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India's Renewable Energy Policies: Progress, Challenges, and their Role in Achieving Sustainability Goals

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ABSTRACT: India, as a rapidly growing economy, faces the challenge of balancing development with environmental sustainability. This paper examines India's renewable energy policies, their impact, and the obstacles in achieving sustainability. The government has actively promoted renewable energy through initiatives like the National Solar Mission and Wind Energy Policy, positioning India as a global leader in renewable capacity expansion. However, challenges persist, including the intermittent nature of renewables, requiring significant investments in grid infrastructure and energy storage. Financial constraints, grid integration issues, and a lack of skilled professionals further hinder progress. Additionally, land acquisition and environmental concerns add complexity to renewable energy deployment. This study assesses how India's policies have helped reduce carbon emissions, improve energy access, and support economic growth while identifying key challenges to full sustainability. The analysis highlights the need for a comprehensive strategy involving policy reforms, technological advancements, financial incentives, and global cooperation. Despite significant progress, overcoming barriers will require continuous policy evolution, increased R&D investment, and collaborative efforts. India's commitment to renewable energy reflects its vision for a cleaner future but also underscores the necessity of innovation and partnerships to achieve long-term environmental and energy goals.

KEYWORDS: India, Renewable Energy, Financial Barriers, Climate Action, Investment & Innovation, Decarbonization, Green Energy Transition, Carbon Emission Reduction, Energy Storage Solutions, Sustainable Development Goals

I. INTRODUCTION

India has invested ₹1.97 lakh crores in renewable energy over the past five years, including ₹4,500 crores for high-efficiency PV solar modules. The shift to renewables began in the 1990s to meet energy demands, reduce fossil fuel dependence, and combat climate change. The 2008 National Action Plan on Climate Change (NAPCC) set clear renewable energy targets, leading to initiatives like the 2010 Jawaharlal Nehru National Solar Mission, which raised its solar power goal from 20,000 MW to 100,000 MW—successfully achieved by 2022. India also launched the National Wind Energy Mission and made scientific advancements like the Aditya-L1 mission for solar research.

India has launched key initiatives like the National Wind Energy Mission and the National Bio-Energy Mission to expand wind energy and promote biofuels. The 2023 budget allocated ₹10,222 crores to clean energy, a 48% increase from the previous year. While solar and wind energy have seen significant growth, sustained policy support and innovation are needed for a fully clean energy future.

II. REVIEW OF LITERATURE

Vipin Jain (2022) The study highlights the economic benefits of renewable energy sources like hydropower, solar, wind, geothermal, and biomass. In Asian economies, renewable energy reduces CO₂ emissions while supporting economic growth. By replacing outdated power sources, renewables meet rising energy demands while minimizing

environmental risks. This transition enables economies to focus on growth without increasing their carbon footprint and supports the achievement of Sustainable Development Goals (SDGs).

Sanjeevikumar Padmanaban (2020) stated in his research that the energy crisis, rising energy prices, and global warming have sparked interest globally. To address the needs of its 1.36 billion people and growing, India has set a goal to achieve 175 GW of electricity from renewable sources by 2022.

Subhashish Dey (2022) The Indian government plans to develop "green cities" powered by renewable energy in each state. However, in emerging economies, technological advancements often prioritize economic sustainability over environmental recovery, reducing reliance on renewable energy. Studies suggest that energy consumption in both developed and emerging economies is influenced by technological innovation and environmental policies.

Chiestina Kennedy (2020) Directing renewable energy projects to redeveloped areas with low conflict risk can help India achieve clean energy goals while preserving food security, forests, and biodiversity. Analysis suggests that India's wind and solar needs can be met without significantly impacting agriculture or conservation. Proactive landscape planning and financial incentives are essential to prevent land scarcity issues. Converted lands could generate over ten times the 2022 renewable energy target, but sustainable siting measures are necessary for long-term success.

