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***An Analytical Study on The Integrated Approach to Climate Change Mitigation***

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**ABSTRACT**

*Climate change is one of the most significant environmental challenges that poses a threat to the ecosystem, economies and human beings across the world. This paper explores four interconnected aspects of sustainability and climate change mitigation. It addresses the importance of sustainability in adapting to, and mitigating climate change, highlighting the challenges such as resource scarcity, policy gaps, and socioeconomic inequalities. It examines the role of the judiciary in India in enforcing environmental regulations, landmark judgements, and promoting climate justice. It also investigates emerging technologies in India's energy and industrial sectors, including renewable energy advancements, carbon capture, and energy efficiency improvements. The research delves into strategies that businesses can implement to ensure sustainability, emphasizing the reduction of environmental impact through innovations and sustainable practices. This research aims to enhance understanding of sustainable approaches can effectively combat climate change and ensure long-term environmental sustainability.*

**Keywords:** *Sustainability, Climate Change Mitigation, Judiciary, Emerging Technologies, Environment Impact.*

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## INTRODUCTION

India, with its diverse geography, dense population, and complex socio-economic landscape, is highly vulnerable to climate change. Air pollution is a major concern, which is exacerbated by climate change. This pollution arises from various sources, including industrial emissions, vehicle exhaust, biomass burning, and dust particles<sup>3</sup>. The significant reason to worry about climate change in India is that, a large portion of the population relies on climate-sensitive industries like agriculture, forestry, and fisheries for their livelihood. The negative impacts of climate change, including decreased rainfall and rising temperatures, has worsened the livelihood of the people across the country<sup>4</sup>.

"Climate" refers to the global environmental conditions, observable through variations in temperature, precipitation, pressure, and humidity in the atmosphere. Consequently, "climate change" signifies a shift in these environmental conditions, driven by natural phenomena or human activities<sup>5</sup>. Climate change impacts the ecological and socioeconomic system that are already under pressure due to industrialization and urbanisation.

Climate change is mainly caused by human activities, such as burning fossil fuels, deforestation, and industrial processes etc, significantly contribute to the release of vast quantities of greenhouse gases (GHGs) into the atmosphere. These gases trap heat, resulting in global warming and causing various environmental effects, including rising sea levels, more frequent extreme weather phenomena's, and changes in biodiversity etc.

According to India's "National Communication Report" submitted to the United Nations Framework Convention on Climate Change (UNFCCC), climate change is expected to impact all natural systems, as well as social and economic systems<sup>6</sup>.

Sustainability provides a means to counter these negative impacts by encouraging development that fulfils the current needs without jeopardizing future generations' ability to do the same. Essentially, sustainability focuses on the balanced use of environmental, economic, and social resources. This equilibrium is vital for addressing climate change<sup>7</sup>. The importance for sustainable solutions for climate change is now universally acknowledged. Global initiatives, such as the United Nations Sustainable Development Goals (SDGs) and the Paris Agreement, are driving international

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<sup>3</sup> Hussain, Sharfaa & Hussain, Ejaz. Navigating the Impact of Climate Change in India: A Perspective on Climate Action (SDG 13) and Sustainable Cities and Communities (SDG 11). *Frontiers in Sustainable Cities*, 5 (2023): Article 1308684.

<sup>4</sup> Mani, Muniyandi Balasubramanian and Birundha, V. Dhulasi, Climate Change and its Impact on India (September 21, 2012). *The IUP Journal of Environmental Sciences*, Vol. VI, No. 1, February 2012, pp. 31-46.

<sup>5</sup> Hussain, M., Butt, A.R., Uzma, F. *et al.* A comprehensive review of climate change impacts, adaptation, and mitigation on environmental and natural calamities in Pakistan. *Environ Monit Assess* 192, 48 (2020).

<sup>6</sup> Borah, Manash Pratim, A Study on Climate Change and Its Impact on India's Sustainable Growth and Human Security (May 1, 2023).

<sup>7</sup> United Nations. "Sustainability." *United Nations Academic Impact*, 2024. <https://www.un.org/en/academic-impact/sustainability>



collaborations to limit global warming and reduce emissions. Achieving a sustainable future requires collective action from governments, corporations, and individuals to reduce climate risks and ensure a liveable planet for future generations.

### **Methodology**

This research paper utilizes a doctrinal method. This research primarily focuses on analysing existing judicial decisions related to climate change and sustainability. This method involves a comprehensive review of primary and secondary legal sources such as case laws, government policies, and international agreements on climate change and it will examine policy frameworks that support the adoption of emerging technologies in the energy and industrial sectors, analysing their effectiveness in developing a sustainable future.

