



INDIA'S ROADMAP ON CLIMATE CHANGE AND GLOBAL WARMING – AN OVERVIEW

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Abstract

Climate change is a major global issue that requires the collective effort of all nations to mitigate its impacts. India, as one of the fastest-growing economies in the world, is no exception. The present study examines India's roadmap on climate change and global warming, using qualitative research methods. The study finds that India has made significant progress in its efforts to mitigate and adapt to the impacts of climate change. However, there are still several challenges that need to be addressed, such as increasing public awareness and participation, improving the implementation of policies and programs, and enhancing international cooperation. The study concludes with recommendations for future research and policy interventions to tackle the challenges of climate change in India.

Keywords: Climate change, global warming, India, emissions reduction, renewable energy, targets.

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1. INTRODUCTION

Nowadays the whole world is suffering by unseasoned raining, Famine, wildfires, Whaler etc. Level of Green house gasses in the surface are increasing year by year. India is the third largest greenhouse gasses emitter in the world that is 2.65 GT (gigatons) of CO₂ equivalent, China emitting 10.06 GT which is in first place, and America got second place with producing 5.41GT.

In this scenario future years are very difficult for human life and Economy of the nation also. 10.23 million Deaths were recorded in India in 2021. 2.4 million Pollution related deaths were caused in India in 2019 which is highest in the world. The climate of India consists of a wide range of weather conditions across a vast geographic scale and varied topography. Based on the Köppen system, India hosts six major climatic sub types, ranging from arid deserts in the west, alpine tundra and glaciers in the north, and humid tropical regions supporting rain forests in the southwest and the island territories. Over industrialization leads a big role in climate change. Developed and developing countries are contributing very high for it. Here, we should not forget India and its role in climate change. Because it is the 5th largest economy, 3rd largest greenhouse gas producing country, 7th largest geographic country and even India has the 2nd largest population in the world and most importantly India is the host country of G20 nations in the year of 2023. With all these aspects, India's plans towards control the global warming will take significant place in global level. Climate change is the highly discussing topic worldwide, India's Prime Minister expressed the future plans of India towards reducing the climate change and global warming in CoP26 (CoP-Conference of Parties).

According to United Nations, Climate change refers to long-term shifts in

temperatures and weather patterns. These shifts may be natural, such as through variations in the solar cycle. But since the 1800s, human activities have been the main driver of climate change, primarily due to burning fossil fuels like coal, oil and gas.

Global warming is the long-term warming of the planet's overall temperature. Though this warming trend has been going on for a long time, its pace has significantly increased in the last hundred years due to the burning of fossil fuels. As the human population has increased, so has the volume of fossil fuels burned. Fossil fuels include coal, oil, and natural gas, and burning them causes what is known as the "greenhouse effect" in Earth's atmosphere. In this article we will discuss about the roadmap prepared by the India against climate change and global warming. Find out the actions taken by Indian government and analyse the probability of achieving them as targets are the main objectives of this article. it uses the secondary data such as research articles, news papers, reports, internet sources etc.

Literature Review

The literature review examines the key policy documents and reports on climate change and global warming in India, to provide a comprehensive understanding of India's roadmap on climate change. The review highlights the major policies and programs implemented by the Indian government to address climate change, including the National Action Plan on Climate Change (NAPCC), which was launched in 2008. The NAPCC comprises eight national missions, covering various aspects of climate change, such as solar energy, sustainable habitat, and water. The review also highlights the key challenges that India faces in addressing climate change, such as increasing energy demand, limited access to finance and technology, and weak institutional capacity.