Ivory (2021) India has been a pioneer in renewable energy, establishing a dedicated ministry in the 1980s. The Ministry of New and Renewable Energy (MNRE) oversees the sector, setting ambitious targets to expand capacity. By 2022, India aimed to more than double its wind power potential and increase solar energy deployment nearly fifteenfold from 2016 levels. By April 2016, the country's total grid-connected renewable energy capacity had surpassed large-scale hydroelectric power.

Mohammed Abdul Majid (2020) To advance renewable energy, the nation should attract private investment, enhance R&D to improve infrastructure and technology, and increase government funding for innovation. Additionally, institutions must address the shortage of skilled workers by providing training for operating and maintaining renewable energy systems.

Abhishek Kumar (2022) India's wind power sector, despite early growth, has faced slower-than-expected expansion. To accelerate progress, the government must address key challenges such as land acquisition, DISCOM financial stability, and policy parity with solar energy. Strategies include location-based auctions, repowering aging wind turbines, upgrading transmission infrastructure, and enhancing grid stability. A focused approach on wind energy or a balanced strategy with solar will be crucial for sectoral growth.

Dhitashree Guha (2022) India's energy landscape is highly diverse, with a wide range of energy sources enabling large-scale power generation. However, decades of heavy reliance on fossil fuels have had a significant impact on both the environment and the economy. As a result, the transition to renewable energy has become essential to ensure sustainability and reduce environmental damage.

Michael Kwenejo (2023) Many developing and underdeveloped countries struggle with inadequate power supply, relying heavily on coal and natural gas, which contribute to pollution, global warming, and health risks. In contrast, developed nations like Germany, the UK, and the USA have made progress in reducing carbon emissions. To address these challenges, transitioning to a sustainable energy mix is essential. Renewable sources such as solar, wind, hydro, biomass, tidal, and geothermal, along with nuclear energy, remain underutilized and should be integrated into power generation. Research highlights hydropower as the most widely used renewable source, followed by solar, wind, and biomass.

Naveen Kumar (2022) Ensuring access to clean and modern energy is a crucial goal in the 2030 Agenda for Sustainable Development Goals (SDGs), as it plays a vital role in alleviating poverty, eliminating hunger, enhancing education, improving healthcare, increasing water supply, supporting industrialization, and addressing climate change. With resources depleting rapidly, the future faces the risk of an "energy crisis" for upcoming generations. To prevent this, there is a pressing need to accelerate the transition toward decarbonized energy generation and shift toward a green and sustainable economy.

Objectives

1. To analyze India's renewable energy policies in achieving sustainability through policy impact, investment, and technology.
2. To identify key challenges hindering the growth of renewable energy in India.
3. To compare India's renewable energy policies with those of other countries (such as China and Japan)

III. RESEARCH METHODOLOGY

The research gap in India's renewable energy policies includes several key areas: assessing policy effectiveness in achieving sustainability goals, evaluating their impact on technological advancements, and determining their economic viability. It also involves analyzing environmental effects, social acceptance, regulatory challenges, and international comparisons to identify best practices. Future prospects for the renewable energy sector can be forecasted based on current policies.

Potential research topics include evaluating policy effectiveness in promoting renewable energy and reducing emissions, assessing their alignment with Sustainable Development Goals (SDGs), and identifying policy gaps. The economic impact, including job creation and investment attraction, should be examined, alongside environmental benefits like pollution reduction. Technological progress, regulatory frameworks, and international comparisons can offer insights for improvement and will provide a comprehensive understanding of India's renewable energy landscape. These areas will help scholars assess the strengths and weaknesses of existing policies and their role in achieving sustainability.

Policy Evaluation and Comparison

Sustainable development seeks to balance economic growth, social equity, and environmental responsibility to meet present needs without compromising future generations. It emphasizes responsible resource use, social inclusivity, and ecological resilience, addressing global challenges like climate change, biodiversity conservation, and overall well-being for a sustainable future.

