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PUNE INTERNATIONAL CENTRE

India in the Climate Challenged World

Laying Foundations for the Future

July 2022

Prof Amitav Mallik Hon. Trustee & Founder Member & Team EECC, PIC

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Prof Amitav Mallik and Team EECC

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Executive Summary

India in the Climate Challenged World

This policy advisory paper from the PIC group engaged in Energy, Environment and Climate Change (EECC) is rather unique in a sense that seeks to change almost everything about present modern life that appears to be 'the normal'. But from an Energy, Environment and Climate Change perspective the entire humankind is under existential threat of collapse without any visible warning. Although the IPCC was established in 1988 and environmental scientists have been sounding alarm of accelerated global warming since 1991 (Kyoto Protocol) there is little action taken for reversing the unprecedented global warming in the range of 1-30C in various regions of the world. Whereas, the escalating climate change impacts are already visible in many dimensions.

The genesis of this policy papers goes back to the online PIC Climate Conference on "Decade of Change – India in the Climate Challenged World" held in Feb 2022. Wherein, over 20 invited speakers spoke on the subject and the need for urgent action within this decade. The backdrop was the then recent IPCC Report (August 2021) that at last was bold enough to flag "Code Red for Humanity". There was clear recognition that time has run out for 'Business as Usual' and humankind has already entered an unprecedented phase where the mother earth was unable to support the greed of the human species. Global Warming is continuing to get aggravated despite multiple warnings and climate summits held among over 195 nations. The youth all across the world are agitating that the present generation is ruining their future. This Policy paper brings out this stark reality of inevitable damage and destruction of Earth 'Eco- system' which had supported humankind's quest for progress for hundreds of thousands of years. **We have entered the new 'Climate Challenged World'.**

With the changing dynamics of the world systems in the Climate Challenged World, radical transitions and transformation are a must to sustain the entire humanity. An array of transitions will be required, which need to be implemented systematically by the government and local citizens. The paper highlights the key themes for the Just transition towards a Net-Carbon Neutral world along with maintaining the ecological balance.

The key themes highlighted in the Paper:

Role of Cities in Climate Action: Cities can play a major role in climate action given that more than half of the world populations reside in cities and urban areas. The current total emissions of India today are about **2.8 billion TCO_2eq** with yearly emission rate of **3.24%** of which the **4 million tonnes CO_2 eq.** comprising of 14.31% emissions are from total population of **127,696,745** from 10 major cities alone. Building resilience and mitigation measures at city level hence is crucial to sustain in the climate challenged world. The key aspects for building resilience are-

- Resilient communities and livelihoods
- Resilient environmental systems of the city
- Resilient and green business and economy

Need for policy interventions: The free-market mechanism, while being the source of prosperity for the society over the years, is also one of the main causes of Global Warming and subsequently Climate Changes. System-level corrective changes call for sound and just policies that address market failures and promote a transition to a Net-Carbon Neutral future. Policies, regulations, and rules are important parts of shaping the future.

As global policies influence national and regional decisions, policy interventions are critical at all levels. The United Nations Framework Convention on Climate Change (UNFCCC) is one such body capable of bringing about policy changes at the international level. A lot remains to be done at national and local levels where all the solutions and capacity exits. But policy interventions are critical for the desired changes in mind-sets.

Optimal consumption and Circular Economy: Reducing and optimizing resource consumption along with shifting the linear supply chain models to circular models is an important transition to achieve Net-Carbon Neutrality. The circular economic model favours activities that reduce the usage of energy, labour, and materials. Thus, emphasizing on designing for durability, reuse, remanufacturing and recycling to keep products, components, and materials circulating in the economy. Such a model must need strong backing by individuals who can reduce demand and prevent mindless consumption which will drastically reduce waste and unnecessary material use in the first place.

Financial Instruments for policy shifts: Financial tools such as carbon pricing, green bonds, carbon trading are essential to mobilize domestic and international sources to meet the high capital requirements of a transition, especially for the energy and transport sector. Improving public finance and investment, and phasing-out GHG intensive activities would catalyze the low-carbon transition. Accounting of Social Cost of Carbon at a wide spectrum is of paramount importance to shift to a low-carbon and green economy.

Climate Justice: Climate Justice calls for equitable distribution of benefits and burdens related to climate action. The impacts of climate change will not be borne equally due to the historical responsibilities of developed nations. The developed nations of today have gotten wealthy while burning fossil fuels and have the capacity to absorb the adverse impacts. Whereas, developing countries like India, might not be able to cope with these drastic effects. Unfortunately, same mistakes are within the developing cities vis-à-vis rural poverty.

Therefore, there is a need to build capacity within developing countries by providing resources and capital to enable a Just Transition. The youth needs to be empowered through quality education, skill development, better healthcare, and improved quality of life so they can be the drivers of the new Carbon Neutral Society which can be less stressful.

Chapter 1

INDIA'S CHALLENGES AND OPPORTUNITIES IN THE CLIMATE CHALLENGED WORLD

As we enter the era of climate challenges, rapid transitions are a must for humanity to survive the brunt of social, economic, technological and political fluctuations. The challenges India will encounter by the end of this decade will perhaps be nothing less than an outcry for immediate and urgent climate actions for mankind's basic comfort zone. Impacts on our food systems, infrastructures, finances, ecosystems will have devastating effects on the future generations. Today, India stands at a crossroad where if we not take a step towards quick and just transitions the very survival of humanity will be jeopardized. The battle we face is not only about climate action but to achieve a just transition that will be inclusive of all sections of the society, so that building collective resilience and adaptation mechanisms at grass-root levels, and maintaining the ecological balance will be possible.

India will face a series of recurrent challenges while transitioning towards net-carbon neutrality, which has now emerged as the best climate action goal for many Nations The economic uncertainties, climate vulnerabilities, socio-cultural fluctuations and financial instability are some of the major obstructions that will require policy interventions. This decade (2020-2030) up till 2050 marks a key period in India's future. It is clear that radical transformations must be taken this decade to start the process of restoring the carbon balance.

As stated unambiguously by IPCC, this is the only decade remaining to undertake decisive transitions away from fossil fuels to renewable energy (RE) sources; to redefine holistic development; and protect the future generations. By 2050, with an increased global population and a resulting rise in consumption, we would have overshot the resources, which is clearly unsustainable.1 The mounting evidence of the effects of fossil fuels and anthropogenic activities has pushed humanity to the brink of societal collapse. Rapid population increase and rising per-capita energy as well as resource consumption, have drained the Earth's resources at an unprecedented rate. Even if the world rapidly decarbonizes now, (which is yet to happen) existing greenhouse gases in the atmosphere and current emissions patterns would make significant climate impacts unavoidable beyond 2030.

Climate change, according to the latest IPCC report' 22, will push 32-132 million people into extreme poverty in the next decade. Food security will be jeopardized as a result of production losses due to global warming, as will the incidence of heat-related mortality, heart disease, and mental health issues. With just 1.5 degrees Celsius of global warming, many glaciers throughout the world are already losing their ice-mass; eventually aggravating water scarcity on one hand and the slow sea level rise drowning coastal cities on the other hand.

Climate change is significantly affecting the species population and ecological systems as well. With rapid glacier melts, habitat loss, fragmentation and increasing calamities, about

14% of terrestrial species are on the verge of extinction. The loss of ecosystems, in turn, exacerbates people's susceptibility.[2]

The world has already seen the effect of the pandemic on the world economy. Well, every challenge is an opportunity and this is the opportunity for the present generation to understand that the so-called recovery that we are talking about today from the dynamic losses is a unique last opportunity to go towards green development in a planned manner. Unless global coordinated efforts are taken within the next 8-10 years, several regenerative processes will continue to take place and become severe at each passing year.

Projections show that India will become the highest emitter by 2050, if we follow the same path, and on the other hand, India is also the most vulnerable country to climate change among all the 1 trillion-dollar economies. This imposes unprecedented risks to our economy, ecology and additionally on our major cities. In the last few decades, India's climate vulnerabilities, as well as the economic losses experienced as a result of them, have increased dramatically. Hence, going Net-Zero at the earliest has become absolutely essential for India and India must bring in certain frameworks and policies that can extend the value of RE and focus on sustainability which can result in a significant reduction of GHG emissions.

The introductory chapters bring out the reality of the changed world where nothing much can remain unaffected. All nations' rich or poor would be affected but the poor without adequate means of fighting very difficult times will of course suffer more. Even though they are the least responsible for causing the problem of unprecedented global warming that is bound to cause devastating impacts on human health, well-being and economic progress. In addition to global warming which is likely to make the earth over 30C hotter before the year 2100, the other major problem is destruction of the ocean-beds and ecological richness on Earth surface that has depleted to alarming levels, endangering the very survival of many life-systems including humankind, despite its huge strides in technology and innovation.

This paper thus attempts to bring out how concerted and coordinated urgent human actions for mitigating the worst effects of climate change can still save the situation with minimal climate impacts. Building resilience may still be possible if all resources of humankind get diverted to averting the worst – the 6th mass extinction within this century. Chapter 1 talks about what all may change very rapidly in the Climate Challenged World (CCW) and highlights the many transitions that would be necessary for addressing the new world, including changes to present economic system based on GDP numbers. It also discusses how major cities of the world, including those in India, can play a very crucial role for Carbon Neutrality.

Chapter 2 tries to indicate some pathways to 2050 by which the world now seems to be committing to 'Net-Carbon-Neutral' (NCN) to avoid debilitating climate impacts that would be very difficult to recover from. Hence this will demand a massive transformation with very responsive Government actions along with well-coordinated policy interventions. Pathways to Carbon Neutrality would be difficult, but it is now an imperative for humankind to survive.

Chapter 3 discusses how urgent actions within this decade must pave the way to achieve major changes that must happen before 2050. There will be changes necessary across all sectors, industries, institutions and societies. There will be a period of hardship, but humans are famously adaptable to change when it comes to survival and progress. The last section of this chapter summarizes some of the important observations and recommendations that deserve immediate attention and rapid action by political and business leadership in India.

The Chapter 4 describes the framework level changes that would be required to convert many promises of today into decisive actions by decision makers at every level, village, cities, States and the Centre. It also attempts to discuss how to design the new Carbon-Neutral world with pragmatism and foresight so that penalties to common citizen could be minimized and the new system could be much more resilient in every possible manner.

1.1 What all may Change in the Climate Challenged World?

India is in the midst of a compound catastrophe due to worsening climate impacts. Humanity has survived with the advantage of a stable climate for the past 8000 years. However, today, we are at a crossroad for survival. The decisions we take now will decide the well-being and survival of humanity as whole, for years to come. Transformations to a good Anthropocene will demand radical changes.

Industrial revolutions have been the pivotal milestone in human history. The extraction and burning of fossil fuels provided the energy for spectacular economic progress. But the dependence on fossil fuels also added unprecedented levels of CO_2 emissions causing the global warming due to rapid accumulation of GHG in Earth atmosphere. The era also witnessed organized deforestation and mining of other valuable materials and Earth resources including water. All this has destabilized the Earth eco-system and its carbon balance.

India is already the third greatest greenhouse gases (GHGs) emitter in the world after China and the United States, despite its per-capita emissions being below global average. India's energy consumption has increased sharply since year 2000, with coal and oil providing over 70% of energy needs with RE including Hydro providing just about 30% as of 2020.

This needs to change very rapidly and an urgent green recovery across all sectors may bring emissions down to **44 GT CO_2 eq/year by 2030,** which is well within the emissions range that, if emulated by global major emitters can give us a **66 percent chance of staying below 2°C.**[3]

If India is to take advantage of the opportunities that exist within its boundaries, it will need to undergo significant economic and technological reforms. A stringent focus on bold reforms in green investments, resource consumption, and government policies would help to shape the New Carbon-Neutral World. Climate change is often focused on the risk and mitigation aspects, and we rarely mention the grassroots cause or the importance of local community participation. Effective policy interventions at the political level are critical, but we will not be able to address climate change issues without active individual participation in grassroots environmental projects. To achieve a sustainable future, it is critical to work together. Greater community awareness necessitates greater initiative.

The focus on long-term economic progress and stability would provide India more leverage to exploring new geostrategic prospects, such as global green technology. Hence, optimizing the existing resources, restoring our ecological systems with apt policies will determine how the country can thrive for decades ahead. Transition to RE, major shifts in green and blue economy, low carbon infrastructure, zero-emission technologies are some of the sectors that need urgent alterations to slow down the climate impacts. The widespread effects of climate change are having severe consequences on socio-economic systems pushing political will to enact effective "climate and energy policies" to quickly minimize the damage.

This paper highlights the challenges India collectively seeks to address. It also attempts to provide a climate-action pathway to limit or curb the impacts of climate change and what are the systemic transformations required to become Net-Carbon Neutral as soon as possible. It is very clear that India alone cannot change the larger picture. And yet, actions for rapid emission reductions as well as building higher climate resilience for un-avoidable climate change impacts in and around India, must begin through local initiatives and regional specific actions. For instance, It is well known that major cities of the world that occupy only about 2% of the land, are actually responsible for over 70% of the GHG emissions. It is thus no brainer that high-population cities must take lead in emission reductions along with demand side controls.

If the world gets serious about achieving Net Carbon Neutrality by 2050, which is indeed is still possible, major cities of the world (and hence India) must aim for Net-Carbon-Neutrality well before 2040. That alone can build the right momentum for a new economic model that

can make progress without adding to existing accumulation of GHG in atmosphere. Given that CO_2 can exist for decades or centuries, world will have to go Carbon-negative for a period with technology-assisted CO_2 removal from atmosphere. Although the technologies are evolving very fast, for them to be cost effective, they will have to become cheaper that emitting CO_2 at present rates are even lower rates. This is the new reality of the 'Climate Challenged World' (CCW) – that humanity must feel safe, secure and progressive, even without the established practice of economic progress and growth. In fact, there is already serious debate if chasing economic growth is any more viable or even prudent.

The whole model of Governance is also going to demand very radical change. On one hand there will be a need for a more effective and just form of universal governance. And yet, such larger model can succeed only if at every local level human values change, once the cost of not doing the right thing becomes too prohibitive to be attractive for quick personal gains. In a sense, the Climate Challenged World will demand complete overall of human value system, because to be honest, the present situation has emerged due to a minority of 10-15% of the global population, whose greed for wealth and consumption of earth resources has put the whole of humanity at the risk of disaster, possibly even extinction if the greed cannot be nullified.

Climate Challenged World also coincides with phenomenal technological innovation that can make Artificial Intelligence (AI) get smarter than average human brain. This can introduce new challenges to doing business of economic progress and ensuring human well-being, while human friendly Eco-system and Earth resources start becoming very scarce. Add to this the destabilizing impacts of hotter world that will seriously affect productivity and even panning for future that may be overwhelmed by sheer struggle for survival. This is not to paint a gloom & doom picture, but an honest attempt to raise public awareness that the worst-case scenario in another few decades may actually be totally unacceptable. Urgent corrective actions are no longer a choice, but an absolute imperative.

The paper outlines the primary challenges that India faces in dealing with its compounded climate crisis and the economic losses incurred due to the same. The paper also lays out structural and technological opportunities in each sector to go carbon neutral with appropriate policy drivers.

An integrated analysis is provided with the need for recovery, resilience, and adaptation for short term (2030) and long-term goals by 2047 when India will celebrate 100 years since independence.

Hence, for India to survive in the Climate Challenged World, urgent climate action needs to be realized by efficiently decentralizing and politicizing Climate change with full responsibility, along with abundant financing and investments so that it becomes the main election issue or the winning formula.

1.2 Important Transitions for India

As stated earlier, this decade marks a crucial period in terms of critical transitions for India. Being a developing country, various factors need to be taken into consideration for strategizing the new approach towards net carbon neutrality. The direct and indirect effects of the changing climate, such as climate effects on livelihoods, social inequity, and economic instability, have a significant impact on the country's overall growth and progress. Hence, for smooth and just transitions, the country will have to mend its existing systems, strengthen resilience and adapt to the changing the dynamics in this climate challenged world.

The major transitions that must start in this decade are economic and energy transitions. Climate change is a global concern, but we continue to overlook its potentially disastrous repercussions for marginalized people, particularly in developing countries. The direct interaction between climate change and economy creates risks to infrastructure, human life and financial stability. The economic damages caused due to climate change are alarming! As a result, there is increased interest from government and financial institutions to incorporate climate adaptation and resilience measures at the local, regional, and national level, but the efforts are nowhere enough to what needs to be done.

With the correct mitigation and adaptation strategies, India has a chance to significantly lessen the effects of climate change. Business as usual, in reality, may not be able to support even current economic trends in the future. Heat waves are expected to cause massive economic losses in major Indian cities such as Delhi, Mumbai, and Kolkata. Climate change costs will not be shared equally across the country. In India, disparities in income, gender difficulties, and socio-cultural factors will exacerbate these inequalities.

Recurring hazards due to climate change and alterations in the weather pattern have risen. Total precipitation has declined significantly in India causing extreme water scarcity. The rise in temperatures in major cities could reduce daylight work hours by almost 25% compared to current levels because it will be unsafe for people to work in high temperatures, thus affecting the overall productivity rate. The low-income and marginalized communities will face more severe effects than the rest of the population. The livelihoods that directly depend on climate will be at higher risks. This would not only affect the GDP of the country but also increase India's national poverty rate by 3.5% by 2040.[4]

Even today, India is reliant on fossil fuels to the extent of about 70%. Renewable Energy (RE) including hydro-electricity, solar and wind total-up to only about 30% and India is committed to increase the Renewable Energy content to 50% by 2030.[5] For decarbonization to be economically viable, India has to rapidly shift away from fossil fuels before 2050 which are no longer economically competitive. In failing to do so, it is projected that the country will lose **around $35 trillion across various sectors by 2070.** A rapid shift from fossil-fuels to renewable energy must also happen with a just transition.[6] Therefore, this decade is extremely crucial for India to alter the trajectory of climate change and its impacts. India, like most of the world, has a narrow window of opportunities to not only execute decisive climate action plans, but also tunnel through smoothly to a sustainable economic development pathway without any major penalty to its people.

a. Transitioning to Green Economy-

Green economy is an alternative approach which not only includes the economic development but also environmental conservation and social well-being. Green Economy requires strategic approaches that bring together the various stakeholders for a collective vision. By rapidly transitioning to a green economy India could have an economic benefit of more than $11 trillion by 2070.[6] This could not only help India shift to an environment-friendly economy but also generate new employment opportunities for people during the transition. Accelerated R&D and technological advancements are key foundations for transitioning to a green developmental model. Innovations in industry, agriculture, energy, transport are crucial for the green transitions amongst the different sectors. Any major transition away from established practices requires pragmatism to accept some short-term compromises for log-term major benefits, and this is the pragmatism that Government policies can make much more acceptable for the common public at large. Decarbonization and achieving net-zero in this decade will require systematic alterations. Therefore, the biggest challenge and opportunity for India is to have an integrated sectorial approach to augment green finance, green technology, and a climate adaptation plan.

