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Climate mitigation and adaptation with challenges, opportunities, and solutions

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Abstract

Climate change is very likely to cause radical changes in forest types in India, eventually leading to irreversible ecological damage and even eventual species extinction, with consequent adverse socio-economic effects on local communities. Projections indicate that 47% and 42% of tropical dry deciduous forests are likely to undergo shifts under A2 and B2 SRES scenarios, respectively, compared with less than 16% in tropical wet evergreen forests. Moreover, the tropical thorny scrub forests under A2 and B2 scenarios may undergo changes in more than 80% and 50%, respectively, of the forested areas. These changes necessitate adaptive management strategies addressing both ecological and socio-economic challenges by incorporating climate concerns into the long-term forest management policies. While novel and progressive forest policies have been developed in India, mechanisms to ensure due implementation of those policies and adaptation responses to climate impacts remain at wish. Further approaches might be necessary that could deal with the scale, uncertainty, and accuracy issues of the assessments of climate impacts. Meanwhile, India has to tread the thorny path of sustaining growth for 1.4 billion people while exploring ways to bring greenhouse gas emissions in line with its net-zero commitment by 2070. Indeed, the current policy on renewables and decreasing reliance on coal is in the right direction, but much more is yet to be done. Bringing down greenhouse gas emissions may hurt growth in the short term and present some distributional challenges, at least in coal-dependent communities. The implication is that it will take action to avoid economic damage, but the costs of such action can be reduced by appropriate policy frameworks. This paper reviews the current status of the Indian climate policy landscape and modeling of emissions trajectories to outline effective mitigation strategies.

Keywords: Mitigation strategies, forest management, climate adaptation barriers, tropical forest shifts, forest policy integration

1. Introduction

In this regard, the unprecedented speed of environmental and socio-economic challenges across the world testifies to the overriding urgency for action on climate change impacts on forests. Forest ecosystems have been shown to play a vital role in maintaining biodiversity, regulating the climate, and supporting livelihoods, although climate change poses a big threat to their stability and resilience. This, in turn, affects forest ecosystems: increased temperatures, changes in precipitation patterns, and a higher frequency of extreme weather events all pose disruptions to the continuity of forests and lead to the loss of species and changes in composition as well as increased vulnerability to pests and diseases. In India's case, the stakes are high. With a population in excess of 1.4 billion and an economy rapidly growing, India's social and economic fabric intertwines significantly with its natural resources.

Indian forests are providing many services to both the rural and urban communities in the form of water regulation, soil conservation, and carbon sequestration. They support the livelihoods of millions of people, mostly indigenous populations, who depend on forests for their cultural, economic, and subsistence needs. Very socio-economically strong changes with regard to climate change impacts in Indian forests exist. Resource scarcity further escalates the risks for resource-dependent communities. This may indeed affect agricultural productivity, increase water scarcity, and eventually destabilize the economy. Beyond this, the socio-cultural significance of forests in India provides one more dimension of complexity to the issue: many communities maintain deep-rooted traditions and practices linked to the

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forest ecosystem, and disturbances may sow the seeds of erosion of cultural heritage and social cohesion. Against this backdrop of close interrelation between environmental health and socio-economic stability, any climate change effect on India's forests must be dealt with through a holistic approach. Climate adaptation and mitigation plans need to be integrated with socio-economic plans in order to strengthen resilience building. This would include sustainable forest management practices, an improved effectiveness of conservation efforts, and support for community-based adaptation. This way, India can face the challenge of saving its precious forest wealth in such a way that the socio-economic welfare of its population is not sacrificed. In a nutshell, urgent consideration of impacts upon forests needs to be taken up within this Indian socio-economic context. It establishes a very complex interrelation between human livelihoods and forest ecosystems, thereby urging direct, sustained actions to protect these resources for a resilient and sustainable future.

2. Climate Change and Forest Ecosystems of India: Effects on Tropical Dry Deciduous and Thorny Scrub Forests

Climate change has emerged as one of the most intense threats for forests at the global level, greatly impacting ecological balance, biodiversity, and living standards. In India, it is one of the worrying matters bearing diverse forest types. Given the extensive coverage by tropical dry deciduous and thorny scrub forests on most parts of the Indian landscape, these forests are sensitive to changes in the climate regime. The expected ecological impacts of climate change imperil not only ecosystems but also dependent communities and economies.