### **Research Question**

- Why is sustainability important and what are the challenges faced due climate change?
- How has the judiciary contributed in addressing climate change impacts in India?
- What are the most effective emerging technologies and policies in place for reducing greenhouse gas emissions in India's energy and industrial sector?
- How can businesses ensure sustainability and effectively reduce their environmental impact?

### **Hypothesis**

The hypothesis of this research states that, there is an immediate need for climate change reforms to prevent further environmental degradation and promote sustainability, as natural resources are rapidly depleting and natural calamities are occurring frequently.

### **Relevance and Significance**

This research is relevant as it addresses the urgent need for sustainable development due to climate change, particularly in India, which faces unique challenges and opportunities. Sustainability ensures economic growth without environmental degradation, which is crucial as climate change worsens resource scarcity, disasters, and inequality. Emerging technologies like renewable energy, carbon capture, and advanced manufacturing can significantly reduce emissions, but policy frameworks are vital for their widespread adoption. Businesses, corporations, and governments must integrate sustainable practices to mitigate environmental risks and support a resilient, low-carbon economy.

### **Literature Review**

The Age of Sustainable Development<sup>8</sup>

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<sup>8</sup> Sachs, Jeffrey D. *The Age of Sustainable Development*. Columbia University Press, 2015

The author provides a comprehensive framework for understanding the critical intersection of sustainability, development, and climate change. The author argues that the 21st century marks a decisive turning point for human civilization, where sustainable development must be integrated into the economic growth, environmental stewardship, and social inclusion to combat climate change effectively. The book emphasizes that climate change is not merely an environmental issue but one that deeply affects global poverty, health, and inequality. This book is essential for understanding how global frameworks like the SDGs can be localized and implemented, particularly in developing nations like India, where rapid industrialization and population growth intensify sustainability challenges.

*This Changes Everything: Capitalism vs. The Climate*<sup>9</sup>

In this book the author offers a critical analysis of the relationship between capitalism and climate change, arguing that the current global economic model is fundamentally at odds with environmental sustainability. The author contends that the capitalist system's relentless focus on growth, resource extraction, and profit maximization, is driving the planet towards catastrophic climate change. The book is particularly valuable for understanding the socio-economic dimensions of climate change, emphasizing that sustainable solutions must be rooted in fairness, justice, and an equitable redistribution of resources.

### **Discussion and Findings**

#### **Challenges faced due to climate change**

Climate change is no longer a distant threat; it has become an immediate and pressing matter that affects every corner of the globe. The escalating temperatures are leading to more frequent and intense heatwaves, industrialisation, green gas emission, global warming etc, are far reaching consequences. Increased mortality rates, reduced productivity, and infrastructure damage are just the beginning. The most vulnerable populations, including the elderly and infants, face heightened risks, while critical sectors like agriculture and livestock suffer reduced yields. Ecosystems struggle to provide essential resources such as clean water and air<sup>10</sup>.

The climate crisis has raised the regular global temperature, leading to more common high-temperature extremes like heatwaves. Higher temperatures can result in increased mortality, reduced productivity, and infrastructure damage. In February 2019, large fires ravaged Karnataka's Bandipur Tiger Reserve Forest, resulting in dry conditions and exacerbated by the presence of dry grass and lantana weed, the fires destroyed over 10,000 acres (approximately 4,000 hectares) of forest. This devastation impacted the tiger population and herbivores like deer. From February 21st

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<sup>9</sup> Klein, Naomi. *This Changes Everything: Capitalism vs. The Climate*. New York: Simon & Schuster, 2014.

<sup>10</sup> Seneviratne, S.I., et al. "Weather and Climate Extreme Events in a Changing Climate." In *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, edited by V. Masson-Delmotte et al., 1513-1766. Cambridge, United Kingdom: Cambridge University Press, 2021.

to 25<sup>th</sup> 2019, the reserve recorded 127 fire counts, causing significant ecological damage, affecting the Nilgiri Biosphere Reserve, including Bandipur and other protected areas<sup>11</sup>.

Higher temperatures also increase water evaporation, which, combined with lack of precipitation, heightens the risk of severe droughts<sup>12</sup>. Severe droughts in Maharashtra's Marathwada and Vidarbha regions have left wildlife without sufficient water sources. In 2019, cases of leopards and other wild animals straying into human habitats in search of water became common. The drought has had a significant impact on both wildlife and local communities<sup>13</sup>.

In recent years, extreme heatwaves in Rajasthan and Gujarat have led to dehydration, heat stress, and mass cattle deaths, these events are a result of the rising intensity of heatwaves driven by climate change. In May 2024, Rajasthan experienced intense heatwaves with temperatures spiking to 49°C, resulting in numerous cattle deaths due to dehydration and heat stress<sup>14</sup>. During the 2022 heatwave, thousands of birds in Gujarat, particularly in Ahmedabad, fell from the sky due to dehydration and exhaustion. The scorching temperatures dried out water sources, leading to severe dehydration among the bird population<sup>15</sup>.