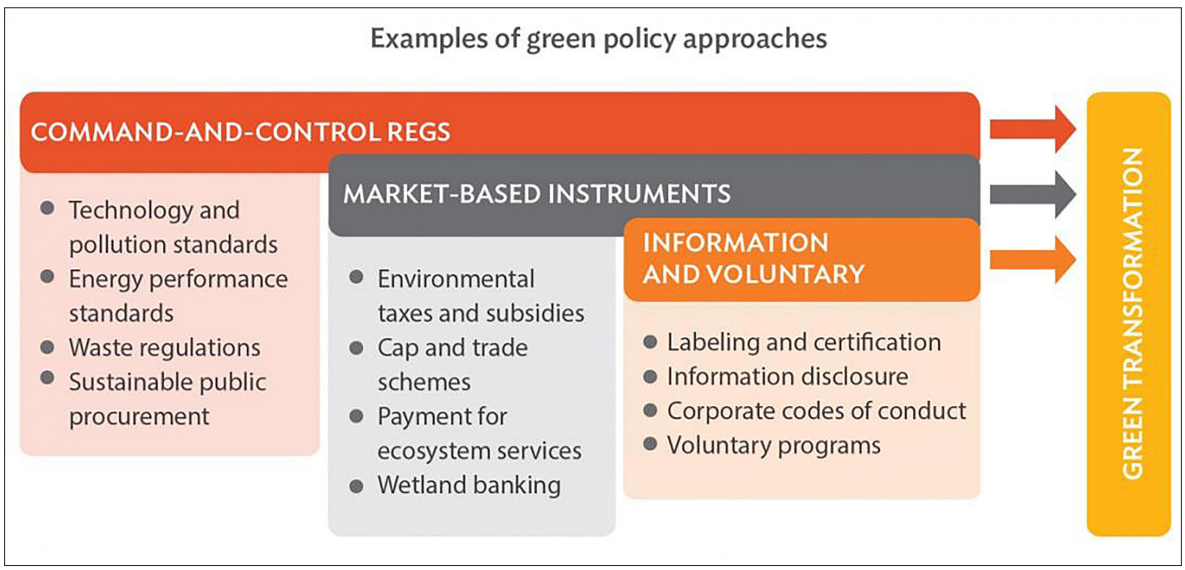


Figure 1 Policies to Promote Green Entrepreneurship

Economic models must reward sustainable practices and penalize for any harm caused to the environment. Governments should subsidize green alternatives to speed up the process and make them more attractive. Eco-labelling, certification, industry codes of conduct, and environmental performance disclosures can play an important role in incentivizing green businesses. A governance system that will promote the environmental preservation and at the same time encourage non-polluting technological interventions needs to be designed. This may be achieved with a different policies listed in the Figure 1.

b. Shifting to Blue Economy-

The long Indian coastline (7500 km) spreading across nine states and four union territories plays a crucial role in generating 95% of the country's business contributing about 4% to the GDP.[7] Globally, India ranks third in fish production and second in aquaculture. Hence, blue economy is critical for India as it generates several economic opportunities and livelihoods. In today's scenario with advanced technology, oceans can become the new centres of economic and restoration activities. India has the potential to enhance sectors such as fishing, aquaculture, fish processing, marine tourism, shipping and port activities. The blue economy is now expanding with the new opportunities that include various types of energy generation such as using tidal waves, Ocean Thermal Energy Conservation (OTEC), marine biology and biotechnology. This transition would be beneficial to India for environmental protection, national security, infrastructure creation, industrial capacity building and marine development.[7]

c. Renewable Energy Transition-

A shift to clean energy represents a significant economic advantage. India has a unique opportunity in making RE available 24x7 with the evolving technologies of energy storage batteries and rapid advances in leveraging green hydrogen particularly for heavy transportation sector as well as energy intensive industries. With significant transition and innovations in clean and low-carbon technologies, India has the potential to create a market worth up to $80 billion in next few decades.[8]

India has announced commitment to achieve Net-Zero emissions by 2070. But in reality achieving Net-Zero status before 2050 offers an enormous economic opportunity for India, In fact on a motivational ground, India should aim to become net-carbon-zero by 2047, 100 years since India gained independence. This can be a major political driver to put India in a leadership role in the new emerging Climate-Challenged World. Of course, India would require three times the current investments ($160 billion per year) until 2030 for the 'fast-forward green transition, but the rewards are many-fold. With the optimal implementation of the existing policies, the rapid shift to cleaner energy sources can be accelerated with well-designed policy drivers. Chapter 3 & 4 will discuss more on the same.

1.2.1 Effects of Climate Vulnerabilities

As global warming reaches different tipping points, the bio-physical characteristics and socio- economic factors become highly unstable. India is the 5th most vulnerable country to climate change according to the Global Climate Risk Index 2020.[9] The current human-induced climate change has been affecting the overall weather patterns resulting in drastic seasonal variations, temperature extremes, sea-level rise and recurring disasters.[10] The intensity of the weather events have escalated two-folds. We are facing the compound events of these weather changes affecting livelihoods, health and economy all at the same time.

Many climate-sensitive communities are facing severe implications like displacement of people, food and water security issues, fall in income level, change in employment pattern, etc. Extreme weather events cost India close to $87 billion annually.[11] The three main climatic regions vulnerable to Climate Change in India are: the Himalayan region and Gangetic plains, Peninsular India and the Indian Coastline and Islands.

Himalayan region and Gangetic plains: The Himalayas are rich in biodiversity, ecosystem services and freshwater sources fostering varied human settlements and ecosystems in the mountainous regions as well as Gangetic plains. The Himalayan environment is quite fragile and sensitive to any climate variations. With glacier coverage of 33,000sq km, the

Himalayan region has the largest concentration of glaciers outside the polar caps.[12] Today, due to accelerated melting of glaciers in the Himalayas, the terrain and water balance of the region have been significantly affected. At 2.5°C warming, the stability and reliability of northern India's major rivers – Brahmaputra, Indus and Ganga – which are all snow-fed rivers, will highly deteriorate.[13] Over the past three decades, the region has witnessed an increased frequency in events such as floods, landslides, mudflows, and avalanches affecting human settlements. Moreover, factors like deforestation, unplanned development, poor civic infrastructure, reliance on subsistence farming and forest products for livelihoods make the Himalayas and adjoining regions highly vulnerable to climate change.[14]

Peninsular India: The Indian Peninsular region is quite varied in terms of the biogeography. It majorly consists of Deccan Plateau, a semi-arid region and mountain ranges like biodiversity-rich Western Ghats. The rivers in the region foster diverse forests and livelihoods such as agriculture. Agriculture and allied activities contribute vastly to India's GDP with around 20% share in 2021, and provide employment opportunities to two-thirds of the population.[15] Temperature rise between 2-3.5°C may lead up to 26% losses in net agricultural revenues. Increasing adverse climate impacts on Indian agriculture and water systems will lead to greater instability in India's food, economic and health security.[16]

Indian Coastline and Islands: Coastal areas are complex environments where natural and socioeconomic systems are deeply intertwined. India has a long coast of about 7500 km.4 The Indian coasts, which have a high percentage of economic activities, are highly vulnerable to sea level rise, due to the extensive low-lying area, high population density, frequent occurrence of cyclonic storms, etc. Approximately 60 million of people live in Low Elevation Coastal Zones (LECZ) in India.[17] Among all tropical oceans, the Indian Ocean is the one that is warming the fastest. Seas absorb more than 93% of the additional heat from global warming.[18] The sea level of the Bay of Bengal has been rising up to twice as fast as the global average at about 4.4-6.3mm/year.[19] Islands in the Sundarbans Delta like New Moore Island and Sagar Island have already been submerged or are on the verge of it. A meter-rise in the sea level will also have severe consequences on major cities such as Mumbai, Kolkata, and Chennai. Timely measures need to be taken to reduce climate impacts on bio-physical and socio-economic factors in India. There is a dire need to emphasize and prioritize in-depth vulnerability studies at community level for informed resilience and adaptation policies at the regional scale.[20] [21]

1.3 Building Resilience for Inevitable Future Damages

As we face the most pressing issues of our time, such as global warming, economic inequality, and all forms of injustice, it is no exaggeration to say that today people live in a climate challenged world. To adapt and sustain in these conditions we must build climate resilience to the numerous repercussions that are now unavoidable, while also reinforcing

initiatives to reduce emissions as rapidly as possible in order to keep these effects from going to catastrophic levels.

The three drivers critical for fulfilling India's development aspirations are:

- Technological innovation
- Financial redesigning for improved resilience
- Strong political leadership

The need for radical transformations is clear, therefore to build climate resilience; India will have to necessitate systemic changes. The first step towards building climate resilience is decentralizing climate action and adaptation. The role of our major cities is extremely crucial as they not only contribute towards a major chunk of India's GDP but also are highly susceptible to climate vulnerabilities. Building resilience will be essential urban development policy and a smart investment for cities. It necessitates the development of long-term financial instruments and systems. A primary challenge preventing cities, particularly in developing countries, from reaching their sustainability targets is a lack of capital and access to finance. Hence, climate financing capacity must be raised among city-level actors involved in planning and funding sustainable cities. Their capacity to utilize climate finance has to be raised. Both private and public sources of financing must be mobilized in order to bridge the gap of lack of funds for urban projects. Various financial instruments and mechanisms such as green bonds, carbon credits etc. can be strengthened at the city level to achieve holistic resilience.[22] The three major areas for building resilience are -

Resilient Communities and Livelihoods- Strengthening early warning systems, decent, secure, and green jobs, resilient value chains, social protection, and finances need to be implemented at the community level. Only then will this contribute to climate justice and a fair transition for all. City governments are responsible for the climate-sensitive development of their urban areas. While cities are a significant contributor to climate change, they are also particularly vulnerable to its consequences. The five major areas that would facilitate climate action and build resilience under the "Climate Smart Cities Assessment Framework" are given below.[23]

- Energy and Green Buildings
- Urban planning and Biodiversity
- Transport and Mobility
- Water and Air Quality
- Waste management

The local people can play a crucial role in building community resilience. Citizens' active participation and direct involvement are critical in combating climate change and other human acts that threaten the environment. Directly involving citizens and communities in climate

action and environmental protection is critical, to improve their own behaviour, reduce their carbon and ecological footprint, and take individual and collective action. Collective action would lead to promoting sustainable lifestyles by supporting biodiversity protection, nature-based solutions for climate resilience, sustainable energy consumption, waste management, and other measures. This can potentially lead to younger generations taking up leadership for climate action and environmental protection by sharing their knowledge, experience and engagement with their families, local communities, and with public and private decision makers. For building community resilience behavioural change is of utmost importance. Hence, the mindsets of people can be changed via education, awareness raising, citizen science dialogue, observation and monitoring of their environmental impacts, and civic involvement.[24]

Resilient and Green Businesses and Economies- Building resilience across and within sectors such as infrastructure, services, agriculture, water ,natural ecosystems, and coastal systems. Businesses must make resilience and preparedness mandatory and install the necessary infrastructures. Developing disaster recovery plans, adding onsite energy resources such as combined heat and power systems or rooftop solar, and establishing backup supply and distribution channels are all examples of how to enhance local resilience. Small businesses can use a variety of techniques, such as planting green roofs for water retention and informing employees about preparedness.[25]

Businesses must put sustainability and social justice at the core of their business models – going beyond corporate social responsibility. This includes making climate risk insurance available to small, medium, and big businesses, as well as ensuring that trillions of dollars in future investments must be climate risk-aware and have positive social, environmental, and economic benefits.

Resilient Environmental Systems- Restoring and conserving natural ecosystems as a first line of defence against climate adversities is critical. For this, we need to revive ecosystems and biodiversity to ensure clean air, fresh water, fertile soils and pollination services. The ecological balance must be maintained at the city level to reduce the overall generation of greenhouse gases. Since cities contribute to about 70% of the total emissions, stringent climate action strategies for building climate resilience is of paramount importance. The Section 1.4 will discuss more about environmental and ecological stability.

The major areas discussed above need robust shifts in our existing systems with strategic planning. India can rebuild and restructure the transportation, energy, agricultural, and urban planning sectors by leveraging the benefits of technology, finance, and leadership. As we know, cities can play a major role in building resilience with the right action plans. The various strategies such as heat management action plans, resilience strategies, carbon-neutral cities, environmental status reports, city development plans, and disaster management plans are

some of the major reforms needed at the city level.[26] While several Indian cities have made headway in drafting local climate action plans, they are still limited by centralized mechanisms and operate within economic narratives of efficiency and urban development. Additionally, crucial problems such as *gender, inclusion, equity, and justice remain unaddressed in these action plans.* Hence, the strategies and action plans towards building climate resilience must be holistic and incorporate social, institutional, economic, and environmental contexts of each city and region. Although the resiliency models can be replicated in India, they must be tailored to the socio-cultural context and vulnerabilities of each city.

1.4 Role of Cities in Environmental and Ecological Stability

Given that half of the world's population started living in cities by 2007, it is no exaggeration to say that the battle against climate change will be won or lost in our cities. Cities currently occupy just 2% area and are responsible for about 70% emissions.[28] In this context, it's important to look at how many major Indian cities contribute to climate change by emitting CO_2 and other GHGs.

Cities are home to over half the population of the world and contribute to 80% global GDP and up to 70% greenhouse gas (GHG) emissions.[27] [28] Cities are major economic and industrial hubs that that have a crucial role in achieving the net-zero targets set by India at the recent COP26 at Glasgow.[29] India's top most 25 cities contribute to about 15% of the GHG emissions.[30] The rate at which Indian cities are expanding, the urban population projected to grow from approximately 480 million today to 814 million by 2050. Urban activities such as transport, buildings, industrial energy use are major source of GHG emissions in the cities. Approximately 70% of the population of India is projected to live in urban areas by 2050.[31]

Moreover, urban infrastructures are extremely energy intensive both in constructing it and using these structures – that is both embedded and operational emissions.

While cities are a major contributor, they are also affected greatly by climate change. Cutting down on emissions locally will not only help in improving urban air quality and reducing pollution, but also improve the overall wellbeing of the city dwellers. Islanding effects of tall, close buildings produce additional heating effects. Decentralizing climate action at city level can have significant impact on emission reduction and efficiency measures like including renewable energy, cleaner industrial activity, regulations and incentives. The urban lifestyle itself is based on a high level of material and energy consumption which needs to change.

Cities directly contribute to climate change through different sources such as transportation, construction, high energy utilities, and waste management and are major sources of GHG emissions in the urban conglomerates.

The current total emissions of India today are about **2.8 billion tonnes CO_2eq.** of which the **4 million tonnes CO_2 eq. (i.e. 14.31%)** are from just these 10 major cities.

Sr No.	Metropolitan regions	State	Current Population	Adjusted CO_2eq Emission Per capita (T CO_2 eq)	Total CO2 eq Emissions (T CO_2 eq) of the city	Optimal Total CO_2 eq Emissions of the city (2T CO_2 eq)	Difference	% in excess
1	Pune	MH	7,893,671	3.36	26,522,735	15,787,342	10,735,393	68%
2	Mumbai	MH	20,961,472	2.21	46,282,930	41,922,944	4,359,986	10.40%
3	Delhi	DELHI	32,065,760	2.88	92,349,389	64,131,520	28,217,869	44%
4	Chennai	TN	11,503,293	5.75	66,120,928	23,006,586	43,114,342	187.40%
5	Kolkata	WB	15,133,888	3.95	59,748,590	30,267,776	29,480,814	97.40%
6	Bangalore	KAR	13,193,035	2.68	35,304,562	26,386,070	8,918,492	33.80%
7	Hyderabad	TEL	10,534,418	2.75	28,948,581	21,068,836	7,879,745	37.40%
8	Ahmedabad	GJ	8,450,228	2.16	18,252,492	16,900,456	1,352,036	0.80%
9	Jaipur	RAJ	4,106,756	3.47	14,252,086	8,213,512	6,038,574	73.52%
10	Lucknow	UP	3,854,224	3.41	13,153,696	7,708,448	5,445,248	70.64%
			127,696,745		400,935,988		144,309,530	
			Total emissions of 10 cities combined		400,935,988	GT CO2 eq	Percentage of total emissions	14.31%
			Total emissions of India today (4000 cities)		2,800,000,000	GT CO2 eq		

Table 1: Table 1 Projections of total CO_2 eq emissions if cities in 2020

The above table summarizes the current trends in CO_2 equivalent emissions per capita in India's ten largest cities. The gap between real and optimal emissions per capita for each city may be seen. The percentage increase in excess emissions is shown in the last column which means that these 10 major cities have already crossed their threshold to tackle climate change.

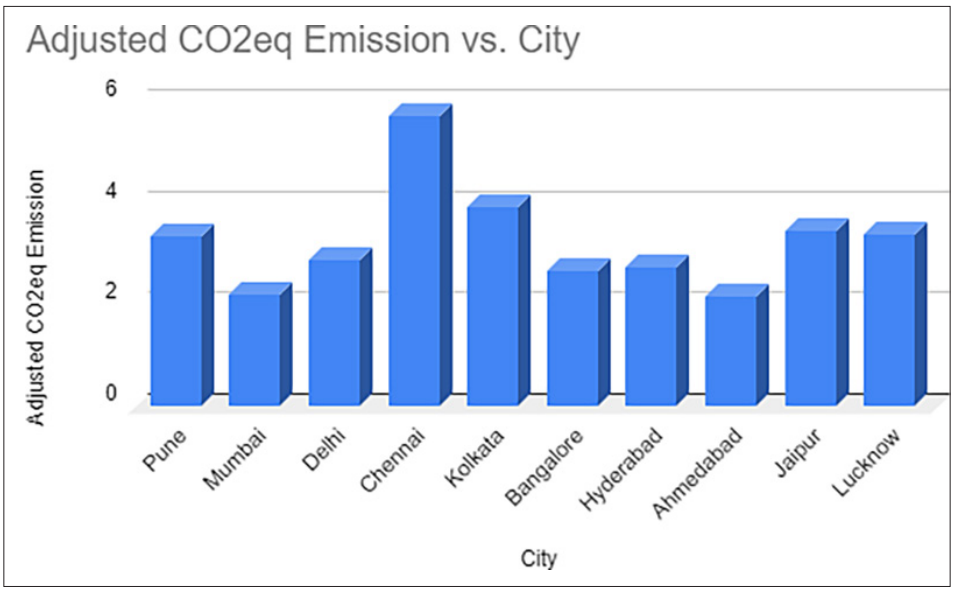
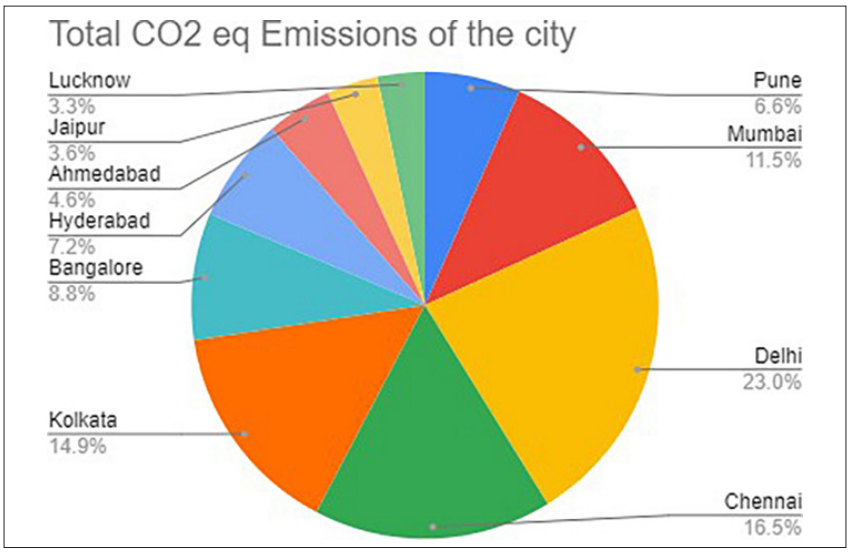


Figure 2 Adjusted CO_2 eq. Emissions per capita

The graph above depicts the expected CO_2eq emissions for India's 10 major cities in 2020. With 5.75 TCO_2eq emissions per capita, Chennai is now the largest emitter, while Ahmedabad has the lowest emissions per capita with 2.16 TCO_2eq. The CO2 emissions of the major cities are shown for the year 2022.