Varun Rai and David G. Victo (2010) tried to find Viable Options in Developing

Countries for Climate Change Mitigation. The fleet of coal-fired power plants in India is also an excellent candidate for policies that harmonise the national interests of India with the effort to slow the rise of CO₂ emission on a worldwide scale. Like before, India continues to boost its energy supply with cheap and plentiful coal in order to support sustained economic growth. However, physical obstacles (poor technology, freight issues, and environmental clearance) and commercial inefficiencies (pricing distortions) in coal extraction have increased the gaps in India's coal supply chain. As a result, India's coal imports have increased dramatically over the past several years, and by 2030, India will probably be importing a lot more coal. India is very interested in using coal more effectively since it is aware of how vulnerable its coal situation is. Since coal-based power generation in India accounts for more than two-thirds of the country's coal usage, those changes must begin there. Although India has started programmes to introduce more effective supercritical coal units, technology has proven to be a significant barrier. A crucial component of such a programme will be developed nations providing India with the appropriate technological and financial assistance when needed. A bilateral or multilateral international agreement may include the specifics of the technological and financial support package. In the next two to three decades, advanced technologies that are also very expensive, such carbon capture and storage, fuel cells, and solar photovoltaic (PV), won't have much of an impact on climate change in developing nations. India must support domestic demonstration projects and take part in global research initiatives. However, as a realistic response by India, that should be a component of a long-term innovation plan (backed with domestic institutional continuity). The battle against climate change will be dominated by new technologies; US, EU, and Japan.

P. Kumar Mehta (2010) reviewed Sustainable Cements and Concrete for the Climate Change Era. The study concluded that, the window of opportunity to prevent a catastrophe is only about 30 years, according to the Intergovernmental Panel on Climate Change conclusions, which have lately been verified by other scientific institutions, including the United States National Oceanic and Atmospheric Administration. If dramatic reductions in global CO₂ emissions are not achieved immediately, there will unavoidably be catastrophic and permanent climate disruption. The developed and fast developing nations of the globe have not taken this warning seriously since they continue to forecast rapid growth rates for the industries that produce energy and minerals. The study believes it is fairly clear that the carbon-intensive sectors of the global economy cannot achieve both the goal—a significant decrease in CO₂ emissions—and a rapid development rate of the energy and material-producing industries at the same time. technologies already in use that are already to blame for extraordinarily high CO₂ levels in the atmosphere. Instead, we should put our attention on tested technologies that will satisfy basic human requirements while also enabling a sustained contraction, not expansion, of the carbon-intensive industries.

William J. Sydeman et al (2012) studied Seabirds and climate change. Seabirds are adapting to climate change on a global scale, and their responses can help us understand how it affects marine ecosystems. Our interpretations, however, are constrained. Because seabird data sets are still too short in duration to distinguish between the effects of natural inter-decadal variability and those of human-induced climate change, despite having some of the best (long-term and comprehensive) biological time series in the marine domain. Therefore, even in times of

financial constraints, it is essential to preserve and possibly improve current long-term research and monitoring programmes. These programmes are crucial to create the time series needed to draw conclusive conclusions about seabirds and human-caused global warming. Our future plan also calls for improving mechanistic hypotheses and analysing seabird-climate connections in a predictive context. Third, physical oceanography and ecosystem research will serve as the foundation for seabird climate change ecology given the requirement for a global evaluation and a better understanding of mechanisms affecting primary productivity and food webs. We see Nutrient-Phytoplankton-Zooplankton (NPZ) models, Regional Ocean Modelling System [ROMS], and individual-based population dynamics models of seabirds are being integrated as a successful strategy.

Abhisekh gupta and Akshoy Paul (2019) studied carbon capture sequestration potential in India. One of the principal greenhouse gases (GHGs) causing global warming and driving climate change is carbon dioxide (CO₂). The burning of fossil fuels is the main cause of the rise in atmospheric CO₂ concentrations. Anthropogenic CO₂ emissions will continue to contribute in the past and the future to Global warming and sea level rise have serious consequences. Developing nations are particularly vulnerable because they have infrastructure that is most vulnerable to extreme weather, and it is anticipated that rapid biodiversity loss will impact their food security, access to clean water, and health. India is a developing nation that perfectly exemplifies the nature of the difficulty involved in growing its economy while simultaneously halting potentially severe global climate change. India is the world's third-largest coal producer, with the fifth-largest coal reserves and around 0.5% of the world's oil and gas reserves. Thermal power plants