2.1 Projected Changes in Climate Change Impacts on Indian Forests

Already, the impacts of climate change are appearing in India's forest ecosystems and are likely to worsen during the coming decades. Warmer average temperatures, changing regimes of precipitation, and higher occurrences of extreme events such as droughts, floods, and cyclones disrupt ecosystems considerably. Indian climate models show that average temperatures will increase by 1.5–3 °C at the end of the 21st century. This rising temperature, accompanied by uneven patterns of rainfall, will directly affect the forest health along with the composition of the forest.

Tropical dry deciduous forests are the most vulnerable, as they are spread extensively across states in central and southern India. They generally prefer medium-type rain conditions with an average annual precipitation of about 700 to 1,500 millimeters. However, the same forests, which are going to be exposed to the foreseen shift in the monsoon pattern, are likely to experience both dry spells stretched beyond traditional averages as well as high-intensity rainfall events. All this leads to the effects of increased soil erosion, loss of forest cover, and alteration in the species composition. Thorny scrub forests largely occupy the arid and semi-arid regions of Rajasthan, Gujarat, and parts of the Deccan Plateau and are also at a high risk. These forests are dry environments, but their susceptibility to moisture and temperature exceeds any extreme limits. It is probable that with climatic change, long drought periods may transform such forests into deserts, desertifying them. This would not only contribute to reduced biodiversity but also accentuate

water shortages and soil degradation in areas already suffering ecological stress.

2.2. Ecological Damage of Tropical Dry Deciduous Forests

Tropical dry deciduous forests are an integral component of Indian forest ecosystems. They can harbor a great variety of flora and fauna, along with some important species of trees like teak and sal, bamboo, tigers, leopards, elephants, and many species of birds. However, these forests are highly sensitive to temperature and moisture regimes.

One of the main effects of climate change is the change in the composition of forests. It might be more challenging for some of the species adapted to certain conditions of temperature and moisture with increasing extremes in temperatures and moisture levels. This could disrupt the balance of dominant tree and plant species. If the invasive species are successful, they become more tolerant to extreme climatic conditions, which would then displace the native species further, thus altering the structure and functions of the ecosystem. The high rate of incidence of forest fires triggered by hotter and drier conditions is also cause for alarm. Tropical dry deciduous forests are bioclimatically susceptible to periodic fires that help in regenerating the forest by clearing old vegetation. Climate change, however, will intensify and increase the recurrence of such fires, burning the bigger areas and lower chances of regeneration. This may lead to long-term loss of the forests, which would have enormous effects on biodiversity and ecosystem services that include carbon sequestration and water regulation.

2.3 Ecological Damage for Scrub Forests

Thorny scrub forests have hardy vegetation with certain species like acacia and euphorbia that tolerate hot and dry environments. This kind of vegetation is nurtured by unique wildlife, including reptiles, small mammals, and birds. However, the fragile balance that sustains thorny scrub forests is exposed to disruptions in the face of climate change.

Some of the impacts that are attributed to climate change on thorny scrub forests include desertification. As their rainfall patterns grow progressively more unpredictable and temperatures continue rising higher, it is easy for these forests to lose their vegetation cover. When the group of thin soils that characterize thorny scrub forests are lost due to the loss of their vegetation, then they become easily erodible. Thus, there is a degradation of land whereby desert-like conditions tend to spread into the surroundings. Apart from mere biodiversity reduction, this has stern ramifications on agriculture in bordering areas and on water availability. It can also have a cascading impact on the local communities, who use these areas for fuelwood, fodder, and other forms of resources. Once these resources begin to dwindle, rural area populations may migrate or undertake unsustainable activities, such as grazing grasslands too long or cutting down protected area trees, which further worsens environmental degradation.

2.4 Socio-economic Consequences

The implications, in a socio-economic sense, are pretty far-reaching since ecological degradation for the cause of climatic change to tropical dry deciduous and thorny scrub forests benefits several Indian people directly, mainly the

rural communities whose chief source of livelihood is agriculture, rearing livestock, and engaging in forest-based activity. Such impacts of loss in forest cover and degradation of ecosystems will hit such communities directly.

Loss of ecosystem services, which includes water regulation and soil fertility, will primarily impact agricultural productivity already vulnerable to climate variability. Soil erosion and reduced water retention in soils will increase as forest degradation continues, making agricultural lands even less productive. Overall, food insecurity will worsen in specific regions that are already stressed because of poverty and environmental stress. Loss of biodiversity and forest resource is also going to affect forest products based industries, including timber, medicinal plants, and NTFPs. As forest ecosystems decline, there would be less resource for both commercial and subsistence use, leading to an unstable economy and even more pressure on the remaining forested areas.

