Planet Earth is our home and it is our duty and responsibility to protect it, not just for us but also for generations to come. We must nurture the planet and keep it livable.

Dr. A. P. J. Abdul Kalam,  
Former President of India, Bharat Ratna

I want you to act as if our house is on fire. Because it is!

Greta Thunberg,  
Climate Activist, Mind Behind Fridays For Future,  
Nobel Peace Prize Nominee
Pathway to Taking Pune towards Carbon Neutrality by 2030
A Climate-Smart Approach to Sustainable Future

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Acknowledgements

Team EECC would like to acknowledge the support and cooperation of PIC Director and Staff and the guidance and advice of President, PIC and Vice-President, PIC.
Executive Summary

This report on “Pathway to taking Pune towards Carbon Neutrality by 2030” can be called a vision document on what a major expanding City like Pune (Pune Metropolitan Region – PMR) should aspire for in the changing era of “Climate-Challenged World”. Although this may sound aspirational now, there are very credible signs that by 2030 most cities in the world would be trying to be Carbon Neutral as quickly as possible.

Carbon Neutrality for any region would mean Net Zero Greenhouse Gas (GHG) Emissions. Even if all nations get serious about reducing emissions today, it may take several decades before ‘net zero’ can be achieved for entire Earth, and given the fact that we are at a precipice of catastrophic destruction of human-friendly environment, every nation or city must try to offset as much emission as possible by enhancing the carbon sequestration capacity. Pune should want to initiate pioneering efforts in India, to lead by example, and this report is about realizing such a vision in the next 10-11 years. It may indeed be very difficult but not impossible.

Pune Metropolitan Region (PMR) is a large ‘to-be-Urban’ area of 7,256 sq-km inclusive of PMC, PCMC, 3 Cantonment Boards, 3 census towns and 842 villages. This peri-urban region with a population of about 14 Million by 2030, offers a unique opportunity to start on the right foot from the very early planning stage to become a model urban centre. The report attempts to bring-out potentials, challenges and possible solutions to evolve a pathway to carbon neutrality by 2030. As the world inches towards 1.5°C warming and more regions feel the impacts of Climate Change, Pune must take a leadership role in combatting climate change.

Achieving carbon neutrality is not a one-time goal but a change for the future, to ensure that future generations may at least enjoy the same friendly environment that this generation has taken for granted. The Earth environment will increasingly get more hostile before it can get better; provided, corrective steps are taken now. As aptly described by the young climate activist Greta Thunberg, this is the worst crisis that human species may be facing and every small bit – whether positive or negative will count in a big way in coming years. Hence this is an unprecedented situation.

Starting with defining carbon neutrality in its various dimensions in Chapter 2, this brief report attempts a deep-dive into issues of desired Climate Actions in various sectors of modern human activity for a large population centre. Reducing overall energy demand by raising energy efficiency will have to be crucial for the socio-economic transition to Low-carbon Economy and this can succeed only if this can be achieved without much of a penalty to economic growth and prosperity. Innovative ideas and
technologies will be required to evolve pathways that can be implemented with efficient and dynamic governance models involving robust citizen participation.

Rapid growth of Renewable Energy technology like Solar, Wind and Bio-Gas are clear easy local options, particularly in distributed generation mode. But obviously moving away from polluting thermal power will depend on State or Central policy guidelines. Transport sector is the 2nd largest GHG emitter and local governments can make a big difference by city level improvements of ‘Public Transport’ through an imaginative set of incentives or dis-incentives to reduce the use of private vehicles. Last mile connectivity will remain a major challenge that will need a customised solution for different strata of society. Introduction of E-Vehicles will be a major step forward.

Another major challenge will be to enhance the green cover of PMR for increasing the natural sequestration capacity of the region by many-fold. Given the widening gap between cumulative total emissions and the limited sequestration capacity, there will be a need for scalable and affordable technology solution for artificial removal of GHG from atmosphere in future. These are new types of challenges for the Next-Gen societies but the innovative solutions must emerge before the gaps become too large to bridge for preventing catastrophic run-off effects. All such issues are briefly discussed in this report with a plan to soon bring out a more detailed version with additional data search and more in-depth analysis to define a road map for PMR.

Chapter 4 examines the policy priorities for preparing stage for an ambitious agenda for well-coordinated climate actions that a large urban centre like PMR can implement within its jurisdiction, indeed with due support from the State and the Centre. Major hurdles may emerge from vested-interest groups like the Construction and Builder’s lobby who may lose out on quick monetary profits. Innovative solutions must be found to create the right motivational gradients for the change to shift to Long-term focus on Sustainability, rather than quick returns on investments, no matter at what cost.

The desired transformative changes will not be possible without a robust people’s movement. Concerns of climate impacts on human health and well-being would indeed help build such momentum for urgent action. But fear alone should not be the driving force. It must be the collective aspiration for better future of our children and grandchildren, that must create the capacity for accepting short term inconveniences as a prudent and willing choice for averting future hardship to younger generations. The reality of the IPCC projections will sink deeper with time – these projections define the next 10-12 years as the only opportunity for humanity to avoid unprecedented sufferings for the next generations. This must generate global positive momentum for securing the future of mankind. Pune must contribute its best.
The report has attempted to list PMR specific priority climate actions and the policy framework that must evolve as we move forward towards carbon neutrality. This should also hopefully provide a model for other cities to follow by learning from PMR success. One of the key recommendation is to ‘Create a Climate Neutral Policy Framework’ and this can go a long way to establish the pathway for the transition to Low-carbon Economy with as little pains as possible. The cost of not acting decisively now may invite many-fold penalties and the reality of this deserves clear understanding.

The report is a modest attempt by the PIC project team on “Environment, Energy and Climate Change” in cooperation with the members of “Climate Collective Pune”.
Chapter 1: Introduction

Global Warming and Climate Change have emerged as the most serious existential danger to human health and well-being. Ironically, the cause of it is also the human civilization that has evolved to this advanced level of modern lifestyle by consuming an enormous amount of Earth resources, particularly over the past 200 years. Today the ecological footprint of human population on Earth-ecosystem has become so large that it is threatening the intrinsic stability of ‘Nature’ that is so vital to all life.

The rapid increase in Green House Gases (GHG) concentration in the earth atmosphere crossed 410 PPM in 2014 (compared to pre-industrial average of 280 PPM) due to excessive burning of fossil fuels. The potential dangers were identified by the scientific community in the late 20th century and global political leadership has been discussing the need for reducing the Carbon dioxide equivalent (CO2Eq) emissions for the past 28 years. But there is yet no sign of real emission reduction to avert catastrophic climate impacts.

The average global warming has already crossed 1.1°C and the effects of global warming are already visible in the form of more intense and frequent cyclones, unusually heavy rains and flooding, and serious melting of polar ice sheets that can raise the sea-levels drowning coastal areas. Long droughts, forest fires and lack of drinking water are already causing heavy economic penalties and the trends indicate much more damage to the economy and human health within the next 10-12 years. Devastating climate impacts will be faced by future generations and school children world over are already staging ‘Friday Protests’ against lack of timely Climate Action.

Although climate change impacts will be global but tropical regions will be more severely affected than the colder higher latitude regions. While combatting climate change will require well-coordinated global action it all starts with local actions. Major cities with high populations will be responsible for over 70% of GDP growth but they will also be responsible for over 75% CO2Eq emissions, if humanity is to avert catastrophic economic and health impacts it is imperative that global GHG emissions stop increasing by 2030, and we achieve net zero emissions before 2050.

Carbon Neutrality means one absorbs as much carbon from the atmosphere and at the same rate, as one emits. This can be attempted regionally or even at City level through proactive actions and careful planning of energy access, generation and consumption methods by concerned Governments and also by changing to low-carbon lifestyles by individuals and communities. Even if future technologies allow removal and storage of excess GHGs from the atmosphere, there will be heavy cost
implications, and hence, achieving Carbon Neutrality within the natural capacity of carbon sequestration in a given region will be very important for future sustainability.

It is in this context that growing large metropolitan urban centres like the PMR (Pune Metropolitan Region) must seriously attempt to become ‘Carbon Neutral’ as soon as possible. This report endeavours to bring out the essential features of defining a pathway to carbon neutrality for the PMR, which is presently in the planning stage, and hence, offers a unique opportunity for taking the desired policy and governance initiative for assuming a leadership role. This will not only make Pune proud but also influence other Indian cities to follow the example and help India fulfil its Paris commitments and speak with high moral authority in global climate negotiations.

1.1 Urgency for Global Climate Action at every level

In its October 2018 report, the Inter-Governmental Panel on Climate Change (IPCC) declared that atmospheric CO2 concentration had already crossed 410 PPM and the window of opportunity to avoid Climate Crisis will be only about next 12 years to 2030. Without serious global action, we are on the path to cross 3°C warming within the lifetime of the present youth population who will face a very hostile environment when they become senior citizens. Scientists also confirm that the rate of change in climate observed to date is much faster than predicted by IPCC conservative reports.

Given the complexity and inter-connectedness of the systems on Earth, it will be practically impossible for any individual or community to evade all impacts of Climate Change. We need to realize and respect that we affect the environment we live in just as it affects us. We must unite to make well-directed efforts as responsible global citizens to mitigate further emissions and adapt to climate changes that are no longer avoidable. We need to think globally but act locally to reduce GHG emissions of all urban areas to successfully reduce the nation’s emissions.

Carbon Dioxide is an invisible, odourless and cumulative gas that stays in the atmosphere for centuries. While the carbon cycle is essential for life, beyond a certain concentration – it needs to be recognized as pollution because it causes undesirable heat-trapping effects that can produce regenerative feedback heating effects on the Earth ecosystem, beyond which, even the best of human efforts may not be adequate to reverse the slide. Thus, it can challenge the very survival of human species. Environmental Degradation and Climate Change are fast becoming global security issues and most nations are now finally waking up to the dangers.
Cities will soon have around 60% population and generate more than 70% GDP growth. They are heavy energy consumers and largest garbage generators, that emit maximum greenhouse gases (GHGs). Hence, Global cities need to take initiative to achieve Carbon Neutrality like Copenhagen is planning to do by 2025. A City is a place where the energy exists, the activity exists, the thought process exists and the city is also a place where it can make a big difference. This can be achieved by focusing on important sectors such as electricity, transportation, construction, water and waste management and overall urban planning. Additionally conserving natural ecosystems and creating carbon sinks for offsetting emissions can play a major role.

The cost of not taking timely climate action in the past decade is already causing huge losses to ecosystems, land availability, businesses, property, and human life - now and in future. In fact, it is well accepted that every dollar invested now in climate action would save more than 5-7$, in future, for combatting more severe climate impacts. Climate Change action needs to receive huge momentum and importance at every level – individual, community and governance. Despite political debates, actual action on ground remains very low or almost non-existent. Thus, creating a new awareness is critical to generating a “Citizen’s Movement” and only then the desired momentum can be built for meaningful and urgent Climate Action.

Indian cities will be among the first in the world to suffer badly. It is therefore very urgent that each city in India must contribute its best to move towards Carbon Neutrality which would also improve its Climate Resilience in the future.

1.2 India’s NDC Commitments – Why we must go beyond

India is known to be one of the disaster-prone countries in the world and its economy, health and security will be hugely affected by Climate Change. Being a tropical country, it will be severely affected at many levels through unpredictable weather events and flooding, frequent long droughts, rise in sea level and shortage of potable water. With frequent heat waves and steady loss of ecosystems, India is recognized as one of the most vulnerable countries to Climate Change in the World.

Majority of the Indian population still occupies rural areas that directly depend on climate-sensitive sectors like agriculture, forests, and fisheries. These sectors are heavily dependent on natural resources such as water, biodiversity, mangroves, coastal zones, and grasslands. With increasing intensity and frequency of climatic disasters and changing weather patterns, the Indian cities too will face considerable stress. Climate Change will also have adverse impacts on food production, water supply, biodiversity, livelihoods and even national security for India.
Indian Prime Minister, Narendra Modi, has put forth some of the most ambitious climate targets at the Paris Conference. India is committed to reducing the emissions intensity of its GDP by 33–35% below 2005 level by 2030. India is also committed to achieving 40% of installed electric power capacity from 'non-fossil fuel' energy sources like solar, wind and biomass by 2030. Yet another important commitment is to create an additional carbon sink of 2.5-3 billion tonnes of CO2 sequestration capacity through additional forest and tree cover by 2030.

