

Empowering India's Future: Aligning Affordable and Clean Energy with Sustainable Development Goals

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Abstract

India, with its vast population and rapid economic growth, faces the significant challenge of providing affordable energy to all its citizens without exacerbating environmental concerns. The central focus is on SDG 7, which advocates for affordable, reliable, sustainable, and modern energy for all. India's energy sector, traditionally reliant on coal, is undergoing a transformation with increased investments in renewable energy sources like solar and wind power. This shift not only addresses the environmental impact of fossil fuels but also supports other SDGs by promoting economic growth (SDG 8) and industry innovation (SDG 9). Education (SDG 4) plays a role in increasing awareness and cultivating a skilled workforce for the renewable energy sector. The transition towards clean energy also supports SDG 13 (climate action) by reducing greenhouse gas emissions. In conclusion, aligning India's energy sector with SDGs is not just about adopting clean energy; it's about integrating environmental sustainability into the fabric of economic and social development, ensuring a brighter and more sustainable future for India.

Keywords: PMUY, Sustainable Energy, Industry Innovation, IEA, National Solar Mission.

I. Introduction

The adoption of the Sustainable Development Goals (SDGs) by the United Nations in 2015 marked a pivotal moment in global efforts to address pressing challenges such as poverty, inequality, climate change, and environmental degradation. Among these goals, SDG 7 – to ensure access to affordable, reliable, sustainable, and modern energy for all – is a critical component, especially for countries like India, where the energy sector plays a significant role in the nation's development trajectory. India's energy landscape is complex and multifaceted, shaped by its vast geographical diversity, large population, and rapid economic growth. As the third-largest energy consumer in the world, India's energy choices have profound implications not only domestically but also globally. The country's reliance on traditional biomass and fossil fuels, particularly coal, has long been a challenge in moving towards more sustainable energy sources. However, in recent years, there has been a significant shift towards renewable energy, driven by both environmental considerations and the need to secure energy for its growing population.

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The Energy Progress Report 2023 was released June 6, 2023. The five SDG 7 custodian agencies, International Energy Agency (IEA), International Renewable Energy Agency, United Nations Statistics Division, World Bank and the WHO, collaborated to release the document. The report highlights various challenges that hinder progress towards achieving United Nations' Sustainable Development Goal 7 (SDG 7). Factors such as high [inflation](#), uncertain macroeconomic outlook, debt distress, and limited financial flows have contributed to the world falling off-track in achieving SDG 7.

India's approach to achieving SDG 7 is also intrinsically linked to other SDGs. Affordable and clean energy is vital for improving health outcomes (SDG 3), as it reduces the incidence of respiratory diseases caused by indoor air pollution from traditional cooking methods. It is essential for quality education (SDG 4), as electricity access in schools can enhance learning environments. Gender equality (SDG 5) is impacted, as women and girls often bear the burden of collecting biomass for fuel. Moreover, clean energy contributes to economic growth (SDG 8) and innovation (SDG 9), and is crucial for combating climate change (SDG 13).

India's commitment to the Paris Agreement and its nationally determined contributions reflect its dedication to climate action. The country aims to reduce the emissions intensity of its GDP and to increase the share of non-fossil fuel-based power capacity. These targets are ambitious for a developing nation and require substantial effort in terms of policy implementation, technological innovation, and financial investment. The Indian government has launched several initiatives to promote renewable energy and improve energy efficiency. The National Solar Mission and the National Wind Energy Mission are notable examples, aiming to significantly increase the country's solar and wind energy capacity. Additionally, programs like UJALA (Unnat Jyoti by Affordable LEDs for All) for promoting energy-efficient lighting and UJJWALA for providing LPG connections to poor households have made strides in enhancing energy access and reducing dependence on traditional fuels. The country's progress and the strategies it adopts in the coming years will be crucial not only for its own sustainable development but also for the global efforts in combating climate change and achieving the SDGs.

II. Methodology

The methodology for this research paper encompasses a systematic and comprehensive review of secondary data, including academic literature, government reports, policy documents, and case studies relevant to India's energy sector and SDG 7.