One of the significant ecological and socio-economic challenges in India is climate change impact on tropical dry deciduous and thorny scrub forests. Increasing temperature, new rainfall patterns, and increased frequency of extreme weather events will degrade these vital ecosystems, threatening biodiversity and millions of people's livelihoods. All this calls for a holistic approach, which integrates sustainable forest management, adaptation to the changing climate, and support for communities who are predominantly dependent on forest resources. Doing this will cushion climate change impacts on India's forests by making them more sustainable for the long term.

3. Barriers to Climate Adaptation in India's Forest Sector: Challenges in Policy Implementation and Adaptation

Adapting the nation's forest ecosystems to changing climate conditions is requisite for Indian environment sustainability and socio-economic stability in the long term. However, the way to effective climate adaptation is wracked with numerous barriers. First, there are challenges in implementing forest policies. Others are institutional, financial and technical limitations, and climate-related projections that present uncertainties for each. Overcoming these barriers is of paramount importance to see adaptation efforts for the protection of India's biodiversity of forests, especially its tropical dry deciduous and thorny scrub forests, go quite successfully without the unwanted impact of climate change.

3.1 Policy and Institutional Challenges

India has well-established and strong regulatory provisions of forest and environmental policies towards conservation and sustainable management. Ambitious policy provisions like the National Forest Policy of 1988; the National Action Plan on Climate Change (NAPCC) from 2008 and the Green India Mission have bigger, more ambitious targets for conservation of forests, reforestation, and climate adaptation. Still, these policies are being bottled up, their implementation being hamstrung by institutional weaknesses, conflicting priorities, and governance ills. One of the major bottlenecks in the implementation of forest policies is a lack of coordination between different government agencies. In the case of India, forest management is considerably divided between the three

levels of government, namely the central government, the state governments, and the local governments. This often leads to jurisdictions dovetailing with each other and diverse priorities, thus making it very challenging to implement flexible strategies. For example, the forest conservation objectives may come into conflict with those of the agricultural or infrastructural sectors where most of the forest land is diverted for development projects. Such conflicting interests lead to bottlenecks in the implementation of policies targeted at building resilience for the forests to changing climate.

In addition, the technical capacity and resources of the forest departments in the states are mostly inadequate to adequately monitor and maintain the forest ecosystems. Most the states with large forest cover face funding challenges regarding conserving and adapting forests for climate change. The lack of proper training and personnel in the forest departments negates the efforts geared toward adaptation of climate change at the departmental level, such as installing an early warning system for forest fires or introducing climate-resilient species.

3.2 Financial and Technical Barriers

The forest sector is bound to take considerable investment in infrastructure, research, and capacity building to adapt to climate change. Financings for climate adaptation in the forest sector are still very low in India. The vast majority of adaptation projects rely on scarcity of funding from the government or international agencies, usually falling behind the scale and time that the more important, long-term efforts in adaptation might require. This financial constraint also restricts forest departments to implement robust adaptation measures because all these are being permitted to happen all at once reforestation, community-based forest management, and restoration of degraded forest landscapes. In addition, a vast knowledge gap together with the technical capability required also exists in order to design and effectively implement adaptation strategies. In more complex forests, like that of a tropical dry deciduous or thorny scrub forest, highly specialized knowledge on species composition, water conservation, and fire management needs to be practiced adequately enough for adaptation to climate change. However, many forest management agencies are not updated with recent scientific studies and technological tools, such as GIS, climate modeling, and remote sensing, that facilitate monitoring of forest health and estimation of the impacts of climate change.

Localized climate data and information for directing adaptation efforts are also generally lacking. Projections of climate are usually made on very large spatial scales, while localized information is important for knowing what specific alterations in the climate will impact the forest ecosystems. There is such a lack of data and this is thereby generating problems in devising focused adaptation strategies; forest managers are thus left to rely on generalized models that do not expose the risks associated with particular types of forests, such as tropical dry deciduous or thorny scrub forests.