account for 66% of India's electricity producing capacity as of 2018. About 85% of the nation's thermal electricity is produced by coal. Utilising India being the fourth greatest CO₂ emitter in the world, it is crucial to understand the country's current emissions and potential future trends. India has a significant opportunity to raise its emissions due to its early economic development, low per-capita emissions, and enormous population. Energy-related CO₂ emissions in India are the fourth highest in the world and are increasing. With the use of carbon capture and sequestration (CCS) technology, waste CO₂ is collected from major point sources, such as fossil fuel power stations, transported to a storage location, and then dumped somewhere it won't enter the atmosphere, typically in subterranean geological formations. The objective is to stop the release of huge amounts of fossil fuel use in the production of electricity and other industries releases CO₂ into the atmosphere. For coal-rich nations like India, CCS is viewed as an essential climate protection technology with the ability to significantly reduce CO₂ emissions in comparison to any other available technology. It has been demonstrated that CCS can substantially lower the CO₂ footprint. The function of CCS goes well beyond that of a "clean coal technology." The last 20 years of experience have demonstrated the variety of CCS applications. There are early deployment prospects for CCS, but they need to be developed. Long-term dedication and consistency in policy frameworks are essential. In the foreseeable future, targeted policies that offer financial incentives for investment will be crucial. Future availability of CCS is dependent on current R&D spending and deployment. For more new projects to become operational in 2020 and beyond, a larger project lineup is required. Governments need to take action to develop markets for low-CO₂ clean

products. Engagement of the community and public knowledge of CCS is must.

Objectives

- To find out the actions taken by India against Climate change and Global warming.
- To study the future plans of India to control climate change and Global warming.
- To analyse the probability of target achieving against climate change and global warming in India.

2. Methodology

This study uses secondary data sources, including reports from the United Nations Framework Convention on Climate Change (UNFCCC), the World Bank, the International Energy Agency (IEA), and the Indian government. The data is analyzed using statistical methods (percentage analysis) to evaluate India's progress towards its climate change goals.

History of climate change in India

Since the Industrial Revolution, the global climate has been warming, and this is also true for India. Between 1901 and 2018, India's average annual temperature increased by around 0.7 degrees Celsius, with the largest warming seen in the winter and post-monsoon season. While these temperature changes may not sound very large, they have had some profound impacts on the country. Heat waves have become more common. In fact, 11 of the 15 warmest years on record in India have occurred since 2004 and New Delhi has broken its all-time temperature record with a high of 48 degrees Celsius. The number of Indians exposed to heat waves increased 200% between 2010 and 2016. Heat waves impact the productivity of workers, agricultural output, and ecosystems. They can also cause severe human health impacts and even death. This change in temperature has also impacted the monsoons. Continuous rainfall during the

monsoon season has been typical for parts of India, and the monsoon rains are a lifeline for much of the population whose livelihoods are dependent on rain-fed agriculture. However, in recent years the monsoons have brought less average rainfall to much of the country, and particularly in the central and northern areas. This has led to water shortages and droughts. While there have been fewer rainy days overall, there has been an increase in extreme rainfall events across the country, which has resulted in damaging and dangerous floods. A small increase in rain over the Thar Desert has also disrupted the fragile ecosystems there. Overall, India has experienced more extreme events in recent years compared to historical periods. In the 35 years between 1970 and 2005, India recorded 250 extreme events such as droughts, floods and cyclones. However, in just 15 years between 2005 and 2020, there were 310 extreme events recorded. In 2018-19 alone, 2,400 lives were lost as a result ^[10].

India's actions on climate change and Analysis:

India is the leading country at taking actions on climate change and global warming. India has prepared roadmap and action plan to reduce the carbon in surface and India has series of targets regarding it. India's role is most important in reducing carbon because it is one of the top countries emitting Greenhouse gasses. According to outlookindia report (11,Nov-2022), India emitted 2.7 billion tonnes of carbon in 2021 (it was 0.39 metric tons in 1970). It is the 7.5% of the global share. India has 28 states and every state has government, while renewable energy sector is contemporary issue in India, state government's commitments also matter. Regarding this many state governments are taking necessary actions to reduce CO₂ emission.

This article is mainly focussing on central government's actions on climate change and global warming.

National Action Plan on Climate Change (NAPCC) launched by the Government of India on 30th June, 2008 outlining eight National Missions on climate change. These include:

1. National Solar Mission
2. National Mission for Enhanced Energy Efficiency
3. National Mission on Sustainable Habitat
4. National Water Mission
5. National Mission for Sustaining the Himalayan Eco-system
6. National Mission for a Green India
7. National Mission for Sustainable Agriculture
8. National Mission on Strategic Knowledge for Climate Change.