Climate change will impact soil erosion rates due to two main factors: reduced rainfall in southern states could dry out topsoil's and weaken soil structure, while more frequent extreme weather events may result in heavy downpours. Heavy rains occurring over a short duration, are a primary cause of soil erosion. When the rain is too heavy for the soil to absorb, water flows across the surface, carrying away a layer of topsoil<sup>16</sup>.

Human activities are the driving force behind this phenomenon. Since the industrial revolution, emissions of carbon dioxide and other greenhouse gases have increased temperatures, especially in the polar regions, causing glaciers to melt rapidly, break off into the sea, and retreat on land<sup>17</sup>.

<sup>11</sup> Times of India. "Fire in Bandipur Kills Wild Animals, Destroys 400 Acres of Forest Land." *Times of India*, 24 Feb. 2019. <https://timesofindia.indiatimes.com/city/bengaluru/fire-in-bandipur-kills-wild-animals-destroys-400-acres-of-forest-land/articleshow/68133064.cms>.

<sup>12</sup> European Commission. "Consequences of Climate Change." *Climate Action*, 2024. [https://climate.ec.europa.eu/climate-change/consequences-climate-change\\_en](https://climate.ec.europa.eu/climate-change/consequences-climate-change_en)

<sup>13</sup> Singh, R., Bindal, S., Gupta, A.K., Kumari, M. (2022). Drought Frequency Assessment and Implications of Climate Change for Maharashtra, India. In: Phartiyal, B., Mohan, R., Chakraborty, S., Dutta, V., Gupta, A.K. (eds) *Climate Change and Environmental Impacts: Past, Present and Future Perspective*. Society of Earth Scientists Series. Springer, Cham. [https://doi.org/10.1007/978-3-031-13119-6\\_22](https://doi.org/10.1007/978-3-031-13119-6_22)

<sup>14</sup> Times of India. "Heatwave Sweeps Across North India, Leaves 9 Dead in Rajasthan." *Times of India*, 24 May 2024. <https://timesofindia.indiatimes.com/city/jaipur/heatwave-sweeps-across-north-india-leaves-9-dead-in-rajasthan/articleshow/110373835.cms>

<sup>15</sup> Al Jazeera. "Dehydrated Birds Falling from Sky in India Amid Record Heatwave." *Al Jazeera*, 12 May 2022. <https://www.aljazeera.com/news/2022/5/12/dehydrated-birds-falling-from-sky-in-india-amid-record-heatwave>

<sup>16</sup> New South Wales Government. "Climate Change Impacts on Our Soils." *Climate Change Environment NSW*, 2024. <https://www.climatechange.environment.nsw.gov.au/impacts-climate-change/natural-environment/soils>

<sup>17</sup> Hancock, Lorin. "Why Are Glaciers and Sea Ice Melting?" *World Wildlife Fund*, 2024. <https://www.worldwildlife.org/pages/why-are-glaciers-and-sea-ice-melting>

Additionally, ocean acidification, caused by the absorption of CO<sub>2</sub> by seawater, is affecting marine life.

Climate change is altering the physical and biological structure of the oceans through rising sea surface temperatures, ocean acidification, and shifts in currents and wind patterns. These changes can affect fish distribution, allow alien species to invade new areas, and impact calcium carbonate-secreting organisms. Such shifts will inevitably affect coastal and marine ecosystems, leading to significant socio-economic consequences for many regions<sup>18</sup>. Polar bears depend on sea ice for hunting seals; global warming causes ice to melt earlier and freeze later, giving polar bears less time to hunt, thus the polar bears are going extinct.

Climate change raises ocean and atmospheric temperatures, leading to higher sea levels and more intense hurricanes. Cyclone Fani, which struck Odisha on May 3, 2019, was one of the most powerful cyclones to hit the region in recent history, leading to the deaths of thousands of livestock and the destruction of habitats for coastal birds and animals. The Puri coastline saw significant damage, disrupting the nesting sites of Olive Ridley turtles<sup>19</sup>. Nature can mitigate some damage, but coastal ecosystems often suffer severe damage like beach erosion, dune destruction, and saltwater intrusion, sometimes resulting in habitat loss for endangered species<sup>20</sup>.

Climate change and the ecosystem are deeply interconnected. Ecosystems and species survival are at risk. Coral reefs are home to thousands of marine species, and suffer from coral bleaching as rising ocean temperatures force corals to expel symbiotic algae, losing their colour and energy source. Since late October 2023, the Lakshadweep Islands have experienced prolonged marine heatwaves, leading to severe coral bleaching. This has caused significant biodiversity loss and impacted the livelihoods of local communities dependent on these coral reefs<sup>21</sup>.