The city's' adjusted CO_2eq emissions per capita are estimated using the PMR trend growth, which is 3.24% rise per year32 w.r.t to the baseline year 2015.



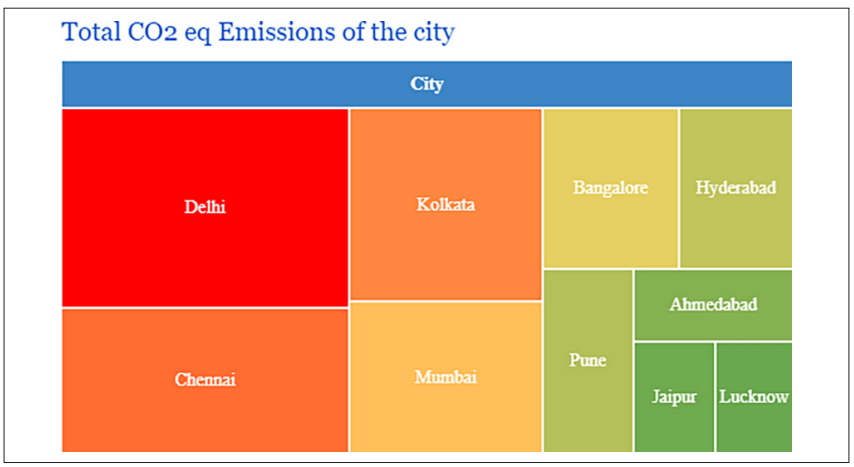


Figure 3 Total CO_2 eq. Emissions of cities (in %)

Figure 3 depict the total CO_2eq emissions of the 10 major cities of India. According to the data, Delhi is the largest emitter of CO_2 in the country, with 92,349,389 CO_2eq (23 %) of carbon dioxide emissions. The second-highest amount of carbon emissions at 66,120,928 CO_2eq (16.5%) is Chennai followed by Kolkata 59,748,590 CO_2eq (14.9%), Mumbai 46,282,930 CO_2eq (11.5%) and Bangalore 35,304,562 CO_2eq (8.8%). The total emissions of the 10 major cities combined are estimated up to 400,935,988 GT CO_2eq, while the total emissions of India today are about 2,800,000,000 GT CO_2eq (for 4000 cities). For ten main cities in India, the difference between adjusted CO_2eq emissions and expected total CO_2eq emissions is 14.31914243. As a result, the **Ten cities account for 14.31% of India's overall emissions.**

City	Population forecast in 2030	Projected CO_2 eq emissions per capita 2030 (BAU) (T CO_2 eq)	Total projected CO_2 eq Emissions of the city 2030 (BAU) (T CO_2 eq)	Optimal CO_2 eq Emissions of the city 2030 (2T CO_2 eq) (T CO_2 eq)	Difference in 2030	Percentage in excess in 2030
Pune	10,187,391	4.84	49,290,674	20,374,783	28,915,892	141%
Mumbai	27,052,397	3.18	86,013,636	54,104,793	31,908,843	58%
Delhi	41,383,337	4.15	171,624,974	82,766,673	88,858,301	107%
Chennai	14,845,887	8.28	122,881,188	29,691,774	93,189,414	313%
Kolkata	19,531,450	5.69	111,038,636	39,062,900	71,975,736	184%
Bangalore	17,026,629	3.85	65,611,095	34,053,259	31,557,836	92%
Hyderabad	13,595,479	3.96	53,798,942	27,190,958	26,607,984	97%
Ahmedabad	10,905,671	3.11	33,920,999	21,811,342	12,109,657	55%
Jaipur	5,300,085	5.00	26,486,520	10,600,171	15,886,349	149%
Lucknow	4,974,173	4.91	24,445,237	9,948,347	14,496,890	145%
			745,111,900	329,604,999	415,506,901	

Table2 Projections of total CO_2 eq. emissions of cities in 2030

Table 2 depicts the projected emissions trends for the 10 cities in the year 2030 for the business- as-usual scenario (BAU). The gap between real and optimal emissions per capita for each city may be seen. The percentage increase in excess emissions is shown in the last column which means that these 10 major cities would surpass their 2020 percentages. This not only highlights the urgency for immediate action but also presents us with a grave situation that we would face in the near future.

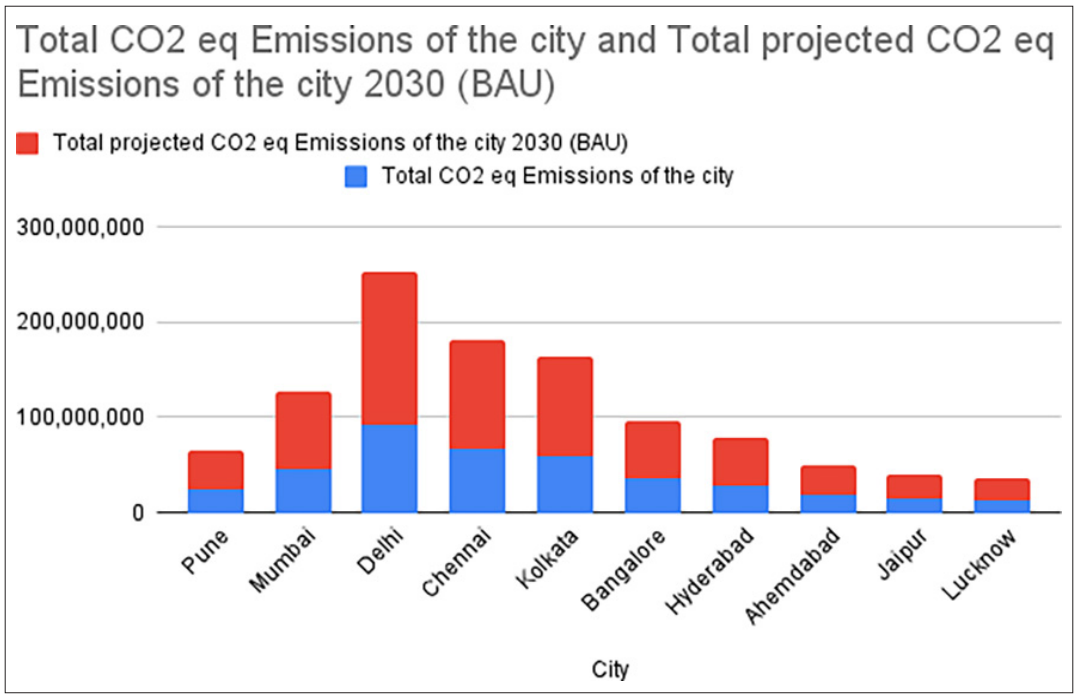


Figure 4 Total CO_2 eq. emissions in 2020 versus 2030

Figure 4 depicts the total CO_2eq emissions of the year 2020 versus 2030. The additional rise in the emissions shown in the figure shows the significant rise in emissions if the current trends continue. As shown in the graph above, the increase in emissions is nearly doubled that of present emissions. Delhi is expected to have a 44% increase in excess CO_2eq emissions in 2020, and a 107% increase in excess CO_2eq emissions in 2030. Similarly, CO_2eq emissions in Chennai are expected to grow by around 313% by 2030, compared to the current 187.4%.

The analysis thus shows the excess emissions of just 10 major cities in 2020 and 2030. The emission of only the 10 major cities of India accounts to about 14.31% to the total CO_2eq emissions of the country. Similarly, one can estimate the amount of CO_2 eq emitted from all the cities in India. Thus, if the BAU trends continue over the next decade, the window for making reparations may no longer be available.

The optimal threshold of emissions is about 2TCO_2 eq to keep the temperature rise below 1.5 degree Celsius

The future trajectory of urban responses to climate change in India will be shaped by how local development and climate goals will be linked and prioritized. While a range of Indian cities are beginning to embark on identifying such linkages, a strategic understanding of interacting climate and development priorities, across governance levels, is yet to be developed. A project- based approach is necessary but not sufficient as cities are not culminations of sites and projects but entail complex systems, interacting infrastructures, and socio-technical systems. Given the magnitude of change that Indian cities will face in the coming years, and their impending challenges of growing population inclusivity and vulnerability, this section outlines the considerations by which climate actions can be mainstreamed in urban areas.

The previous section emphasized on building overall resilience within communities to combat and adapt to the inevitable changes that will occur due to climate change. However, it is fundamental that the natural systems of the region also must be stable and effective. Thus, future-proofing our cities with climate smart solutions is a major requisite to maintain the environmental and ecological stability as well as long term sustainability.

The major step towards restoring ecological and environmental balance in the city is improving the natural sequestration capacity. The natural sequestration capacity can be improved by using climate-smart planning models for urban spaces.

1. Urban greens: Urban forests, according to these studies, serve as key carbon sinks and storage. The net carbon sequestration of urban forests is positive when they are young, but it decreases as the forest matures. Hence completely relying on forest cover for carbon sequestration won't be as effective. A study conducted on 'Carbon Sequestration and Storage Potential of Urban green in Residential Yards'33 have pointed out that soils in urban parks and lawns can store large amounts of carbon. Hence having urban green areas in the cities can help sequester substantial amounts of carbon. Urban forests include all trees in urban areas (i.e. urban trees). It is also found that cities provide important carbon storages and carbon sinks. Long-term terrestrial carbon storage occurs in soils in particular.[33] Therefore, due to its large capacity and potential for carbon storage, urban forestry must be included in urban green planning and architecture along with improving the urban green cover in cities.

2. Green infrastructures: Green infrastructure includes all the natural, semi-natural and artificial networks of ecological systems in urban and peri-urban areas, such as forests, parks, community gardens, and street trees and lakes and ponds. [33] Buildings consume about 40% of the city's energy. Economic expansion and population growth clubbed together fuel a large need for infrastructure and building. These demands thus, present a good opportunity for city planners to achieve energy and cost savings in the next decades by incorporating energy efficiency measures and innovative building materials into newly constructed buildings.[34]

Hence, solutions like, installing green roofs and terrace gardens, solar powered infrastructures, energy efficient construction methods, waste management systems, etc. can help reduce the emission rates of cities significantly.

3. Using regenerative models: Our current development systems are degenerative in nature. The resources are extracted from various unsustainable sources such as mines, farmlands, rivers to provide our cities. The impacts of such a model are observed with contamination of our natural resources. Hence, shifting to a more regenerative model is the need of the hour. The regenerative models are based in the principles of circular economy. Thus, bringing in new innovative designs that reduce the waste, recycle materials and reuse resources to the forefront will increase the ability of the urban environment system to withstand future shocks and stresses.[35] Our cities and structures require supply chains that actively contribute to their preservation and improvement.

Chapter 2

CLIMATE ACTION PATHWAYS TO 2050

2.1 Enviro- Economic Challenges for India and the World

The world is dealing with challenges like rising debt, inflation, disruption of supply-chains due to the pandemic and even conflicts. To add to these challenges, humanity has started to face the consequences of slowing economic progress. These activities have led to a gap between the economic aspirations, environmental well-being and quality of life of citizens. Globalization has significantly altered the economy, ecology, and society in the last few decades.

Climate Change is leading to, and even fuelling various disasters and extreme weather events faster than scientists predicted. The frequency of events like forest fires, floods, heat-waves, droughts, cyclones, etc. has increased to a great extent. Natural disasters alone caused up to $343 billion global economic losses in 2021.[36] As temperatures are set to rise further, the impacts may become more unpredictable.

As discussed in the 1st Chapter, India is in a unique situation - it is a major emitter of Green House Gases (GHGs), but also vulnerable to the effects of climate change. India's resource patterns differ from developed nations. The Indian workforce is largely dependent on climate-sensitive sectors like agriculture, livestock, fisheries, construction and these sectors are already feeling the brunt of climate change.

Our current economic model focuses heavily on economic growth and is incompatible with environmental sustainability. Due to this, we are facing challenges like air, water and soil pollution, biodiversity loss and excessive loss of lives and livelihoods at the time of disasters. Currently, India's energy sector is majorly fuelled by thermal power and India also imports close to 80% of its crude oil.[37] Fossil fuels are finite resources found only in specific nations. Any disruption can lead to market volatility and have direct macroeconomic effects like inflation.[38] These are felt across sectors. Hence, dependence on fossil fuels not only has economic implications, but also on our energy security.

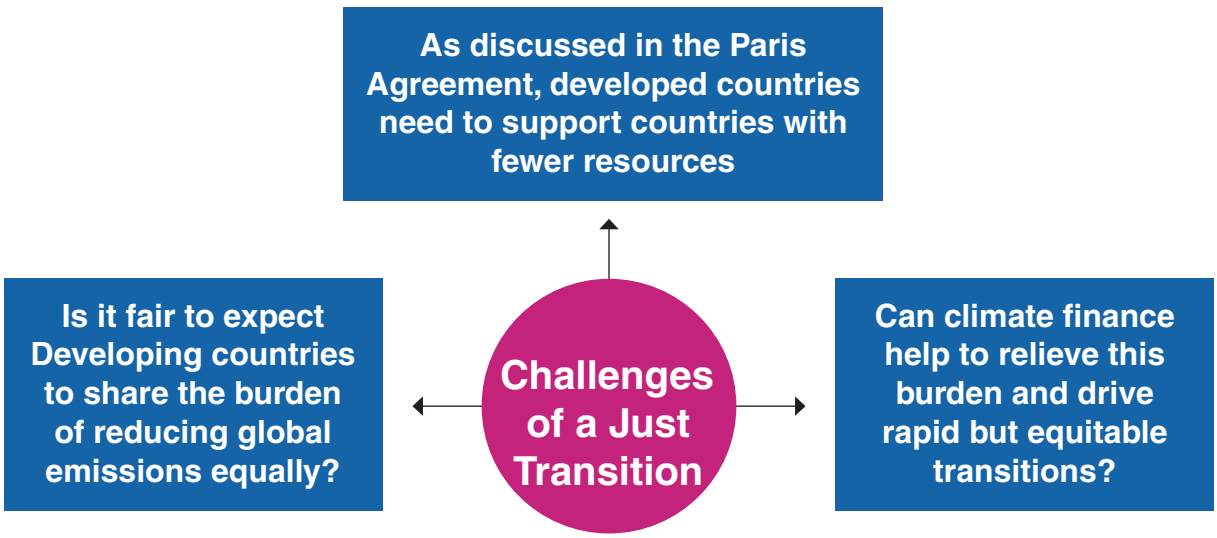
India's push towards large scale infrastructure projects at the cost of the environment is unsustainable. These assets created today might face disruptions in the future. But the dilemma is- the investment in infrastructure projects such as highways, port facilities and power would attract private investment and give a much-needed boost to manufacturing and other sectors. This, in turn, is the key to generate jobs needed to employ India's growing working age population, expected to number over 800 million by 2050. This is important as a large section of India's population is still recovering from poverty.39 In addition, rising inequality resulting in increasing polarization of society is itself a threat to achieving sustainable development. A hotter planet might eventually end up hampering our progress itself. Moreover, the health,

well- being and productivity of Indian citizens is already at risk.

A Green Economy is an alternative vision for growth that is consistent with advancing environmental and social well-being. One significant component of a green economic strategy is to promote the development and adoption of sustainable technologies.[40] There is an urgent need to focus on understanding how it might be possible to shift human behaviour toward achieving sustainable development.

2.2 Challenges of a Smooth and Just Transition

The figure below addresses important themes of the Just transition debate:



The consequences of Global Warming have been discussed at length in the policy paper. But it is important to note that the effects of climate change will be felt differentially across different geographies. The impacts are also influenced by the ability of a country to cope with the challenges. The reality is that the Industrial countries accumulated their wealth and progress by burning fossil fuels. They are the initiators of the problems humanity is facing today.[41] Developing countries, like India are not initiators of these challenges, but are rendered vulnerable due to them today. To add to this, these countries have a huge share of population living in extreme poverty. We are facing a challenge at a larger scale than developed countries are.

A fair and a Just transition is important as resource and technology constrained countries face their own set of challenges like [42]

- Strong link between economic growth and burning of fossil fuels
- Dependence on fossil fuels increasing the cost of economic and political transition
- High levels of poverty, inequalities and social exclusion
- Lack of financial resources
- Absence of safety nets
- Technology needed to mitigate and adapt to climate change and its impacts is expensive

Acknowledging the same, international conventions and agreements have evolved to develop frameworks to support a Just transition. In 1992, United Nations Framework Convention on Climate Change (UNFCCC) initiated the conversation about a Just Transition. Aspects such as funding and technology transfers were considered. The Paris Agreement on climate change drafted in 2015 enabled developing countries to determine their own goals and pathways through the mechanism of Nationally Determined Contributions (NDCs). NDCs are a set of targets and action plans chosen by the signatories of the Paris agreement to reduce their emissions and adapt to the effects of climate change.[43] This is an important step to address specific needs and concerns of developing countries whose economies are heavily reliant on burning of fossil-fuels. It is therefore important to take action on multiple fronts like shifting to Renewable Energy, Energy efficiency and demand-side reduction of fossil fuels. The UN Climate Change Conference (COP26) passed the Just Transition Declaration in 2021 brought forth the importance of a social, economic and technological transition that must take everyone along. [44]

But, despite multiple international agreements and conventions, it is important for this process to be owned at the regional level and by the people themselves. Those on the frontlines like state and city governments need to be supported and their capacities need to be built.