The National Action Plan on Climate Change (NAPCC) launched by the Government of India on 30th June, 2008, outlines eight national missions to address the challenges posed by climate change. These missions aim to reduce greenhouse gas emissions, enhance adaptive capacity, and achieve sustainable development.

Here is a brief overview of each mission and its progress:

National Solar Mission: The mission aims to achieve 20,000 MW of solar power capacity by 2022. As of March 2021, India's installed solar power capacity was around 41 GW, which is almost double the target set under the mission.

National Mission for Enhanced Energy Efficiency: The mission aims to reduce energy intensity by 20% by 2020. As of 2019, India has achieved a 17.83% reduction in energy intensity.

National Mission on Sustainable Habitat: The mission aims to promote sustainable and eco-friendly urban development. There is no official information available on the progress of this mission.

National Water Mission: The mission aims to conserve water, minimize wastage, and ensure equitable distribution. The mission has achieved significant progress in terms of water conservation and management.

National Mission for Sustaining the Himalayan Eco-system: The mission aims to promote sustainable development in the Himalayan region. The progress of this mission is not clear.

National Mission for a Green India: The mission aims to increase forest and tree cover by 5 million hectares and improve ecosystem services. The mission has made significant progress, and the country's forest and tree cover has increased by 15,000 sq km over the last two years.

National Mission for Sustainable Agriculture: The mission aims to increase the resilience of agriculture to climate change. There is no official information available on the progress of this mission.

National Mission on Strategic Knowledge for Climate Change: The mission aims to build a knowledge base on climate change and promote research in this area. The mission has achieved significant progress in terms of knowledge creation and dissemination.

Overall, the progress of each mission varies, and there is a need for continuous efforts to achieve the targets set under the NAPCC. However, it is important to note that these missions have helped India make significant progress in addressing the challenges posed by climate change.

India has known that, reduction of the Greenhouse gases emission will be the only way against the global warming and climate change especially in energy sector. Because, energy sector emitting 68.7% of GHGs in India as the chart shows below. And 19.60% by Agricultural sector, 6.0% by Industrial processes, 3.80% by Land change and Forestry and 1.90% of GHGs emitting by Wastes. ^[12]

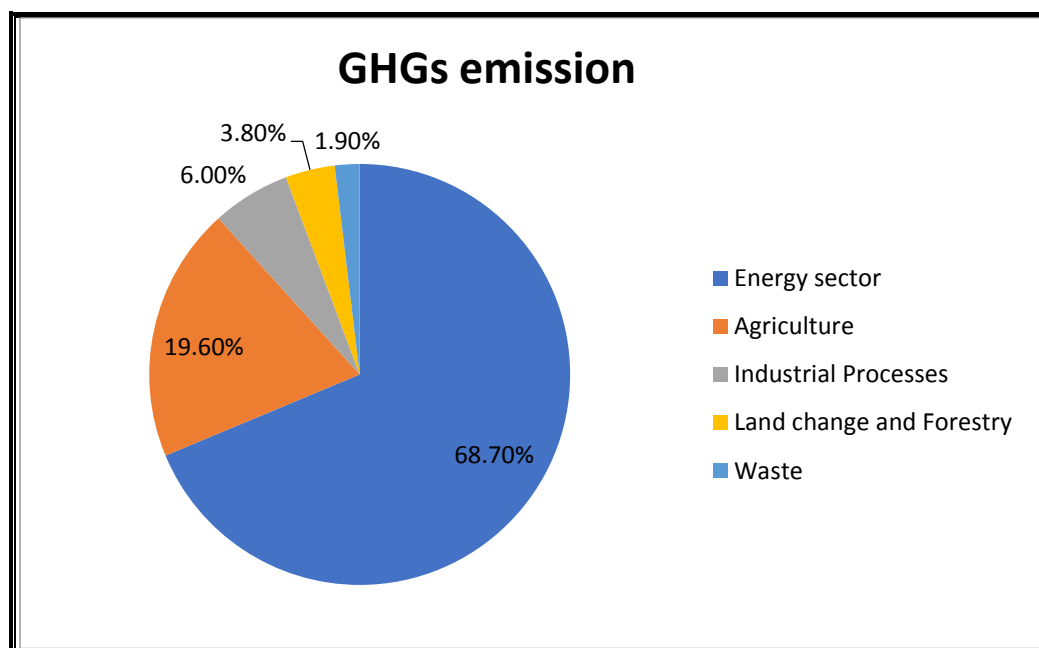


Chart showing sector wise greenhouse gasses (GHGs) production in India as per Jan-2019 reports (www.climatelinks.org).