III. India's Progress in Affordable and Clean Energy

India's progress in achieving affordable and clean energy, aligned with Sustainable Development Goal 7 (SDG 7), reflects a significant shift in its energy paradigm. This section examines India's strides

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towards affordable and clean energy and its implications for sustainable development.

1. Expansion of Renewable Energy Capacity: A cornerstone of India's energy strategy has been the rapid expansion of its renewable energy capacity. The National Solar Mission, part of the National Action Plan on Climate Change, set ambitious targets for solar energy, aiming to establish India as a global leader in solar power. As of 2023, India has made remarkable progress, with a significant increase in its solar power capacity, including large-scale solar parks and rooftop solar installations. Similarly, wind energy has seen substantial growth, with India being one of the top wind energy producers globally. Other renewable sources like biomass and small hydro have also contributed to the diversification of India's renewable energy mix.

2. Improvements in Energy Accessibility: India has made tremendous strides in improving energy accessibility, particularly in rural areas. The Saubhagya scheme, aimed at universal household electrification, has been a monumental step in this direction. As a result, millions of households have gained access to electricity, transforming lives and opening up new economic opportunities. The Pradhan Mantri Ujjwala Yojana (PMUY) has been another significant initiative, providing LPG connections to millions of households for clean cooking. This program has not only improved health outcomes by reducing indoor air pollution but also eased the daily burden on women and girls who traditionally manage household cooking.

3. Energy Efficiency Measures: Energy efficiency has been a key area of focus, with initiatives like the Perform, Achieve, and Trade (PAT) scheme and the UJALA program. These programs have promoted the adoption of energy-efficient appliances and technologies, leading to substantial energy savings and emission reductions. The Bureau of Energy Efficiency (BEE) plays a central role in formulating and implementing these measures.

4. Policy and Regulatory Framework: The Indian government's policy and regulatory interventions have been pivotal in driving the shift towards clean energy. Policies like the Renewable Purchase Obligation (RPO) and Renewable Energy Certificates (REC) have encouraged utilities to increase the share of renewables in their energy mix. Incentives such as tax benefits, subsidies, and feed-in tariffs have also been effective in attracting investments in the renewable sector.

5. Investment in Renewable Energy: There has been a significant increase in both domestic and international investment in India's renewable energy sector. The International Solar Alliance, co-founded by India, exemplifies the country's commitment to global collaboration in solar energy. Public-private partnerships and foreign direct investment have played a crucial role in financing renewable energy projects.

6. Challenges and Limitations: Despite this progress, India faces several challenges in fully realizing its clean energy potential. Grid integration of renewable energy, particularly managing the

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intermittency and variability of solar and wind power, remains a technical challenge. Financial constraints, especially in attracting long-term financing for renewable projects, are another hurdle.

7. Impact on Sustainable Development: India's progress in affordable and clean energy has had a significant impact on sustainable development. It has contributed to economic growth and job creation, particularly in the renewable energy sector. The improvement in energy access has had positive effects on health, education, and gender equality, contributing to multiple SDGs. The shift towards renewables is also crucial for India's climate change mitigation efforts.

India's progress in clean energy is not just about achieving SDG 7 but also about contributing to the broader sustainable development agenda.

IV. Challenges in Achieving SDG 7 in India

While India has made significant strides in advancing towards Sustainable Development Goal 7 (SDG 7) - ensuring access to affordable, reliable, sustainable, and modern energy for all - the journey is fraught with challenges. This section explores the key challenges India faces in its pursuit of SDG 7.

1. Grid Integration and Infrastructure Limitations: One of the major challenges in expanding renewable energy in India is the integration of this energy into the national grid. The intermittent nature of solar and wind energy requires robust grid management and storage solutions. Additionally, the existing grid infrastructure in many parts of the country is inadequate to handle the increasing load and fluctuating nature of renewable power.

2. Financing and Investment Hurdles: Securing adequate financing for renewable energy projects is a significant challenge. While investment in India's renewable sector has been growing, the scale of funding required to meet ambitious targets is enormous. There is a need for innovative financing mechanisms and more substantial support from both domestic and international investors.