The nation aims to adopt a more climate-friendly and cleaner path to achieve economic development than any country in the past. It needs to simultaneously balance – expanding electricity access and achieving its climate target. India needs to drastically reduce GHG emissions by reducing Carbon Footprint at the individual, community and organizational level and by implementing better Climate Change Mitigation and Adaptation Policies. India has also decided to rapidly shift to e-mobility across all segments by 2030. If much of these can be charged by distributed solar generation facility, that would be a major achievement for climate resilience.

India’s energy system faces the triple challenge of meeting growing demand, cutting pollution and offering access to electricity to more than 300M people not connected to the grid power. India’s power demand is projected to increase three-fold between 2015 and 2040. Shifting away from coal-power to less polluting options must get priority. India is determined to achieve 40% cumulative electricity generation capacity from non-fossil fuels based energy resources by 2030. Current Electricity Demand is 1400 TWh and is expected to rise to 2500 TWh by 2030. A major chunk of this demand will arise from rapidly urbanizing centres, and hence, regions like PMR must create suitable infrastructure for enabling the rapid shift to renewable clean power.

There is growing awareness that even if all countries meet their Paris commitments, that may not be enough to stay within 2°C warming to avert serious climate impacts. Hence all countries, particularly those most vulnerable to climate change, must go beyond Paris commitments. India aims to achieve its Nationally Determined Contributions (NDCs) and go beyond because these targets are economically wise, and India can benefit from its strong institutional framework and robust domestic policies to get reliable financing to achieve the NDC objectives and go beyond.

There is growing awareness that even if all countries meet their Paris commitments, that may not be enough to stay within 2°C warming to avert serious climate impacts.
1.3 Why Pune must take Leadership and become a Role Model

India’s CO2Eq emissions are growing at a faster rate than any other major energy-consuming nation. In 2018, India was the 4th largest emitter accounting for 7% of the total global CO2Eq emissions and the country emissions rose 4.8% from the previous year, according to a new report by the Paris-based International Energy Agency. However, per-capita emissions are still at 40% of the global average.

Urban areas including small towns and cities contribute to 2/3rd emissions in India. A study also reported that the per-capita emissions in urban Indian households are 16 times greater than their rural counterparts – almost equalling modern global cities. Affluent urban areas clearly have a much higher responsibility to reduce per-capita emissions. This is why, Pune being the cultural and knowledge capital of Maharashtra, must take leadership role in moving towards net carbon neutrality.

Greater Pune is considered to be one of the fastest growing cities in the Asia-Pacific region. Currently, it is the 8th most populous city in India with approximately 5 million population, which is expected to rise to over 10 million by 2030, with larger PMR growing to 14 million. Pune was once known for its friendly climate, well suited for Pensioners. However, with increasing population and expanding concrete constructions it is getting hotter - requiring air-conditioning systems for comfortable living. Hence, Pune has an opportunity of creating a Climate-friendly neighbourhood by first learning to reduce its per-capita energy demand and simultaneously shifting to Renewables like rooftop solar to become a city with Climate-Smart Development.

The city is well known for its diverse educational and cultural organizations and it also hosts a large number of Manufacturing and IT industries, making it an energy guzzler. Evolving adequate clean energy infrastructure for rising energy demand and for efficient water & waste management can go a long way towards preserving the natural environment. Carbon Neutrality is indeed a tall goal to achieve within 10-12 years; and yet, for Pune region that takes pride in being very pragmatic, it should not be very difficult to become highly climate resilient city, if conducive policy environment is created for the pioneering transformational change desired.

The proposed Pune Metropolitan Region (PMR) is spread across 7,256.46 sq. km. and comprises of two Municipal Corporations of Pune and Pimpri Chinchwad, three Cantonment Boards, seven Municipal Councils, 13 census towns and 842 villages and most of it falls under ‘Greenfield Development’. The Pune Metropolitan Region Development Authority (PMRDA) is set up to facilitate planned growth of infrastructure
and public services, enhance the ease of doing business for domestic and international investors, develop a system of futuristic governance and a market-based economy. The region must promote Green innovation with e-management and digital information dissemination, and generate sustainable employment and wealth creation opportunities for all. It should integrate culture and heritage into the very ecosystem of PMR and consistently promote a higher Happiness Index.

To achieve this, it is important to annually track GHG emissions and prepare an inventory of the current emissions scenario for PMR. This will help to analyze trends and identify potential areas to drastically reduce the region’s Carbon Footprint. These suggestions need to be included in the Comprehensive Development Plan by PMRDA, to adopt low-carbon practices and achieve Net Carbon Neutrality by 2030. The co-benefits of these practices include local income generation, circular economy, less environmental degradation, and pollution.

The city emissions have increased by 12% from 1.46 tonne carbon dioxide equivalent (tCO2Eq) per-capita in 2012 to 1.64 tonne in 2017, just within 5 years. This rising rate, if not checked in time, will severely affect the environment and contribute to Climate Change. Pune also needs to develop resilience towards impacts of Climate Change, as the city is already witnessing changes like lowering of minimum and rise in maximum temperatures and irregular monsoon. This paper aims to set specific goals for Pune to become ‘Net Carbon Neutral’ by 2030 and develop a pathway to achieve it.

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This is why Pune being the cultural and knowledge capital of Maharashtra, must take leadership role in moving towards net carbon neutrality.
Chapter 2: Carbon Neutrality for Sustainable Future

2.1 Importance of Achieving Carbon Neutrality

CO2Eq emissions are cumulative and the effects of total emission deposited in Earth atmosphere become evident only years later. More the concentration of GHG, more heat-trapping occurs to raise the average temperature of atmospheric air and the ocean waters. In fact, over 60% of the carbon emissions are absorbed by the oceans making them more acidic and making them less efficient for further absorption of CO2. Natural processes are very slow, allowing gradual adjustment processes; but human-induced emissions rates are much faster and nature is unable to adjust. Hence the rate of global warming, although seemingly slow, is today actually much faster than it has ever been in human history. Hence it is important to immediately stop adding more anthropogenic (human-caused) CO2Eq emissions, as soon as possible, to stop further degradation of Earth’s ecosystem.

Although the problem is global and requires global level thinking, it is important to act locally to reduce GHG emissions of urban areas in every possible manner, as that consists of the essential contribution to country level performance. Cities in India will soon support around 60% population and are responsible for more than 70% GDP growth fuelled by heavy energy consumption and thus accounting for over 75% carbon emissions.

Hence, it is all the more important for major cities to take initiative to achieve Carbon neutrality like Copenhagen aims to do in next 3-4 years. A City is a place where the awareness is highest, the activity is maximum, the thought process exists and the city is the place where it can make a difference. Unlike older cities that have small margins for changes, the emerging urban centres like the PMR have the maximum potential for transformational changes. Electricity, water, waste, transportation, constructions, and indeed the overall urban planning for land-use, play a significant role in reducing emissions. Additionally, such regions that encompass surrounding peri-urban areas also have promising potentials for enlarging green cover for effective carbon sequestration to partially compensate the local GHG emissions.

It is in this context, that this report presents an analysis of sector-wise opportunities that can be leveraged for, designing for low-carbon development, focusing on minimizing the per-capita energy consumption combined with per sq.km. sequestration capacity. One promising approach; to be discussed in later section, is the idea of designing Green Townships to absorb the growing urban population, each
striving for self-reliance in energy, water, waste, and transportation issues; so that collectively the region can plan for Carbon Neutrality.

Given the growing concerns of global warming in future, it will be imperative for every new urban centre in India to not only plan for doing its best for mitigation of further warming; but also build resilience for adapting to changes that are beyond the control of individual cities. Planning for ‘Carbon Neutral Development’ must become the new mantra for PMR and other major cities under development. Since much of the planning and construction for 2030 is yet to happen, this offers a unique opportunity for PMR to create a leadership role for itself and become a catalyst for transformational change across India.

For the PMC area, a special purpose vehicle (SPV) has been created for effective implementation of Smart City Plans at a faster pace than typical governmental agencies may be able to manage because of cumbersome rules and norms. The evolving PMR region also must leverage the full authority of the PMRDA, as an independent policy-making authority within the guidelines of the State. For now, an impressive ‘Comprehensive Mobility Plan’ has been prepared for the PMR’s vision for 2030. This is indeed a good starting phase, but there is also a need for evolving an integrated plan for ‘Low-Carbon Economic Development’ vision that can transform the region into a highly climate resilient model for future.

Reducing Carbon Footprint must become the new ‘cool-culture’ for the modern urban citizen, where having a lower carbon signature must acquire a brand value to be sought after. That is the kind of transformation that PMR can strive to achieve. Scope of such a transformation can only be defined only in terms of limits to innovative imagination. If one really wants to work for creating a model PMR in 2030, it should be easy to imagine a technology-empowered smart future where IOT (Internet of Things) will be oriented to provide every modern facility, but with a clear underlying focus on saving energy and conserving nature without compromising the human comfort zones.

Artificial intelligence could be operative at all levels for eco-friendly daily practices and technology will significantly reduce energy wastages by use of video-conferencing and online inert-actions to minimize physical travel. Solar power, with efficient battery storage, would provide 24x7 clean and abundant energy – like the Tesla-Wall systems that are already sold faster than they can be produced!

Modern buildings will have efficient solar charging for the E-vehicles and the charging process could be enabled or monitored through innovative application on Smartphones. Beautiful solar trees and artificial carbon-absorbing trees could line the
landscape to supplement the natural green surroundings; ensuring a level of carbon
neutrality, that can actually accelerate affordable progress for all and add real value to
quality-of-life in the brave new human society; in the backdrop of environment getting
more hostile before it can get better for future generations.

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2.2 Scope and Challenges for Climate Resilient Planning in PMR

While most of the past urban development concentrated on rapid economic growth,
with a more modern lifestyle for enhanced sense of well-being for the citizens, the new
reality of a ‘Climate-Challenged World’ will demand much more attention to
environmental parameters and stricter compliance with environmental protection
codes for all new buildings and structures, whether for domestic or commercial
purposes. All new structures must conform to ECBC Green building codes, that
should seek a healthy contribution of rooftop solar electricity generation, rainwater
harvesting and built-in capacity for effective water and waste management. These will
be crucial attributes of modern Urban centres.

Having discussed the potentials for environment-friendly planning for PMR, it is
important to assess the scope and challenges in the implementation of ambitious
plans. The proximity of knowledge centre like PMC and the IT hub of Hinjewadi, along
with nearby automotive and manufacturing complex around PCMC, makes the PMR
region very attractive for robust wealth generation through rapid economic growth. It would be very natural to put the environment and climate change agenda on the back burner in the atmosphere of vibrant economic progress. Hence it is important to remember that any such delay or neglect of environmental priorities will cause many-fold losses in the future to the same economic aspirations driving progress.

Achieving carbon neutrality, under such circumstance, will require clear long-term attention to real priorities of sustainable growth. Short-sighted policies for a quick return on investment must now change to a more prudent approach for long-term sustainability, in a changing Earth-Ecosystem that will get increasingly hostile. For achieving carbon neutrality under more stressful conditions it would be important to annually track GHG emissions and prepare an inventory of the current emissions scenario in the entire PMR region. This will help to analyze emission sources and trends, and thus, help in identifying focus areas to drastically reduce the region’s Carbon Footprint. To understand the scope of the challenge, we analyzed some available information on PMC and PMR.

**PMC Emissions according to Economic Activity:**

The latest GHG emissions inventory given in PMC Environmental Status Report 2017-2018 gives a detailed account of fuel-wise and sector-wise data according to economic activity. Relating these two, it is seen that in the context of PMC sectors like Residential, Transport, Industry, Commercial, Waste and Water Management involve intense direct use of fossil fuels.

<table>
<thead>
<tr>
<th>Sector</th>
<th>GHG Emissions</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>1,943,342.67</td>
<td>32%</td>
</tr>
<tr>
<td>Commercial</td>
<td>1,104,100.61</td>
<td>18%</td>
</tr>
<tr>
<td>Industrial</td>
<td>1,128,388.46</td>
<td>19%</td>
</tr>
<tr>
<td>Agriculture</td>
<td>18,117.71</td>
<td>0%</td>
</tr>
<tr>
<td>Transport</td>
<td>1,372,700.26</td>
<td>23%</td>
</tr>
<tr>
<td>Others</td>
<td>225,466.14</td>
<td>4%</td>
</tr>
<tr>
<td>Municipal</td>
<td>219,358.6045</td>
<td>4%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>8,040,674.46</strong></td>
<td></td>
</tr>
</tbody>
</table>

Table: Energy Consumption in PMC (From PMC ESR Report 2018)
Rapidly changing Landscape and Diversity in Land-use in PMR:
There has been a rapid change in land-use pattern in PMR and it needs to be planned meticulously for more efficient resource use and better Climate Resilience (Butsch, C., et al. (2017)).
Comparing the fuel-wise consumption with available PMR data from 2008, it is seen that the energy usage within PMR will change according to settlement and economic activity, i.e. PMC in this case. Thus, the strategies adopted to go low-carbon will differ in rural, rurban, peri-urban and urban regions within PMR.