Sustainability is crucial for mitigating climate change impacts on animals by protecting ecosystems, promoting responsible resource use, and enhancing resilience to disasters. Practices like water conservation, forest management, and renewable energy, reduces harm from heatwaves, droughts, floods, fires, and cyclones. By balancing environmental health, economic growth, and social well-being, sustainability preserves biodiversity, protects habitats, and ensures a future where both humans and animals can thrive.

## **Judicial Activism**

<sup>18</sup> [https://climate.ec.europa.eu/climate-change/consequences-climate-change\\_en](https://climate.ec.europa.eu/climate-change/consequences-climate-change_en)

<sup>19</sup> 4 Years of Fani: A Look Back at the Severe Cyclonic Storm's Trail of Destruction in Odisha." *Odisha TV*, <https://odishatv.in/news/odisha/4-years-of-fani-a-look-back-at-the-severe-cyclonic-storm-s-trail-of-destruction-in-odisha-203274>

<sup>20</sup> Vernick, Daniel. "Is Climate Change Increasing the Risk of Disasters?" *World Wildlife Fund*, 2 Oct. 2024. <https://www.worldwildlife.org/stories/is-climate-change-increasing-the-risk-of-disasters>

<sup>21</sup> Down To Earth. "Lakshadweep Worst-Affected by Coral Bleaching on India's Coastline, Scientists Tell DTE." *Down To Earth*, 26 Jun. 2024. <https://www.downtoearth.org.in/wildlife-biodiversity/lakshadweep-worst-affected-by-coral-bleaching-on-indias-coastline-scientists-tell-dte>





The Indian judiciary has advanced climate litigation through specialized environmental law and judicial activism, addressing issues overlooked by the Legislature. Public Interest Litigation (PIL) empowers the courts to tackle social issues, often stalled by political inaction, with innovative rulings fostering a proactive stance<sup>22</sup>.

The right to a healthy environment, guaranteed under Article 21 of the Constitution, has led the courts to direct several private sector organizations to adopt measures to protect the environment and reduce pollution. Additionally, the judiciary has ruled against both direct and indirect harm caused by pollution to monuments, heritage buildings, rivers etc.

In the case of **M.C. Mehta v. Union of India (Oleum Gas Leak Case) 1985**, the court introduced the concept of absolute liability for environmental harm, mandating that industries causing environmental damage must compensate affected individuals and restore the environment. This case laid the foundation for environmental jurisprudence in India, ensuring that industries are held accountable for any pollution or ecological damage they cause by promoting sustainability and making industries more cautious of their environmental impact. It has significantly contributed to the broader effort to address climate change and environmental protection<sup>23</sup>.

In **Vellore Citizen Welfare Forum vs. Union of India**, the Supreme Court emphasized on the Precautionary principles to promote Sustainable Development and ordered the closure of polluting industries in Tamil Nadu, holding the State and Central Governments responsible for not preventing environmental degradation and promoting sustainable development. It strengthened the responsibility of industries in managing pollution and mitigating their environmental footprint. This landmark judgment established the judiciary's critical role in enforcing environmental protection laws in India<sup>24</sup>.

In **M.C. Mehta v. Union of India (Air Pollution and Vehicular Emissions)**, the Supreme Court of India addressed the severe air pollution caused by vehicular emissions in Delhi. The court mandated the conversion of all diesel buses to Compressed Natural Gas (CNG) to reduce pollution and protect public health. This decision was based on the right to a clean and healthy environment, as guaranteed under Article 21 of the Constitution. The ruling emphasized the state's duty to secure the health of its citizens and improve public health by protecting the environment<sup>25</sup>.

<sup>22</sup> Wegener, L. (2020) 'Can the Paris Agreement Help Climate Change Litigation and Vice Versa?', *Transnational Environmental Law*, 9(1), pp. 17–36. doi:10.1017/S2047102519000396.

<sup>23</sup> **M.C. Mehta v. Union of India**, (Oleum Gas Leak Case), 1987 AIR 1086 (SC)

<sup>24</sup> Vellore Citizens Welfare Forum v. Union of India, A.I.R. 1996 S.C. 2715.

<sup>25</sup> M.C. Mehta v. Union of India, A.I.R. 1998 S.C. 2966

In **Court on its Own Motion v. State of Himachal Pradesh**, the Himachal Pradesh High Court ordered a ban on diesel vehicles in the Rohtang Pass region due to the rising pollution levels, which were harming the local ecosystem, glaciers, and air quality. The decision reduced air pollution in the region, contributing to the preservation of glaciers that are critical for climate balance and helped protect the region's fragile environment. It highlighted the importance of preserving vulnerable areas from climate change effects<sup>26</sup>.