3. Policy and Regulatory Framework: The policy and regulatory environment in India's energy sector can be complex and sometimes inconsistent. Challenges include bureaucratic hurdles, changing tariff structures, and policy uncertainty, which can deter investors and slow down project implementation. Ensuring a stable and supportive policy environment is crucial for the growth of renewable energy.

4. Technological Constraints: Technological advancements are essential for enhancing the efficiency and reducing the costs of renewable energy. However, India faces challenges in accessing cutting-edge technologies, partly due to high costs and intellectual property rights issues. Developing indigenous technology and adapting global innovations to local conditions is vital.

5. Distribution Sector Reforms: The financial health of power distribution companies (discoms) in India is a critical concern. High levels of debt and losses in discoms affect their ability to purchase

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renewable energy and invest in grid improvements. Comprehensive reforms in the distribution sector are needed to ensure its sustainability and efficiency.

6. Ensuring Energy Access: Despite progress in electrification, ensuring universal energy access remains a challenge. Remote and rural areas often face difficulties in accessing reliable electricity. Moreover, transitioning households from traditional biomass to cleaner cooking fuels is a slow process, affected by cultural preferences and economic factors.

7. Balancing Energy Demand and Environmental Sustainability: As India's economy grows, so does its energy demand. Balancing this increasing demand with the commitment to environmental sustainability is a complex challenge. The continued reliance on coal for a significant portion of energy needs poses a dilemma in terms of emissions and environmental impact.

8. Social and Behavioral Aspects: Social and behavioral factors play a crucial role in the adoption of renewable energy and efficient technologies. Public awareness and acceptance are essential for the success of clean energy initiatives. Changing long-standing habits and encouraging the adoption of new technologies can be challenging.

9. Climate Change Impacts: Climate change poses additional challenges to India's energy sector. Extreme weather events can damage energy infrastructure and disrupt supply. Adapting the energy sector to be more resilient to climate impacts is increasingly important.

10. Skill Development and Job Creation: The renewable energy sector requires a skilled workforce for its growth. Developing the necessary human capital through training and skill development programs is essential. Additionally, ensuring that the transition to clean energy creates jobs and supports economic development is important for its social acceptability.

The challenges in achieving SDG 7 in India are multi-dimensional, requiring concerted efforts from the government, private sector, civil society, and international community.

V. Case Studies and Success Stories in Achieving SDG 7 in India

India's journey towards achieving Sustainable Development Goal 7 (SDG 7) - affordable and clean energy for all - is marked by numerous success stories and innovative initiatives.

1. Gujarat's Solar Power Success: Gujarat has emerged as a leader in solar energy in India, thanks in part to the establishment of the Charanka Solar Park. This solar park, one of the largest in Asia, represents a successful model of public-private partnerships in renewable energy. It has not only contributed significantly to the state's energy capacity but also created jobs and boosted local economies. Gujarat's proactive policies and incentives for solar energy have set a benchmark for other states.

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2. UJALA Scheme for Energy Efficiency: The Unnat Jyoti by Affordable LEDs for All (UJALA) scheme, launched by the Government of India, has been remarkably successful in promoting energy efficiency. The program's objective was to replace conventional bulbs with energy-efficient LED bulbs across the country. This initiative has led to massive energy savings and a reduction in carbon emissions, making it a cost-effective and scalable model for energy efficiency.

3. Karnataka's Wind Energy Development: Karnataka is one of India's leading states in wind energy production. The state's policy environment, including favorable tariffs and land policies, has attracted significant investments in wind energy. Karnataka's success in harnessing wind energy demonstrates the potential of this renewable source in India's energy mix, particularly in areas with high wind potential.

4. Pradhan Mantri Ujjwala Yojana (PMUY): The PMUY initiative aimed at providing LPG connections to below-poverty-line households has been a significant step towards clean cooking energy. By reducing dependence on traditional biomass for cooking, the scheme has had a positive impact on health, particularly for women and children, and has contributed to environmental sustainability.

These case studies from India demonstrate the effectiveness of diverse approaches in addressing the challenges of achieving SDG 7.