Some, enabling conditions for a Just transition [45]

- Investment in energy efficient and new renewable technologies
- Innovation to create new technological options
- Education and training the workforce
- Social protection measures
- Economic diversification into less polluting areas.

Without a Just Transition there is a risk that we will not achieve a low-carbon economy that the future generation deserves. The economic and social changes that are underway could result in increased social inequalities and unrest, reduce productivity and therefore impact businesses and the market.[46] To reduce the adverse impacts of transitions in different sectors, we need measures that make sure that it is inclusive of everybody. Therefore, a truly

Just transition is incomplete unless supported by policies that address the 'Climate-Divide' that exists between, as well as within countries.

2.3 Need for Policy Interventions

India's journey towards achieving Carbon neutrality by 2047 (100 years since Independence) is a multi-level challenge and involves various stakeholders. Our current GDP oriented economic model is proving to be unsustainable as it does not take the cognizance of two important things, the limits on resources and the adverse impacts of hyper-consumption. India will have to chart its own path to become Carbon Neutral as many of these problems are context-specific, besides being geo-specific. Relying on Western models is not beneficial for India as there are fundamental differences in the way of life, technology, resources, political systems, etc. between these civilizations. Gross Domestic Product (GDP) as a measure of all the output a country generates in a given period of time. But it is highly inadequate as it doesn't account for market externalities or human welfare. Alternatives to GDP exist. Measures like Genuine Progress Indicator (GPI), Human Development Index (HDI) are being discussed by experts.[47]

India's challenges can broadly be categorized into:

- Making government institutions resilient to climate change,
- Ensuring sustainable livelihood opportunities
- Moving towards a development model based on well-being of all citizens, ratherthan the current model that only help the rich get richer.
- Enabling the transition under adverse climate conditions.

Depending on purely market-based mechanisms or waiting for demand to shift organically will lead to piecemeal changes. For systemic change to occur rapidly, just and sound policies are required. Policies also play an important role in influencing the market, setting rules and regulations, increasing uptake of new technologies and phasing-out harmful ones. It is also important to invest in R&D programmes and create a supportive framework for green entrepreneurship. Policies that help in addressing market failures which have played a role in creating the climate challenge in the first place will be critical.[48]

Despite international and national reports, policies and agreements like, the Paris Agreement, National Action Plan for Climate Change (NAPCC), their impact remains limited. Climate change mitigation needs a decentralized approach that provides space for diverse local solutions. This can be done by building the capabilities of local political institutions in terms of knowledge, finance and authority. The current approach is highly centralized and under- participative.[49] Climate action would need massive changes in the working structures, decision- making processes and man-power utilization of our existing government institutions.

The major change will be ensuring an integrated approach where diverse institutions work together to solve an issue.

The challenges India faces can be seen in this following example: Indian Electricity & distribution companies (DISCOMS) have been hesitant to undergo reforms, which are one of the main bottlenecks of a renewable Energy transition. The issue needs to be dealt with by the Central government. The Central government has brought in different schemes like UJWAL, loan waivers etc. to facilitate these reforms, but progress remains limited. But, if the reform process doesn't begin now, meeting our target of reaching 50% electricity generation from RE will remain a pipe dream. This is because it would heighten the risks for investors compared to the returns.

There is a need to be mindful of India's current energy geography to understand the challenges of the energy transition. The regions with coal reserves like Odisha, Jharkhand, Chhattisgarh and Madhya Pradesh are also the poorest regions in India. Coal mining is one of the main sources of their revenues. Today, around 7% to 10% of revenue received of these States are dependent on coal. Around 60% of the GDP of some districts is dependent on coal within these regions; there are districts like Dhanbad, Chakra, Singauli which are more economically backward. This transition will create short-term pain, hence the government will need to be innovative enough to incentivize this change. One big issue of this green transformation which is underway is the management of the political economy of this transition. The climate challenge, while being an important one, is also embedded in socio-economic and development-related issues India faces till today. This is where 'smart policies' can play an important role in creating and facilitating alternatives.

The rapid changes in the market related to technology, changing consumer trends and government regulations can hurt employment if policies are not designed to accommodate and adapt to the changing nature of employment. India needs an economy which has a much lower carbon footprint and yet creates jobs.

2.4 Pathways to Carbon Neutrality in a Climate Challenged World

The above-mentioned aspects of the transition must have already brought how crucial our decisions on all fronts will be, but another aspect is of urgency of action which is brought by science through the recent IPCC reports. The techno-economic and socio-economic aspects that need to change are huge in scale as well as numbers and it will take some time, because if the techno economic aspects (such as renewable energy, CCUS, Climate finance, etc.) political economic changes will be slower than the techno-economic changes and we will witness a major mismatch. The changes need to be more widespread and adopted at all levels. All 1.39

billion people of India need to become participative in this transition as all their lives are essentially dependent on this transition. Therefore, we cannot wait to act only as the deadline for action nears, the rapid decarbonization pathway is already overdue and this decade must be recognized for serious and dedicated climate action at all levels and sectors to ensure efficient, equitable and a productive transition.

A carbon neutral India by 2050 will need to stand on 5 pillars- low-carbon developments, institutionalizing Climate Justice, sustaining sources of climate finance, redesigning existing governance and implementation frameworks and decarbonizing our systems. These represent the cross-sectoral transformations that need to happen through the next 28 years. This paper also puts forth the immediate actionable solutions in each area. Below we explain what all these changes mean, how they are relevant for India and how to achieve them.

2.4.1 Shifting to Low Carbon Development Model

We need to take action on multiple fronts to combat climate change. Stockholm Resilience Centre put out a concept of "Nine Planetary Boundaries." Led by Johan Rockström, the team of 28 internationally renowned scientists set out the boundaries within which humanity can develop and thrive for generations to come. They are biogeochemical flows and biosphere integrity. Research shows that of the 9 planetary boundaries, humanity already exists outside the safe operating space of at least 4 boundaries: Climate change, biodiversity, land-system change and biogeochemical flows (nitrogen and phosphorus imbalance).[50] Continuing this trend will lead to widespread displacement, disasters and irreversible changes to the way humans can live. The other planetary boundaries have not yet been crossed, but the current scenario all but ensures that most of these will be breached in the future, presenting the urgent need to redefine the current way of humanity.

Our current economic systems have become addicted to 'growth at all costs', as measured by Gross Domestic Product (GDP). They mistakenly assume that GDP growth is synonymous with increasing prosperity, wellbeing and satisfaction in life. Since the 20th century, the extraction of construction materials grew by a factor of 34, ores and minerals by a factor of 27, fossil fuels by a factor of 12, and biomass by a factor of 3.6.[51] This expansion of exploitation/ consumption was not equitably distributed, and it had profound environmental impacts. Over- exploitation, climate change, pollution, land-use change, and loss of biodiversity rose towards the top of the list of major international concerns. This approach has led to growing inequality, an escalating climate crisis, and the depletion of natural and social capital.

Our current exploitative development model needs to be replaced by a more socially and environmentally prudent 'Green Low-carbon development model'. 'Low-carbon economy' can

be characterized by optimal resource utilization which means producing more with fewer natural resources and less pollution and contributing to higher living standards and a better quality of life. India as a developing country has to redefine the low-carbon pathway with the view of emphasizing harmony with the overriding priority of poverty eradication and sustainable development. These approaches acknowledge the fact that a single-minded consumption economy, often driven by corporate need to create new markets, is not central to our society; therefore these approaches need to be backed by more holistic development indices which can replace GDP. Options like Gross National Well-Being and Genuine Progress Indicator need to be discussed further.

The textbook definition of low-carbon economy is simply an economy that causes lower levels of Carbon emissions than the current economy. We need to redefine the way the low carbon economy is going to work for India. There is a whole lot of India which does not have the basic infrastructure, access to education, health care, so on and so forth. And that's going to come from the taxes, which are going to come from economic growth. So, economic growth which leads to wellbeing without damaging the environment is the kind of growth we are going to look at. As urbanization continues at a fast pace, India has a unique opportunity to switch to low-carbon, resilient, and equitable pattern of development for the long term. Thereby, ensuring economic sustainability.

To achieve a 'Low carbon economy', India needs to focus on four major sectors. These four objectives need to be incorporated in policy-making in different sectors such as energy, agriculture, infrastructure, manufacturing, etc.

1. Decoupling GHG Emissions from Economic Growth: [52]

We are using unsustainable amounts of the Earth's natural resources. We need to reduce the carbon intensity of our productivity (doing more with less).This is the notion behind "decoupling". This 'dematerialization' is based on using less material, energy, water and land resources for the same economic output. There are the two processes of decoupling that we need to look at for the economic growth which will lead us to the goals.

- **Resource Optimization:** Resource decoupling leads to an increase in the efficiency with which resources are used. There is a tendency of underestimating the real value of resources. As compared to the world we cannot be more energy intensive in our resource usage. Raising the value addition per resource is not all that difficult and we can measure it by resource, we can budget by sector and measure it by life cycle analysis. Value addition is not just in the production process but also from mining, converting, distribution, production, the entire value chain of the mineral to the final product and, to the end of life cycle. There are various

methods of increasing the value addition per resource consumption, for example, switching to EVs enhances efficiency of resource use.

- **Low Impact Growth:** It requires increasing economic output while reducing its negative impact on the environment. Such impacts arise from various processes. For example, the extraction of required resources by mining or agriculture leads to GHG emissions, land degradation and pollution due to discharge of hazardous waste; transportation of produced goods results in CO_2 emissions. Low Impact growth means planning the production activities in a way that it has as the lowest possible impact on the natural environment while value is added in economic terms.

2. Increasing the Sequestration Capacity of the Country:

The global energy demand is predicted to almost double by 2030. With the lack of alternative infrastructures, substantial amounts will be met by fossil fuel sources. Hence, to stay within the 1.5 ^{0}C limit, RE would have to majorly contribute to the energy demand as compared to the current scenario. This is a pressing concern from ecologic and environmental perspectives as coal combustion is a chief source of CO_2.[53] Carbon can be sequestered in two ways-

a. **Naturally:** with the help of ecosystems into the natural carbon sinks such as forests, oceans, plants, soils, geologic formations, etc.
b. **Artificially:** with the help of artificial technologies to capture atmospheric carbon and sequester into the ground.

Natural sequestration capacity of India can be improved by managing the existing dense forests for biodiversity conservation and maintaining the ecological balance. The capacity can be improved by multispecies reforestation on non-forest lands, wastelands and other public spaces. Furthermore, ethno-forests, urban forests or common spaces could widen the scope for natural carbon sequestration.[54] Despite these suggestions, sequestration capacity is not increasing at a pace faster than the pace of emissions. Therefore, for building aggressive sequestration capacity, there is a need to push for development of technology assisted CO_2 sequestration.

The artificial sequestration capacity can be improved using the technologies such as CCS/CCUS. The artificial sequestration is a process of capturing CO_2 from large point sources such as fossil fuel plants, then transporting it to a storage site and depositing in inaccessible areas (underground geological formations) or under sea. These technologies need to become more efficient and affordable to be deployed at scale.

The carbon capture and sequestration capacity avoids the unwanted and large amounts of CO_2 from fossil fuel industries and other industries which use fossil fuels as a source of energy for production. Although India has a huge potential in reducing its emissions, lacks the systemic adjustments needed to put this technology to use.[55] In the Indian context, the project design and development include several other factors. Understanding and planning for all possible outcomes are required for carbon capture and storage operations. Accidental leakages must be accounted for because the storage of CO_2 at geological repository depths is of main significance. The financial fluctuations between buyers and sellers must also be taken into account in the plan. Furthermore, the implementation of costly CCS technology in India necessitates financial incentives from local and central governments, as well as good governance policies that allow for FDI.

3. Scale up Sustainable Low-Carbon Practices, Investment and Finance:

Green finance has largely been routed towards mitigation rather than adaptation. Market dynamics are changing and corporates and businesses are responding to calls by the public to push for Net-Carbon Neutrality. It is important to mobilize domestic and international sources of finance to meet the high capital requirements of a transition, especially for the energy and transport sector. Different mechanisms like carbon credits, green bonds, and sustainability-linked bonds need to be tapped. Public finance and investment can also catalyze the low-carbon transition provided that governments phase-out their support for investments in greenhouse- gas-intensive activities. There is also a need to mainstream climate objectives into public procurement and official development assistance measures to meet capital needs.

4. Encourage Low-Carbon Innovation on a large scale:

Clear and credible government commitment to ambitious core climate policy instruments is an important incentive for low-carbon innovation. The low-carbon transition could – and in some cases already is – driving a boom in innovation and emerging businesses, and a parallel shift in skills and the labour force. Innovation for the low-carbon transition is about the creation of new businesses, the restructuring or the phasing out of old ones, the emergence of nascent technologies and business models, and the right support frameworks for innovations to be widely adopted. This includes addressing potential skills gaps through education, training and labour market policies. The shift towards green low-carbon development should coincide with the Industrial revolution 4.0 which will initiate massive progress through innovation in Artificial intelligence and machine learning. This revolution must be used to the advantage of the world by finding innovative green solutions which can increase the efficiency of the new development models.

The agrarian economy has high potential and India must concentrate on using the potential for reformative growth. Today 58% of Indian citizens are in agriculture-related businesses and they contribute not more than 15% to 16% to the GDP. Changing the resources which are used and using resources in more environmentally friendly ways can increase the resource efficiency. The choices to do the same could be:

- Use of renewable energy such as solar PV, and wind energy
- Use of alternate energies such as agricultural waste to fuel
- Use of technologies to Seed and yield improvements
- Diversifying cropping patterns
- Using less water intensive crops

We need natural farming; it has a huge potential to store carbon in the soil and natural farming is one of the ways towards moving to soil as a storage and help sequestration cycle, but we need to build this capacity. The natural farming crops are going to be more expensive in terms of inputs but they don't get more prices at the moment and we need to have some separate market mechanism where they can get higher prices.

Changing the processes and disincentivizing the negative externality is something which really needs to come under focus in the Indian context. There is a need for dedicated government programmes on low-carbon technologies and innovations, along with provision of incentives and financial support for diffusion and adoption. Incubation centres with industry-academia linkages and technology-transfer programmes can provide a boost to innovation. Inter- ministerial co-operation, financing mechanisms, and building human capabilities are key in encouraging low-carbon innovation.[56]

2.4.2 Decarbonization of our World Systems

To keep global warming within acceptable levels, humanity's only chance is deep decarbonization or Net-Carbon Neutrality. Decarbonization refers to the process of reducing carbon dioxide (CO_2) emissions resulting from human activity in the atmosphere. The current (and optimistic) objective of decarbonization is to, eventually; eliminate our carbon dioxide emissions by balancing the carbon cycle. To achieve deep decarbonization, we need to rethink how we produce and consume energy and operate a radical switch to renewables and low carbon energy sources.

Decarbonization or Carbon neutrality at core means having a balance between emitting carbon and absorbing carbon from the atmosphere into carbon sinks. Global greenhouse gas emissions will have to initially be drastically reduced and the remaining emissions

counterbalanced by carbon sequestration or any other offsetting process, to truly achieve sustained Net-Zero emissions or Net-Carbon Neutrality.

Zero emissions refer to a process where no CO_2 is released at all. Among the current mining and manufacturing systems in the world, no technology can produce zero emissions yet. However, a Net-Zero scenarios where emissions are being generated but are offset by equivalent amounts elsewhere, is possible. Offsets include restoring natural ecosystems to enhance the natural sequestration capacity, build on the CCUS technologies and innovation in direct removal of CO_2 in the atmosphere.

The term 'Net-Carbon Neutral' is sometimes used instead of Net-Zero, as they broadly mean the same thing. Some ways to move to Net-Carbon Neutrality in national plans are:

- Drastically reducing or eliminating fossil fuel use in energy and transport sector
- Improving energy efficiency and/or redesigning products and processes to reduce emissions as well as energy demand
- Investing in natural sequestration, ecological restoration and CCUS technologies as well as artificial removal of CO_2 from air

Decarbonizing our carbon intensive world systems can provide a stable zone for all life forms to exist. Locally chartering pathways for carbon neutrality will be an essential activity in our journey towards carbon neutrality, but looking at carbon neutrality from an executory point of view will be critical for cities to set realistic targets and achieve them through projects. India, since it's a developing country, has great potential for development. But carbon neutrality must become the underlying basis of this development overarching theme of this development.

A systematic approach to Net-Carbon Neutrality is needed for every region, therefore starting off by getting to know the enviro-economic status quo of the region is necessary. This will require a high amount of data to figure out possible correlations and causations in the economic and environmental systems. Assessing technological local solutions for the region with respect to factors such as its native biodiversity, bio-capacity, carbon footprint, etc. will be the next logical step which can lead to a better understanding of how systemic changes need to be designed in order to make them effective. These systemic changes must be operative at political, social as well as environmental level, e.g. Transforming from a centralized waste management system to connecting many decentralized waste management systems together in order to obtain a more efficient waste management system with minimal impact on the environment. Throughout this process, a realistic financial assessment of all the projects must be done. This approach can culminate into a strategy for mobilizing citizens as well as local leaders by engaging them and fixing responsibilities. The final step in this approach will be to

put research and strategy into action by kick-starting some pilot-projects in the urban areas.

This systematic approach makes the governments and industries take a closer look at how our manufacturing, supply chain logistics and transportation systems function. Taking a closer look refers to rethinking how we operate today and decarbonizing those systems, for e.g. Just electrification of transportation would not make it zero carbon, but using Renewable energy to charge these EVs can help us reach a sectoral near Net-Zero goal. Likewise, for moving to green buildings we need to have a zero Construction and Demolition waste management system in place as well.

Such an approach towards achieving Net-Carbon Neutrality can be decentralized and address inter-relationships between different components, e.g. open dumping of waste and soil quality degradation etc. with a project structure which is localized. This will also provide more flexibility as a closer feedback system can be established at local levels than state or national levels.

2.4.3 Institutionalizing Climate Justice

Believing that climate change is only an environmental problem is a big misnomer: Climate change interacts with our social systems, privileges, embedded inequities, and affects people unequally based on class, race, gender and geography. From extreme weather events to rising sea levels, the effects of climate change often have disproportionate impacts on historically marginalized or underserved communities. As the temperature of our planet creeps up, for many the fight to stop climate change is truly a matter of life and death. Climate justice is not just about how humans are responsible for protecting next generations or addressing perceived future problems – because these problems are very much harming our current health, quality of life and environment too.

Climate justice at its core means a reshaping of climate action from a technical effort to cut emissions into an approach that also addresses basic human rights and social inequality. It can be looked at from three standpoints, first advocating a historical view that says, as industrialized nations and corporations have amassed wealth by burning fossil fuels. Many also argue that a just outcome would involve the “polluter pays” principle, which will ensure that wealth be distributed equitably to deal with the consequences of climate change

Secondly, we can take a more current view of the consequences by acknowledging that climate change will have differential social, economic, public health, and other adverse impacts on underprivileged populations and this makes it necessary to equip such populations with adequate tools to better adapt to the impacts of climate change.