Figure: Fuel-wise Energy Consumption in PMR and PMC

Indirect Emissions:
Scope 1 (direct emissions) and Scope 2 (electricity) emissions are relatively easier to estimate. However, quantifying Scope 3 emissions like indirect emissions is challenging. This could be done to some extent by quantifying the amount of waste production and disposal systems in terms of emissions. But it is difficult to calculate emissions involved in water use, pollution and management. As RCC too has a large Carbon Footprint, it needs to be calculated for the entire region and especially in huge infrastructure projects like the Metro, Satellite cities, etc.

For Example, we tried to roughly estimate organic emissions in PMC and PMR from available data. PMC, with just an area of 331.56 sq.km., generates 2000-2100 metric tonnes/day of waste which already occupies 15 hectares area which is land-filled and has been sealed-off permanently. In 2008, PMR waste production was 1500 tonnes/day. However, with increasing activity, it is likely to be at least 2 ½ times more than PMC i.e. 5000 metric tonnes/day. Thus, the waste volume to be treated annually will be around 18,25,000 metric tonnes.
From PMR data, 45-50% of this is organic waste which means approximately 2500 metric tonnes/day and 9,12,500 metric tonnes/year. If all this goes to landfills, the estimated emission is 40,150 tCO2e/year. Percentage of recyclable waste is 35-40% i.e. 2000 metric tonnes/day, and thus, including management of collection, distribution, and recycling of wastes in the development plan is important. The remaining inert waste which goes to landfills is 10-15% which is around 2,73,750 metric tonnes annually. Thus, emissions from these activities need to be quantified and taken into account while inventorying emissions.

These suggestions need to be included in the Development Plan by PMRDA to adopt low-carbon practices and achieve ‘Net Carbon Neutrality’ by 2030. The co-benefits of these practices include local income generation, circular economy, less environmental degradation, and less hazardous air-pollution.

The real challenge for regions like PMR will be to become the pioneers as successful carbon neutral habitats, that will no longer be treated as agents of slowing down the economic progress but a new formula for sustainable progress for generations.

There has been a rapid change in land-use pattern in PMR and it needs to be planned meticulously for more efficient resource use and better Climate Resilience.

2.3 Enhancing CO₂ Sequestration and Carbon Capture Capacity

Even after reducing Carbon Footprint drastically, some emissions due to urban activities will still persist. Hence, Carbon sequestration (Carbon Negative processes which absorb and store CO2 from the atmosphere) is important to achieve true Carbon Neutrality. The main Sequestration methods include:

- Enhancing the storage of carbon in forests and other vegetation (plant sequestration)
- Restoring and enhancing the storage of carbon in soil (soil sequestration)
- Storing carbon in the ocean (ocean sequestration)
- Storing carbon in underground geological formations (geosequestration)
Subjecting carbon to chemical reactions to form inorganic carbonates (mineral carbonation)

Plants take in carbon dioxide for photosynthesis, and thus, act as natural sinks by removing the main GHG from the atmosphere. Trees do not exist in isolation but have a symbiotic relationship with other organisms in their native ecosystem, and thrive in their natural surroundings. In addition, destruction of forests adds to more CO2e emissions as the sequestered carbon gets released into the atmosphere. Patches of local ecosystem or wilderness need to be conserved and restored to sequester Carbon. Destruction of forests adds to more CO2Eq emissions as the sequestered carbon gets released into the atmosphere.

The Global Forest Watch data reveals that 29% of the carbon stored in trees across the world is concentrated within Intact Forest Landscapes. Those in the tropics are particularly carbon-rich, accounting for 23% of the world’s tree-stored carbon, despite making up just 13% of the world’s total forest area. Secondly, 11% of all global greenhouse gas emissions caused by humans are caused by deforestation — comparable to the emissions from all of the cars and trucks on the planet.

To reach the Paris Agreement goal of reducing economy-wide emissions, countries around the world must manage forests better, and especially Intact Forest Landscapes, to both reduce emissions and increase global sinks. Over the centuries, forests have accumulated vast amounts of carbon, and our climate mitigation efforts must take the same long-term approach towards their protection.

Hence, the most effective and efficient carbon removal from the atmosphere occurs if we have patches of restored local forests and ecosystems rather than manicured patches of plantation or garden. Conserving ecological habitats and maintaining stringent pollution and emission standards in and around PMR will play an important role in achieving true Carbon Neutrality for PMR. This includes conserving the patches of forests, all water-bodies and wetlands, migration corridors and protecting traditional conservation practices like Sacred Groves that already exist. The Cost of preserving or restoring forests are very low, and there are minimal environmental impacts. We also need to create new patches in open spaces and water bodies across the cities and settlements.

The total PMRDA Area is 764200 hectare; out of which only 22% i.e. 172000 hectares is under forest cover. An additional area of just 14000 hectares is proposed to be added in future. This will capture 9,30,000 tCO2eq/year, considering higher estimates applicable to forests. The additional cover under green belt and vegetation may
Sequester around 1,00,000 - 1,50,000 tCO2eq/year. These proposed measures account for just about 1&1/2 times more than current PMC Carbon Footprint, and hence, are definitely inadequate to offset even current PMR Carbon Footprint.

The biggest advantage of increasing forests for carbon sequestration capacity is that there are so many environmental benefits from forests that it would be worth increasing them anyway - even if they weren't so effective at sequestering carbon. Although, forests alone can't sequester all of the excess carbon added by burning fossil fuels, they can make a difference, especially if we help and encourage them and promote stewardship of private forest lands. Wisely managed forests can sequester carbon and also provide a sustainable source of fuel and lumber, help clean our air and water, preserve wildlife habitat, provide recreation opportunities and preserve the beauty of trees in their natural home for generations to come.

Thus we need to prioritize to prevent emissions from deforestation and for Offsetting emissions using natural carbon sequestration; which is self-regulated, highly efficient and low cost. Following actions will play an important role to prevent Environmental Degradation, loss of Biodiversity and developing Climate Resiliense and Carbon Sinks in PMR.

- Implement Environmental Laws including BDP strictly and prevent pollution and encroachment
- Reduce unnecessary deforestation and add forests especially in urban areas
- Increase sustainable forest management and conserve local knowledge practices
- Increase native trees and wilderness and discourage exotic tree plantations
- Conserve, Restore and protect ecological habitats in and around Pune like forests, grasslands, lakes, rivers, and wetlands to reach ideal 33% forest cover
- Conserve Watershed and improve monsoon tracking for better resilience
- Protect Soil on open patches and leave open soil intact in Public areas and roads

Even after reducing Carbon Footprint drastically, some emissions due to urban activities will still persist. Hence, Carbon sequestration (Carbon Negative processes which absorb and store CO2 from the atmosphere) is important to achieve true Carbon Neutrality.
2.4 Next-Gen Technologies to help achieve Carbon Neutrality

There is a constant search for advances in technologies for expanding the options for cleaner sources of energy, so that, future generations may have access to abundant energy essential for human development and progress. There are also innovative approaches evolving for removal of carbon dioxide from the atmosphere at a scale that can ensure net-carbon neutrality even for high energy consuming societies. All these represent ‘Next-Gen’ technology promises for future generations.

Carbon dioxide capture and storage (CCS) is the capture and secure storage of carbon dioxide (CO2) that would otherwise be emitted to the atmosphere. Currently, the major CCS efforts focus on the removal of carbon dioxide directly from industrial or utility plants, and subsequently storing it in secure geological reservoirs. The rationale for CCS is to enable use of fossil fuels while reducing the emissions of CO2 into the atmosphere, and thereby mitigating global climate change.

CO2 capture processes from power production fall into three general categories: (i) post-combustion capture; (ii) oxy-combustion capture; and (iii) pre-combustion capture. The first two categories are compatible with the existing pulverized coal (PC) power plant infrastructure that relies on the combustion of fossil fuels. The last category is generally reserved for incorporation into an integrated gasification combined-cycle (IGCC) power plant.

There are many promising incremental innovations like “Perovskite solar cells” that will operate at 28% efficiency and also provide flexible solar panels for wider applications, about to enter the market within this year, 2019. The ‘TESLA Wall’ energy system with solar roof-tiles and wall-mounted battery storage systems are already fast selling in California homes, for 24x7 high-quality solar power in stand-alone mode. Other innovations include foldable solar-trees that are portable and provide higher output per-square-meter Footprint. Istanbul is already testing mini-towers of “Vertical Fin Wind-mills” that rotate with fast-moving traffic on highways.

With the fast pace of battery storage technology, distributed power generation opens up a vast new horizon for 100% efficient utilization of clean power at even remote locations. Such solutions will also be important for the charging of E-Vehicles which otherwise may charge their batteries from Grid power, and thus, increase the grid-load and consequent emissions. Hydrogen energy is another futuristic option for producing abundant clean energy and hydrogen-powered cars already being used in some states like California. Its generation and storage is still not cost-competitive. As user base increases, the costs will get affordable, particularly in Auto-industry.
Nuclear energy is a proven clean energy option but in India, it is not popular due to its perception as environmentally hazardous and even life-threatening in the event of an accident. The technology has made significant progress and developed the generation IV nuclear reactors are much safer. The close loop fast-breeder reactors and tested in India offer attractive benefits like much less radio-active waste and far safer operations. But India is yet to leverage this option for lack of political will. Given the more adverse impacts of climate change in the near future, this technology option deserves a serious re-look for India specific solution. – These are indeed options that cannot be available for a local government to deploy, but spreading correct awareness always can help decision making at State or National level.

Other benefits of technological innovations for ‘Net-Zero’ emission solutions include artificial sequestration or direct removal of GHG gases from the atmosphere. Scientists have designed a synthetic tree that traps carbon dioxide from the air in an attempt to combat growing emissions. The device can collect carbon about 1,000 times faster than a natural real tree. One synthetic tree could absorb one ton of carbon dioxide per day, and after being trapped in a chamber, the carbon would be compressed and stored in liquid form for sequestration. Artificial trees are made from a special resin – a unique plastic that sponges up CO2 from the air in a chemical reaction. When the resin is dry, it has an exceedingly high affinity to carbon dioxide. And when the resin is submerged in water, it releases the carbon dioxide.

There are also ‘Negative Emission Technologies’ emerging that could be crucial to reaching “net zero” carbon emissions – the point where any climate pollution we add to the atmosphere is balanced by what we take out. A key challenge is getting to scale. It is estimated that to meet its climate targets, the world will need to remove as much as 10 G-Ton of CO2 from the atmosphere each year by mid-century – nearly twice the current annual emissions in the U.S. alone, from burning fossil fuels. Pricing emissions through a carbon tax or an emissions trading system creates an economic incentive for cheaper, faster ways to cut pollution. Many such solutions are evolving for the future. For the next generations of human civilization that will have to face a more hostile environment, technology and innovations will have to provide new solutions for problems not even visible now.

There is a constant search for advances in technologies for expanding options for cleaner energy sources so that future generations may have access to abundant energy essential for human development and progress.
Chapter 3: Pathway to Achieving Carbon Neutrality for PMR

3.1 Enhancing Efficiency and Reducing Energy Demand

Energy efficiency is essential for sustainability as it saves not only money but also helps the environment. Cities are important engines for economic growth and socio-economic development. Rapid urbanization in recent decades has led to ever-expanding cities, creating massive energy requirements to promote growth and expand basic service infrastructure.

Energy is widely viewed as the life-line of cities, powering public services, hospitals, and schools while moving people within the city and beyond. Against this backdrop, many cities struggle to meet the growing energy demand and reducing energy use through efficiency measures. Improved urban planning can lessen a city’s dependence on imported fuels and reduce energy costs, freeing up resources for improved city services and socio-economic benefits.