VI. The Nexus of Clean Energy with Other SDGs in India

India's pursuit of clean and affordable energy, in line with Sustainable Development Goal 7 (SDG 7), is intrinsically linked to several other SDGs. This section explores how India's focus on clean energy intersects with and contributes to the achievement of other SDGs.

1. Clean Energy and Health (SDG 3): Access to clean energy significantly impacts public health. In India, the transition from traditional biomass fuels to cleaner energy sources like LPG and electricity has reduced indoor air pollution, a major contributor to respiratory diseases and premature deaths. The Ujjwala scheme, which provided LPG connections to millions of households, exemplifies this positive impact. Furthermore, electrification of healthcare facilities enhances medical services, contributing to overall health and well-being.

2. Clean Energy and Quality Education (SDG 4): Electricity access in schools enables better educational outcomes. It facilitates the use of digital learning tools, extends study hours, and improves the school environment. Electrification of schools in rural and remote areas of India has been pivotal in enhancing education quality and accessibility, contributing to equitable education for all.

3. Clean Energy and Gender Equality (SDG 5): Access to clean energy has a profound impact on

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gender equality. In India, women are primarily responsible for managing household energy needs. The availability of clean cooking fuel and electricity reduces the time and effort spent on energy-related tasks, freeing up time for education and income-generating activities. It also reduces health risks associated with indoor air pollution, disproportionately affecting women and children.

4. Clean Energy and Decent Work and Economic Growth (SDG 8): The renewable energy sector has emerged as a significant driver of economic growth and job creation in India. The development of solar and wind energy industries, in particular, has created new employment opportunities, including in manufacturing, installation, and maintenance. This contributes to economic growth while promoting sustainable industrial practices.

5. Clean Energy and Industry, Innovation, and Infrastructure (SDG 9): Investing in renewable energy technologies and infrastructure fosters innovation and supports sustainable industrialization. India's push for solar energy, including the establishment of solar parks and encouragement of domestic solar panel manufacturing, exemplifies this. These efforts bolster infrastructure development and technological capacity in the renewable energy sector.

6. Clean Energy and Sustainable Cities and Communities (SDG 11): Urban areas benefit significantly from the adoption of clean energy solutions, which contribute to sustainable urban development. Renewable energy sources reduce pollution and enhance the resilience of cities to energy-related issues. Initiatives like smart cities in India integrate sustainable energy practices in urban planning, improving the quality of life in urban areas.

7. Clean Energy and Climate Action (SDG 13): The shift towards renewable energy is crucial for India's climate action efforts. Reducing dependence on fossil fuels and increasing the share of renewables in the energy mix lowers greenhouse gas emissions, helping mitigate climate change. India's commitment to expanding renewable energy capacity under its nationally determined contributions (NDCs) highlights this critical nexus.

8. Clean Energy and Affordable and Clean Water (SDG 6): Clean energy technologies play a role in ensuring sustainable water management. Solar-powered water pumps and treatment plants provide an energy-efficient and sustainable solution for water supply and sanitation, especially in remote and rural areas. This aligns with ensuring availability and sustainable management of water.

9. Clean Energy and Reduced Inequalities (SDG 10): Access to clean energy can help reduce inequalities within and among countries. In India, efforts to extend electricity and clean cooking fuels to underserved and marginalized communities are steps toward reducing socio-economic disparities.

The nexus between clean energy and other SDGs in India underscores the transformative power of sustainable energy solutions in achieving broader development goals.

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VII. Future Directions for Advancing SDG 7 in India

Here are some key future directions that India can consider:

1. Embracing Technological Innovations: Technological advancements will play a pivotal role in India's energy future. Investing in next-generation renewable technologies, smart grids, energy storage solutions, and energy efficiency innovations is crucial. Technologies like battery storage, floating solar panels, and offshore wind turbines can revolutionize the renewable energy sector.

2. Expanding Renewable Energy Portfolio: While solar and wind will remain the mainstays of renewable energy, diversifying into other renewable sources like biomass, small hydro, and geothermal can enhance energy security and sustainability. Exploring new renewable energy frontiers, such as hydrogen fuel cells, can provide additional pathways for clean energy.