Case Study: In March and April 2019, two devastating cyclones swept through Mozambique, one of the world's poorest countries. Hundreds of people were killed and millions more left in need of humanitarian support, such as access to safe water. This is a classic case of climate injustice. The first storm, Cyclone Idai, was the second deadliest to ever hit the Southern Hemisphere. The second, Cyclone Kenneth, was the strongest to ever hit Africa. This year, a major drought has led to severe famine like shortage of food sources in Madagascar, according to the United Nation's World Food Programme. The "famine-like conditions", driven by climate change, are leaving people to eat only locusts and cactus leaves, it said in November. Just 0.09% of the world's total emissions are produced in Mozambique. On average, its 31 million citizens each have a carbon footprint around a quarter of someone in the United Kingdoms. It is among the many vulnerable countries expected to bear the brunt of the impact of climate change, but can hardly be expected to dramatically cut its own emissions.

India also is in a similar situation. In a span of 14 months, India witnessed three fatal cyclones- Cyclone Nisarga, Amphan and Tauktae. The impacts are borne first and foremost by the native communities who are thrown 10-15 years into the past as they lose their livelihoods and basic social foundations. Therefore, just knowing about climate justice would not be enough. Institutionalizing a national as well as an Inter-governmental global framework to address climate justice issues is necessary. Institutionalizing such a framework can help establish equitable norms for compensation and insurance. It must also ensure equality of opportunity and security for all. Climate Justice must be recognized internationally but must be provided at a local level to avoid disproportionate climate impacts and displacement and forced migration of populations.

Institutionalizing climate justice, should highlight how we put in place norms, rules and institutions, more so institutions, organizations that can bridge the gap between those who have benefited, and those that will not. And that gap between the beneficiaries and the non- beneficiaries of climate change is currently enormous and increasing. It must be noted that the underprivileged will also be less prepared for adapting to climate change. **Hence the question really is - how do we bridge this gap? Will it require a new approach to climate justice?** This will require clarity at the political level and resolve at the administration/ judicial level.

The entire discussion on just transition is picking up across the world, and therefore there is a need to ensure that districts and States are on board and are being provided alternatives. Countries like India are now realizing that if they do not handle the political economy of this

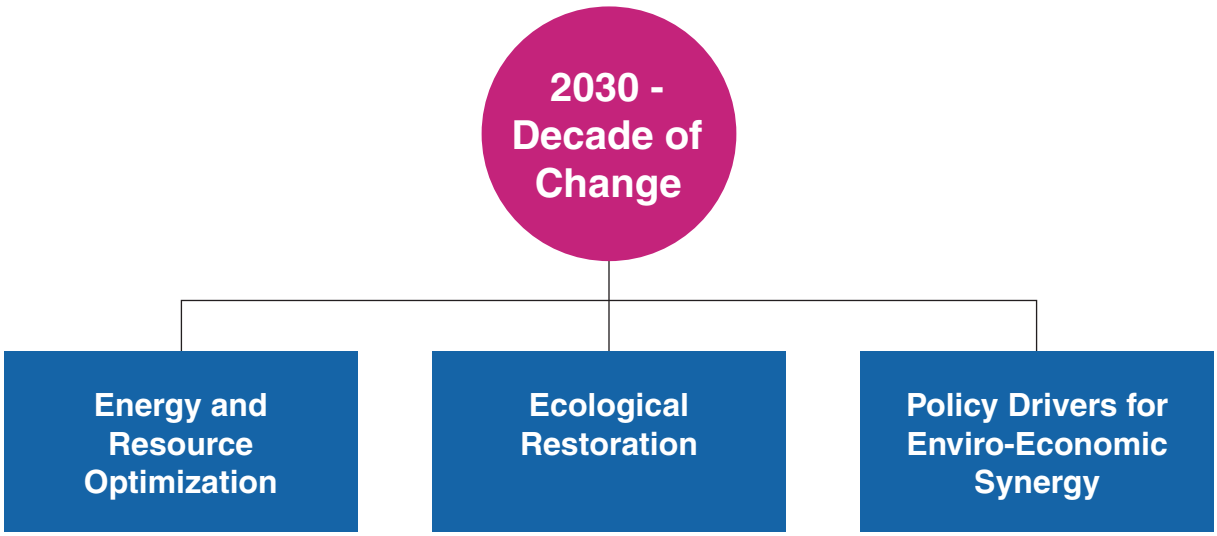
transition, then this transition will be far more expensive than what was expected before. In India's case, the process has not been started. A Just Transition is not only an issue between countries, but also within.

As we discuss the transition towards Renewable Energy, our associated tribal communities and forests are facing severe consequences in terms of loss of livelihood. The transition should not happen in a way that the poorer part of the country becomes even poorer. For example, the Korba district in India is the largest producer of coal. A haphazard transition will lead to loss of livelihood for a large chunk of the population in resource-rich states. The political economic aspect needs to be dealt with a renewed approach to climate justice. Thus by ensuring that most States are on board and are being provided alternatives for a just transition We need to place all countries in the context of their respective emissions, in terms of their economic vulnerabilities and their capacities to deal with the climate impact. Climate justice needs to be institutionalized and should eventually become a norm.[52]

Chapter 3

ENVIRONMENT TARGETS FOR INDIA: BY 2030 AND 2050

As the world is slowly coming to grips with the reality of global warming and climate change, we are seeing many organizations and even countries making commitments to go Net-Zero. These targets are a step in the right direction but seem far-fetched. While most countries appear committed to going net-zero by 2050, some other major emitters like China (2060) and India (2070) appear yet to recognize the urgency. Moreover, these targets need to be backed by a solid economic strategy and proactive action plans. Additionally, it needs to be governed with certain principles or frameworks that can act as a guide to create a Net-Zero pathways. The pathway will require radically different policy decisions and actionable goals in key sectors aspects such as Energy, Transport, Resource Optimization, Circular Economy, Ecological restoration with foresighted public interventions. To understand the correlation of these aspects and need for changes within this decade, we need to classify it as a three-way approach-



The first is to minimize the anthropogenic emissions i.e., our economic processes to change so that it can eliminate the carbon emissions or reduce them drastically, which will contribute the most towards Carbon Neutrality. The process of doing so will be governed by, energy demand reduction, shifting completely to RE and innovative low-carbon technology routes especially for industries, such as circular economic practices. Secondly, we need to balance the Earth's Environment through restoration of various earth ecosystems to reduce or eliminate the threat of climate tipping points as discussed in the earlier chapters. And driving the change this decade can be achieved by public policy interventions that are governed by the circular economic aspects. Reducing demand for resources and yet maintaining satisfactory life-style will require major socio-economic transformation in progressive societies.

3.1 Solutions for Decarbonization

The approaches for low carbon development or decarbonization of our economy are already available today. As mentioned earlier, optimization of Energy & Resource use and Ecological Restoration of the earth ecosystem along with the right policy interventions are the three main approaches crucial for this decade.

- **Energy and Resource Optimization**

The first includes the aspect of Energy and Resource Optimization which talks about the need to reduce the work done or materials needed to accomplish a given task, in order to reduce carbon emissions. For example, by using a more efficient pump and micro irrigation technique, we can not only save on energy used to pump agricultural water but save on water losses as well for irrigation. This is how one can achieve reduction of energy and resource use while accomplishing the same task. Additionally, we must replace old technology itself. For example, replacing the polluting grid power that powers the pump, with a solar PV system to reduce carbon emissions.

Energy is the most important commodity in the world today for fuelling economic growth. Energy has become a key ingredient in human development. Major global concerns such as food, water, health and waste come together because we need the energy to deal with each one of these things. The Energy sector is also the largest contributor to global warming, it accounts for nearly 70% of total GHG emissions. We need to seriously 'Decarbonize'. The decarbonization of our economic systems combined with decentralized and digitally-enabled electrification technologies can provide access to modern energy services for the billion people who currently lack it, strengthen energy security, reduce exposure to energy price volatility build overall system resilience to the rapidly increasing natural hazards (especially in vulnerable, small island states) and cut the costs of air pollution worldwide.

Projections show that India will become the highest emitter by 2050, if we follow the same path. **It is evident that India will have to overcome the trilemma of Energy access, energy sustainability and energy independence.** So, transitioning to RE will meet the twin goals of energy access and sustainability. Achieving energy independence means being able to fulfill your energy demand through indigenous sources and not being dependent on imports. Achieving energy independence will give India the autonomy to make decisions about pivotal factors such as budgeting, national security, resource allocation and national security, etc. Promising Renewable Energy alternatives include Solar, Wind, Biofuels, Hydro-Electric, Green Hydrogen, Geo-thermal or Wave energy. All these have huge untapped potential and combine very suitably to meet inevitable increasing demands of the future.

In the energy sector, there is a need for paradigm change to address the problems at hand, some of these changes include:

1. Looking out at development rather than growth
2. Reducing energy use in addition to over-all energy efficiency
3. Transition to renewable energy from fossil fuel as rapidly as economically feasible
4. Focusing on reduction in life cycle carbon over upfront capital cost
5. Giving attention to the consumption in first place over conservation
6. Transition to circular economy over linear economy
7. Promote small independent smart micro-grids in certain locations

- **Ecosystem Restoration**

The aspect of Ecological restoration is crucial for stability of the earth environment. The United Nations has classified this decade from 2020 to 2030 as the decade of restoration. Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed. Ecosystems are dynamic communities of plants, animals, and microorganisms interacting with their physical environment as a functional unit. These communities can be damaged, degraded, or destroyed by human activity.[57]

As the UN Secretary General states – We must make peace with nature if humanity has to achieve the UN sustainable development goals. It is a really commendable and much needed start to declare 2021-2030 as the **Ecosystem Restoration Decade.** Three-fourth land-based and two-third marine environments have already been significantly altered and degraded by human activity. We are practically going to make it or break it by the decisions we make today and now. The world economic forum with the UN decade on restoration has embarked on the 1 trillion trees campaign, where the aim is to promote nature-based solutions to Climate Change and restore 1 trillion trees by facilitating nature.

Ecosystem is a place where plants, animals and other organisms, in conjunction with the landscape around them, come together to form the web of life. Ecosystems can be large, like a forest, or small, like a pond. Many are crucial to human societies, providing people with water, food, building materials and a host of other essentials. Ecosystems also provide planet-wide benefits like natural sequestration and biodiversity conservation. There are 3 broad types of ecosystems, Terrestrial ecosystem, Aquatic ecosystem and transitory ecosystem. They include 8 subsets among them, farmlands, forests, lakes & rivers, grasslands & savannahs, mountains, oceans & coasts, Peatlands and urban areas. In recent decades, humanity's hunger for resources has pushed many ecosystems to the breaking point.

In many ecosystems, humans have altered local native populations of plants and animals, introduced invasive species, converted natural communities to extractive use (such as agriculture or mining), fouled waters, and degraded soil resources. Ecological restoration focuses on repairing the damage human activities have caused to natural ecosystems and seeks to return them to an earlier state or to another state that is closely related to one unaltered by human activities. Ecological restoration is distinguished from the practice of conservation, which is primarily concerned with preventing further losses to ecosystems.

Ecological restoration is a hugely important tool for addressing and reversing the climate catastrophe. It offsets climate change by increasing carbon storage in soils and vegetation, and can influence the Earth's reflectivity, which can have significant regional effects. As the biodiversity comes back, soil fertility improves, soil moisture improves, crop yield improves and economic gains improve. The restoration of ecosystems is intrinsically linked to the restoration of human health. The COVID-19 pandemic, which has so far caused over a million deaths worldwide, is a poignant reminder of how ecosystem degradation can contribute to the emergence and spread of novel pathogens. To combat these emerging global conditions and protect the lives of future generations, we need to protect and restore our habitats and biodiversity.

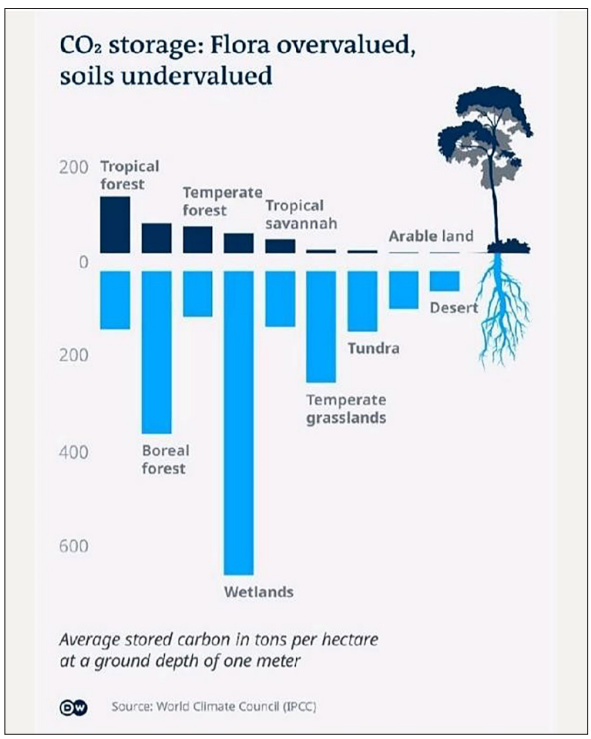


Figure 5 Carbon sequestration potential of various ecosystems [58]

Ecological restoration must be sustainable. Real challenge is making the economic incentives so that nature restoration is a viable and sustainable approach for local communities. Restoration activities must benefit their well-being and economic sustainability. Integrating agriculture or agro-forestry into a natural forest ecosystem can be one solution, eg. Coffee plantations in the gaps of forest canopy in Ethiopia. Economies will have to drive direct finance to such activities.

Restoration happens in the long term and is beneficial to the overall health of our planet. Different locations will need different solutions. India can also both adapt and mitigate climate change by restoring and expanding natural ecosystems.

- **Policy Drivers for Environment-Economic Synergy**

The third major aspect is public policy interventions that are required for the necessary shifts in developmental models. India will have to restructure its existing economic models and shift to more holistic developmental matrices. Policy is a major driver for efficient alterations within industry, technology, infrastructure, energy and financial instruments. This aspect will highlight the right approach towards fabricating and implementing various policy drivers in this decade and beyond.

Climate Change is now an economic, developmental and societal threat and most imminent existential threat for several people worldwide. Human population increased two-folds in 60 years (1960-2020) and Global GDP increased by 30-fold per capita. For India, it is 75-fold GDP growth in 2019, within the same time. But we are still facing problems of poverty, hunger, poor conditions, growing waste, and environmental crisis. The most basic and pressing issues like hunger, shelter, health, unsustainability, environmental and climate crisis, etc. continue to prevail all over the world. These are also consequences of short-term planning and rewarding short term economic gains. We need to understand and explore – what is the economic activity per hectare that will be caring and respectful to the planet? We need to ensure Ecological Integrity and a habitable planet.

With the current economic model India may want to develop at all costs and grow fast, but if we want to sustain in this 'Climate-Challenged World' we need to develop responsibly. We need to take a strategic approach to make a swift clean transition to Green Development. To transition to a better and reliable present and the future, we need to opt for the following inclusive, sustainable and eco-environmental frameworks:

3.1.1 Aims for 2030

India needs to aim to become carbon neutral by 2050 along with most progressive nations and this decade will be essential to set India on the right pathway. Making 10 major cities carbon neutral to understand what we need to do for all other cities can be a realistic and useful target for India. India will need a strong integrated Enviro-Economic-Energy policy.

Foundations for Net-Carbon Neutrality:

- **Green Climate Smart Development:** Redesigning priorities and processes for deep decarbonization, energy transition to RE, Green Industrial Ecosystems and restoration of ecosystems.
- **Systemic Changes:** Focusing on resilience and national security in terms of energy, resources and land use and aim for achieving a Frugal Economy which will be imperative for climate secure future. Strong green institutions must be established and empowered to drive systemic change. An All-India Service for the environment, much like the Forest service, could be a step in the right direction.
- **Integrated Policies:** Considering Environmental Responsibilities in all policy and finance decision-making, at all levels must be introduced quickly

Some Important Approaches:

- **Driven by Science:** Decision-making must be driven by the new and upcoming as well as the fundamental knowledge of the Ecology and climate system.
- **Decentralized:** Centralized governance is environmentally and energy-wise expensive. India is a geographically and socially diverse country. We need locally-rooted solutions based on globally relevant science.
- **Multi-stakeholder participation:** Multiple stakeholders such as government institutions, Industry, communities, organizations need to be empowered and included in the decision-making.

Key drivers for Change:

- **Non-Fossil Fuel Economy:** Rapid transition to Renewable Energy, especially solar, wind and waste-to-energy processes and phasing out Fossil-Fuels systematically with policy interventions.
- **Decreasing Demand:** Reducing overall demand by changes in lifestyle and product lifecycle to reduce adverse effects of consumerism while simultaneously increasing efficiency of energy and natural/local resource use at individual, community as well as regional levels with due incentives and subsidies.

- **Ecological Prudence:** Ecological Restoration, accountability for the Cost of doing nothing when nature is being destroyed and considering long-term consequences and benefits of any development activity.
- **Accelerating Climate Action:** Policy Drivers, Incentives, Regulations and Laws to encourage citizens and industry to shift to green practices and applying Climate Economy principles with Carbon Pricing and green finance.
- **Technology and Innovation:** Potential for energy efficient systems and carbon sequestration systems is huge and must be accelerated by capacity building and incubation programs.

Shifting metrics to realize the 2030 aims:

- **Using green economic models and indicators:** The wealth of a country should be defined based on Produced, Finance, Natural, Social and Human Capital together. The produced and financial capital gains should be calculated for distributive efficiency and not just economic growth.
- **Assessing impacts of action:** Focusing on factors like Renewability, food and nutrition, ecosystem services and security for all life forms. These should be measured using proxy indicators or indices with regular monitoring and mapping of success.

We are living in an Age-of-consequences, where our actions today will be defining the fate of the country and the world for years to come. The next 9 years will be decisive and long-lasting. We can foster human aspirations without jeopardizing environmental health and security if we make the right decisions within this decade. We need to ensure that India takes responsibility towards the future and makes low carbon sustainable progress a reality, starting now.