Energy efficiency improvements in the urban context should take a holistic approach of both supply and demand side measures across all sectors. Cities require locally customized approaches for developing sustainable energy strategies, and require finances for evaluating investment options, and for monitoring and implementing well-planned programs. PMR starting with the planning phase has huge potentials through an ‘Energy Efficient City Initiative’ model approach to focus on--

- Diagnose Inefficient Energy Use and Offer Solutions. Cities must develop tools to review a city’s existing systems for overall performance; identify sectors where the most improvements can be made and provide a list of policy recommendations, practical actions, and investment options to save energy and lower costs. This can mainstream good municipal energy management practices and scale up energy monitoring and also help in targeting water and sanitation utilities.
- Share Good Practices and Reward Innovation by establishing an online database to share good practices from all city sectors and promote targeted publications on global good practices in public procurement, building codes, sustainable transport, and other areas will also be developed and disseminated.

India remains one of the few countries with rapidly growing power demand, and its total electricity consumption is projected to increase fourfold between 2015 and 2040.
It, thus, becomes crucial to reduce demand (wherever possible) and increase energy efficiency to reduce losses which lead to high amount of emissions. This requires–

- Improving Energy Distribution - Energy distribution should be made more equitable, and the supply quality must improve to reduce the use of inefficient alternatives. Along with this, improving end-use efficiency by using modeling, optimization and suitable technologies, and methods reducing demand for electricity, is required.

- Adapting Energy Efficient Appliances and Processes, and rejecting Energy-intensive ones - Only the efficient devices requiring less wattage and having good Bureau for Energy Efficiency (BEE), GOI ratings should be used at all levels. It is also necessary to set minimum standards; below which, any appliance or process will not be permitted to be commercially sold. Simultaneously, Phasing out sales of energy-intensive appliances like Diesel Gen-Sets & incandescent lamps with supply-side incentives will help to reduce tCO2eq emissions.

- Installing Smart-Metering will give better real-time estimates of daily usage and peak times and hence help in better load distribution, data collection, billing, and monitoring.

Reducing energy demand, particularly in cities, will be a major vehicle for all attempts to achieve net-zero carbon culture in future societies. As is famously said – Earth has all resources for everyone’s needs but not for everyone’s greed. The industrial revolutions have brought-in the business culture of ‘maximum profits in the next quarter’, no matter what the consequences be to less influential human societies or the environment. This kind of un-satiable greed or limitless growth ambitions is no longer sustainable.

The modern innovations in information technology have great potentials for reducing energy demand through many measures such as video-conferencing to minimize physical travel for a business transaction. The simple growing practice of digital money payments across India is already saving significant amounts of energy and human resources. The future spread of Robotics and Artificial Intelligence (AI) can revolutionize the energy demands of future societies, if planned properly with energy conservation as the ultimate aspiration.

Enhancing energy efficiency and reducing energy demand will be the most critical aspect of achieving carbon neutrality for future civilization.
3.2 Rapid Transition to Clean Energy Sources (Solar / Wind / Bio-Gas)

Rapidly replacing fossil fuels with Renewable Energy sources is a priority for effective reduction of CO2Eq emissions. Choosing rightly from several alternatives like Solar and Wind energy, Hydropower, Bio Gas, etc. can help to simultaneously meet our energy needs and climate targets. In the context of PMR, Solar Photo Voltaic (SPV) power has the maximum potential to be effective. SPV costs have come down over 300%, in the past decade, thanks to technology improvements and global market expansion. Following measures will help in making it more market competitive-

Distributed Solar Power (DSP)

- Industry, academia, media, and government should build public confidence in Distributed Solar Power (DSP) with Batteries, and highlight its benefits over grid electricity in terms of high efficiency and ease of quick deployment. Procedural norms and the steps for change-over to DSP need to be simplified to encourage users to install them.
- Eventually, with the introduction of E-Vehicles, charging stations should make provisions for Solar Charging to reduce fossil-fuel-based emissions.
- Implementing Net-Metering in a grid-connected mode removes the need of storage battery and thus further reduces the cost, but procedural issues persist with MSEDCL, who have yet to modify their distribution networks for easy two-way connectivity with competitive tariffs. The potential is large for PMR.
- All government buildings and street lights must be powered by Solar Energy, leading to major saving in power-bills while also reducing CO2Eq emissions. Every 1000 KWh of power from fossil fuel saved by Solar, amounts to 940 tonnes of emissions – almost one Kilo-tonne of GHG given our system inefficiencies.
**Net-Metering**

- Implementing Net-Metering with simpler procedures plus competitive tariffs and increasing Power Purchase Agreement (PPA) confidence, will encourage consumers to opt for Solar Power
- Few alternative Models or Schemes to increase the use of Rooftop Solar, like RESCO, should be introduced together, to let citizens choose one that suits them best
- All PMC buildings and street lights should be powered by Solar Energy to serve as effective working examples of using solar power, and to reduce emissions by municipal activities

**Incentivizing the use of Clean Energy**

Functionality and Percent use of Renewable/Clean Energy should be monitored when giving subsidy, and the subsidy or incentive must be proportional to energy generation, and independent of installed capacity. As a major contributor of carbon emissions; the electricity sector, with its over 70% dependence on coal-powered generation plants in India, has the maximum potential for emission reduction through rapid shift to Renewable Energy (RE), like Solar or Wind; in ‘Distributed Generation’ mode using smart micro-grids (wherever possible). This is what PMR can very easily do along with efficient LED installations for major savings. In fact, PMC already is a one of the city recognized for ‘Maximum Solar City’ performance; and that experience can help PMR to expand the Solar use for maximum benefits.

Taking the 2018 ‘Environment Status Report’ (ESR) of PMC as a reference, the per-capita emission of PMC was estimated to be 1.64 tonnes in 2017 and for an estimated population of about 3.66 Million, the total emission of Pune would be about 6,011474 tonne or 6,011 Kilo-tonnes. From this, one can roughly estimate the per-capita emission for PMR at the same 1.64 tonnes CO2Eq in 2030, given that growing Solar, etc may limit the per-capita polluting-energy consumption significantly for the region. Within such an assumption, and for an estimated population of 14 Million for PMR by 2030, total emission could be about 19.6 Mega-tonnes/year. This would be the annual carbon sequestration capacity of the region for achieving “Carbon Neutrality”.

This above is just a sample calculation for highlighting the benefits of Renewable Energy towards taking PMR to Carbon Neutrality. It also indicates how much more of green cover the region must develop for carbon sequestration to approach Net-Zero! This is why rapid spread of roof-top solar and introduction of E-vehicles with Solar charging will be a must for PMR, to perhaps; half the target for emission absorption, making it within reach of PMR, as an independent entity for carbon neutrality considerations. Sharp drop in the cost of solar panels, and the associated equipment
has made Solar power very competitive with grid electricity and it is now 4-times cheaper than Diesel Gen-set.

India has performed fairly well in adopting solar and wind power with about 20% of national power requirement coming from just solar and wind (by 2018). The National target of 200 GW from Wind and Solar by 2022 still looks rather tall, but not impossible. Of this total 200, the roof-top solar target is 45 GW, while total to date is just ¼. This represents a huge opportunity for PMR to aggressively spread SPV in the region. Hence, switching to solar or wind power has become really a ‘win-win’ opportunity, and PMR can easily aim for generating over 75% of electricity from renewable clean energy sources. Solar power via local distributed technology should meet both the regular electric power supply needs, and also, meet the new additional requirements for charging of E-Vehicles. This would greatly help in taking the PMR region towards carbon neutrality.

The technology of bio-fuel is also an attractive option in reducing carbon emissions; as it does not add to atmospheric carbon, provided it is burned fully for energy. The process can also use raw organic waste which otherwise would release Methane, which is a GHG far more potent than CO2. Bio-gas generation has very good potential for converting waste to energy in PMR with surrounding peri-urban regions, and this must be leveraged innovatively towards reducing Net emissions.

Rapidly replacing fossil fuels with Renewable Energy sources is a priority for effective reduction of CO2Eq emissions. Choosing rightly from several alternatives, like Solar and Wind energy, Hydropower, Bio Gas, etc. can help to simultaneously meet our energy needs and climate targets.

### 3.3 Emission Reduction in Transport Sector

Transport has been identified as one of the major contributors to GHG emissions globally, and can be one of the top contributors in urban areas. Any attempt to limit the GHG emissions of a city must focus on moving away from fossil-fuel based private modes of transport, towards modes that are either zero or low emission modes measured on a per passenger km basis.
Some guestimates from RTO data, show that the maximum emissions in PMC are caused by private modes of transport and Trucks and Lorries.

<table>
<thead>
<tr>
<th>Vehicle Type</th>
<th>No. of Vehicles</th>
<th>TCO2e %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cars</td>
<td>537613</td>
<td>22%</td>
</tr>
<tr>
<td>Motor Cycles</td>
<td>1750171</td>
<td>21%</td>
</tr>
<tr>
<td>Trucks and Lorries</td>
<td>33408</td>
<td>19%</td>
</tr>
<tr>
<td>Scooters</td>
<td>523698</td>
<td>8%</td>
</tr>
<tr>
<td>Delivery Van (4 wheelers)</td>
<td>42467</td>
<td>7%</td>
</tr>
<tr>
<td>Articulated/ Multi</td>
<td>7032</td>
<td>3%</td>
</tr>
<tr>
<td>Moped</td>
<td>195691</td>
<td>3%</td>
</tr>
<tr>
<td>Luxury Tourist Cabs</td>
<td>21158</td>
<td>3%</td>
</tr>
<tr>
<td>Delivery Van (3 wheelers)</td>
<td>31920</td>
<td>3%</td>
</tr>
</tbody>
</table>

Table: PMC Vehicle-wise Emissions

A city must achieve a maximum modal share (percentage of people using a particular type of transport) of public transport and non-motorized transport to reduce its GHG emissions. In contrast, encouraging personal modes of transport will tremendously increase GHG emissions with rising economic levels. Unregulated increase in number of vehicles causes massive traffic management issues, increases pollution and also leads to congestion and traffic rule violations.

Regulations in the European Union, the United States, and Japan have reduced vehicle emissions of conventional pollutants by about 99%, at a cost to the consumer of roughly $ 500 — or less than 2% of the average cost of a new gasoline-fueled car. According to the U.S. Environmental Protection Agency, the social benefits — such as reducing premature deaths, respiratory ailments, and crop damage — outweigh the manufacturing costs on the order of 2-5 times.

The co-benefits associated with sustainable modes are improved air quality, travel safety, lower expense on commuting and democratizing citizens by slowing people down and increasing their mutual interaction. These objectives can be achieved using the following measures. (More details given in Annex III)

- **Encouraging the use of public transportation**
  - Drafting out a Metropolitan multi-modal transport structure
  - Increasing tracks for local train routes
- Rapid Improvement in Bus Transport by improving benchmarks, increasing frequency and number of rides, starting BRT routes and strategizing route maps for ease of access and better connectivity

- **Provisioning for Last Mile Connectivity through services like cycle and E-rickshaw**
  Cycle sharing is a flexible form of personal public transport. Cycles are stored in a closely spaced network of stations. With a smart card or another form of identification, a user can check out a cycle from a station, use it for a short ride, and return it to any other station.

  E-rickshaw is an eco-friendly alternative to the current LPG or Diesel based options that are currently available. The use of rickshaw will not only reduce CO2Eq emissions but also substantially decrease the levels of sound pollution as well.

- **Reducing the use of motorized vehicles**
  - Banning vehicles with Bharat Standard III or below.
  - Introducing Superblocks across the city

- **Incentivizing the use of Electric vehicles**
  - Parking Incentives
  - Access
  - Infrastructure
  - Direct Incentives for Vehicles

- **Taxing carriages and trucks entering the city, especially the ones below BS III passing**

- **Setting up a Sustainable Transport Committee that prioritizes emission reduction**
  A Sustainable Transport Committee should be instated to monitor and coordinate the planning and implementation of urban transport programmes and eliminate overlapping functions, ensure adequate provisioning of the budget for all modes and integration of transport modes, fare integration, research and awareness. It should play an important role in achieving user-friendliness, last-mile connectivity and reducing pollution including GHG emissions; simultaneously.