**The National Green Tribunal (NGT)** in India was established under the National Green Tribunal Act of 2010. It is crucial in addressing environmental issues and promoting sustainability. As a specialized judicial body, the NGT resolves environmental disputes swiftly, upholds environmental laws, and ensures compliance. The NGT comprises of judges and experts in environmental law and science, empowering it to make informed decisions<sup>27</sup>.

**The Ganga Rejuvenation Case** involved the National Green Tribunal (NGT) directing the government to take comprehensive measures to clean and rejuvenate the Ganga River. This case was part of the broader Namami Gange Programme, launched in May 2015, aimed at rejuvenating the river and conserving its tributaries. The NGT's directives emphasized the need for stringent pollution control measures, sustainable management of water resources, and the protection of the river's ecosystem<sup>28</sup>.

In the **Suo Moto Case on Plastic Waste Management**, the National Green Tribunal (NGT) took proactive action to address the issue of plastic waste pollution. It initiated proceedings to tackle the disposal of plastic waste, which was causing significant environmental pollution and health problems. The tribunal directed various state governments and local authorities to implement effective plastic waste management practices, including segregation, recycling, and proper disposal<sup>29</sup>.

In **Suo Moto Case on Environmental Compensation Funds Misuse**, the National Green Tribunal (NGT) took action against the Central Pollution Control Board (CPCB) for diverting environmental compensation funds meant for air pollution control to unauthorized activities, such as road construction and repairs. It imposed a fine of Rs 25,000 on the Union Ministry of Environment. The tribunal emphasized the need for accountability and proper utilization of environmental funds<sup>30</sup>.

The judiciary in India plays an important role in addressing climate change and sustainability. Through activism, strong legal principles, and the issuance of guidelines, it has made significant strides in environmental protection. However, the effectiveness and efficiency is limited by

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<sup>26</sup> Court on its Own Motion v. State of Himachal Pradesh, (2014) 2 S.C.C. 135.

<sup>27</sup> The National Green Tribunal Act, No. 19 of 2010, India Code (2010)

<sup>28</sup> M.C. Mehta v. Union of India, (2017) 5 S.C.C. 326.

<sup>29</sup> Re: Destruction of Environment due to Plastic Waste, (2021) 3 S.C.C. 606.

<sup>30</sup> Re: Environmental Compensation Fund, (2022) 5 S.C.C. 1.



enforcement challenges, delays in hearings, resource constraints, including limited financial and human resources, hinder their effective functioning, public awareness about environmental laws is often lacking, limiting the impact of legal actions. Political influence can affect impartiality, effectiveness, and the need for more robust integration of judicial decisions with executive action<sup>31</sup>. Despite these challenges, the judiciary continues to be a strong force in shaping India's environmental landscape<sup>32</sup>.

### **Emerging Technologies and Policies to Reduce Environmental Impact**

The countries that emit carbon dioxide (CO<sub>2</sub>) at large are China, United States, India, Russian and Japan this is due to the anthropogenic activities<sup>33</sup>. India is the third largest emitter of greenhouse gas (GHG) amongst the above country due to which it is laying the groundwork to scale up important emerging technologies and policies that help reduce the greenhouse gas. India has announced that it aims to reach zero emission by 2070 and to meet 50% of its electricity from renewable energy sources by 2030, this is a significant initiative in the global fight contrary to climate change<sup>34</sup>.

### **National Action Plan on Climate Change (NAPCC)**

The NAPCC was launched in the year 2008 and is India's primary strategy to address climate change, it outlines eight national missions focusing on sustainable development, energy efficiency, renewable energy, and climate adaptation. These missions help reduce greenhouse gas emissions and enhance resilience to climate impacts<sup>35</sup>.

### **State Action Plans on Climate Change (SAPCC)**

State governments in India are encouraged to develop their own climate action plans, aligned with national goals. These SAPCCs focus on local climate challenges and prioritize adaptation measures in agriculture, water management, and disaster preparedness<sup>36</sup>.

### **National Clean Energy Policies**

India's National Clean Energy Policy includes the National Solar Mission and Energy Efficiency Policies. The National Solar Mission, part of the NAPCC, has significantly boosted solar energy

<sup>31</sup> GILL GN. Mapping the Power Struggles of the National Green Tribunal of India: The Rise and Fall? *Asian Journal of Law and Society*. 2020;7(1):85-126. doi:10.1017/als.2018.28

<sup>32</sup> Singh, Maitri. "Understanding the Jurisdiction and Powers of the National Green Tribunal." *Drishhti Judiciary*, 24 Sep. 2024, www.drishhtijudiciary.com/blog/understanding-the-jurisdiction-and-powers-of-the-national-green-tribunal.

<sup>33</sup> Shukla, and V.K. Dadhwal. "Regional and Sectoral Assessment of Greenhouse Gas Emissions in India." *Atmospheric Environment*, vol. 35, no. 15, 2001, pp. 2679-2695. ISSN 1352-2310.