3.1.2 Sector -Wise Solutions for Decarbonization

India's commitment towards achieving net-zero is commendable w.r.t. to its NDC targets. Yet, the emission trajectory has not altered with the existing policies to maintain the 1.5°C goal. To put its economy on track, India would need to embrace a comprehensive set of climate measures on course to achieve- at the same time- strong economic growth, job creation, and reductions in emissions. According to the research conducted by ORF, India has the potential to generate thousands of new jobs opportunities, fuel economic growth substantially above business-as-usual (BAU), and reduce the country's GHG emissions by more than two-thirds the BAU by mid-century if appropriate policies are put in place. The figure 3 shows the highest CO2 emitting sectors- Energy, Industry and Transport.[59]

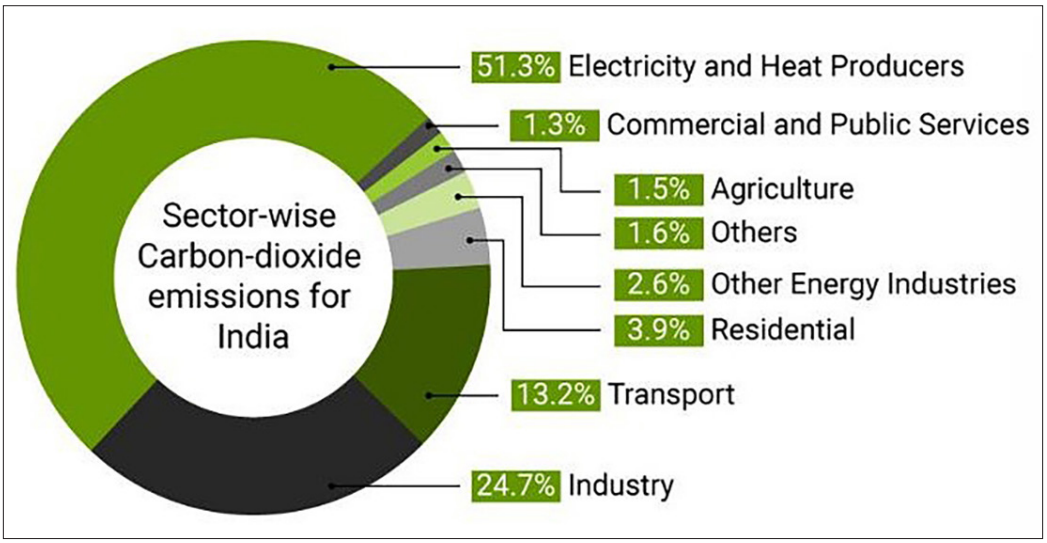


Figure 6 Sector-wise CO_2 emission share in India (IEA, 2021)

The following steps provide a sector-wise way forward for decarbonizing India-

1. Energy sector:

To decarbonize the energy sector, India should significantly reduce it dependency on coal powered plants and make considerable investments in transmission and distribution infrastructure, demand response, and a doubling of energy storage capacity from BAU predictions (450 GW by 2050).[60] Energy generation is linked with emissions. Therefore, for a particular application it is essential to look at the efficiency of energy generation terms of its input and output of various fuel sources. Hence, India should emphasize on implementing an energy transition standard to reduce the emissions by achieving 90% of the energy from non- fossil fuel sources. Furthermore, with the advancements in renewable energy sources, energy storage technology will become an imperative part of development in India. Energy storage is a must as it will benefit the entire supply chain because of improved electric power quality, reliability, and grid stability.[61] Similarly, setting aside climate funds for investing in new emerging technologies and subsidizing them would improve R&D as well as build scope for introducing emission-efficient technologies in the country.

India has a tremendous Renewable Energy potential. The Solar irradiation in India averages at 5.5 kWh/m^2 which amounts to 7.5 times greater than India's total annual energy consumption.[52] One of the key advantages of Solar PV is the short financial and carbon payback period which ranges between 2 to 4 years and has a lifespan of 25-30 years. In other words, once payback is reached, we get access to free electricity and non-polluting electricity

for the remaining years. India also has a vast wind potential. At 100 m mast height the potential is approximately 300 GW and at 120 m it is approx. 700 GW.[62] As the height of the wind turbine increases, so does the potential to capture more wind into turbines.

Biomass can provide 42 GW of energy in India.[52] One of the key advantages of biomass is the ample availability of raw material in agriculture waste and wet waste from homes and commercial establishments. This organic matter can be converted into biogas and can be used to make electricity and CNG or LNG to run our vehicles. Additionally, through this process we also end up producing organic fertilizer which would be a great boon to the Indian agricultural sector. Taking advantage of India's large population, the availability of organic waste and feed stock is a great advantage for generating Bio Fuels. Biomass also has a short financial and carbon payback period, making it an ideal case for Renewable Energy investment.

India can harness these various RE sources, having large population base and large market to get economies of scale. Pathways to energy security: Measure the need, reduce the consumption through efficiency, find alternative RE sources and evaluate for further betterment. The ideal future for the Indian energy sector will be one in which India is self-reliant for all kinds of energy, this will lay the foundation for having robust energy access, healthy economic growth and sustained human well-being. But, for this to happen, this decade will be decisive and our actions today will be defining the fate of the country for years to come. Decentralized-diversified-distributed energy will ensure equitable energy for all and reduce the burden on the government.

2. Transport sector:

India is one of the world's largest automotive and two-wheeler producers as an emerging market. It also features the world's fourth largest railway network and the world's fastest-growing aviation market. Our automobile fleet is rapidly expanding; with the number of vehicles on the road predicted to nearly quadruple to over 200 million by 2030. India's transportation industry is the third-largest emitter of greenhouse gases (GHGs), accounting for 14% of all energy-related CO_2 emissions. These emissions have more than tripled since 1990, and they are predicted to continue to rise when India's urban population doubles by 2050.[63]

The Indian government has taken a number of measures in this regard. However, to strengthen the existing targets, India will need to incentivize charging infrastructure along with enforcing EV sales mandates. Subsequently, the EV mandate sales to efficiently improve will need significant increases over time along with a gradual decrease in purchase incentives to ensure that the passenger segment shift substantially to EV. Additionally, imposing disincentives on

certain facets for rapid shifts to EV should be necessitated. Such as establishing higher fuel economy criteria for heavy-duty vehicles, as well as a long-term policy to transition the fossil-fuel-dependent heavy-duty vehicle segment to electrification and hydrogen.60 This would impede the demand on fossil- fuel vehicles and broaden the scope and availability for newer technology in EVs.

Hydrogen powered vehicles also have great potential in the current markets. Since hydrogen can provide greater ranges and quicker refilling periods, could be a possible complement to electrification provided the fuel is created from low-carbon sources. To make it cost-effective and competitive in the current market, up scaling manufacturing of hydrogen is necessary. It is evident to decarbonize the sector; various fuel alternatives must be efficient in terms of cost and feasibility than the conventional fossil-based fuels.[64]

3. Industry Sector:

After the energy sector, India's industrial sector is one of the second largest contributors to GHG emissions. It accounts for about 20% of India's overall GHG emissions, with 90% of that being CO2 emissions from industrial processes. India has pledged to lower its emissions intensity of GDP by 33–35 percent by 2030, compared to 2005 levels, as part of the Paris Climate Agreement.[65] India has implemented a variety of policies to promote improved energy efficiency throughout the economy. Off which the Perform, Achieve, and Trade (PAT) scheme is the most important policy affecting the industrial sector. The PAT scheme is a regulatory tool for lowering particular energy consumption in energy intensive industries. The government created it as a cost-effective approach to execute energy efficiency initiatives. To effectively decarbonize the industry sector, the PAT scheme should be expanded to reduce energy use by 25% throughout the cement, iron, and steel, and chemicals industries. Additionally, along with the PAT scheme, a progressive carbon tax should be enforced to encourage industries to minimize their reliance on fossil fuels by improving material efficiency, converting to electrification, and using green hydrogen.[60]

3.2 Importance of Reducing Resource Consumption and Role of Circular Economy

The world's population is growing, and with it, the demand for raw materials. However, the supply of crucial raw materials is limited. Extracting and using raw materials has a major impact on the environment and its resources. It adds to the energy consumption and CO_2 emissions. However, smarter use of raw materials and solutions like eco-design and sustainable design can help in reducing the amount of waste generated, pressure on the environment, CO_2 emissions and create durable products. These help consumers save money in the long run, improve their quality of life, and help conserve the environment.[66]

Reducing demand and mindless consumption will prevent generation of waste in the first place. It can help in saving energy, materials and even reduce the amount of waste that needs to be recycled and sent to landfills or incinerators. Recycling also helps in prolonging the use of materials like plastic, paper, electronics, glass and metals by repurposing them for different uses. This reduces the need to grow, harvest and extract new raw materials which is beneficial economically, ecologically and socially. A circular economy favours activities that reduce the usage of energy, labour, and materials. This means designing for durability, reuse, remanufacturing, and recycling to keep products, components, and materials circulating in the economy.[67]

The western civilizations/nations progressed with unchecked use of resources, which resulted in the current situation. Therefore, the developing nations have opportunity to develop using the newer technologies which would have lower impact on the environment. Circular economy is one such model. One of the major hurdles to going Net-Zero is the current linear economy that we live in. Where we take resources from nature, make products, deliver services and upon using them we dispose them off as waste, all while using fossil fuel energy.

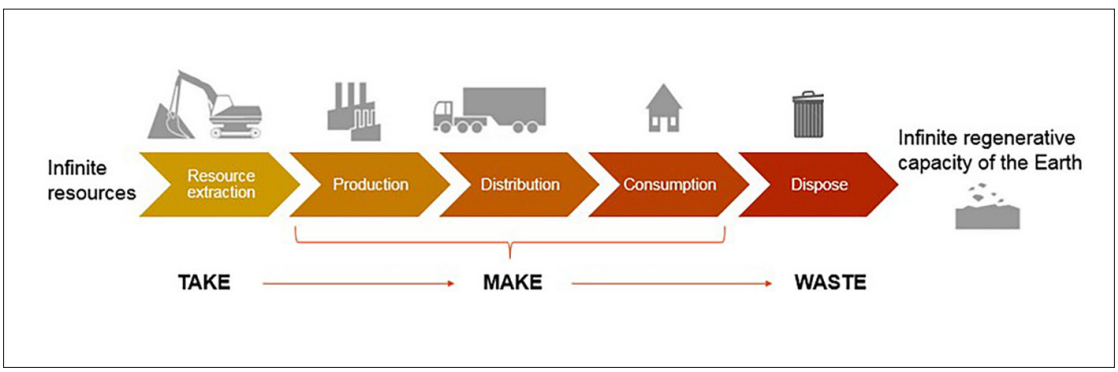


Figure 7 Linear Economic model [68]

Due to this, on 29th July, humanity's demand for ecological resources and service 2022 exceeded what the Earth can regenerate in that year. Today, we are using about 1.6 earths; meaning we're using about 60% more of the earth's resources than it can regenerate every year. By 2050, with an increased global population and a resulting rise in consumption, that "overshoot" could get to 3-4 earths, which is clearly unsustainable.[69] Hence, going Net-Zero would not be possible unless we bring in certain frameworks and policies that can extend the value or use of the energy and resources which result in a significant reduction of GHG emissions.

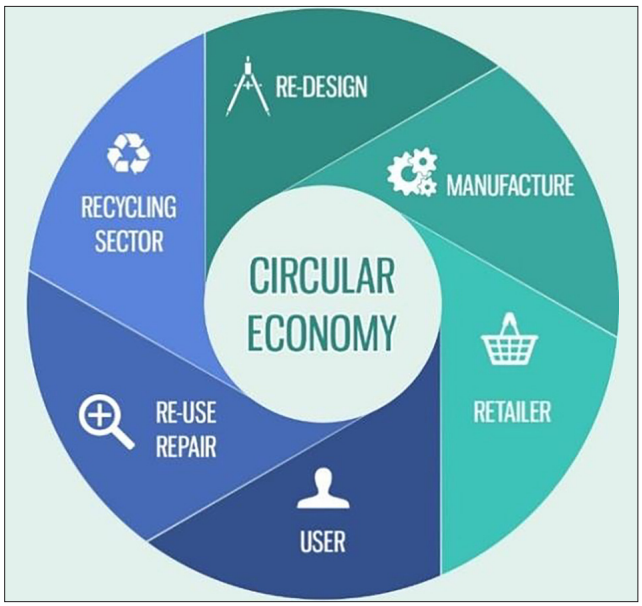


Figure 8 Circular Economic model [70]

The circular economy is a key element in solving the problem of resource scarcity, as it links economic and ecological potential. In a sustainable circular economy, materials and substances are kept in use within products for as long as possible. These can be reclaimed for future production processes and are thus not lost permanently as waste. Facilitating sustainable consumption and production patterns and drastically cutting resource requirements is thus a key goal of global sustainable development. A circular economy is one possibility to decouple growth from the consumption of non-renewable resources. As seen in the graph below, even if emissions reduce in the coming decades until the end of the century, we might still see an increasing trend in temperature rise until 2050, following which it stabilizes and reduces drastically. Hence, we need to be able to bring in new policies and business models now, that will show the direction to head to Net-Zero by 2050, circular economic principles could be like a navigation system that takes us to net zero.

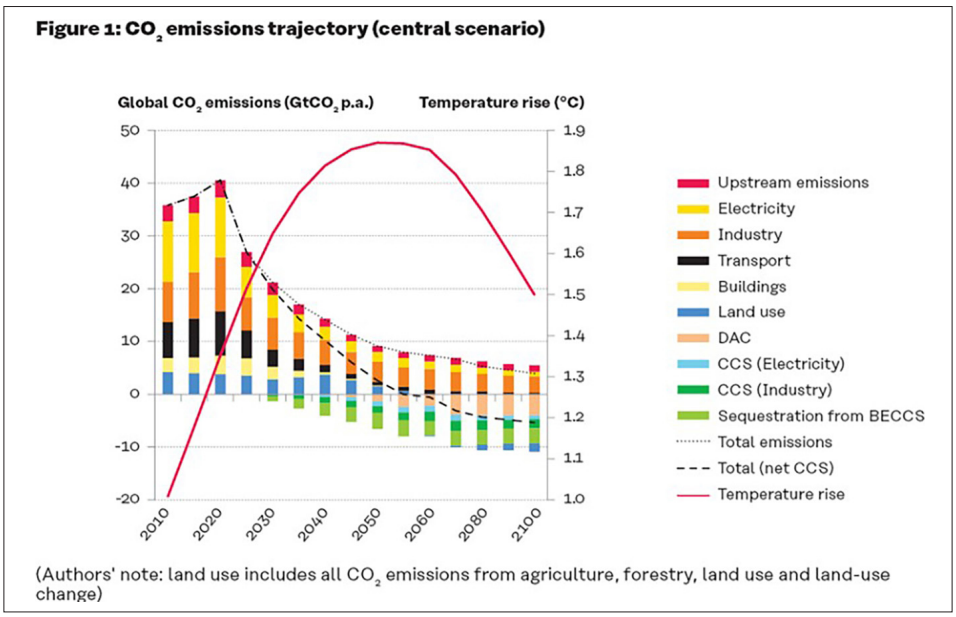


Figure 9 Relation of land use to GHG emissions per capita [71]

The new business models need to be financially sustainable and will require fundamental changes in the economic reforms in which they operate, to ensure continued economic growth. We need new economic reforms and move away from GDP and find alternatives for pragmatic progress. The evidence that this may be possible comes from the European Union and some individual member states. Between 1990 and 2016 the EU economy grew by more than 50%, while CO_2 emissions from fuel combustion fell by 25%.[72] It is also estimated that half a million jobs would be created by transforming our economy from a take, make and throwaway model to a genuinely green one which optimizes efficiency, renewability and working with environmental respect. This is the conclusion of a recent report by the Waste and Resources Action Program (WRAP) and the Green Alliance.

The use of regulatory instruments has been central to resource efficiency and circular economy policy making to date. The EU is a key example, where diversion of landfill wastes and recycling targets led 19 member states to reduce municipal waste to landfill from 55% in 2000 to 23% in in 2017 through the Extended Producer Responsibility framework (Eurostat, 2019). Another unique approach is to build industrial symbiosis, particularly through the creation of eco-industrial parks. In 2016, 250 eco-industrial parks existed around the world. Of those for which data was available, 45% engaged in industrial symbiosis, whilst 51% engaged in other waste management measures, and 35% in other resource efficiency activities, often generating substantial savings and efficiencies (Kechichian & Jeong, 2016).

It is clearly intended that a circular economy would be more environmentally sustainable than a linear economy and, plausible. The question of which particular uses, re-uses or recycling of materials are environmentally preferable need to be determined through specific analysis, using methods such as Life Cycle Analysis and Ecological Footprint Analysis.

Circular Economy is estimated to boost 2.5 billion euros annual gains for Finland's economy and may benefit 1000 billion US dollars to global economy annually.[72] The European Commission recently estimated that green economic transitions can create 600 billion euros annual economic gains for the EU manufacturing sector alone.[73] Such studies need to be conducted in India too, as the growing Manufacturing sector can benefit immensely from it.

Hence the challenges for developing countries like India in the global climate challenge are to modify the Kuznets curve and develop using low carbon pathways as depicted below:

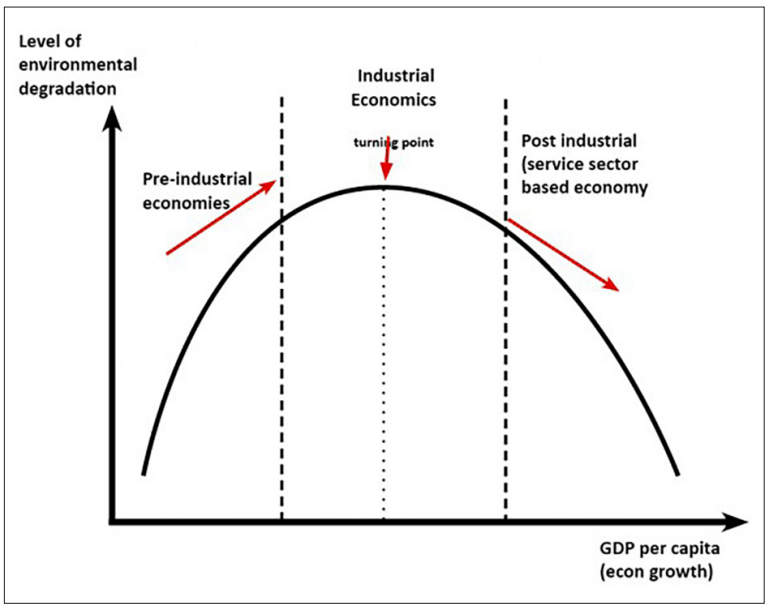


Figure 10 Indian trend lines that can cut the Kuznets curve

In the circular economy waste does not exist as resources keep on recirculating. Diversity is designed and built into systems, processes and manufacturing - making communities and society more resilient. The whole idea is based on systems thinking, seeing situations in total i.e., as a whole, accounting for interactions, interrelationships and interdependencies between parts. The significance is that society would be dynamically stable, secure and able to persist over time, leaving a decent world for future generations.

Hence in any given system, one must manage the energy and material flows for maximum optimizations of energy and resources.

