
DRM	Disaster Risk Management		
DRM-1	Integrate future climate change projections and uncertainties into state disaster management plans and disaster risk reduction strategies.	High	Integrate future climate change projections and uncertainties into state disaster management plans and disaster risk reduction strategies.
DRM-2	Incorporate climate change concerns into development plans and land use planning.	Medium	Incorporate climate change concerns into development plans and land use planning.
DRM-3	Develop early warning systems for dissemination of advisories to vulnerable districts in the state related to disaster management.	Medium	

DRM-4	Develop coordination mechanisms with different departments for dissemination of information on climate change related incidents.	Medium	
DRM-5	Establish ecosystem-based disaster management and risk reduction systems.	Very High	Ecosystem based approach for disaster risk reduction in urban areas.
DRM-6	Incorporate climate change concerns into development plans and land use planning.	High	
INFRA	Infrastructure		
INFRA-1	Climate proofing of new public infrastructure (like bridges, roads, ports, etc) by incorporating additional ranges of temperature, rainfall, and sea level rise into design specifications and relevant policies.	High	Climate proofing of new public infrastructure.
INFRA-2	Undertake plantation on both side of roads with local species for providing shade/ shelter during intense heat waves in districts such as Nagpur etc.	Medium	
INFRA-3	Modify guidelines to incorporate green building norms in constructions of governmental and non governmental organizations and institutions.	Medium	
UD	Urban Development		
UD-1	Develop early warning system for extreme rainfall for communities residing in low-lying areas in cities.	High	
UD-2	Develop long and short-term strategies and systems for managing extreme precipitation events in urban areas.	High	Incorporate increased risk of extreme rainfall or flooding in planning new infrastructure.
UD-3	Consider flooding and groundwater levels while giving approval for construction especially in low lying regions.	Medium	
UD-4	Integration of flood level norms while giving approval for constructions in areas near river banks.	High	
UD-5	Mandate water recycling and reuse by industries, commercial establishments, residential etc. to reduce demand for fresh water.	Very High	Prepare action plan for water use efficiency.

UD-6	Develop climate resilient cities.	Very High	Develop climate impact assessment criteria for allocating budgets for schemes, facilitate departments in accessing external climate funds for relevant projects.
UD-7	Integrate strategies to reduce carbon footprint while planning new cities and constructions.	Very High	Stringent norms for vehicular emissions on air pollution and health impacts and information dissemination.
UD-8	Introduce policies to reduce solid waste and sewage generation to reduce Greenhouse Gas emissions.	High	Active promotion of waste-to-energy technologies.

A.10 ClimateSMART Cities (CSC) Assessment Framework[23]

Table 17: List of indicators for CSCAF 2.0

#	INDICATORS
ENERGY AND GREEN BUILDINGS	
ENERGY-1	Indicator 1: Electricity consumption in the city
ENERGY-2	Indicator 2: Total electrical energy in the city derived from renewable sources
ENERGY-3	Indicator 3: Fossil fuel consumption in the city
ENERGY-4	Indicator 4: Energy efficient street lighting in the city
ENERGY-5	Indicator 5: Promotion of green buildings
ENERGY-6	Indicator 6: Green building adoption
URBAN PLANNING, GREEN COVER AND BIODIVERSITY	
URBAN-1	Indicator 1: Rejuvenation & conservation of water bodies & open areas
URBAN-2	Indicator 2: Proportion of green cover
URBAN-3	Indicator 3: Urban biodiversity
URBAN-4	Indicator 4: Disaster resilience
URBAN-5	Indicator 5: City climate action plan
MOBILITY & AIR	
MOBILITY-1	Indicator 1: Clean technologies shared vehicles
MOBILITY-2	Indicator 2: Availability of public transport
MOBILITY-3	Indicator 3: Percentage of coverage of non-motorized transport network (pedestrian and bicycle) in the city
MOBILITY-4	Indicator 4: Level of air pollution
MOBILITY-5	Indicator 5: Clean air action plan (Planning and Implementation)
WATER RESOURCE MANAGEMENT	
WATER-1	Indicator 1: Water resources management
WATER-2	Indicator 2: Extent of non-revenue water
WATER-3	Indicator 3: Wastewater recycle and reuse
WATER-4	Indicator 4: Flood/water stagnation risk management
WATER-5	Indicator 5: Energy-efficient water supply system
WATER-6	Indicator 6: Energy-efficient wastewater management system

[23] MoHUA. (2019). ClimateSMART CITIES Assessment Framework. 78.

WASTE MANAGEMENT	
WASTE-1	Indicator 1: Waste minimization initiatives undertaken by the City
WASTE-2	Indicator 2: Extent of dry waste recovered & recycled
WASTE-3	Indicator 3: Construction & Demolition (C&D) waste management
WASTE-4	Indicator 4: Extent of Wet Waste Processed
WASTE-5	Indicator 5: Scientific landfill availability & operations
WASTE-6	Indicator 6: Landfill/ dumpsite scientific remediation



50
YEARS IN INDIA

Working to sustain the natural
world for people and wildlife

together possible wwfindia.org

Climate Change and Energy Programme
WWF-India Secretariat
172 B, Pirojsha Godrej Building, Lodhi Estate, New Delhi 110003