China's Approach to Sustainable Policies

China prioritizes sustainable development, integrating the 2030 Agenda with national policies and fostering international cooperation. It has eradicated extreme poverty, lifting nearly 99 million people above the poverty line by 2020, and continues to focus on rural revitalization and food security. As a global leader in renewable energy, China has reduced carbon intensity by 18.8%, with clean energy comprising 23.4% of its energy mix. Committed to the Paris Agreement, it aims to peak carbon emissions before 2030 and achieve carbon neutrality by 2060, advancing global green development.

China has strengthened public health governance and successfully managed the COVID-19 pandemic while prioritizing citizens' well-being. It expanded public health infrastructure, covering over 1.3 billion people with basic medical insurance, improving overall happiness and security. Despite global challenges, China maintained steady economic growth, with GDP rising from under 70 trillion to over 100 trillion yuan. In 2020, China's GDP grew by 2.3%, making it the only major global economy to achieve growth during that period.

China has strengthened international development cooperation, promoting peace, fairness, and sustainability while aligning the Belt and Road Initiative with the 2030 Agenda. It has supported global efforts by aiding over 160 countries during the COVID-19 pandemic, supplying materials to over 200 nations, and providing vaccines to more than 80 developing countries. Despite challenges posed by the pandemic, it continues to work with other nations to enhance implementation strategies and support developing countries, ensuring no one is left behind in achieving sustainable development goals.

Japan's Approach to Sustainable Development Policies

The COVID-19 pandemic disrupted global progress on the SDGs, creating a human security crisis that emphasized their importance for guiding social transformation. Japan's Voluntary National Review (VNR) assesses its SDG efforts and strategies to "build back better." Collaboration among stakeholders is key, and Japan has promoted sustainability through institutional frameworks like the "Japan SDGs Award." Led by the Prime Minister's SDGs Promotion

Headquarters, this initiative recognizes leading companies and organizations, fostering awareness and engagement nationwide to drive sustainable development.

Japan's Voluntary National Review (VNR) was developed through extensive collaboration, including discussions within the government and the “SDGs Promotion Roundtable,” which involved diverse stakeholders such as civil society, youth, and the public. Input from private sector evaluations provided additional insights beyond the government’s perspective. The VNR process reviewed institutional frameworks, key initiatives, and strategies for advancing the SDGs. Based on expert and public feedback, the report concludes with Japan’s future approach to SDG implementation.

Japan is dedicated to global cooperation, prioritizing human well-being to tackle health issues, achieve universal healthcare, and build an inclusive society where the Sustainable Development Goals (SDGs) are realized, ensuring no one is left behind.

India's Approach to Sustainable Development Policies

India's commitment to the SDGs is reflected in its national development agenda, Sabka Saath Sabka Vikaas (Collective Efforts for Inclusive Growth). The SDG India Index tracks progress at the subnational level, showcasing a strong localization model that ensures SDG adoption, implementation, and monitoring across States and districts.

The following discussion provides further insight into India's advancements across the SDGs.

Sashakt Bharat - Sabal Bharat (Empowered and Resilient India): India has lifted over 271 million people out of multidimensional poverty through economic growth and empowerment initiatives, improving access to nutrition, healthcare, education, sanitation, clean water, electricity, and housing, reducing inequalities among vulnerable populations.

Swachh Bharat - Swasth Bharat (Clean and Healthy India): India has achieved 100% rural sanitation and significant reductions in stunting and maternal and child mortality through the Clean India Campaign and National Nutrition Mission.

India has led global efforts against COVID-19 by providing medical aid, creating the SAARC COVID-19 Emergency Fund with an initial USD 10 million, and implementing a USD 22.5 billion domestic economic stimulus. Its response included extensive health coverage for frontline workers and direct cash transfers to support vulnerable populations.

Samagra Bharat - Saksham Bharat (Inclusive and Entrepreneurial India): India promotes social inclusion through universal access to nutrition, healthcare, education, and social protection while fostering entrepreneurship. This framework has enhanced credit, insurance, and Direct Benefit Transfers (DBT), benefiting over 200 million women and boosting economic empowerment.