3.3 Social and Cultural Barriers

Socio-economic and cultural aspects also represent barriers to climate adaptation for forest management in India. To a majority of the communities that depend on forests for their survival, including indigenous and tribal communities,

forests are an integral part of their identity and livelihood. These communities have a vast knowledge system about the local ecosystems and are one of the most vulnerable peoples related to the impact of climate change on forest resources. One of the main challenges is that adaptation of these communities is not part of planning and implementation. Forest adaptation policies are often devised at higher levels of administrative organization without adequate input from these communities who would have firsthand experience of the changes happening in their environment. This top-down approach can easily lead to adaptation measures that are out of touch with local realities and ineffective on the ground. New practices or policies are often resisted because they interfere with tradition in forest management and seem to threaten acquired rights or livelihoods.

In this respect, adaptation planning needs to ensure the involvement of local communities in a participatory approach that acknowledges their traditional knowledge and demands their needs be met. Well-resourced community-based forest management programs have been shown to be more resistant to climate change while keeping cultural and social bonds with the forest.

3.4 Uncertainties and Climate Risks

One of the most important hindrances to effective climate adaptation in the forest sector is the inherent uncertainty around projections of climate change. Indeed, there is general consensus that impacts of climate change will continue to reshape forest ecosystems, but it remains rather impossible to predict their very nature, scale, or timing. Such unpredictability makes the formulation of long-term adaptation strategies highly complicated, as forest managers have to consider all the various possibilities for scenarios. For example, changes in monsoon patterns and temperature may bring about variations in species composition and forest productivity, which are definitely the opposite of what is expected and desired. In the dry tropical deciduous and thorny scrub forests, changes in rainfall may be minimal, but their effect on tree species and plant life, highly sensitive to moisture availability, would force draconian changes in the ecosystem. Absence of any clear prediction regarding likely outcome would be seen as species migration, forest degradation, or an increase in fire incidence ensures adaptation will indeed be reactive rather than proactive. Another challenge arises in the form of trade-offs between short-term gains and the longer-term. Adaptation measures go hand in hand with trade-offs between the short-term gains and long-term sustainability. For example, in some cases, short-term pressures such as economic development or land use change/population demand may overcome long-term forest resilience, making policy decisions counterproductive to efforts on adaptation. Overcoming these barriers in climate adaptation within India's forest sector is critical to saving rich biodiversity in the country and saving the livelihoods of millions of people who depend on forests. This will be through an integrated and inclusive approach, facilitated by resources and access to localized climate data. With strengthened forest institutions; with community engagement in these institutions, and the scientific research integrated into policy-making, India can secure its forests and ecosystems into a sustainable future against climatic change impacts.

4. Policy Framework and Renewable Energy Transition in India

Coping with the Shift from Coal Dependency the transition

of India toward renewable energy is a critical component of a much broader strategy as is used for fighting climate change, ensuring energy security, and promoting development. The country has one of the fastest-growing demands for energy in the world, thus presenting a dual challenge of ensuring access to electricity for its people while reducing GHG emissions. India's energy policy has, therefore focused considerably on the growth of renewable energy, especially solar and wind, amidst navigating very heavy coal dependency that stands out both as a major driver of its economy and source of environmental pollution. India's Energy Transition in Renewable Energy India has set rather ambitious targets for development of renewable energy, mainly a cleaner and sustainable mix of energy. The country boasts vast renewable resources, thanks to abundant sunlight and wind in the country; India is an undisputed leader in the global renewable energy landscape. Within its NDC submitted to the Paris Agreement, India agreed to produce 40% of electricity from non-fossil sources by 2030. This forms part of an effort aimed at reducing the GHG emission intensity in India by 33-35% from the levels registered in 2005.

India has made significant strides in the last few years in direction of achieving these targets. Currently, with nearly 120 GW of installed renewable energy, including mainly solar and wind power, India leads the pack. Solar power, particularly has grown by leaps and bounds on account of positive policies, technological progress, and falling photovoltaic panel prices. The International Solar Alliance, the flagship program underlined by the government of India, showcases the commitment of the country to becoming a leader in the world for solar energy. Wind energy is also very significant in the renewable energy mix for India. Considerable capacities are estimated in states such as Tamil Nadu, Gujarat, and Maharashtra. Efforts are also being carried on to encourage bioenergy, hydropower, and offshore wind projects, making further diversification in the portfolio of renewable energy.