A city must achieve a maximum modal share (percentage of people using a particular type of transport) of public transport and non-motorized transport to reduce its GHG emissions.
3.4 Emission Reduction in other Sectors / Activities

Buildings and Construction:
It is estimated that at present, buildings contribute as much as 1/3 rd of total global GHG emissions, primarily through the use of fossil fuels during their operational phase. Infrastructure sector is a key driver for the Indian economy. The building sector in India consumes around 33% energy, with commercial sector and residential sector accounting for 8% and 25% respectively. It is also estimated that 70% of the building stock in India, that will exist in the year 2030, is yet to be built. Buildings have a relatively long lifespan, and therefore actions taken now will continue to affect their GHG emissions over the medium-term. Some effective strategies to reduce emissions in this sector are as follows-

- Designing Strong Code for efficient buildings
- Focusing on New Infrastructure
- Mandate Industrial and Commercial Sector to go Low-carbon
- Use Climate Friendly Design in all upcoming constructions
- Encourage and Incentivize “Carbon Neutral Buildings” and infrastructure projects

Waste Management:
Waste Management and Circular Economy are important in reducing the Carbon Footprint of cities in rapidly industrializing countries like India. Minimizing the waste generation by improving the efficiency of use, and streamlining material flows is a must. Along with this, wastes must be properly segregated at source, for each type of waste there are various options of management, either at source, at the cluster level (e.g., gated community or municipal ward) or at the city level.

Today, the choice of an option is driven by convenience and economics, but lifecycle GHG emissions of the waste management process should also be a consideration. Although, provisioning for some of the following measures already exists, improvisation and increasing the efficiency and scale of these activities is crucial to make changes urgently.

Soil Management:
Soil currently offsets about 15% of agricultural greenhouse gas emissions. Soil organic matter (SOM) is composed of soil microbes including bacteria and fungi, decaying material from once-living organisms such as plant and animal tissues, fecal material,
and products formed from their decomposition. SOM is made of organic compounds that are highly enriched in carbon. Soil carbon storage is a vital ecosystem service, resulting from interactions of ecological processes.

Human activities affecting these processes can lead to carbon loss or improved storage. Since the industrial revolution, the conversion of natural ecosystems to agricultural use has resulted in the depletion of Soil Organic Carbon levels, releasing 50 to 100 GT of carbon from the soil into the atmosphere!

**Water Management:**

Water management faces pressures like stricter water-quality standards, increasing demand for water and the need to adapt to Climate Change while reducing emissions of greenhouse gases. Currently; all used processes, for uplifting, distributing and treating of fresh water and wastewater, demand energy. Energy use in the water sector is growing, yet its importance is under-recognized, and gaps remain in our knowledge. Hence, there is a need to integrate energy use further into water resource management, and identify opportunities for the water sector in reducing CO2Eq emissions.

All natural water systems also play an important role in Carbon Sequestration. Wetlands occupy only 6% of the world’s land, but 14.5% of the world’s soil carbon is found in wetland soil. Currently, oceans take up 1/3rd of the carbon emitted by human activities, which is roughly 2 billion metric tonnes / year. (More details in Annex IV)

**Waste Management and Circular Economy** are important in reducing the Carbon Footprint of cities in rapidly industrializing countries like India. Minimizing the waste generation by improving the efficiency of use and streamlining material flows is a must.
4.1 Integrated Planning for Land-Use and high Climate Resilience

Land-use Planning can serve as a very effective instrument to build climate-friendly cities, and consequently slowing down the process of climate change. Creating awareness about the fulfilment of entitlements, and prioritizing implementation of norms useful to mitigate our carbon footprint is important to reduce the city’s emissions.

Ensuring consistency across the economic, social and environmental dimensions of development policy is a core challenge in achieving sustainable and low-carbon development. This can be achieved by using the right methods and technology to reduce losses during distribution, increase energy efficiency with modelling and strategic planning, and monitoring and punishing exploitation of resources. Hence, the use of relevant science and techniques and educating and developing the values and beliefs of sustainability and low-carbon infrastructure, especially amongst the Planners, will be crucial in determining Urban Development.

The PMR occupies a huge area with diverse settlements including urban, rural and peri-urban regions. From an environmental perspective; the peri-urban interface can be characterized as a heterogeneous mosaic of “natural” ecosystems, “productive” or “agro-” ecosystems and “urban” ecosystems; affected by the material and energy flows demanded by urban and rural systems. Geographical and administrative boundaries prevent a strategic approach to environmental planning and management of these regions.

![Figure: Processes of Change in Peri-urban regions](image)
Efforts to build resilience to climate impacts – from more frequent droughts and stronger storms, to changing rainfall and failed harvests – aim to ensure that families, communities and governments can manage and bounce back from them. Sound development policies are needed to build climate resilience by building people’s resilience to socio-economic and climate-related shocks. Policies must lead the way towards achieving the kind of transformations required to build Inclusive and Climate-resilient Societies. Sometimes, just making citizens and not just planners, more aware of the growing risk of shocks, and that, something can be done to prepare, helps in disaster risk reduction and disaster management.

The challenge is centred on the adoption of national policies which will, within each country’s context and constraints drive efforts towards poverty eradication, human development, and climate resilience. Those who are the most exposed and vulnerable are also the ones who are already economically and socially disadvantaged and the least likely to have access to support systems. Thus, the in absence of government support, even small changes in temperature or rain and wind patterns can push people into poverty traps. Climate Resilience demands that social, economic and ecological systems become capable of reorganizing, so as to maintain their essential functions, identity, and structure; while also maintaining their capacity for adaptation, learning and transformation. The PMR covers the mountainous region, river basins and plateau region. Hence building resilience becomes crucial for economic success.

Planning must involve the following processes and specific solutions to achieve the required targets.

- Map environmental assets, land-use, and risks & natural resources regularly to determine emission-reduction targets, climate change adaptation measures and time frames for the climate neutral transition
- Evolve a Climate Action Plan with 5-year Time-frames for Climate Mitigation & Adaptation up to 2030 and beyond
- Enhance Climate Awareness for the urgency of Climate Action at all levels
- The Carbon Footprint for essential infrastructures serving cities should be calculated using accounting methods which include Scope 3 emissions like the Trans-boundary Infrastructure supply chain Footprint (TBIF) tried in Delhi. (Chavez, A. et al. (2012))
- Use traditional knowledge practices, like Sacred Groves which serve as seed banks for native vegetation
- Include continuity of local vegetation and animal corridors, using landscape matrix studies, in development plans
• Promote, develop, safeguard or retrofit green and blue infrastructure (for water management) while improving grey (hard) infrastructure to address biodiversity outcomes
• Restore, enhance and conserve ecosystems and corridors, especially forest cover on slopes of Western Ghats and in Catchment areas using landscape planning for better Climate Resilience
• Plant native trees or retain naturally occurring grass patches along Roads and increase tree density/wilderness in building premises. Palms may be planted additionally but only native woody medium or large-sized trees should be used for plantations and gardens.

Ensuring consistency across the economic, social and environmental dimensions of development policy is a core challenge in achieving sustainable and low-carbon development.

4.2 Creating ‘Green Township Clusters’ for future Urban Expansions

Satellite townships and Peri-urban regions, around cities, have a key role to play in the transition towards sustainability. All over the world, cities are rapidly expanding and experiencing radical social and economic transformations, especially in such regions. This results in complex challenges both globally and locally.

Pune itself is expanding at an exponential pace to soon become a global metropolitan city to be known as Pune Metropolitan Region (PMR), that may hold over 13-14 Million population by 2030. A major reason for such a steep influx is job opportunities and urban facilities. Most migrants that move to the city, however, are a challenge due to their poor economic conditions and another problem that exists is their minor training, except some basic human skills. The challenge is further aggravated by lack of government planning which leads to the formation of urban sprawls, illegal slums and hawker zones. The development of planned green townships could also help bridge the growing social, ethnic, cultural and economic divide between urban and rural populations.
One possible solution is distributing the urban influx into modular small townships.

To reconcile the seemingly intractable problems created by the conventional relationship between cities and suburbs: congestion, pollution, skyrocketing housing costs, hyper-gentrification, reduced diversity in city centers, and affordability, acute divide in public school quality, what is proposed is a green township system. Each green township would provide the basic affordable facilities to ensure that the large population of migrants/residents is provided affordable housing, healthcare, and other basic facilities without compromising on the environmental sustainability aspect of the city.

- Develop self-sufficient green Satellite cities/settlements, each housing 75,00,000-1,00,000 people, with public facilities planned in advance and built proactively with the vision.
- Each township must insist on energy efficient appliances and LED lights for indoor/outdoor lighting - backed with solar micro-grids. Distributed power generation can leverage RE to the maximum for a high degree of electricity independence.
- Rainwater harvest can complement township water reserve. Optimum linkage to nearby water-bodies should be planned for an adequate supply of drinking water even during lean monsoon years. Harvested water should be used for recharging groundwater.
- On-site STP (Sewage Treatment Plant) must be mandatory to ensure zero soil pollution. Wastewater can be suitably treated and re-circulated to irrigate nearby farm-lands designed for organic farming to supply vegetables, fruits etc.
- Educational and vocational training centers including soft-skills centers should be planned for groups of 2 or 4 blocks along with Shopping centers, Cinemas, Malls, etc. E-learning must be encouraged with affordable internet access to ensure world-wide connectivity, and TV and Radio should be used for enhancing awareness.
- Apart from that, include development of efficient, ecologically responsible and compact mixed-use communities with walkable, bikeable and transit-oriented transport reducing vehicle miles traveled.

To ensure quality, ensure the design, and maintenance of residential, commercial and public buildings with gradually improving green building standards. Some desirable approaches could be the following:
• Construct all new government buildings showcasing green guidelines, even if low-cost
• Designate and incentivize near-zero energy townships and development zones
• Progressively incorporate improving green guidelines in development regulations
  Promote town and customer utilized renewable energy based on local resource availability, including
• Establish clean and efficient public/private transportation services interconnected with neighborhood, with no-emission pooled vehicles, and using locally produced renewable fuels

Lastly, multiple townships could be designed, as clusters, to establish management frameworks for the effective operation of urban infrastructure and services, and develop frameworks for continuous improvements in the plans based on the performance of actual systems.

The peri-urban region in PMRDA will have diverse economic activities, and any attempt to classify it into solely urban or rural strategies or development plan will not be successful. Hence, planning in these rapidly developing areas must be strategic rather than comprehensive and take into consideration the local environmental, social, economic and cultural characteristic. It should focus on the fulfilment of normative entitlements like maintaining natural-to-built environment ratio, considering carrying capacity of the area being developed, availability of water and land to provide for the acceptable density of population per unit of Planning.

Develop self-sufficient green Satellite cities/settlements, each housing 75,00,000-1,00,000 people, with public facilities planned in advance, and built proactively with the vision.

4.3 Changing Lifestyles for Low-Carbon Economic Development

The concept of low carbon development has its roots in the UNFCCC adopted in Rio in 1992. Low-emission development strategies (LEDs) / low-carbon development strategies / low-carbon growth plans are generally used to describe forward-looking national economic development plans or strategies that encompass low-emission and/or climate-resilient economic growth.
Yuan, H. et al (2011) define Low carbon development by dividing it into three phases, including low-carbon economy, low-carbon society, and low-carbon world. Thus, policies to reduce GHG emissions, exploit low-carbon energy, and ensure economic growth need to be structured to suit this transition. (Additional Notes in Annex II)

**Low-Carbon Economy:**
Introducing economic signals for low-carbon practices, then letting the market find the cheapest way accelerates Low-carbon development. Economic signals, such as a price on carbon, do not require governments to intervene in individual sectors, choose a particular technology, or dictate consumer behaviour. Building the confidence, that implementing environmental protection measures also attracts investors amongst industries and commercial ventures, is necessary. Carbon accounting is an essential requirement for firms, particularly in light of increasing awareness of risks associated with GHG emissions in a climate-challenged future, and will likely become necessary due to government legislation. A company must look at its overall environmental responsibilities and accurately gauge and measure carbon production and emission caused by its very existence.

Financial data must be directly linked through lifecycle assessments enabling action to be taken to help reduce greenhouse gas emissions. Wide participation by firms in activities in the area of carbon accounting, emission reductions and reporting can send a strong signal that industry is proactively engaging in the climate change dialogue and response process. Such activities will contribute towards the political process through analysis and reporting.
**Low-carbon Society:**
As consumers and citizens, individuals should support low-carbon and eco-friendly measures through investments and support relevant campaigns like conserving ecosystems, pressurizing City/State to improve conditions for sustainable modes of transport like walking, cycling, and public transport, disinvesting from fossil fuels and plastics, etc. The society will play an important role in the low-carbon transformation and changing development priorities to achieve meaningful Climate Action. Some decisions that encourage low-carbon practices are-

- Reduce avoidable energy demands & Change Lifestyle to consume less so as to not compromise the environment for comfort
- Invest only in low-carbon goods and services and in companies supporting them
- All individuals and organizations must plan and use Refuse, Reduce, Reuse and Recycle strategies to avoid wastage and emissions
- Citizens can reduce wastage by buying less and giving away all consumables some time before expiry
- Consumers should be on a watch of the available renewable and clean energy technologies and push for their implementation
- Explore Reused Goods Sellers and Stores to reduce the production of goods
- Buy only the properties that assure Green Infrastructure such as Solar Water Heating, Organic Waste composting mechanism, Common lighting on Solar PV, Green on ground, insulation for the roof if buying the topmost flat etc.