3.3 Financial Instruments for Economic Policy Shifts

Green finance is any structured financial activity – a product or service – that's been created to ensure a better environmental outcome through conservation or protection. The aim of green financing is to increase the level of financial flows from banking, micro-credit, insurance and investment sectors to sustainable development priorities such as Renewable energy and energy efficiency as well as Pollution prevention and control, Biodiversity conservation, Circular economy initiatives, Sustainable use of natural resources and land, etc. There is a need for a variety of green bonds, loans, debt mechanisms, development aid, private investments and carbon markets that are used to encourage the development of green projects or minimize the impact on the climate of more regular projects.

Carbon pricing has evolved to be a potent mechanism for capping emissions and generating green finance simultaneously. "A well-designed carbon price is an indispensable part of a strategy for reducing emissions in an efficient way" (Stiglitz et al. 2017). The fundamental purpose of carbon pricing is to make consumers and producers of polluting goods take into account the costs imposed by this pollution on society as a whole.

A root motivation for cost internalization is that economic markets require all exchanges in the economy to be voluntary, between freely consenting trade partners. Third parties must not be forced to pay for external costs arising from transactions. When the production of a good causes' pollution, the costs of that pollution must, therefore, be paid by those taking the decision to produce and consume the product, rather than by unrelated third parties. Otherwise, producers and consumers can forcibly redistribute welfare from those third parties to themselves. Without bearing the full costs of their actions, such producers and consumers have an incentive to carry out transactions even when those transactions cause net harm to society after factoring in the external costs borne by their victims. To safeguard the core principles of liberty and net value creation, economic agents must, therefore, bear the full costs of their own actions. Pricing carbon emissions contributes to this "cost internalization."

As a by-product of its environmental role, carbon taxation or emissions trading systems is the fact that the permits can be auctioned to generate public revenues. This way climate policy can be designed so that it benefits not only future generations but also current ones. Carbon pricing, in the form of carbon taxes or emissions trading schemes, has been used since the 1990s as an incentive for abating greenhouse gas (GHG) emissions, and since then spread to 461 jurisdictions, presently raising 43 billion in revenues.[74] Green bonds (or climate

bonds) represent a more recent development in the policy toolkit for financing climate change mitigation, adaptation or conservation of natural capital.

In the coming years, deep decarbonization financing will most certainly account for the majority of India's overall investments. For example, the International Energy Association (IEA) forecasts that India would require US$1.4 trillion in green energy technology funding over the next two decades. Industries can begin to minimize their use of fossil fuels or trade surplus credits with other companies to continue emitting carbon. To prevent the usage of carbon border taxes, India's carbon trading system will need to be harmonized with the EU and other countries. Carbon pricing could be differentiated around the world to ensure that India and other emerging countries have a clear market incentive to engage in decarbonization technologies first. This will promote investment in decarbonization in developing countries, in line with the climate justice principle of shared but differentiated responsibilities.[60]

Another important component of Carbon pricing is the Social Cost of Carbon (SCC). The SCC differs for every country depending upon their emission history and impacts on the socio-economic and environmental systems. The Social Cost of Carbon of India is $86 per tonne of CO_2.[75] This means the Indian economy will lose $86 by emitting each additional tonne of CO_2. The social cost of carbon is a crucial instrument for factoring climate change costs into policy, corporate planning, and investment decisions. The SCC is a method for accounting for future damages and non-market costs.[59] The major challenges for pricing carbon as a tool for regulating the emissions in different sectors are-

- Diffused benefits and concentrated costs, making it less likely for the policy's beneficiaries to support it politically
- Regressive process for lower and middle income households
- Strong opposition from carbon-intensive companies (Oil refineries etc.)

India's carbon taxes will need to be restructured. Petrol, diesel, aviation fuel, natural gas, and coal taxes currently bring in several trillions of rupees (almost a hundred billion USD) for the central and state governments. Furthermore, coal freight prices on railways are fixed at high levels to subsidize passenger fares. These different taxes and fees have distorted the market significantly. Fuel taxes should be included into the GST framework in the coming years, and taxation should be rationalized while maintaining revenue neutrality. Longer term, as fuel usage declines, tax collections decline, and carbon tax levels must also be gradually increased to preserve revenue neutrality. Carbon pricing will also need to be in line with the global carbon trading system.

Therefore, in order to strengthen carbon pricing certain strategies must be devised. For instance, for the general public to accept an additional tax must have clear indications of its additional benefits. If the public understands how the proceeds will be used, they are more inclined to embrace a carbon tax. This emphasizes the importance of establishing a strong communication, public dialogue, and social deliberation system. In the short term, India should concentrate on phased-out fossil-fuel subsidies and boosting the efficacy of existing carbon-price policies. The medium term plan should be capitalizing on the recent advancements in renewable technologies to accelerate the decline of the fossil-fuel industry and catalyze the economy's green transition. Lastly, diverting funds to green projects/initiatives combining it with a revenue recycling mechanism would gradually increase acceptability.

3.4 Impacts on the Next Generation

Children are also more susceptible to indirect effects of climate change, such as food shortages, intergroup conflict, economic disruption and migration. Particularly for younger children, their dependency on adults can lead to psycho-social consequences due to the impact of climate-related extreme weather events on parents' physical, emotional and social well-being, family functioning and economic status. Climate-related disasters have been linked to consequences including post-traumatic stress disorder, depression, panic, sleep and anxiety disorders, cognitive deficits, learning problems and impaired language development.

3.4.1 Intergenerational Justice

Another important aspect of climate justice is the **Intergenerational Justice.** The world is home to 1.8 billion young people between the ages of 10 to 24 [76]— the largest generation of youth in human history. Developing countries are expected to bear the initial brunt of climate change, which is where more than 90% of the world's young people live. Till now numerous conferences, promises and policies have been made, but what actually lacks is the will to transform these promises into actions on a large scale.

The major challenge is that empowering youth requires capacity building through quality education, skill development, healthcare and improved quality of life. This helps develop cognitive abilities for innovation and opportunities in the decision-making system and ensures responsive, inclusive, participatory and representative decision making at all levels. For this to happen, the youth can use tools to question the authorities/decision-makers about various social and environmental actions carried out by them.

The National Youth Policy, 2014 (NYP-2014)[77] seeks to define the vision of the Government of India for the Youth of the Country and identify the key areas in which action is required and to enable youth development and to provide a framework for action for all stakeholders. This policy also needs to address the role of youth in climate action and creating multi-dimensional opportunities for them without affecting the environment or without letting climate change affect their job security. Job security and opportunities in the agriculture sector are affected too because of the direct impact of climate change on agriculture which is one of the reasons why youngsters are migrating to cities and looking for careers only in the secondary and tertiary sectors which are also becoming hard to get.

The Youth's unprecedented mobilization around the world shows the massive power they possess to hold decision-makers accountable. For them Climate action is about survival and not just righteousness. Currently the youth (18-29 years) constitute 22% of India's population[78] which is more than 26.1 crore people, but this will remain a mere numerical strength unless we proactively and consciously focus on empowering them. A recent study conducted on climate anxiety in children and young people found that the Indian youth are among the most worried in the world [79] and the climate anxiety has started affecting even the younger minds under the age of 18. The current effects of climate change have had a huge impact on employability, health facilities, education and so on. The diminishing opportunities and lack of quality services in health, education, etc. add up to the anxiety levels amongst the youth. The climate anxiety stems via direct and indirect effects of changing climate and its impacts on the current systems.

3.4.2 Importance of Women's Participation

No green or inclusive society is possible without fair representation of women in decision-making because they directly represent the status and experiences of around 50% of the global population. When it comes to Climate Change impacts, it is already affecting women more severely than their male counterparts. Climate change-induced migrations often leave women to take care of household responsibilities and agriculture alone, increasing their burden manifold. In regions that face annual disasters like floods, women and children are at a risk of being trafficked.

Women's knowledge and participation have been critical in the survival of entire communities in disaster situations therefore; the government should recognize their specialized skills in livelihood management in mitigation and adaptation measures. Women in countries like India have an intricate association with families, people, nature and natural resources around them. And hence, if empowered with climate action knowledge, they can hugely contribute in reducing emissions from energy use, household resource consumption and environmental degradation.

For example, women produce the majority of the food globally and yet less than 15% are landholders.[80] In India, 84% rural women depend on agriculture for livelihood.[81] If they are empowered with education about sustainable agriculture and empowered to revive effective traditional farming practices, the climate change and food security issues can be addressed simultaneously. And yet they are few and far in number in governments and businesses. This needs to change especially for Net-Zero targets and for a green inclusive development; we will need people and solutions from all walks of life.

We need to integrate material well-being, non-material quality of life, equity, justice, sustainability, resilience, and democracy as the pillars in planning and development. Ecological Integrity is a concept that reinstates humans in nature while respecting the latter. It has been useful in finding clear answers in cases of conflicts between economic human interests which tend to be immediate and ecological concerns which are generally long term. We need to ensure Ecological Integrity to build a habitable planet and climate secure future.

Chapter 4

FRAMEWORK TO CONVERT PROMISES TO ACTION

This chapter explores the understandings derived from the earlier chapters and the foundations and principles which can help humanity navigate the climate crisis and ensure our own well- being while doing so. India can set an example and lead the world in sustainable climate action and green low-carbon development given its rich diversity, community and resources. The first three sections explore the nuances of the framework which is proposed in the last section of this chapter.

4.1 Creating Climate Conscious Communities

One of the key strategies acknowledged across the world is Carbon Neutrality or 'Net Zero' targets, and the society plays an inseparable part in achieving it. According to a report from Japan "Building a Low-Carbon Society" [82], a low-carbon society is required to follow three principles – minimizing all the sectors' GHG emissions, pursuing a simple lifestyle with higher quality, and living in harmony with nature.

A low-carbon society should act consistent with principles of sustainable development; ensure green inclusive development, while contributing to reducing GHG emissions. It focuses on high energy efficiency and uses low-carbon energy and low-carbon manufacturing technologies, and adopts low-carbon living and consumption styles. It requires the decarbonization of economic development as well as social aspects such as life and culture. To achieve this rapidly, creating a new awareness and a Citizen's Movement for meaningful Climate Action is necessary.

Perspective is the key to Action; because even a single perspective has the power to bring about an enormous change. Thus, climate consciousness and pro-environmentalism need to be instilled in all the age groups. Especially in youngsters whose minds are still afresh and who are going to face an escalating climate crisis in upcoming years. The role of awareness, education, media, social media and various communities is also crucial in raising climate consciousness. Individuals don't just contribute to climate action, but they actually help to promote and engage communities to build momentum. As the awareness increases and concerns of climate impacts become acute, building a culture of being conscious about one's Carbon Footprint will be a step in the right direction.

A cross-community approach, where diverse groups of people educate, influence and work collectively, will help to achieve such a society quickly. The role of individuals is to first lead a sustainable lifestyle, educate people around them like societies, schoolmates, college mates, and colleagues, and then, urge the local and national authorities to make policies and take action. This builds a pressure from the grass-roots. Individuals must start re-thinking and transform their lifestyles with environmentally ethical ways like- switching to low-polluting

products, plastic-free or zero packaging alternatives, reducing discretionary purchases and reducing demands. By limiting the demand for electricity, water, food, clothes, as well as materials and electronics etc. we can ensure that we stay within the planetary boundaries.

4.1.1 Youth Empowerment

From Bengaluru to New York City, the world is taking notice of youngsters who are walking out of class and marching on the streets to demand action on climate change from political representatives. Young climate activists are using their moral authority and their social-media savviness to address increasing climate concern. The youth has been talking about climate change for decades. But the latest generation of protestors is louder and more coordinated than its predecessors. With rising knowledge about Climate Change, the demands of the youth have evolved and their priorities are getting clearer. However, these movements and demands are not appreciated and acknowledged by all. Their fears are being termed as irrational and emotionally motivated. Especially, the older generation who possesses major political power are facing major inertia towards radical change.

The Green low carbon economy-related knowledge should be made available right from primary to higher education. This can be achieved by integrating research and local case studies in syllabi and empowering teachers to accomplish it. We also need to democratize knowledge through open access resources, invest people's talent, skills and ambition in achieving Sustainability and Climate Action. The new era of social media can really turn out to be the game changer for raising climate consciousness. Most people find its content more appealing and there are billions of people using these.

Social media holds great potential in spreading climate awareness, encouraging youth's participation and fostering youth leadership. About 90% of the information our brains processes is visual. Thus, the exponential rise of video on social media provides an immediate opportunity to raise awareness. Facebook reports a staggering 8 billion video views per day.[83] YouTube estimates about 500 hours of video content that is uploaded every minute, generating billions of views each day. This can pave the way to a carbon-neutral world.

Although these are long-term solutions, a lot remains to be done. Along with this we need changes in the education framework and efficient policy structure to reduce the goods and services that are not sustainable. The mainstream approach is only economic growth oriented. It is limited to achieving economic development goals without truly addressing critical issues like climate crisis, justice, health, etc. We must have mechanisms to monitor and manage our direct and embedded carbon footprints. Although Climate Governance is gaining weight in international and national policies, the rate at which the change is happening is not enough to protect the well-being our future generations.

Given the scale of the problem we're facing, we need to think differently. We are living in unprecedented times. We created these problems ourselves, as society became larger and larger, ignoring the situation we are in now. Going beyond self, our daily moral and ethical decisions should be made by thinking about how it is affecting the rest of the world and the future of humanity and other species we share the earth with. **The story of this century really depends on whether humanity can restore its relationship with nature or suffer without it.**

4.2 Addressing Environmental Justice

The rapidly rising resource crunch has compromised the well-being of the present and all forthcoming generations. Earth Overshoot Day[84] is one such indicator that marks the date when humanity has exhausted nature's budget for the year. In 2021, Earth Overshoot Day fell on July 29th. For the rest of the year, we are maintaining our ecological deficit by drawing down local resource stocks and accumulating carbon dioxide in the atmosphere. As climate change disrupts the basic necessities of life – shelter, air, food and water – it is regarded as the biggest threat to humanity in the twenty-first century.

Climate and Environmental Actions that happen or don't happen today are going to determine the fate of humanity, and all the living beings we share the earth with, for decades and centuries to come. We are running short on the greenhouse gas emissions reduction targets and the Carbon budget, beyond which we will cross the threshold leading to catastrophic climate change consequences. Choosing Climate Action is the same as choosing to be on the right side of history now. Experts and world leaders are also starting to acknowledge that environmental issues are deepening into 'human-rights' issues. So the question that remains is how we can transform to a Green and Carbon Neutral world in a quick but just manner. And this decade will be critical to ensure that we achieve these targets.

Environmentalism has long been associated with Future-thinking but it actually includes many dimensions in the present. Even pollution, although perceived as a future threat, is a current problem. The pollution caused by the polluters is costing the humans or ecosystems in the surroundings in terms of health, wealth and well-being in the present. This also applies to historical responsibility, often neglected in international Climate Change discussions. Environmental justice is not just about how humans are responsible for protecting next generations or addressing perceived future problems – because these problems are very much harming our current health, quality of life and environment too.

One of the most vulnerable groups to climate change impacts are children and youth, with the World Health Organization estimating that children will suffer more than 80% of the illnesses, injuries and deaths attributable to Climate Change, due to their immature

physiological defence systems and the ways they interact with their immediate environment. They are physically more vulnerable to the direct effects of extreme heat, drought and natural disasters through injuries, environmental toxins and infectious diseases that will become more prevalent with warmer temperatures and changed rainfall patterns. For example, in 2000 Climate change was estimated to have increased the number of cases of under-nutrition, diarrhoeal diseases and vector-borne diseases such as malaria by 3–10% as compared to the three decades preceding it.[85]

4.3 Designing A New-Carbon Neutral World

We all learn about water and other cycles like the Carbon cycle in school. The natural carbon cycle is balanced and helps to maintain the global average temperature. However, due to the use of fossil fuels, extracted from the deep earth and other resource and energy-intensive activities by humans, particularly in the last 100 years, this cycle has been severely affected. The concentration of greenhouse gases, which trap the sun's heat and make our planet livable, are rising beyond normal at alarming rates due to human activities. This is leading to global warming and consequently changing the world's climate at a faster pace than any in the history of the earth. The concentration of carbon dioxide is now so high that we will not be able to go back to the original carbon balance now. The year 2021 already recorded an all-time high of 1.11°C rise since pre-industrial revolution levels.[86] If we don't take action now and the warming exceeds to 1.5°C or beyond, the stability of earth and climate on which all human systems rely will be threatened. Beyond 2°C the climate tipping points will be triggered and that will cause unprecedented impacts on Planet Earth.

Some studies say that the first occurrence of a 1.5°C rise may happen as early as 2025! [87] Thus, every 0.1 °C rise now is going to drastically affect our future.

Average 1.1°C in global temperatures rise, will affect some regions far more than we can expect such as the Arctic region which is already over 3 degrees hotter.

India has the dual challenge of being the third largest greenhouse gas emitter and being one of the most vulnerable countries to climate change impacts. Systemic changes like green low-carbon technologies, energy conservation, material and resource efficiency, circular economy, ecological restoration, etc. are all very important for economic and environmental stability. The foundations for this can be laid by ensuring that we drastically reduce our greenhouse gas (GHG) emissions and simultaneously restore natural ecosystems to help revive the carbon balance. Thus reducing emissions and resource use in all human activities and offsetting the

remaining excess emissions by methods like expanding land and water ecosystems form the basis of a Net-Carbon Neutrality or Net-Zero strategy. The final goal of Net-Zero targets should be achieving low-carbon development which is also inclusive.

4.3.1 Importance of Decentralization in Climate Action

To shape the New Carbon-Neutral world, the priorities of its citizens (i.e. today's youth) must be understood and sincerely realized. The young leaders do not prioritize mere financial gains as their whole existence is at stake. They prioritize inclusive development, improved standard of living for all, empowerment of vulnerable Communities and most importantly, a synergy between environment and economy. Centralized governance is environmentally and energy- wise expensive. India is a geographically and socially diverse country. Larger the system and more complex the network, larger is the energy use required to maintain it and it also becomes less and less green. The current development model is not viable economically or environmentally anymore. Hence, we need to find alternatives standards and models that are inclusive of socio-economic and environmental aspects.

The approaches to Net-Carbon Neutrality will be different for different nations, but the core value of developing via 'Climate Conscious and Environmentally Ethical' ways must remain constant. This approach challenges the traditional approach of development and thus will require 'New Innovative Frameworks and Indices' which acknowledge the importance of holistic development. This framework we propose here focuses on 'Collective and Decisive Action', which ideally should be across all global geographies.