Satat Bharat – Sanatan Bharat (Sustainable India): India's climate policies focus on clean energy, disaster resilience, and eco-restoration. With targets of 450GW renewable energy and restoring 26 million hectares of land by 2030, India ranks among the top in renewable, wind, and solar power. It also leads global initiatives like the Coalition for Disaster Resilient Infrastructure and the International Solar Alliance.

Sampanna Bharat - Samriddh Bharat (Prosperous and Vibrant India): India, one of the fastest-growing economies, aims for a USD 5 trillion economy by 2025. With a young population and a strong innovation ecosystem, it focuses on inclusive and sustainable growth by boosting manufacturing, infrastructure, investments, technology, and entrepreneurship.

India supports developing nations through the USD 150 million India-UN Development Partnership Fund, reinforcing its commitment to global cooperation and the 2030 Agenda. Entering the Decade of Action with confidence, India remains dedicated to working with domestic and international stakeholders to advance sustainable development.

Which Country Leads in Sustainable Policies?

The answer to this question relies on a number of individual factors and priorities. Every nation possesses both strengths and shortcomings in various facets of sustainability.

- China leads the world in the use of electric vehicles and the investment in renewable energy. It does, however, confront considerable environmental difficulties.
- Japan stands out for its technology advancements and preparedness strategies for natural disasters. However, it is criticized for its energy mix and worries about nuclear safety.
- India has made strides in the development of renewable energy sources and rural areas, but it also faces challenges with air pollution and other environmental problems.

The "best" policies ultimately rely on the situation and objectives. A thorough analysis would need to consider a number of things, such as the influence on the environment, social fairness, economic progress, and ability to adapt to new challenges. Additionally, international cooperation and ongoing policy reform are essential for attaining sustainable development on a global scale.

IV. FINDINGS

India has made remarkable progress in renewable energy policies to advance its sustainability goals. Key findings highlight:

- **Ambitious Goals:** India has set bold renewable energy targets, aiming for 175 GW by 2022 and 450 GW by 2030, showcasing its strong commitment to sustainability.
- **Solar Power Expansion:** The Solar India mission has driven significant growth in solar energy, positioning India among the world's largest solar markets.
- **Wind Energy Development:** The country has also strengthened its wind energy sector through supportive policies like the Wind Energy Mission.
- **Policy Support:** Initiatives such as the Ujwal DISCOM Assurance Yojana (UDAY) and the Renewable Purchase Obligation (RPO) require utilities to source a portion of their power from renewables, boosting market expansion.
- **Investment & Innovation:** Encouraging both domestic and foreign investments, along with fostering innovation in renewable technologies, has been a key factor in India's renewable energy success.

Despite significant progress, India faces several challenges in its transition to renewable energy:

- **Grid Integration:** Managing the intermittent nature of renewables while maintaining grid stability and a reliable power supply remains a critical challenge.
- **Land & Resource Constraints:** Limited land availability and access to raw materials can hinder the expansion of renewable infrastructure.
- **Financial Barriers:** The high upfront costs of renewable energy projects pose challenges, though government incentives help mitigate this issue.
- **Policy Implementation:** Achieving renewable energy targets depends on effective policy execution at the state level.
- **Ambitious Targets:** India's commitment to sustainability is reflected in its bold renewable energy goals.
- **Solar Energy Expansion:** Rapid growth in solar power has positioned India as a key player in the global solar market.

These insights underscore India's advancements and the challenges it must overcome to achieve its sustainable energy goals.

V. CONCLUSION

India's commitment to renewable energy is evident through ambitious initiatives like the National Solar Mission and Wind Energy Policy, positioning the country as a global leader in sustainable energy. However, India faces significant hurdles, including the intermittent nature of renewable energy, the need for grid modernization, financial constraints, and challenges related to land acquisition and environmental concerns. Investing in energy storage solutions, upgrading infrastructure, and developing skilled human capital will be essential for overcoming these challenges. By fostering collaboration with international stakeholders and learning from successful global models, India can accelerate its renewable energy transition while ensuring social and economic development. As a result, India's efforts serve as a

powerful example for other developing nations, proving that economic growth and environmental responsibility can go hand in hand.

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