**Low-Carbon World:**
Transition to Carbon Neutrality will provide a unique opportunity for India to leapfrog technologies and avoid going down the same carbon-intensive development path that today’s industrialized countries followed, thereby reducing serious air pollution problems and economic and security risks associated with reliance on fossil fuel imports. It will allow India to reap the economic benefits as a leader in rapidly growing global green energy markets.

**Transition to Carbon Neutrality will provide a unique opportunity for India to leapfrog technologies and avoid going down the same carbon-intensive development path that today’s industrialized countries**
4.4 Creating Framework for Enhancing Citizen Participation for effective Implementation & Monitoring

Awareness about the growing menace of global warming and the serious impacts of climate change is alarmingly low, despite many early indicators of extreme weather events around the world. There is, even less clarity, about what urban communities and local citizen groups can do to help. It is ironic that there is little appreciation that – the investments needed today for timely action at various levels to prevent debilitating climate impacts, could actually save many more millions that would have to be spent for recovery from unprecedented climate-induced disasters and losses in future. This Framework must prioritize on significant actions at all execution levels and include guidelines or targets to be reached rather than specific actions.

India is a developing economy with a rapidly upcoming infrastructure and dynamic economic growth. In the presence of large development gaps and incomplete markets, public policies have an important role to play in creating the incentives and regulations capable of increasing provision by the private sector of the goods and services (including their accessibility) that facilitate low-carbon development. Creating the incentives needed to expand access to credit and insurance markets is an example of government activity that will play an important role in empowering people to adopt climate-friendly lifestyles. At the same time, social processes and institutions need to be flexible enough for learning climate mitigation, adaptation, and resilience with regard to development planning.

Involving all stakeholders including citizens in the decision-making process is important to meet Climate Targets within the next decade. Empowering people will not only help in better implementation of policies but it will also facilitate their improvement with inputs from the users or beneficiaries. Hence, we need to enhance processes and capacities for integrated and participatory development planning. This may also be achieved with promotion, incentives, and mandates like-

- Evolve ‘Pledges’ to do with less Resources and start awards and recognition for citizens accomplishing them
- Prices affect decisions about technology and behaviour and these reinforce each other, thus incentivize a reduction in energy use and fuel use per household and institute high cost for heavy users of energy, especially electricity.
- Mandate ECBC codes, Maximum RE generation and Climate-Friendly design for all new constructions
- Help citizens develop a mature understanding of cause and effect cycles and optimize at every level to reduce emissions
• Encourage Voluntary Carbon and Energy audits in all businesses and commercial ventures to understand the energy use and then take respective actions to reduce CO2Eq emissions

• Make all celebrations and festivals low-carbon events

• Conserve ecological habitats and maintain stringent pollution and emission standards in and around PMR

• Involve traditional and local knowledgeable people when preparing development plans for peri-urban regions

• Establishing Platforms for analytical assessments and informed dialogues between stakeholders will help the development of more effective interventions

• Conduct Public Meetings for PMRDA master plan currently being prepared

• Increase awareness about right nutrition and encourage low-meat diet (wherever possible) to reduce Carbon Emissions from the meat industry

• Terrace farming, gardens, avenue trees and patches of wilderness also contribute to local food availability – indirectly reducing the emissions on account of transportation needs from a distant source

• Encourage rooftop or balcony gardening and well-planned local tree-planting drives for reducing the heat-islanding effects so typical to modern cities. This can not only help reduce the energy use for cooling and air-conditioning purposes but also maximise the potential of every square meter of usable area for carbon sequestration

Involving all stakeholders, including citizens, in the decision-making process is important to meet Climate Targets within the next decade.

Empowering people will not only help in better implementation of policies but it will also facilitate their improvement with inputs from the users or beneficiaries.
Chapter 5: Recommendation for Climate Actions and Advocacy

5.1 Introduce a ‘Carbon Neutral Policy Framework’ and evolve Procedural Reforms necessary for aggressive Implementation

Environmental planning and management of the Peri-urban regions to be integrated into the PMR region should be sensitive to the specific local environmental, social, economic and institutional aspects. The urbanization process should not cause any disruption to the eco-system of the new villages being included in PMR.

Planning should be focused on long-term goals, but it should also be an iterative, flexible and participatory process. PMR can emerge as one of the first cases of “planning for carbon neutrality” as the underlying priority. Hence this also opens up an opportunity for creating a new and pioneering ‘Carbon Neutral Policy Framework’ for an integrated approach to low carbon economy that will be more conducive to carbon neutrality in the future. The region should attract investment for technological and social innovations needed for pioneering economic transition. (More Information in Annex I and V)

PMR should take full advantage of early planning from the start with very little baggage of already existing compulsions. It can use the opportunity for demonstrating how environmental friendly policies and practices need not be in conflict with the economic agenda of the nation. Some of the priorities may include -

- Map Land Use, Risks, Demographics, and Emissions every two years
- Create a conducive environment for choosing alternative clean energy options through Incentives, Schemes and Mandates (wherever possible)
- Support Innovation and R&D in Low-Carbon and Green Technologies with strict monitoring of unintended consequences
- Increase performance standards like vehicle fuel efficiency standards, building codes and energy efficiency ratings for saving energy and impose charges when the standards are not met
- Prices, taxes, fees, and fines should reflect the full costs of the energy wastage, including externalities such as pollution
- Consider the economics, security, health, politics, environment cost of not taking timely action
- Set up a climate change/environmental policy unit to frame and supervise policies and strategies at the city level and facilitate coordination between departments to achieve them
5.2 Initiate Actions by Local Government / Manufacturing Industry / Commercial units / Educational Institutions / Hospitals and other significant polluters

While pragmatic planning can indeed bring out what needs to be done in what sequence and time-frame, implementation of the plan depends on a clear action-plan that is doable in desired time limits. Most such actions will have to be proactive and with due sensitivities to the diverse sectors. This calls for sector-wise action plans depending on the potentials discussed in earlier chapters. For instance, reducing carbon pollution by the transport sector will need a different approach than one for reducing electricity demand and related emissions. Some other sectors like poor water and waste management represent the indirect cause of adding to carbon emissions.

Some of the priority actions may include -

- Constitute a multiple stakeholder committee including academia, experts, knowledgeable citizens, NGOs, policy-makers, and office-bearers to monitor and guide the planning and execution of low-carbon processes and practices.
- Land-use guidelines must be enforced strictly for bio-diversity preservation, notwithstanding the muscular lobbying of powerful Construction industry giants.
- Local governments must use the latest satellite-based Geo-mapping technology for real-time monitoring of violations of land-use that must be stopped immediately.
- Green Building Codes must be made mandatory for all classes of buildings including residential and they should be revised periodically to include a higher percentage of renewable energy like solar power and other green criteria.
- Encouraging Distributed Solar Generation and roof-top solar use is very much within the jurisdiction of local governments; this must be supported with robust policy guidelines and attractive incentives.
• Waste should be treated as a hazard and dealt with locally and carefully using a circular economy. Encourage ‘Circular Economy’ practices in Waste and Water management for reducing wastages as well as avoidable emissions.

• Pune / PMR area is full of Institutions that are often impersonal to environmental priorities. PMR should mandate a minimum set of ‘Best Practices’ for all Educational institutions, Hospitals, Commercial complexes and public utility facilities for strict compliance, with annual rewards for competitive performance.

• Involvement of young school and college student population can create lifestyle transformational changes through public awareness. NGOs and environment experts must engage the young population for desired changes.

5.3 Incentivise Citizen action for Carbon Footprint Reduction

Given that urban populations in India will keep rising steadily due to migration from the surrounding rural areas, the very essence of carbon neutrality will be to reduce the carbon footprint per person or activity at all levels. The scope for carbon footprint reduction includes all levels – individual, households, society groups, industries, businesses, everyone! These may appear small, but taken together they can add-up to very large impact especially for large population centers like PMR. As the awareness increases and concerns of climate impacts become acute, building a culture of being conscious about one’s Carbon Footprint will be very useful.

This has to be a movement driven by citizen awareness and choice - a momentum where the local government can be the facilitator and supporter with attractive incentives for better performance. It is actually a win-win situation that can benefit both mankind and the environment. Even irrespective of climate concerns, there is a need to end the culture of limitless consumerism to save precious earth resources for a growing world population that may stabilize over 10 billion. Even if modern mankind
manages to limit further exploitation of Earth resources from now, the only planet available will not be sufficient for the present level of consumption. The desire for carbon neutrality must, therefore, emerge as the new civilization culture. Caring for other living species as well as the natural flora and fauna must become integral to human priority.

Some of the important recommendations include -

- Recognize that every human activity creates a "Carbon Footprint" and facilitate easy methods of measuring it at all levels
- CO2 emissions are not included as “Pollutants”. This must be changed to recognize it as one of the most dangerous pollution beyond a certain threshold. Such recognition is important for limiting Carbon emissions in the future and must be included in the pollution status report at City, State, and even National level
- Encourage innovative application of social media to advertise the cost of not reducing Earth energy demands and over-exploitation of resources
- Reward performance; not just investment in low-carbon and green measures
- Empower NGOs and citizen groups to increase awareness and acceptance
- Provide tariffs and political support to the local economy to strengthen it for competing with cheap goods that may have high carbon footprints
- Connect innovative ideas and create platforms for collaborative learning, problem-solving and conflict resolution in achieving Climate Action

The scope for Carbon Footprint reduction includes all levels – individual, households, society groups, industries, businesses, everyone!

5.4 Ensure State / National Level Support for City-level Climate Performance

Carbon Neutrality, as a concept, can be an aspiration at the individual level or at an institutional level like a University campus, through the collective will of a large group of students. Hence, for a city with a larger population – estimated over 14 million for the PMR by 2030, it can have a very significant regional impact. However, the regional benefits will also accrue to the larger State agenda for carbon neutrality and even to the national commitment (NDC) on climate action. Hence legislative reforms and policy
support at the State or National level can help build large momentum for rapid action, and initial quick success stories are very good for spreading the message.

Some of the important drivers can include –

- Establish a nation-wide mechanism for clear benefits of climate action to human health, national economies, and long-term Earth eco-system.
- Revise policies periodically to adapt to external factors such as evolving technology and changing prices and their impact on the environment.
- Establish the necessary cooperation with relevant authorities at the national and regional level, including the involvement of large industries.
- Increase performance standards like vehicle fuel efficiency standards, building codes and energy efficiency ratings for saving energy and impose charges when the standards are not met.
- CO2 emissions are not included as “Pollutants”. This must be changed to recognize it as one of the most dangerous pollution beyond a certain threshold. Such recognition is important for limiting Carbon emissions in the future and must be included in the pollution status report at City, State and even National level.
- Forest Status and percent Forest cover, Continuity in wilderness patches, Maintaining environmental water-flows and Soil, Air and Water quality should be important criteria while determining land-use and development.
ANNEXES

Annex I. Carbon Neutral City initiatives across the World

Copenhagen: “CO2 Emissions reduced by 20% from 2005-2015. Our vision is to be the first carbon neutral capital in the world by 2025.”
Climate Plan isn’t sectoral and all areas are included. The climate plan’s goals are an extension of the city’s other goals in transport, housing and construction, health, heating and cooling, education and behavioural change. It has a unique network of bicycle paths and a world-class public transport system. More than 30% of energy supply comes from carbon neutral sources today and a new green and recreational areas have been established.

Challenges and barriers which a city can’t solve on their own are undertaken in partnership to get the best results for both Copenhagen and global climate. CERTIFICATION DGNB Denmark is a Danish certification scheme within sustainability. A sustainable certification scheme provides the necessary framework and criteria for the planning, design, construction and property industries. The objective of working with DGNB is to improve quality and support the ambition that new buildings should be as sustainable as possible. (Copenhagen 2025, Copenhagen solutions for sustainable cities)

Some Unique Solutions developed by the City:
(Copenhagen 2025, Copenhagen solutions for sustainable cities)
San Francisco: “San Francisco has long been a leader in environmental, social, and economic prosperity. Today we confront what may prove to be the greatest challenge of our era—climate change.”