<sup>34</sup> 32. International Energy Agency (IEA). "India's Clean Energy Transition Is Rapidly Underway, Benefiting the Entire World." IEA, 2022, www.iea.org/commentaries/india-s-clean-energy-transition-is-rapidly-underway-benefiting-the-entire-world.

<sup>35</sup> National Action Plan for Climate Change & Human Health. Ministry of Health & Family Welfare, Government of India. 23 Oct 2018

<sup>36</sup> *A Common Framework for Revision of State Action Plan on Climate Change*. Ministry of Environment, Forest and Climate Change, Government of India.

capacity, targeting 100 gigawatts of solar power by 2022. Energy efficiency initiatives, like the Perform, Achieve, and Trade (PAT) scheme, encourage industries to improve energy efficiency. Additionally, the Energy Conservation Building Code (ECBC) ensures that energy-efficient practices are implemented in building construction and maintenance. These policies reflect India's commitment to sustainable energy and climate action.

### **International Commitments**

India is a signatory to the Paris Agreement<sup>37</sup> and has committed to reducing its carbon intensity by 33-35% by 2030. This commitment aligns with global efforts to limit global warming and demonstrates India's dedication to climate action<sup>38</sup>. India has implemented carbon pricing through a coal cess, which taxes coal consumption to fund clean energy projects. Market mechanisms like the PAT scheme encourage industries to reduce emissions and trade surplus energy savings<sup>39</sup>. India's policy framework for climate change, while ambitious, faces implementation challenges. However, it sets a strong foundation for transitioning to a low-carbon economy, enhancing climate resilience, and meeting international climate commitments.

### **Technologies for renewable energy**

Numerous studies, such as TERI (2008), UNFCCC (2007), and McKinsey (2009), have attempted to predict the technological changes required to curb India's increasing emissions. The overconsumption of non-renewable energy resources heightens energy scarcity. Among clean energies, renewables like solar, wind, and ocean power are seen as vital and efficient methods for achieving carbon neutrality.

### **Solar Energy**

Solar energy is an inexhaustible resource. Its clean, renewable, and ubiquitous nature positions it as a key player in the global renewable energy supply. Rapidly developing photovoltaic technology has become a powerful method to harness solar energy. Recently, new solar cells, such as organic, perovskite, quantum dot, and other integrated devices, have emerged as promising photovoltaic technologies. This new generation of solar cells complements traditional ones and serves as low-cost alternatives in specific areas, effectively reducing CO2 emissions<sup>40</sup>.

### **Wind Energy**

In India, wind energy is becoming a crucial element in the fight against climate change and the move towards a low-carbon economy. Wind power helps decrease reliance on fossil fuels and cut

<sup>37</sup> Paris Agreement. United Nations Framework Convention on Climate Change, 2015, [unfccc.int/sites/default/files/english\\_paris\\_agreement.pdf](https://unfccc.int/sites/default/files/english_paris_agreement.pdf).

<sup>38</sup> Prakash, Anjal, et al. "India at Crossroads: Embracing ESG for a Sustainable Future." *FORBESINDIA*, 17 Oct. 2024, <https://www.forbesindia.com/article/isbinsight/india-at-crossroads-embracing-esg-for-a-sustainable-future/94414/1>

<sup>39</sup> Ji, C.J., Hu, Y.J. and Tang, B.J., 2018. Research on carbon market price mechanism and influencing factors: a literature review. *Natural Hazards*, 92, pp.761-782.

<sup>40</sup> Wang, Fang, Jean Damascene Harindintwali, Zhizhang Yuan, and Min Wang. "Technologies and Perspectives for Achieving Carbon Neutrality." *The Innovation*, vol. 2, no. 4, 2021, article 100180. ISSN 2666-6758,



greenhouse gas emissions, aligning with the country's commitments under the Paris Agreement. The government's ambitious goals, like reaching 60 gigawatt of wind power capacity by 2022 (a milestone recently achieved), demonstrates its strong commitment to renewable energy<sup>41</sup>.

### **Ocean Energy**

Ocean energy, harnessed from seawater movements like tides, waves, and currents, is a promising renewable resource for mitigating climate change. This vast, largely untapped resource can substantially reduce dependence on fossil fuels and lower greenhouse gas emissions. With its extensive coastline, India is exploring ocean energy as part of its strategy to combat climate change and shift to clean energy. Although the technology is still developing, tidal, wave, and ocean thermal energy systems could offer a consistent and sustainable energy supply, aiding India's climate goals and carbon neutrality efforts. Despite challenges like high costs and technological limitations, ocean energy holds significant potential for India's future renewable energy mix<sup>42</sup>.