4.1. Policy Framework Supporting Renewable Energy

It is supported by a series of policy frameworks at the national and state levels. Among the leading ones is the National Solar Mission (2010), which provided the foundation for quick expansion in solar energy by setting this ambitious target for adding grid-connected solar power and galvanizing off-grid applications. The target of the mission has, time and again been revised through which the government aims to achieve 280 GW of solar by 2030. Another significant policy is the National Wind-Solar Hybrid Policy enacted in 2018, which shows how efficiently transmission infrastructure is being utilized through integrating solar and wind-based systems. It will also help bridge the intermittency issue confronted with the renewable-based systems, thus achieving a better quality power supply.

RPO is essentially a regulatory mandate. Electric distribution companies have been required, under the norms of the RPO, to procure a part of their power from renewable sources. This factor has, therefore, greatly driven the state-specific installation of renewable power. Feed-in tariffs, and incentives for rooftop solar, and tax benefits on investments in renewable energy have promoted participation, as well as attracted foreign investment, in the energy sector. Despite these policy successes, up scaling the deployment of

renewable energy faces some challenges. Problems in infrastructure, grid integration, land acquisition, and financing remain major hurdles to realizing India's true renewable energy potential. More importantly, the transmission networks will have to be upgraded and energy storage technologies invested in, as renewable power can be unreliable at times.

4.2. Coal Dependence and Issues

Although India has made spectacular strides in increasing the use of renewable energy, to this date, there remains plenty of reliance on coal. Coal serves a share of almost 55-60% of electricity produced in India and forms an important element for the economy, more so in terms of employment and regional development. India is the world's second-largest consumer of coal and has tremendous interlinkages with the lives of millions of people. The danger lies in lowering coal reliance, considering the vast population and ever-increasing base of industries requiring coal as a cheap and stable source of energy. Socio-economic risks are also high while shifting away from coal, especially for coal mining states like Jharkhand, Odisha, and Chhattisgarh, whose whole communities rely on the coal economy.

A just transition framework to reconcile the government's goals of renewable energy with its reliance on coal is through the need for retreading to mold a better future for coal workers, a promotion of cleaner coal technologies, and the gradual retirement of old and inefficient coal plants. However, the shift to renewables will be the real challenge and requires their best efforts: in other words, increased investments, reforms in policies, and regional support for economies dependent on coal. India's story in renewable energy is remarkable, underpinned by solid policy frameworks and international leadership. However, the country still heavily relies on coal and remains yet to bring this into manageable balance with climate goals. Scaling up renewable energy while maintaining energy security and addressing socio-economic challenges that moving away from coal will pose requires a delicate balance. With continued policy innovation and investment, India is definitely well on course toward a more sustainable future with cleaner energy.

5. Mitigation and Adaptation Solutions for Climate Change in India: Policy Integration, Emission Reduction, and Adaptive Management

As climate change continues to intensify, India has an urgent role of reducing emissions and adapting to changes in the environment that are now inevitable. Climate action involves a holistic approach, incorporating policy across sectors, effective emission reduction strategies, and adaptive management aimed at strengthening resilience within this diversified country of fragile populations and an emerging economy. That is what is of top priority to India to ensure continued environmental sustainability, economic growth, and social well-being.

5.1. Integrating Climate Policy for Action Towards Climate Change: Integration of climate policy in various sectors such as energy, agriculture, water management, and infrastructure has been one of the most significant steps forward in addressing climate change. India has shown considerable development in this regard, particularly with

the National Action Plan on Climate Change, striking a balance between sustainable development and environmental protection. The NAPCC consists of eight national missions on solar energy, energy efficiency, and sustainable agriculture, among others. There is a good comprehensive framework for policy integration provided.

On the other hand, an area of challenge is the integration of climate considerations into some of these more general policy frameworks-urban planning and industrial development. Indeed, so often, policies for mitigating climate change run in contradiction with short-term economic objectives-may be literally evident in sectors such as coal and heavy industry. This demands the central government in India to strengthen coordination between the center and state so as to bring in integrated policies that would enable economic development across the lines of climate resilience. Take, for instance, regional policies should encourage investments in renewable energy and in coal-dependent regions, transition towards clean energy sources should be distributive as well as efficient. In addition, India's climate policy must be integrated with local governance structures. This is due to the fact that sub-state states and local town councils have a far stronger direct influencing capacity in state implementation of adjustment. Decentralized delivery and implementation of climate adaptation can be strengthened through ensuring participation and engagement from the grass-root level, through climate-responsive budgeting. Localizing climate action will enhance adaptive capabilities in rural and urbanized vulnerable populations.