Over the past two decades, San Francisco’s local government, businesses, and private citizens have made tremendous progress, reducing the citywide carbon footprint by 14.5% while building the economy and improving quality of life. The City continues to implement effective policies regarding energy use in buildings, transportation, zero waste, the urban forest, and municipal operations. Projections demonstrate that GHG emissions reduction goals of 25% below 1990 levels by 2017 and 40% below by 2025 are attainable.

San Francisco’s GHG Emissions Declined as Its Economy Grew

- The largest reduction came from a decreasing emissions intensity of the electricity consumed in San Francisco.
- Overall electricity use in San Francisco increased 11% between 1990 and 2010, but the decrease in the carbon intensity of grid electricity outweighed the growth in usage for electricity, resulting in a net decrease in GHG emissions from the building sector.
- Emissions reductions in San Francisco have come from a cleaner supply of electricity, reduced consumption of natural gas and electricity in the commercial sector, and less waste sent to landfills due to progressive increases in composting and recycling.
- The City and County of San Francisco have been at the forefront of the U.S. movement for addressing climate change issues through the consistent and strategic reduction of greenhouse gas (GHG) emissions for nearly a decade. In 2008, as a result of this commitment, the City’s Board of Supervisors adopted, and the Mayor signed into law, Ordinance No. 81-08 (“Climate Change Goals and Action Plan”), which mandates the achievement of the following GHG emission targets by each City Department:
  - 25% below the 1990 emission level by 2017
  - 40% below the 1990 emission level by 2025
  - 80% below the 1990 emission level by 2050

Some initiated Strategies:

- Move 100% of residential buildings and 80% of commercial electricity consumption to 100% renewable electricity
- Grow public transportation options and expand alternative transit infrastructure
- Achieve zero waste to landfills through recycling and composting; Reduce upstream waste through material management
- Secure funding to maintain existing urban forest and increase the canopy of the urban forest
Enforcing the Commercial Building Ordinance for energy benchmarking and auditing will drive new investments in energy efficiency.

**Melbourne:** “Since 2012, City of Melbourne operations have proudly been certified carbon neutral, and we have maintained our carbon neutral status every year”

Melbourne is currently implementing a five-year Emissions Reduction Plan with a strong focus on building efficiency, rooftop solar and street lighting upgrade. The planning includes Science-based target to avoid 1.5-degree global temperature rise by 2020–21. Priorities for action over five years from 1 July 2016 to 30 June 2021 are:

1. Develop a low carbon culture
   - Integrate Aboriginal knowledge, cultural diversity and social inclusion in the delivery of the Emissions Reduction Plan.
   - Conduct staff training and behaviour change programs to ensure facilities and equipment are operated efficiently and Establish internal monitoring and reporting for the implementation of the plan.
   - Report progress in implementing the plan to the public and to councillors annually.
2. Celebrate Melbourne, without the emissions
   - Calculate the emissions from premier events and develop a carbon neutral ticketing option for patrons. In less than five years the city has saved or offset more than 200,000 tonnes of carbon dioxide equivalent already.
   - Identify sponsorship or crowd-funding to offset emissions from free public events and promote it through event publicity.
   - Develop practical information for premier event partners and community event planners on how to reduce and offset emissions from venues, catering, transport, and waste.
3. Zero carbon for our buildings
   - Right decisions: Install energy efficient equipment and renewable energy technology in existing buildings and invest in new green buildings that exceed best practice.
   - Right information: Develop the asset management plans, designs and specifications for each building in the portfolio to reduce emissions through the capital works program.
   - Right data and processes: Improve the energy intelligence of buildings so that we know when the equipment inside buildings is not operating efficiently, and which buildings need to reduce emissions further.
4. Queen Victoria Market renewal
5. Carbon neutral goods and services
• Continue to measure and report emissions from major categories of supply and require contractors to report any large sources of emissions from sub-contractors.
• Organize supply chain workshops to encourage businesses to reduce emissions and develop carbon neutral products and services.
• Work with other local governments and similar organizations to amplify market demand for carbon neutral goods and services.

6. Zero carbon transport
• Promote walking, cycling and public transport options to staff for commuting and business travel.
• Ensure vehicle leasing and purchase arrangements support efforts to increase vehicles that use zero-carbon technology.
• Continue to survey, monitor and report the use of transport fuel and require transparent reporting of transport-related emissions from suppliers and contractors.

7. Reduce emissions from waste
• Continue to promote waste avoidance, diversion from landfill and recycling through staff and community engagement programs.
• Ensure the waste collection, office cleaning and parks, and gardens maintenance contracts support emission reductions from waste.
• Continue to collect and report data on waste from community and office facilities and ensure the updated Waste and Resource Recovery Plan addresses greenhouse gas emissions by promoting waste avoidance, diversion from landfill and recycling.

Three essential principles form the basis of the City of Melbourne’s Carbon Neutral Strategy and are incorporated into every step of our efforts to maintain carbon neutrality. The principles are:

1. Compliance with the National Carbon Offset Standards (NCOS) Carbon Neutral Standard: This is considered the Australian Standard for achieving and claiming carbon neutrality for an organization or product.
2. Social responsibility: The City of Melbourne must consider the social impact of all decisions to reduce carbon emissions and in the purchase of offsets. Decisions that have positive social outcomes will be prioritized.
3. Timeliness: The City of Melbourne became a certified carbon neutral organization in 2012 and has since maintained carbon neutral certification without compromising cost-effectiveness or quality.
Annex II. Additional Notes on Low Carbon Development

perspectives

Low-carbon economy

Low-carbon economy is the early phase of low-carbon development, during which reducing CO2 emissions in economic development is the main target. To achieve this goal, a country needs to formulate a clear plan to promote low carbonization in its economic development. The plan includes the R&D of low-carbon technology through financial, tax and legal support finance, the development and usage of low-carbon energy, and the adjustment of economic structure towards low-carbon industry. Low-carbon tourism and low-carbon industry are indivisible components of low-carbon economy. Green recovery is a set of established policies and measures aiming to build a low-carbon economy.

Cranston and Hammond (2010), low-carbon economy in the 21st century means balancing and harmonizing population growth, economy development and environmental protection.

The main characters of low-carbon economy are low energy consumption, low pollution and low emissions. Low-carbon economy cannot move forward without innovations in energy field. Finally, the final goal of low-carbon economy is to achieve sustainable development.

Low Carbon Development

When the stage of low-carbon economy is completed, low-carbon development enters the second phase, i.e. low-carbon society, which includes low-carbon life, low-carbon culture, low-carbon politics, etc. In this stage, government should try to promote low-carbon life styles and consumption patterns such as encouraging people to choose low-carbon transport mode. Once a city achieves low-carbon in all aspects including economy, daily life, politics and culture, it can be defined as a low-carbon city. Low-carbon community is an epitome of low-carbon city. In the same way, a society will become a low-carbon society when its economy, daily life, and culture have achieved low-carbon. After most countries in the world have become low-carbon societies, low-carbon development becomes matured and the stage “low-carbon world” has started.

In the process of low-carbon development, we need many instruments to track the performance of development.

- Low-carbon society

Low-carbon society is the concept which has often been cited by countries such as Japan. According to Japan’s report “Building a Low-Carbon Society”, a low-carbon society is required to follow three principles, namely minimizing all the sectors’
emissions, pursuing a simple life style with higher quality and getting well along with the nature.

Low-carbon society should carry out the actions consistent with principles of sustainable development, ensure all the social crowds’ development demand can be satisfied, contribute to reducing GHG emissions in the course of preventing the disasters from happening caused by the climate change, get high energy efficiency and use low-carbon energy and low-carbon manufacturing technologies, and adopt low-carbon living and consumption styles.

Low-carbon society requires the low-carbonization of not only economic development but different aspects of a society such as life and culture.

- **Low-carbon City**
  low-carbon city refers to a city in which low-carbon economic development pattern is adopted, citizens prefer to low-carbon life styles, and the government considers low-carbon society as their blue print.

- **Low-carbon life**
  Low-carbon life is considered as a decrease in energy demand in daily life in order to reduce CO2 emissions. It is an indispensible part of low-carbon development. Many countries/regions in the world has implemented a great deal of policies to boost low-carbon life. Despite the discrepancies among different understandings, there is a common point on low-carbon development: reducing GHG emissions, exploiting low-carbon energy, and ensuring economic growth. Generally speaking, low-carbon development is a new pattern of political and economic development aiming at reducing CO2 emissions and achieving the sustainable development of environment, economy, and society.

**Maturity stage**
After most countries in the world have become low-carbon societies, low-carbon development becomes matured and the stage “low-carbon world” has started. In the process of low-carbon development, we need many instruments to track the performance of development. The concepts such as carbon footprint, carbon label and carbon certification can serve the purpose well. Carbon footprint is the total CO2 emissions caused by an organization, a product or a person. Carbon label and carbon certification are an integrated system used to measure and display the CO2 emissions of a product or a kind of service during its whole lifecycle. This stage is considered to be the optimum level and it is about achieving the low carbon of economy, politics, culture, and life all over the world.
Annex III. Additional Notes on reducing emissions in Transport Sector

- **Improving and Mandating BS Standards**
  The Bharat Stage are standards instituted by the government to regulate the emission of air pollutants from motor vehicles. The norms were introduced in 2000. With appropriate fuel and technology, they limit the release of air pollutants such as nitrogen oxides, carbon monoxide, hydrocarbons, particulate matter (PM) and sulphur oxides from vehicles using internal combustion engines. As the stage goes up, the control on emissions become stricter. Thus Bharat Stage VI norms are two stages ahead of the present Bharat Stage IV norms in regulating emissions. These norms are based on similar norms in Europe called Euro 4 and Euro 6.

- **Introducing Superblocks in strategic locations**

  ![Superblock Diagram](image)

  The superblock (in physical terms) is composed of a set of basic roads forming a polygon or inner area (called intervía) that contains within it several blocks of the current urban fabric. This new urban cell has both an interior and exterior component. The interior (intervía) is closed to through vehicles and open to residents, primarily. The exterior forms the basic road network on the periphery, and is approximately 400 metres wide for use by motorized vehicles. Areas like Tulshibaug are already a part of Pune’s culture. These centres can become hubs for cultural and social activities and increase local businesses and hence local
income. Introducing superblocks to other areas in a planned manner will reduce pollution and emission levels in the city.

- **Promote E-Vehicles**

  **Parking Incentives**
  - Free parking for EVs citywide, downtown, or in select sectors of the city
  - Free parking while charging
  - Parking for EVs allowed in otherwise restricted areas
  - Parking spaces reserved for EVs only
  - Reduced parking fees for EVs in public lots

  **Access**
  - EVs allowed when other vehicles banned (e.g., during smog alerts)
  - Permitted into Congestion Charge Zones/ Umweltzonen, Zero Emission Zones, etc.
  - Permission to use bus lanes, high occupancy vehicle lanes, and priority lanes

  **Infrastructure**
  - Local grants/incentives to support the installation of home or workplace charge point
  - Municipal support for the installation of on-street charging points where off-street parking is limited
  - Municipal requirement that commercial properties and/or workplaces install EV charging stations in a certain percentage of parking places
  - Municipal requirement in building code that requires parking garage owners to install EV charging stations in a certain percentage of parking places
  - Municipal requirement in building code that requires parking garage owners to allow tenants to install EV charging stations if they want to
  - Municipal requirement in building code that requires parking garages to be “EV ready” by including proper wiring and power capacity within walls/floors/ceilings to eventually install EV charging stations
  - Time-of-use pricing for EV charging that offers lower rates at certain times (i.e., off-peak times at night)
  - Quick, streamlined EV charging station permitting
  - Tax rebate on installation of EV home chargers
  - Reduction in connection charges

  **Direct Incentives for Vehicles**
  - Direct subsidies for EV purchase or lease from local municipality or utility
  - Exemption/reduction on local taxes for EV ownership, including road tax, registration tax, etc.
  - Exemption from local use fees and tolls for EV owners
o Discount on electricity bill for ownership of EV
o Discounts for EV owners at other public activities — events, concerts, museums, etc.

3. Taxing carriages and trucks entering the city

Banning of heavy vehicles with BS III/ Euro III standards within city limits should be enforced. In addition to the ban, a system that enables regular emission checks must be conducted. Any vehicle that fails the emission check should be reprimanded through a fine, revoking of license or banning of the vehicle. Toll booths should also charge emissions fine on each truck that enters the city.