Major plans and actions taken by India on climate change are relating to energy sector as mentioned above. It is very essential to reduce CO₂ in the atmosphere.

By 2030, India has to meet half of its energy requirements from renewable energy sources. So would expand its renewable, hydro electric and nuclear power to 500 GW (gigawatts). India's renewable energy capacity reaches 168.96 GW till Feb-2023 out of 412.21 GW of power generating by India as on Feb 28, 2023.

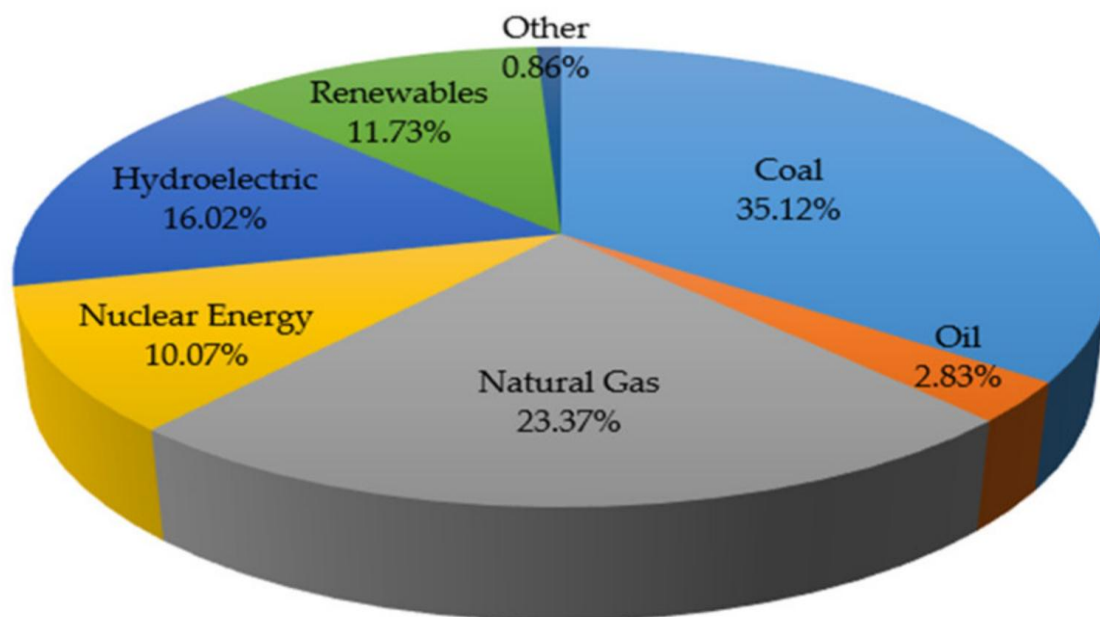
To meet 500 GW of Renewable energy productions, India is implementing many schemes by the Ministry of new and renewable energy. Such as Solar Parks Scheme, PM-KUSUM Scheme, Solar

Rooftop, Off-Grid Solar, Green Energy Corridor, Wind Energy, Bio-energy, Production Linked Incentive (PLI) Scheme, Solarisation of sun-temple and town of Modhera, Gujarat, Human Resource Development, National Green Hydrogen Mission, International Solar Alliance.

Power Generation

Industries, homes, and vehicles in all aspects the whole world is mostly depending on electricity. People can't live without electricity even a day normally.