The "L.I.F.E" Framework addresses the priorities of today's youth:

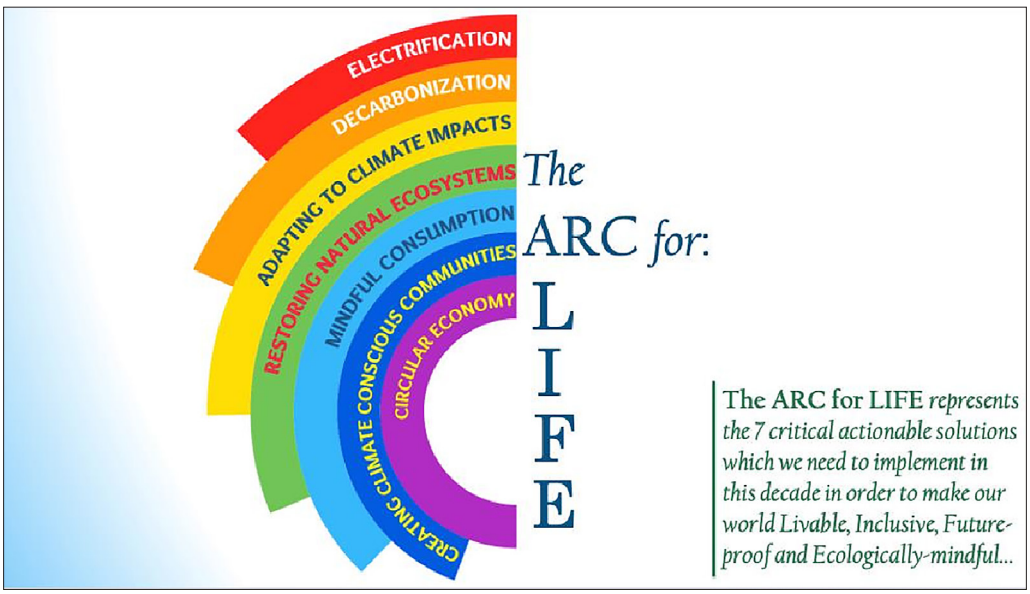
- L- Livable: a future that caters to the basic needs of all life forms
- I- Inclusive: a politically, socially and economically inclusive world that allows for a diversity of development pathways
- F- Future- Proof: a resilient world capable of adapting to shocks.
- E-Ecologically mindful: a world that fosters synergy between the economy and environment

This framework explains how the youth prioritizes well-being rather than pure economic aspirations. It also addresses the Sustainable Development Goals (SDGs) and development needs while being within planetary bounds. For a truly carbon neutral future, there is a need to start reducing the carbon footprint of our activities and industries. To do this, some pre-conditions need to be met:

- The overall energy demand needs to reduce;
- There is an absolute need to use alternatives to fossil-fuels. For this, investments in

low- carbon technologies are critical to meet basic energy needs;

- There is a need to create carbon sinks and restore degraded land to manage existing and future carbon emissions.
- The overall Carbon intensity of the development needs to be reduced.



The ARC for LIFE represents the 7 solutions that need to be implemented within this decade to ensure a smooth transition to a carbon-neutral world:

1. **Electrification:** of our transportation systems, energy sources and industries. This will reduce our dependence on burning of fossil fuels.
2. **Decarbonization:** of our energy sources. This step must be coupled with electrification for meaningful impact.
3. **Adaptation:** to the consequences of the changes already made. This is important to protect lives and livelihoods from the impacts of climate change.
4. **Restoration of natural ecosystems:** will play an important role in maintaining ecological balance as well as building resilience against future shocks.
5. **Mindful consumption:** Changing the existing consumerist lifestyles will be necessary to stop the exploitation of resources. This calls for monumental change in the current human lifestyles.
6. **Climate conscious communities:** Climate change is a global phenomenon with local impacts. Therefore, it is important for communities to take local action and implement solutions that are close to them and affect them directly.

7. **Circular economy:** Shifting from the present linear economic model to a circular one can help in increasing material and resource efficiency. This will significantly help in growth while reducing wastage of resources.

Finally, collective and well-coordinated action is incomplete without a strong political impetus. The effects of climate change, like erratic rainfall, droughts, floods and so on, have started to disrupt the daily lives of citizens. The activities people perform in a specific geography have been more or less the same, yet the weather around them has changed, changing the kind of challenges they face. This has moved the demands for compensation from one bucket to another. Hence; it is not a distant challenge anymore. To deal with this effectively, the root cause needs to be addressed.

A relief-based approach will not solve the problem in the long run as the extreme events are not an anomaly anymore. This isn't possible without politicizing climate change and making climate action an electoral agenda. People will demand climate action from politicians when they are able to connect their day-to-day hardships with the climate challenge. This calls for re-emphasizing the debate to a simpler and more secure lifestyle and drawing people's attention to matters that affect them directly- clean water, clean air, livelihoods and so on. It is important to move beyond policies to timely implementation of existing rules and regulations. It is also important to revise the existing policy instruments to incentivize to a low-carbon future.

An array of changes will be essential- some which may be inevitable and some that are proactively taken by the government and citizens. As very rightly identified this is the Age-Of- Consequences, what humankind does differently in the next few decades will dictate how the next few centuries will shape out. This is the new reality of climate challenged world. The scale and scope of changes that must happen in the next few decades will be unprecedented. And yet, different regions of the world will respond differently. India being the largest democracy, must view this as an opportunity to forge ahead with bold and radical reforms across all human activities. India can play a key role in this transition, as the country has age-old experience of living close to nature with its traditional practices and cultures. Thus, these reforms must be led by Asian countries, which contribute to about two-thirds of the global economic activities and population.

In addition to the changes at the level of government, and individuals, we need drastic changes in the current world systems which focus on the kind of development that prioritizes GDP. The existing assessment methodology which relies heavily on economic aspects of development needs radical reforms. There is a need to look beyond the current development standards and make changes in the international governance models which incorporate alternative indices such as Genuine Progress Indicator (GPI), Human Development Index (HDI) etc.

Net-Carbon Neutrality and Ecological restoration are the two sides of the same coin. Every nation, including India is greatly influenced by international governance models and policies. Systemic changes at a national and regional level are incomplete without sound international strategies and frameworks. Hence, there is a dire need to redefine the roles of international bodies such as the United Nations (UN), UNFCC, and Conference of Parties (COP) which need to emphasize on restoring the Earth's ecological balance along with pushing for Net-Carbon Neutrality in the climate agenda. This radical change in world systems needs to be led by academia, especially by economists.

Every action taken this decade will have huge impact in the coming times. The cost of delay will far exceed the cost of action. Nations need to start the transition towards a low-carbon economy now, as any delay will have subsequent effects on socio- economic and environmental systems. It is evident, that the transition will not be a smooth one, and will demand for unprecedented cooperation between governments, nations, companies, and citizens. The recent Conference in Bonn, Germany (6th- 16th June 2022) hopefully will lead to resolve our global climate crisis and take bold steps to deliver the urgent and transformational targets before we run out of the brief time window we have left! This policy paper, therefore seeks radical policy interventions in this scale of change rather than face fait-accompli reactions.

4.4 Recommendations for India in the Climate Challenged World

4.4.1 Industry and Infrastructure

1. New townships and cities must be self-sustaining and carbon neutral.
2. Cities and infrastructure constructions: Resources need to be allocated into building low-carbon infrastructure and the concept of circular economy needs to be incorporated into the building of large infrastructure stocks. Construction can be planned using energy-efficient materials.
3. Strict compliance to land-use rules and legislations will be very critical for the future.
4. Companies need to switch to using environmental, social and governance (ESG) considerations during their investment process.
5. The PAT (Performance Achieve Trade) scheme should be expanded to reduce energy use by 25% throughout the cement, iron, and steel, and chemicals industries.
6. The supply-chain needs to be redesigned to promote durable design, maintenance and repairs. Businesses and researchers must collaborate to work on innovative technologies and peer-to-peer sharing and circular economic business models can be developed.
7. There is a need to formulate and enforce guidelines for material efficiency for the

construction sector, create formal markets for sustainable building materials, and financial incentives for the use of such material.

4.4.2 Energy

1. India should push for innovation in new Renewable technologies and strengthen its production capabilities to ensure that these technologies can scale to achieve low-cost manufacturing and hence lower capital expenditures.
2. Acquiring energy independency and making shifts by-
   - Installing Solar electricity in public spaces (ground mounted & rooftop)
   - Up to 50% of electricity should be integrated from RE microgrids to the main grid. To add to this, energy use estimations, forecasting and scheduling can be done to address Demand-Side energy management. 'Smart Microgrid Networks' can play an important role in immediate future.
   - Establishing suitable financing for RE deployment in the state will be critical
3. Promotion of the use of Electric Vehicles while simultaneously investing in infrastructures like accessible charging stations powered by RE sources.
4. Strengthening the waste-to-energy capacities at local level.
5. The government needs to reduce its dependence on fossil fuel revenues. India needs to commit to not building new coal-fired plants and phase-out its existing fleet of thermal power plants.

4.4.3 Economic and Finance

1. Carbon accounting and carbon pricing frameworks can be adopted to reduce CO_2 emissions while using the revenues to finance the transition to a low-carbon economy.
2. The 'ease of doing business' for the RE sector needs to be improved .Green Economic Zones can be set up to support and incentivize circularity, while promoting green entrepreneurs, businesses and start-ups. Companies above a certain revenue threshold should provide full carbon disclosures.
3. Local body authorities must practice carbon accounting and carbon budgeting.
4. Green financial instruments and mechanisms- green bonds, climate funds, and sustainability-linked bonds can be strengthened. Climate Risk Assessment and Insurance can be provided to micro, small and medium-sized businesses at concessional rates.
5. Environmental Protection Code (EPC) must be adopted to effectively phase-out the use of non-renewable energy. Strict compliance with the rules will be critical.
6. Fuel taxes should be included into the GST framework in the coming years, and taxation should be rationalized while maintaining revenue neutrality

4.4.4 Transport

1. Pushing for further electrification of public transport and setting up supporting infrastructure in urban areas is a very laudable development and must be included.
2. Mobility and vehicle manufacturing: Using digital technology to design a convenient, multimodal transportation system that is both resource-efficient and effective.
3. Incentivize RE charging infrastructure along with enforcing EV sales mandates.
4. Disincentivizing fossil-fuel such as establishing higher fuel economy criteria for heavy- duty vehicles by use of alternatives such as Hydrogen or Bio-CNG.
5. Up-scaling manufacturing of hydrogen, battery storage technologies and other alternative storage technologies to make RE availability 24*7.

4.4.5 Administrative / Governance

1. Climate action needs to be decentralized and responsibly politicized at all levels of governance to make it an electoral agenda. Localizing national targets can help in making city administration accountable for their respective emissions.
2. Addressing the issue of Climate Justice by making local/ regional climate action plans participative and inclusive of gender, caste and class. The enviro-economic, as well as technological status quo of a region needs to be assessed before policies are upgraded for better impacts.
3. Providing alternative avenues for Green employment generation, reskilling, building human capital as well as providing social safety nets is an important aspect of the transition to a low-carbon economy.
4. Reforms in IT sector are a must to rapidly shift to a less energy intensive systems.
5. Education needs to be used as a tool to raise awareness and generate civic involvement. Strong communication, public dialogue and deliberation systems must play a key role in increasing public participation.
6. Climate-smart planning must include sustainability and integrated into Smart-City planning model. Hence a circular economic models can be adopted rapidly to help with ecological restoration as well as for maintaining ecosystem integrity.

In Summary

India, in the Climate Challenged World as elaborated in this paper, needs to make radical shifts at the systemic levels with appropriate policy interventions. These shifts should come from the top 5 most emitting sectors- Energy, Industry & Infrastructure, Transport, and Economics & Finance as well as Administrative practices.

Electricity/ Energy

For transition to 100% RE in record times, India must push for innovation in all Renewable technologies and strengthen its production capabilities to ensure that these technologies can be scaled to achieve low-cost manufacturing and thus lower capital expenditures. Simultaneously, acquiring energy independency is crucial for rapid shifts into renewable sources of energy. Hence, installing solar panels in public spaces (rooftop/ ground mounted) wherever possible, integrating Micro-grids into the main grids and establishing a suitable financing for RE deployment in the state, will be most crucial for the country.

With the rapid expansion in our EV fleets, efficient and easily accessible charging stations powered by renewable energy sources should be promoted along with the use of Electric vehicles. The government needs to reduce its dependence on fossil fuel revenues and invest in RE sources for which India needs to commit to not building new coal-fired plants and phase-out its existing fleet of thermal power plants.

Industry/ Infrastructure

The second most carbon emitting sector is the Industry/Infrastructure sector due to the materials and processing of various carbon-intensive products. To make our cities and urban spaces self-sustaining and carbon neutral the construction resources need to shift to complete low-carbon infrastructure with reusing and recycling building materials (circular economy). The construction planning right from the materials to the processing needs to be energy-efficient in order to reduce the overall carbon emissions of our cities. There is a need to formulate and enforce guidelines for material efficiency for the construction sector, create formal markets for sustainable building materials, and financial incentives for the use of such material.

India has implemented a variety of policies to promote improved energy efficiency throughout the economy. Of which the “Perform, Achieve, and Trade” (PAT) scheme is the most important policy affecting the industrial sector. To effectively decarbonize the industry sector, the PAT scheme should be expanded to reduce energy use by 25% throughout the

cement, iron, and steel, and chemicals industries. The supply-chain needs to be redesigned to promote durable design, maintenance and repairs. Businesses and researchers must collaborate to work on innovative technologies and peer-to-peer sharing and circular economic business models can be developed.

Transport

According to the IEA, 2021 report, transport sector contributes about 13.2% of CO2 emission rate. To strengthen the existing targets in making transport sector low-carbon, India will need to incentivize charging infrastructure along with enforcing EV sales mandates. Subsequently, the EV sales backed with good charging infrastructure will significantly increases over time, to ensure that majority passenger segment shift substantially to EV. Additionally, imposing disincentives on certain facets for rapid shifts to EV should be necessitated. Such as establishing higher fuel economy criteria for heavy-duty vehicles, as well as a long-term policy to transition the fossil-fuel-dependent heavy-duty vehicle segment to electrification and hydrogen. This would impede the demand on fossil- fuel vehicles and broaden the scope and availability for newer technology in EVs.

Hydrogen powered vehicles also have great potential in the current markets. Since hydrogen can provide greater ranges and quicker refilling periods, could be a possible complement to electrification provided the fuel is created from low-carbon sources. To make it cost-effective and competitive in the current market, up scaling manufacturing of hydrogen is necessary. It is evident to decarbonize the sector; various fuel alternatives must be efficient in terms of cost and feasibility than the conventional fossil-based fuels

Economic & Finance

To reduce CO2 emissions, carbon pricing and carbon taxation frameworks will be critical finance the transition to a low-carbon economy and society at large. Green financing needs to be drawn from public, private and other sources of financing to speed up the move to a new economic reality. Climate finance is important for both- mitigation and adaptation. The transition calls for funneling large amount of resources in 'Green' innovations, methods and processes. This will help in promoting large scale adoption. The 'ease of doing business' for the RE sector needs to be improved. There is a need to set up Green Economic Zones to incentivize green entrepreneurs, business and start-ups. Carbon disclosures need to become the norm. Green financial instruments and mechanisms- green bonds, climate funds, and sustainability-linked bonds can be strengthened. Climate Risk Assessment and Insurance can be provided to micro, small and medium-sized businesses at concessional rates.

Administrative/ Governance

There is a strong link between Climate Action and Decentralization. This link gets strengthened as citizens' awareness levels increase. This helps in making local climate action an electoral agenda and making city administrations accountable for the same. Local governments need to take responsibility for their emissions. Climate action plans and policies need to be made in an inclusive and participative manner. The enviro-economic, as well as technological status quo of a region needs to be assessed before policies are upgraded for better impacts.

Local governments will be at the forefront of managing emerging risks due to natural disasters.

When it comes to initiatives like carbon pricing and driving public investments into climate adaptation and mitigation, local governments are at the forefront. Therefore, they are critical in driving action on the ground.

In the changing world of the future with multiple technological, environmental, and societal challenges, India will have to break-free from dogmatic or bureaucratic approaches to problem solving. Almost every aspect of modern life will be undergoing some radical changes and people as well as Governments and Politicians will require very effective planning and implementation with foresight for the future for the young generation of India.

Glossary

- **Global Warming** - is the long-term heating of Earth's climate system due to human activities, primarily fossil fuel burning, which increases heat-trapping greenhouse gas levels in Earth's atmosphere

- **Greenhouse Gas (GHG)** - is a gas that absorbs and emits radiant energy within the thermal infrared range and can cause greenhouse effect

- **GHG Emissions** - the emission into the earth's atmosphere of any of greenhouse gases, especially carbon dioxide that contributes to the greenhouse effect

- **TCO2eq** - all GHG emissions are measured in equivalence to carbon dioxide and expressed as tonne carbon dioxide equivalent e.g. TCO2eq

- **Net-Carbon Neutrality** - means having a balance between emitting carbon and absorbing carbon from the atmosphere in carbon sinks

- **Carbon Sequestration** – The process of capturing and storing carbon from the atmosphere through different means

- **Carbon Footprint** - amount of carbon dioxide emission associated with all the activities of a person or the entity (e.g. building, corporation etc)

- **Circular Economy** - A circular economy is an economic system aimed at eliminating waste and ensuring continual use of resources. It involves reuse, sharing, repair, refurbishment, remanufacturing and recycling to create a closed-loop system; and minimising the resource inputs and creation of waste, pollution and carbon emissions

- **Low-Carbon Development** - A development approach which is based on less use of energy, decrease in carbon emissions and moving away from fossil-fuels to renewable energy sources

- **Climate Adaptation** - means anticipating the adverse effects of climate change and taking appropriate action to prevent or minimize the damage they can cause

- **Climate Mitigation** - tackling the causes and minimizing the impacts of climate change

- **Climate Resilience** – ability to anticipate, prepare, and respond to hazardous events, trends, or disturbances related to climate

- **Human Development Index** – HDI is a statistic composite index of life expectancy, education, and per capita income indicators used to rank countries into four tiers of human development

- **Genuine Progress Indicator** – is a national-level measure of economic growth and prosperity. GPI is an alternative metric to GDP but which accounts for externalities such as pollution.

- **Intergovernmental Panel on Climate Change** – IPCC is the United Nations body for assessing the science related to climate change

- **Sustainable Development** – is the organizing principle for meeting human development goals while simultaneously sustaining the ability of natural systems to provide natural resources and ecosystem services on which economy and society depends

- **Biofuels** – are a renewable energy source, made from organic matter or wastes that can play a valuable role in reducing carbon dioxide emissions

- **DISCOMs** – The power distribution sector consists of Power Distribution Companies (DISCOMS) responsible for the supply and distribution of energy to the consumers

- **Ecosystem Services** – Ecosystem Services are the direct and indirect contributions of ecosystems to human well-being, quality of life and even survival

- **End-of-Life Solutions** – mainly includes reduce, reuse and recycle policies

- **Energy Efficiency** – refers to a method of reducing energy consumption by using less energy to attain the same amount of useful output.

- **Grid Power** – an intricate system designed to provide electricity all the way from its generation to the customers that use it for their daily needs

- **Green Financing** – providing finance while enhancing the resource efficiency and reducing the impact on the environment and the global climate

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