4. Metropolitan Multimodal Hub Structure

The biggest challenge a citizen to shift from private motorized to public transportation is the time, cost and physical exertion that needs to be invested on a daily basis to move from home to office and back. Such a challenge increases multifold in a metropolitan city due to availability. Setting up a city public transportation structure that makes traveling efficient and convenient for passengers is required to overcome the above challenge. What the city needs are an intermodal structure where multiple forms of transportation such as trains, metros, and buses are interlinked through intermodal hubs. Intermodal hubs are transport hubs or a station that seamlessly allows a passenger to shift from kind of transportation structure to another.

There are three major types of intermodal hubs that are defined

- Base intermodal hub
- Metropolitan intermodal hub
- Urban intermodal hub

The base intermodal hub combines flight, national and regional railways such that passengers easily transport between international, national and local transportation networks. Similarly, metropolitan intermodal hubs combine national and regional transportation. Urban intermodal hubs provide end to end public transportation within the city.

5. Increasing tracks for local train routes

Local railway systems have been an internal cog in several metropolitan cities. The most famous example would be the Mumbai locals. Having a local railway system has several advantages. The construction of local railway tracks as compared to a metro construction is almost ten times cheaper on kilometers basis. It’s also relatively a much greener option. Local railway systems come at considerable need when a city needs
to connect itself to the suburban regions around the centre. A city like Pune has been facing considerable challenges to meet the demands of the working population at the periphery.

Take for example the Pune - Lonavala railway track. Currently, this track provides train services every hour during the day. However, the train service is not sufficient as the compartments end up being congested and over-crowded. Moreover, the time taken to travel from Lonavala to Pune is about an hour. Experts like Pedro Ortiz, recommend that for modern metropolitan travel time from suburban to the urban region should not take more than 30 minutes. Such challenges exist not only between Lonavala and the Pune, other developing towns and suburban regions also struggle with public connectivity. It’s for this reason citizens find it more convenient to travel within the city using private vehicles.

Cycle sharing stations are often placed near public transport systems to provide last-mile connectivity.

Today there are cycle sharing systems in over 200 cities around the globe, and more programs start every year.

Some of the largest cycle sharing systems are in Chinese cities like Hangzhou and Shanghai. Washington, D.C., USA; Paris, France; and London, U.K., have hugely successful systems that have helped re-energize cycling in those cities, providing an ideal transport solution for short trips and a feeder to other public transport options. Cycle sharing is a nonpolluting and healthy mode of transport. Modern cycle sharing systems have the ability to track the identity of the user as a way of preventing the theft of cycles.

All users are required to furnish identity proof, either at the time of registration or when signing up for temporary subscriptions. When the user checks out a cycle, the identity of the cycle is recorded along with that of the user. The user’s account is cleared when the system detects that the cycle has been returned.

On December 5th, 2018, Pune Municipal Corporation launched its own public bike sharing scheme. The scheme showed promise with over 3.5 trips taken in the first four months. However, there has been a steady decline since because of thefts and more importantly, lack of infrastructure such as separate cycles tracks and stations.
Current Recommendations:
- Create a Cycle Network draft plan with over 300 km of cycle tracks
- Design cycle design Guidelines draft including width and surface of tracks, the height of tracks, junction design, etc.
- EOI to be published soon, Create a public Bicycle Share System – Phase 1 planned with over 3000 cycles, over 250 stations in 40
- Enforcement plan with physical design of tracks to prevent encroachment, cycle wardens, CCTV and e-challans

6. Sustainable Transport Committee
There are major advantages of implementing such a body.
- The biggest one would be the consolidation of decision making specifically with respect to transportation within the PMR jurisdiction.
- It would help achieve the common goals to increase public transportation as well as reduce the use of non-motorized vehicles.
Annex IV. More Actions and Recommendations in Other Sectors

Buildings and Construction:

- **Designing strong code for efficient buildings**
  A large share of the world’s energy is used in buildings to control the temperature and power appliances, lighting, and other equipment. While appliances and equipment are typically replaced every few years, buildings last for decades or even centuries. Poorly designed, leaky homes and offices can lock in high energy demand for a long time, so building them right is crucial. Many barriers hamper the inclusion of energy efficient features in new and existing buildings.

  Building codes can be made smarter by including certain provisions, such as automatically incorporating additional features as they become cost-effective. A code could mandate “rolling in” all energy efficiency improvements whose increased up-front costs will be recouped through energy savings within a predetermined payback period. A system of enforcement and penalties must be in place for any mandatory building code to be effective. Retrofit programs, often administered through utilities or cities, can also slash the energy used by homes and other buildings, save money, and create numerous local jobs.

- **Focusing on New Infrastructure**
  It is important to introduce important processes that require life-cycle carbon emission studies for all large infrastructure projects. Secondly, making investments to adopt low-carbon design in new infrastructure when it is designed, rather than waiting to retrofit or replace it makes more economic sense. In extension to this argument, policies designed to affect a dozen car manufacturers or regional utilities, for example, are likely to be far more effective than those aimed at millions of consumers.

- **Mandate for Industrial and Commercial Sector**
  Setting fines or high prices for emissions and environmental degradation, on Industries and Commercial will push the market to choose the best solutions to achieve them. Mandating Carbon and Energy auditing for all big infrastructure projects is a must to achieve this. Highlighting market competitiveness & employment potentials of energy saving in the commercial and industrial sector are likely to trigger more response than just mentioning its emission reduction potential.
• **Use Climate Friendly Design in all upcoming constructions**
  Buildings should be designed to comfort of the users but not at the cost of the environment. Following points help in accomplishing this goal.
  - Avoid Ultra-urbanization which promotes a lack of contact with people and nature
  - Maximizing natural cooling and ventilation while building infrastructure
  - Audit energy and water consumption and waste generation at the society level and identify areas of improvement
  - Use eco-friendly material for small structures

• **Encourage and Incentivize Carbon Neutral buildings and infrastructure projects**
  Big Complexes and Townships should aim to become Carbon Neutral and plan all systems likewise. They must implement green measures and maintain data for resource use. Governance policies to incentivize Green Infrastructure and penalize the insensitive will accelerate this process.

**Waste Management:**

• Develop adequate infrastructure for dealing with a huge volume of Waste
• Introduce protocols for minimizing Waste Processing and increasing efficiency
• Ward-wise segregation and Local Collection Centres for recyclable wastes
• Energy Production from Wastes
  - Replacement of fossil fuels with decentralized Biofuel and Bio-Char needs to be made economically viable and provided with policy support
• Appropriate Disposal of wastes
• Minimizing Leakage, Pollution and Energy loss in municipal activities
• Establish or Grant permissions to waste collection and recycling centres
• Encourage terrace and urban farming, especially using organic wastes, to reduce food CO2e emissions
• Petroleum-based plastics can be replaced with bioplastics
• Waste segregation and treatment should be dealt at ward level and not city level
• Recycling/reusing/upcycling plastic waste within the city limit means offsetting emissions by reducing the use of virgin plastic, a petroleum product
Soil Management:

- **Encourage Organic Farming**
  Prevent Soil pollution by incentivizing organic farming. This will also help in increasing Carbon Capture potential of soil

- **Using stabilized or slow-release fertilizers when required**
  Stabilized fertilizers can produce similar yields with lower emissions of greenhouse gases. Recent results also suggest that combining no-tillage agriculture (in which soils are not turned over with farm implements) with the use of slow-release fertilizer can result in a reduction of 75% or more in soil N2O emissions from irrigated systems. However, the use of improved fertilizers in central and eastern regions of the country has demonstrated inconsistent results, with some studies showing little impact on emissions and others showing reductions of 30% or more.

- **Adapting carbon friendly management practices**
  - Tractors and many other types of farm implements run on fossil fuels, so reducing the number of times that a tractor passes over a field or using the most efficient implements available will immediately reduce CO2 emissions.
  - No-tillage agriculture and other forms of conservation agriculture, in which fewer tractor passes are needed because the previous year’s crop residue, such as corn stalks or wheat stubble, is left on fields before and after the next crop, are potentially useful in this regard.
  - Planting marginal croplands with perennial grasses.
  - Planting hay or pasture in rotations with annual crops
  - Planting winter cover crops can add organic matter that locks in more carbon

- **Grazing practices**
  Keeping livestock from stream banks, properly resting pastures to restore degraded land, and determining the proper duration and season for grazing

- **Promote Soil as a sink**
  Soil currently offsets about 15% of agricultural greenhouse gas emissions. Among ways to boost this capacity, planting winter cover crops can add organic matter that locks in more carbon.

Water Management:

- Plumbing to segregate water at the source with facilities to segregate waste at source and decentralizing water treatment in the city will increase efficiency and effectiveness of the treatment procedures. Install new STPs with biological processes which require less energy for processing.
Resolving issues and streamlining Water demand management and Water metering is necessary and urgent due to water scarcity and to avoid loss of energy

- Stringent and tall fines should be implemented for illegal usage, water wastage, leakage and overflows
- Regularly test water bodies for water quality, Maintain vegetation in recharge areas and near water bodies and Conserve environmental flows of all water bodies, while planning constructions
- Proportional and telescopic charges to Water Demand should be charged for treating municipal wastewater
- Ban and make legal provisions to punish unprocessed sewage water being released in water bodies
- Map, identify and conserve Groundwater recharge areas; Construct water permeable roads in Groundwater recharge areas and avoid concretization of footpaths by use of permeable materials; Conserve environmental flows when planning any development
Annex V  Indian Settlements and Carbon Neutrality

Meenangadi is marching towards carbon neutrality!
Meenangadi is a small town in the Indian state of Kerala. It has accomplished and is doing what the entire world has not been able to. The small town is well on its way towards a green future. Its march is for a noble cause: the aim to achieve carbon neutrality.

Methods:
It involves several strategic as well as innovative steps in order to go green. The steps include-
- Planting of saplings in about 38 acres of land
- Encouraging the use of compost
- Distribution of 300,000 saplings to different households
- Digging of around 456 ponds
- Use of electric crematorium to prevent the burning of wood for cremation
- Replacement of plastic bags by naturally made bags
- Distributing free bicycles to several students

The free distribution, part of the village’s food-security programme, comes with strict riders from panchayat officials: “Don’t throw the plastic cups away. Store them and our workers will pick them up. Also, while using kitchen waste as manure, limit the use of soap to clean utensils. It contains chemicals.”

Success:
Meenangadi is now the first carbon neutral town of India. The efforts of the people of the town have been receiving global attention and recognition. The village has achieved the milestone and is an example to the whole world how people in various parts of the globe are fighting against climate change and global warming. This town in the Wayanad district (Kerala) has been witness to a high number of environmental initiatives like a plant population census, soil audit, energy audit, organic farming, and awareness campaign against the use of plastic bags.

Sikkim: The First Indian State to Assess Its Carbon Footprint and Estimate A Trend for Emissions

As part of its initiative “Sikkim Climate Inventory and Monitoring System” launched in 2017, all sectors in the Himalayan state, like transport, tourism, industry, roads, agriculture, are being studied to estimate carbon emissions from each of them.
Methods:
Sikkim has always done well in sequestering carbon but this is the first time it has been found carbon-negative. In 2012, a state government report Climate Change in Sikkim called the carbon sequestration of forests in Sikkim “very significant in India”. A study published the same year by the Indian Institute of Science (IISc), Bengaluru, put Sikkim’s annual CO2 emissions at 432.3 gigagram/Gg (1,000 Gg= 1,000,000 kg=1 teragram/Tg) per year, but estimated its carbon storage capacity to be 382.1 Gg per year—less than the carbon emissions, making it carbon-positive.

Success:
“Sikkim is not only carbon-neutral but carbon-negative, according to the preliminary report. This means our forests sequester more carbon than the state’s total emissions,” says Thomas Chandy, the state’s principal secretary-cum-principal chief conservator of forests. However, the status is in jeopardy, given the recent trends.

Phayeng: India’s first carbon positive settlement!

Phayeng is a scheduled caste village of the Chakpa community in Imphal West district, A village that is home to 660 households in Manipur is using its lush community-managed forest to develop itself as India’s first carbon-positive settlement.

A village is given the carbon-positive tag if it sequesters more carbon than it emits, slowing the accumulation of greenhouse gases and mitigating the effects of climate change.

Methods:
Phayeng, which is surrounded by three densely forested hillocks with fruit trees at centre and a stream flowing through it, has been resurrected from the dry and denuded village it was in the 1970s and 80s through the sheer determination of its residents and funding under National Adaptation Fund for Climate Change (NAFCC), a central scheme to support adaptation to climate change impact in various states.

Success:
A village with carbon-positive tag
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