**Hydrogen Energy (H<sub>2</sub>)** Hydrogen has been essential for industrial use for the past two centuries. Producing hydrogen using renewable energy shows promise for future viability. Advancements in AI are expected to reduce costs and improve logistics. Safe and low-cost hydrogen storage and transportation technologies are still developing. Hydrogen, which can be stored in gas, liquid, and solid states, offers a low-cost option for long-term energy storage, but achieving large-scale, cost-effective, and safe storage remains challenging<sup>43</sup>.

### **Nuclear Energy**

Nuclear energy, which makes up 40% of low-carbon electricity globally, helps avoid about 1.7 Gt of CO<sub>2</sub> emissions annually, making it a strategic choice for energy security and carbon neutrality. While nuclear fission is the primary method, it is still in the research and development phase. However, the future of fission energy is uncertain due to rising costs, radioactive waste disposal challenges, safety concerns, and proliferation risks.

### **Carbon Capture and utilisation**

Carbon Capture and Storage (CCS) technologies aim to capture carbon dioxide emissions from sources like power plants and store them underground to prevent them from entering the atmosphere. The captured CO<sub>2</sub> can either be permanently stored deep underground or transformed into various products.<sup>44</sup>

<sup>41</sup> "Wind Overview." *Ministry of New and Renewable Energy*, Government of India, [mnre.gov.in/wind/overview](https://mnre.gov.in/wind/overview).

<sup>42</sup> "Tidal and Ocean Current Energy" *Journal of Marine Science and Engineering*, vol. 11, no. 4, 2023, article 683. <https://doi.org/10.3390/jmse11040683>.

<sup>43</sup> Wang, Fang, Jean Damascene Harindintwali, Zhizhang Yuan, and Min Wang. "Technologies and Perspectives for Achieving Carbon Neutrality." *The Innovation*, vol. 2, no. 4, 2021, article 100180. ISSN 2666-6758,

<sup>44</sup> "The Loadstar Explains: Onboard Carbon Capture and Storage." *The Loadstar*, [www.theloadstar.com/the-loadstar-](https://www.theloadstar.com/the-loadstar-)

## **Sustainable Agriculture**

Sustainable agriculture and precision farming focus on maximizing crop yield while minimizing environmental impact. Precision farming uses technologies like sensors, drones, and GPS to monitor soil conditions, water use, and crop health, enabling farmers to apply inputs like water and fertilizers more efficiently. This reduces waste and lowers the carbon footprint of agriculture. Sustainable practices, such as crop rotation, organic farming, and reduced pesticide use, help maintain soil health and biodiversity. Together, these approaches promote an eco-friendlier and resource-efficient farming system, supporting food security while mitigating the effects of climate change<sup>45</sup>.

## **Waste Management**

Waste management and the circular economy aim to minimize waste and maximize resource efficiency. Advanced recycling technologies enhance material sorting, processing, and repurposing, boosting recycling rates and reducing waste. Circular economy initiatives promote designing reusable, re-manufacturable, or recyclable products, cutting the need for new raw materials. Together, these approaches create a closed-loop system where resources are continually repurposed, reducing environmental impact and fostering sustainable consumption<sup>46</sup>.

## **Sustainability in business**

Environmental impact in business pertains to the consequences of business operations, practices, and products on the environment. This includes factors such as, pollutant emissions, excessive use of natural resources, deforestation, degradation of ecosystems, loss of biodiversity, and contributions to climate change. Environmental impact has become a critical factor, as the world grows more considerate about the environment and its rapid depletion of resources, which is pressurising businesses to step up and lower their impact on the environment.

Corporations, as major emitters of greenhouse gases, are also seen as crucial players in addressing climate change<sup>47</sup>. Industrial production, especially in areas like manufacturing, energy, and transportation, can negatively impact the environment.

To effectively ensure sustainability and reduce their environmental impact, businesses and corporations must adopt a comprehensive and strategic approach that integrates sustainable practices into every aspect of their operations. It is vital for businesses to **conduct environmental**

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explains-onboard-carbon-capture-and-storage/.

<sup>45</sup> Dwivedi, Yogesh K., et al. "Climate Change and COP26: Are Digital Technologies and Information Management Part of the Problem or the Solution? An Editorial Reflection and Call to Action." *International Journal of Information Management*, vol. 63, 2022, article 102456. ISSN 0268-4012,

<sup>46</sup> Negrete-Cardoso, M., G. Rosano-Ortega, E. L. Álvarez-Aros, et al. "Circular Economy Strategy and Waste Management: A Bibliometric Analysis in Its Contribution to Sustainable Development, Toward a Post-COVID-19 Era." *Environmental Science and Pollution Research*, vol. 29, 2022, pp. 61729–61746.