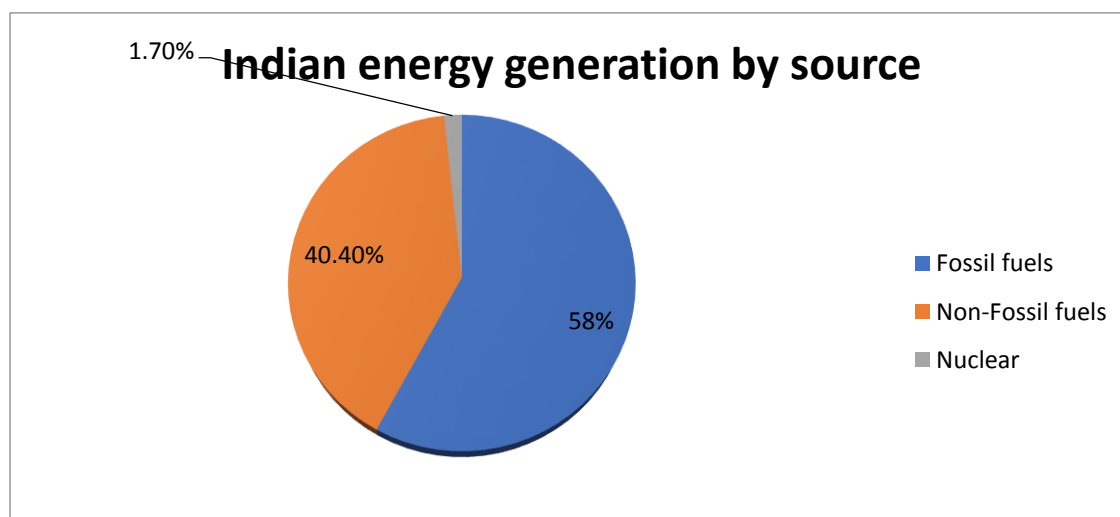
To fulfil the electricity demand, using many resources to generate electricity such as coal, oil, natural gas, nuclear energy, hydroelectric, renewable and others. Here the below chart shows that percentage of electricity generating by various resources.



Source: Khriydel Rhea M. Supapo et al
 As this chart shows that only 27.75% power is generating from clean energy including Hydro electric power. In this scenario we can't reduce global warming. We need to transform this into 100% of power generation to clean energy. Every country should take actions to generate clean energy only.

India in power sector

In India, sources of energy generation are classified into three types such as Fossil fuels, Non-Fossil fuels (Renewable) and Nuclear by Oct, 2022.



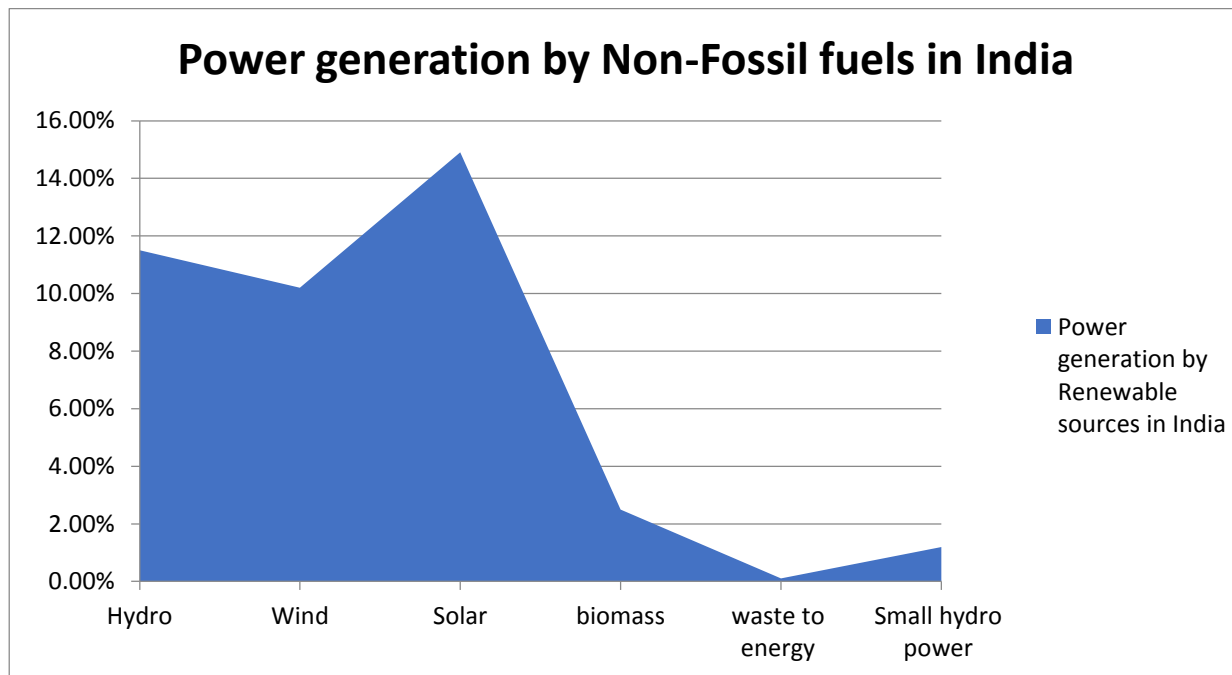
Above chart shows, power generation by sources in India. According to Power ministry of India 58% of energy is generating from Fossil fuels, 40.40% of

