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EDITORIAL OPEN ACCESS

Green Energy Resources: Clean Environment in India

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Abstract
India's rapid advancement in renewable energy deployment exemplifies a strategic response to global climate imperatives while addressing domestic energy security and environmental degradation. By January 2026, the nation's installed renewable energy capacity has reached approximately 263 GW, with solar contributing 140.6 GW and wind 54 GW, surpassing the Paris Agreement's non-fossil fuel target of 50% installed power capacity five years ahead of schedule. This progress, bolstered by initiatives such as the PM Surya Ghar Muft Bijli Yojana for rooftop solar installations and the National Green Hydrogen Mission with ₹20,000 crore allocation, has facilitated a shift towards low-carbon energy systems. Environmentally, the transition has led to a plateauing of power sector CO_2 emissions, with a 1% decline in the first half of 2025, alongside reduced air pollutants from achieving 20% ethanol blending in petrol, saving USD 19.3 billion in foreign exchange and curbing 698 lakh tonnes of CO_2 equivalents. However, challenges persist, including intermittency of renewables, reliance on coal for 70% of electricity generation, inadequate energy storage infrastructure, and regional disparities in grid modernization. Future trajectories aim for 500 GW non-fossil capacity by 2030 and net-zero emissions by 2070, supported by the 2026 Union Budget's emphasis on critical minerals and electric mobility. This editorial underscores India's model for developing economies, balancing economic growth with ecological sustainability through innovative policies and international collaborations like the International Solar Alliance, while emphasizing the need for enhanced battery storage and equitable resource distribution to mitigate potential setbacks.

Keywords: Renewable energy; Solar photovoltaic; Wind power; Green hydrogen; Ethanol blending; Climate mitigation

Introduction

In the context of escalating global climate challenges, India has emerged as a pivotal player in the transition to sustainable energy systems. As the world's third-largest energy consumer and emitter of greenhouse gases, the country's commitments under the Paris Agreement— including achieving 50% non-fossil fuel-based electric power installed capacity by 2030 and reducing emissions intensity by 45% from 2005 levels—represent ambitious yet achievable milestones. Remarkably, India attained the 50% non-fossil fuel capacity target in June 2025, five years early, with non-fossil sources comprising 51.9% of total installed power capacity by early 2026. This achievement underscores a paradigm shift from fossil fuel dependency towards diversified green energy resources, driven by abundant solar irradiance, coastal wind potentials, and biomass availability.

The proliferation of renewable technologies has not only enhanced energy access but also mitigated environmental externalities associated with coal-dominated power generation, which historically accounted for nearly half of India's CO_2 emissions. This editorial examines the current landscape of green energy in India, its environmental ramifications, inherent obstacles, and prospective pathways, positioning the nation as a blueprint for emerging economies navigating the energy-environment nexus.

Current Status of Green Energy Resources in India

India's renewable energy sector has witnessed exponential growth, with installed capacity expanding from modest levels in 2014 to 263.2 GW as of January 2026. Solar photovoltaic (PV) installations lead this surge, reaching 140.6 GW, a remarkable increase from 2.5 GW a decade prior, fueled by cost reductions and policy incentives. Wind energy contributes 54 GW, with hybrid solar-wind projects optimizing grid stability through complementary generation profiles. Hydropower and bioenergy add stability, the latter utilizing agricultural residues to produce biogas, thereby reducing stubble burning—a major source of particulate matter pollution.

Key initiatives propel this momentum. The PM Surya Ghar Muft Bijli Yojana targets rooftop solar for 10 million households, democratizing access to clean power and alleviating grid pressure. The National Green Hydrogen Mission, endowed with ₹20,000 crore, aims to establish India as a global hub for this zero-emission fuel, with pilot projects focusing on electrolyzer technologies and applications in hard-to-abate sectors like steel production. Biofuels complement these efforts; ethanol blending in petrol achieved 20% in 2025, ahead of the 2025-26 target, with national averages exceeding 20% by January 2026 and projections for 23% by year-end. This has diverted surplus sugarcane and grains into energy production, enhancing rural economies.

State-level variations highlight progress: Karnataka excels in decarbonization with 37% renewable share in procurement, while Gujarat and Rajasthan leverage desert landscapes for mega solar parks. The 2026 Union Budget reinforces this trajectory, allocating funds for critical minerals, electric vehicles (EVs), and energy storage, aligning with the 500 GW non-fossil capacity goal by 2030.

Environmental Impacts and Benefits

The pivot to green energy yields profound ecological dividends. Power sector CO_2 emissions, a dominant contributor to India's greenhouse gas inventory, declined by 1% in the first half of 2025—the second such drop in five decades—and are projected to plateau or slightly decrease in 2026, contingent on sustained renewable additions. This decoupling of economic growth from emissions is evident in states like Himachal Pradesh and Kerala, where high renewable penetration has lowered emission intensities to below national averages.

Ethanol blending has curtailed urban smog; 20% integration has reduced CO_2 equivalents by 698 lakh tonnes since 2014, alongside slashing oil imports by mitigating 181 lakh metric tons of crude demand. Bioenergy from crop residues abates methane emissions from open burning, improving air quality indices in agrarian regions. Moreover, large-scale solar and wind farms in arid zones foster land regeneration, enhancing biodiversity and soil carbon sequestration.

Socio-environmental synergies are notable: Green hydrogen initiatives target carbon capture in industries, potentially sequestering millions of tonnes annually, while EV promotion under budget incentives reduces tailpipe emissions, fostering cleaner urban environments. Collectively, these measures support India's net-zero ambition by 2070, contributing to global mitigation efforts.

Challenges in Implementation

Despite advancements, systemic hurdles impede full realization. Renewable intermittency—solar and wind's weather-dependent output—necessitates robust energy storage, yet battery deployment lags, with only nascent progress in states like Karnataka. Coal persists as baseload, generating 75% of electricity, bolstered by subsidies that distort market competitiveness for renewables.

Land acquisition for utility-scale projects often incites socio-political conflicts, particularly in densely populated areas, while import reliance on solar modules exposes vulnerabilities to supply chain disruptions. Regional inequities exacerbate issues; southern states advance smart grids, but northern counterparts struggle with transmission losses and storage deficits. Surging energy demand from urbanization could revert to fossil fuels if renewable scaling falters. Ethanol programs face feedstock volatility, with El Niño impacts on crops underscoring supply chain resilience needs.

Future Prospects and Recommendations

Looking ahead, India's trajectory hinges on accelerated innovation and collaboration. The 500 GW target by 2030 demands annual additions of 50 GW, achievable through enhanced production-linked incentives and domestic manufacturing under the 2026 budget. Green hydrogen's scale-up, via international partnerships, could decarbonize heavy industries, while biofuels extend to sustainable aviation fuels by 2027.

Recommendations include prioritizing grid modernization, subsidizing storage technologies, and fostering equitable policies to bridge state disparities. Global alliances, such as the International Solar Alliance, can disseminate best practices, positioning India as a leader in clean energy diplomacy.

Conclusion

India's green energy odyssey embodies a harmonious blend of ambition and pragmatism, transforming environmental liabilities into opportunities for sustainable development. While challenges like coal dependency and infrastructural gaps remain, the nation's early milestones and policy resolve herald a cleaner future. As a model for the Global South, India's approach—leveraging indigenous resources for ecological and economic gains—offers invaluable insights amid planetary warming.

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