3. Strengthening Policy Consistency and Support: Clear, consistent, and long-term policy support is essential for the growth of the renewable energy sector. Policies need to provide certainty to investors, facilitate ease of doing business, and encourage innovation. Regular policy reviews and updates to align with technological advancements and market dynamics are vital.

4. Promoting Decentralized and Community-Based Models: Decentralized and community-based renewable energy models can effectively bridge the energy access gap in remote and rural areas. Microgrids, standalone solar systems, and community-managed renewable projects can empower communities, ensuring energy access and contributing to local development.

5. Enhancing Grid Infrastructure and Integration: Improving grid infrastructure to efficiently manage the variability and intermittency of renewable energy is a critical challenge. Investments in grid modernization, including smart grids and grid-scale energy storage, will be essential. Developing grid management capabilities and integrating regional grids can enhance reliability and resilience.

6. Focusing on Sustainable Transportation: The transportation sector presents significant opportunities for reducing carbon emissions. Accelerating the adoption of electric vehicles (EVs), expanding charging infrastructure, and promoting public transportation systems powered by clean energy can contribute significantly to sustainable urban development.

7. Scaling up Financing and Investment: Mobilizing finance for renewable energy projects is key to achieving SDG 7. Innovative financing mechanisms, risk mitigation instruments, and fostering public-private partnerships can attract the necessary investment. Leveraging international climate finance and green bonds can provide additional funding sources.

8. Leveraging International Collaboration: International collaboration remains vital for technology

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transfer, knowledge sharing, and capacity building. Active engagement in global initiatives like the International Solar Alliance and partnerships with other countries and international organizations can enhance India's capabilities in renewable energy.

9. Prioritizing Energy and Environmental Sustainability: Integrating environmental sustainability into energy planning is critical. This includes assessing and mitigating the ecological impacts of renewable energy projects and ensuring sustainable land and water use in energy production.

10. Climate Change Adaptation and Resilience: Adapting the energy sector to be resilient to climate change impacts is increasingly important. Developing strategies for climate change adaptation and resilience in the energy sector can ensure long-term sustainability.

The future directions for advancing SDG 7 in India encompass a wide array of initiatives and strategies, ranging from technological innovations and policy reforms to social engagement and international collaboration.

VIII. Government Initiatives

India has a crucial role to play in shaping the SDGs and has done a commendable job in providing clean and efficient energy to the people. In this regard, India has taken various steps like: Pradhan Mantri Ujjwala Yojana, Deen Dayal Upadhyay Gram Jyoti Yojana and SAUBHAGYA Scheme, National Solar Mission, Wind Energy, National Green Hydrogen Mission, Pradhan Mantri Urja Ganga Project. The Government of India has set up the Ministry of New and Renewable Energy (MNRE) to promote renewable energy and set a target to attain the capacity of 227 GW by 2022, including 114 GW from solar, 67 GW from wind, and other including bio and hydro energy. In addition to that, it is proposed to set up 5,000 compressed biogas plants across India by 2023. The renewable sector is projected to attract investment worth USD 80 billion in the next couple of years. Further, it is estimated that 49% of total electricity will be generated by renewable energy to be achieved by 2040. Considering the scarcity of fossil fuels and resultant carbon emissions, renewable energy is the future energy and will mitigate the energy crisis of India and will provide sustainable and affordable energy to its citizens. The Government has made plan to increase the renewable electricity capacity to 175 GW by 2022 and to 450 GW by 2030.

IX. Conclusion

In conclusion, India's journey towards achieving Sustainable Development Goal 7 (SDG 7) – ensuring access to affordable, reliable, sustainable, and modern energy for all – is a crucial component of its broader sustainable development agenda. The progress made so far reflects a significant commitment to transforming the energy landscape, with notable strides in renewable energy expansion, energy accessibility, and efficiency improvements. However, the path ahead is lined with

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challenges, including technological, financial, infrastructural, and policy-related hurdles. Overcoming these challenges will require a multifaceted approach encompassing innovative solutions, supportive policy frameworks, robust financing mechanisms, and inclusive community participation.

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