energy is generating from Non-Fossil fuels (Renewable) and 1.70% is generating from Nuclear.

According to world-nuclear.org (Oct,2022), Worldwide emissions of carbon dioxide (CO₂) from burning fossil fuels total about 34 billion tonnes (Gt) per year. About 45% of this is from coal, about 35% from oil and about 20% from gas. Over 40% of energy-related carbon

dioxide (CO₂) emissions are due to the burning of fossil fuels for electricity generation.

If we focus on energy generation by renewable sources in India, that is 40.40% from all types of renewable energy sources as per government data.



Above chart shows, power generation by source of renewable energy by Oct, 2022. 11.5% power is generating from Hydro, 10.2% from Wind, 14.9% from Solar, 2.5% from Biomass, 0.1% from Wastes and 1.2% from Small hydro power.

India has the largest 7th geographical area in the world. It has lot of opportunities to become a leading country at power generation by Renewable sources and it can convert it into business opportunities.

Indian government need to promote people who are interested in renewable energy business with providing subsidies and incentives.

India is becoming a big start-up hub in the world. Govt and people must grab this opportunity and develop the business models on power generation from renewable sources.

5paisa.com(2022), India ranks 4th in the list of power consumers and producers in Asia-Pacific. While India ranks 4th in

wind power, it ranks 5th in solar power and renewable power. With an installed capacity of 382.15 GW (Giga watt) (as of April 2021), the Indian power sector is a major contributor to the country's growth. Also, by allotting US\$90 billion between 2010 and 2019, India has grabbed the sixth position in the list of countries making significant investments in clean energy.

As per the objectives- actions taken , future plans and probability of target achieving against climate change and global warming in India the country reshuffle its energy mix to meet its needs by 2030.

In terms of the climate catastrophe, India's pledge to reach Net Zero emissions by 2070 is equivalent to doing more than merely talking the talk. Indian Prime Minister Narendra Modi announced a five-step plan, known as the panchamrita, at the 26th Conference of Parties (CoP26), to

accomplish this. These five ideas consist of:

- By 2030, India's non-fossil energy capacity will reach 500 GW.
- By 2030, India will use renewable energy to meet 50% of its energy needs.
- From now until 2030, India will cut its entire estimated carbon emissions by one billion tonnes.
- India will cut its economy's carbon intensity by less than 45% by 2030.
- Therefore, India will reach the goal Net Zero by 2070.

The country's energy mix for 2030 has been forecast by India's Central Electricity Authority (CEA). This states that India's installed capacity of non-fossil energy for power generation, including solar, wind, hydroelectric, and nuclear, was 134 GW in 2019, and that it will increase to 522 GW by 2030. This will require wind energy to reach 140 GW and solar energy installed capacity of 280 GW. This predicts that by 2030, there will be 817 GW of installed capacity overall, producing 2,518 billion units of electricity.

S.No	Item	Generation (Billion Units)	% of generation	Installed capacity (GW)	% of installed capacity	Generation (Billion Units)	% of generation	Generation (Billion Units)	% of generation
		2019	2019	2030	2030	2030		2030	
1	Coal and gas	228	63	1,072	80	282	36	1,393	56
2	Hydro	45	12.5	139	10.1*	61	7.5	206	8
3	Renewable	82.5	22.7	126	9.2	455	54.5	805	32
4	Nuclear	6.7	1.9	378	2.7	19	2.3	113	5
Total		362		1376		817		2,518	

Source: Central Electricity Authority

The CEA estimates that India generated 9.2% of its power from renewable sources in 2019. With the capacity of renewable energy rising to 102 GW by 2021, the generation had climbed to about 12%, which indicates we must raise this to reach the aim of 50% power generation by 2030. India's predicted 2030 power demand is 2,518 BU, and if we aim to supply 50% of that demand with renewable energy, installed capacity will need to rise from the original 450 GW to 700 GW. We will need to boost new renewable capacity to 630 GW if hydroelectricity is included in renewables as it is globally. You can surely accomplish this.