<sup>47</sup> Wright, Christopher, and Daniel Nyberg. "Corporations and Climate Change: An Overview." *Wiley Interdisciplinary Reviews: Climate Change*, 19 Sep. 2024, <https://doi.org/10.1002/wcc.919>.



**impact assessments**, which enables companies to identify the specific environmental impacts of their operations, products, and services. By recognizing and analyzing their environmental footprint, businesses can minimize negative effects and enhance resource efficiency. Mitigating environmental impact frequently requires the adoption of sustainable production techniques and technologies.

Sustainability in business involves a company's strategies and actions aimed at minimizing negative environmental and social impacts stemming from its operations in a specific market. Typically, an organization's sustainability efforts are assessed using environmental, social, and governance (ESG) metrics.<sup>48</sup>

Businesses also need to implement **waste management strategies**; by focusing on circular economy principles, businesses can reduce waste and maximize resource efficiency. This involves adopting product designs that emphasize durability, repairability, and recyclability, as well as implementing responsible practices for disposal.

Businesses should invest in **sustainable supply chain management** by partnering with suppliers who demonstrate a commitment to environmental responsibility. This can involve conducting audits to evaluate suppliers' practices, requiring sustainability certifications, and fostering relationships with local businesses that prioritize sustainable methods. By choosing eco-friendly materials and promoting fair labour practices, companies can not only reduce their ecological footprint but also enhance their brand reputation and appeal to environmentally conscious consumers.

**Incorporating circular economy principles** is another effective strategy. Businesses should design products with longevity and recyclability in mind, encouraging a shift from traditional linear models of consumption to systems where resources are reused and recycled. Initiatives such as product take-back programs and repair services can help keep materials in circulation, thus reducing waste and resource extraction. Investing in renewable energy sources is also crucial for corporations aiming to minimize their environmental impact.

Businesses could also **collaborate** with external partners, including governments, NGOs, and industry groups, which can enhance a company's sustainability initiatives. Public-private partnerships can facilitate the development of innovative solutions to pressing environmental challenges, such as climate change and resource depletion. By implementing these practices, organizations can contribute to environmental preservation while enhancing competitiveness in the market.

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<sup>48</sup> "Business Sustainability." *IBM*, [www.ibm.com/topics/business-sustainability](http://www.ibm.com/topics/business-sustainability).

**Corporate Social Responsibility (CSR)** involves companies incorporating social concerns into their business operations, aiming to benefit both society and their stakeholders. It's all about businesses taking responsibility for their impact on social, environmental, and economic aspects. In India, Corporate Social Responsibility (CSR) is regulated by Section 135 of the Companies Act, 2013, supplemented by Schedule VII of the Act and the Companies (CSR Policy) Rules, 2014<sup>49</sup>.

In India, an increasing number of companies from traditional industries to tech giants are leading the way in integrating sustainability into their business model, but through their business operation, production process, supply chain and consumption they affect the environment. So, some of the corporations and business adopt sustainable practices such as reducing energy consumption, minimizing waste, promoting circular economy principles, and utilizing renewable energy sources, businesses can significantly lower their environmental impact. This not only enhances their brand reputation but also improves operational efficiency<sup>50</sup>.

### **Conclusion**

Sustainability is crucial in combating climate change because it ensures that economic growth does not come at the cost of environmental degradation. The challenges due to climate change include resource scarcity, increased natural disasters, and socio-economic disparities. The judiciary in India has played a pivotal role in addressing these impacts by enforcing environmental laws, issuing landmark rulings, and promoting climate justice. Emerging technologies like renewable energy, carbon capture, and energy efficiency improvements, supported by robust policy frameworks like the National Action Plan on Climate Change (NAPCC), have been effective in reducing greenhouse gas emissions in India's energy and industrial sectors. Businesses can ensure sustainability by adopting practices such as reducing energy consumption, minimizing waste, promoting circular economy principles, and utilizing renewable energy sources. Integrating these practices into business models and governance structures helps mitigate environmental risks and contributes to a resilient, low-carbon economy.

This proves the hypothesis that, there is an immediate need for climate change reforms to prevent further environmental degradation and promote sustainability, as natural resources are rapidly depleting and natural calamities are occurring frequently.

Thus, comprehensive strategy to effectively combat climate change and ensure long-term environmental sustainability in India involves a collaboration of technological advancements, legal frameworks, and policy initiatives.

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<sup>49</sup> The Companies Act, 2013. Government of India, 2013, [www.mca.gov.in/MinistryV2/companiesact.html](http://www.mca.gov.in/MinistryV2/companiesact.html).

<sup>50</sup> Rizwan, Mirza. "Corporate Sustainability Practices in India: A Review and Analysis." *The Review of Contemporary Scientific and Academic Studies*, vol. 4, 2 May 2024, <https://doi.org/10.55454/rcsas.4.05.2024.002>.