5.2. Strategies for Emissions Reduction

The targets set for India regarding emission reduction are really ambitious. It has aimed for net-zero emission by 2070. Several mitigation measures will be required to achieve these targets in the future. The frontline measure in emission reduction effort in India is the expansion of renewable energy. Indeed, solar and wind power have grown rapidly but require greater acceleration to resolve the challenges of grid integration, storage, and land-use conflicts. Decentralized renewable-energy projects such as rooftop solar can help generate new emission-reducing sources, but impact will mostly remain localized in urban areas.

Important also is the energy efficiency improvement in key sectors, including transportation and the industry as well as construction. Programs, like the Perform, Achieve, and Trade scheme can be extended to even more sectors toward improving energy efficiency in specific, energy-intensive industries. Transportation is another very important sector where the introduction of EVs, infrastructure improvements in public transport systems, or the development of smart mobility solutions may play a key role in reducing emissions.

Third, agricultural and waste management sectors require an all-rounded approach to mitigate emissions. Agriculture is one sector where a bulk of methane and nitrous oxide releases are happening, and India will certainly see benefits from climate-smart agriculture, organic farming, and the improvements in water management. Similarly, utilization of waste-to-energy projects combined with better segregation in urban areas will pull down the overall emission trajectory.

5.3 Adaptive Management and Building Resilience

While mitigation is essential, the country must undertake adaptive management that can respond to established impacts of climate change that are already emerging in vulnerable regions. Adaptive management is flexible, responsive decision-making based on continuous monitoring and feedback that enables policies and practices to evolve based on environmental changes.

Key areas for adaptation relates to water resource management. Adaptive water management strategies will be needed to adapt to growing variability in rainfall patterns and risks of droughts and floods, as well as improvement in irrigation efficiencies, building resilient infrastructure, wetland and forest restoration, and agriculture - a sector requiring adaptive management. Climate change has already brought about yield impacts on crops, available water resources, and even the life of farmers. Adaptive responses include promotion of drought tolerance crop varieties, improved irrigation technologies - drip irrigation, and diversified agricultural production that increases resilience to climate variability. Crop insurance schemes need to be strengthened, and financial incentives provided to farmers to minimize the economic risks of adverse climate impacts.

Adaptive strategy focuses on building robust infrastructure for communities in coastal areas to guard them against rising sea levels, storm surges, and erosion. The coastal zone management plans that incorporate ecosystem-based adaptation-thus, restoring mangroves and coral reefs-provides natural defense mechanisms against such threats, promoting biodiversity and livelihood. Adaptation and mitigation for climate change: India's approach has to be multi-dimensional for sustainability over the long term. India would then address the rising risks of climate change by addressing its considerations through the incorporation of climate dimensions in national and local policy frameworks, scaling up emission reduction strategies and key sectors, and adopting adaptive management. And though the challenge will be quite daunting, given the real tension always involved between generating economic growth and environmental protection, only active and continuous efforts will succeed to have India fulfill its climate obligations while building a better resilient society.

6. Conclusion

India's approach to climate change would necessarily have to be holistic and multi-dimensional because it would involve strategies that both mitigate the problem and adapt to it. Being one of the world's fastest-growing economies with increasing energy demands, India faces twin challenges of reducing its greenhouse gas emissions while building resilience to impacts of climate change. The country has managed to make reasonable progress in renewable energy besides having a good policy framework in support of growth for solar and wind energy. Reliance on coal, however, has been pretty challenging, and the success of an equilibrium transition would require well-coordinated action for a balanced and equitable energy transition the climate of India to take action into national and local policy frameworks to meet ambitious climate goals. Strengthen coordination among government departments, encourage investment in renewable energy, and decentralize governance to help balance economic growth with the imperative of environmental sustainability. More importantly, to achieve India's net-zero emissions by 2070,

the pathways to reducing emissions - expansion of renewable energy, strengthening of energy efficiency, and promoting climate-smart agriculture among others-need to be accelerated end.

The other important area of work is building resilience through water, agriculture, and coastal zone management. Climate change adaptation requires sensitive, responsive strategies that address local vulnerabilities in strengthening infrastructure and livelihoods. India confronts some pretty large challenges for balancing economic and environmental priorities; it has taken a proactive approach to policy integration, emission reduction, and adaptive management, which will lend a solid base for building a more sustainable and resilient future. Therefore, India can meet its international commitments not just by continuing to innovate and invest in climate action but also in setting a pathway toward sustainable development that will translate to benefits both for its people and the planet.

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