India's aim and energy strategy for 2030 also suggest that India will limit its use of

coal-based energy; at the moment, about 60 GW of coal thermal power is being built or planned. India currently emits 2.88 Gt of CO₂ per year (2021). According to predictions made by the Centre for Science and Environment (CSE) based on the median yearly rate of development over the past ten years, 2010-2019, India's generation in 2030 will be 4.48 Gt.

This goal calls for India to reduce its carbon emissions by 1 billion tonnes (1 Gt), which will reduce our emissions in 2030. In future, Energy industry provides more jobs and it will contribute for the GDP.

Scrapping policy

The Indian Prime Minister unveiled the 2021 auto scrappage program in Gujarat at

an investor summit. The implementation of the automobile scrappage policy is anticipated to mark a significant turning point in our nation's development. The nation's automotive and manufacturing sectors are intended to receive a much-needed boost from the Nitin Gadkari automobile scrappage strategy. The 2021 vehicle scrappage policy will assist in identifying automobiles that are unfit for use on public roads. As the name implies, under the new scrappage policy, outdated and unfit automobiles that pollute the environment and do other harm will be destroyed. As soon as the car registration period is over, the vehicle junk policy will start. The car will go through a fitness test after a predetermined amount of time. A car is only regarded as suitable for 15 years, according to national motor vehicle laws. When a car is above 15 years old, it starts to pollute the environment more than a brand-new car. When commercial and passenger vehicles older than 15 and 20 years, respectively, fail the fitness test, they will be scrapped.

Ethanol mix to petrol

On Monday, February 6, 2023, 20% ethanol-blended gasoline went on sale at a few select gas stations in 11 states and the union territories as part of a campaign to increase the use of biofuels to reduce emissions and reliance on currency-depleting imports. Currently, 10% ethanol is blended into gasoline (90% gasoline, 10% ethanol), and by 2025, the government wants to quadruple this amount. 15 cities will be covered in the initial phase, and over the following two years, coverage will be extended nationwide. In addition to helping farmers, India saved up to \$53,894 crore in foreign exchange expenses by blending 10% of its crop.

Hydrogen vehicles

One of the largest emerging auto markets, Toyota Kirloskar Motor, has announced a project to bring India's first hydrogen-

powered fuel cell electric car to the market. The goal is to hasten the country's transition to clean transportation. Toyota will explore the fuel cell electric car Mirai for Indian roads and climatic conditions with the government's testing organization International Centre for Automotive Technology. Utilizing biomass that is widely available and renewable energy sources, green hydrogen can be produced. India will need to adopt technology to fully realize the potential of green hydrogen if it is to have a clean and inexpensive energy future.

3. Results

The findings suggest that India has taken significant actions to reduce its carbon footprint, including the implementation of policies to promote renewable energy and energy efficiency. The study also finds that India is committed to meeting its climate change targets, as reflected in its INDCs and NAPCC. However, the study reveals that there is a need for further action and implementation of policies to achieve the set targets.

4. Discussion

The study's key findings and implications are discussed, along with its limitations and recommendations for future research. The study's implications for policy and practice are also highlighted.

References

A list of references cited in the article, formatted according to the journal's guidelines.

5. Discussion and Conclusion

Improvement of renewable energy sector is the major solution for climate change and global warming. Regarding this Indian government is very humble to become Clean India with Make in India.

This study provides an overview analysis of India's roadmap on climate change and global warming, highlighting the progress made so far and the challenges that remain. The findings suggest that while India has taken significant steps to address climate change, there is still a need for increased public awareness and participation, better implementation of policies and programs, and enhanced international cooperation. The results of the survey indicate a low level of awareness and knowledge about climate change among the Indian public, but also a high level of support for policy interventions to address this challenge.

In conclusion, this study recommends that future research and policy interventions focus on increasing public awareness and education about climate change, promoting sustainable development and renewable energy, improving implementation of policies and programs, and enhancing international cooperation. The results of this study have important implications for policymakers, researchers, and civil society.

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