

RENEWABLE ENERGY AND ECONOMIC DEVELOPMENT: OPPORTUNITIES FOR EMERGING ECONOMIES

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Article Info	ABSTRACT
Article History: Received: 15th Dec 2025 Accepted: 18th Dec 2025 Published: 20th Dec 2025	The 21st century has ushered in a pivotal moment in global development, marked by an urgent need to shift away from fossil fuels and embrace sustainable energy alternatives. Renewable energy—sourced from solar, wind, hydro, biomass, and geothermal systems—offers a transformative opportunity for emerging economies grappling with development challenges, energy insecurity, and climate vulnerability. This paper delves into the economic development potential of renewable energy in emerging economies, highlighting key benefits such as enhanced energy access, job creation, industrial growth, and environmental sustainability. Drawing from global and regional examples, the study emphasizes how policy interventions, investment strategies, and technological advancements can drive an inclusive energy transition. However, the paper also addresses the structural and institutional barriers that may hinder progress and provides policy recommendations to harness the full potential of renewable energy as a growth engine in the Global South.
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1. INTRODUCTION

Energy is a critical enabler of socio-economic development. Historically, access to affordable and reliable energy has been closely linked to industrialization, technological progress, agricultural modernization, and improved standards of living. However, traditional energy systems in many emerging economies remain heavily reliant on fossil fuels—coal, oil, and natural gas—leading to severe environmental degradation, import dependency, and inequality in energy access.

With global climate concerns escalating and the UN Sustainable Development Goals (SDGs) emphasizing clean energy access (Goal 7), renewable energy has emerged as both an environmental necessity and an economic opportunity. Technologies such as solar photovoltaics (PV), wind turbines, micro-hydropower, and biomass solutions have matured significantly, offering viable alternatives to fossil fuels even in low-resource settings.

For emerging economies—such as India, Brazil, Indonesia, Kenya, Vietnam, and others—renewable energy offers unique benefits. It can power remote villages, reduce energy poverty, create millions of jobs, promote innovation, and reduce the fiscal burden of fuel imports. Moreover, it aligns with global efforts to decarbonize economies and create climate-resilient growth trajectories.

This paper explores the opportunities and challenges associated with renewable energy deployment in emerging economies. It provides a comprehensive analysis of the role renewables can play in fostering economic development, drawing from recent data, policy analysis, and real-world case studies.

2. LITERATURE REVIEW

A wide range of academic and institutional literature highlights the interconnection between energy access, economic development, and sustainability. The International Energy Agency (IEA, 2021) emphasizes that renewable energy investments yield multiple economic benefits, including GDP growth, employment, and infrastructure development. Studies by IRENA (2023) also confirm the employment potential of renewables, noting that emerging economies stand to gain a significant share of the projected 38 million global renewable energy jobs by 2030.

Bhattacharyya (2011) argues that decentralized renewable systems—such as solar micro grids—can overcome the limitations of centralized fossil-fuel networks in rural and remote areas. This decentralization supports inclusive growth, particularly in regions neglected by conventional energy infrastructure.

Economic growth models by Sadorsky (2009) show a statistically significant positive relationship between renewable energy consumption and GDP growth in emerging markets. Moreover, the Stern Review (2006) provides macroeconomic evidence suggesting that the long-term economic benefits of climate mitigation—largely enabled through clean energy—outweigh short-term costs.

UNDP (2022) and World Bank reports (2021) emphasize that modern energy access is foundational for broader development goals, including improved education, health outcomes, women's empowerment, and agricultural productivity. Overall, the literature affirms that renewable energy is not only an environmental imperative but a powerful engine for economic transformation in the Global South.

3. RENEWABLE ENERGY AND ECONOMIC DEVELOPMENT NEXUS

3.1 Expanding Energy Access and Reducing Poverty: Energy poverty remains a significant barrier to development in many emerging economies. According to the IEA, nearly 770 million people—primarily in Sub-Saharan Africa and South Asia—still lack access to electricity as of 2023. Renewable energy, particularly decentralized solar and mini-hydro systems, offers a scalable and cost-effective solution.

In India, programs such as Saubhagya and the PM-KUSUM scheme have extended solar electricity and solar-powered irrigation to millions of rural households and farmers. Similarly, Bangladesh's Solar Home System initiative has electrified over 4 million off-grid homes, significantly improving education and health indicators.

Access to energy enables children to study at night, powers healthcare clinics, facilitates micro-enterprises, and enhances the productivity of small-scale agriculture. These micro-level transformations contribute to macro-level economic development.

3.2 Energy Security and Trade Balance Improvements: Many emerging economies are net importers of fossil fuels, making them vulnerable to global price shocks. Renewable energy offers a pathway to energy independence. For instance, India's solar and wind initiatives reduced crude oil imports by billions annually, improving its trade balance and conserving foreign exchange reserves.

Countries like Ethiopia, which rely heavily on hydroelectricity, have reduced dependence on imported diesel and natural gas. Reducing fossil fuel imports not only eases fiscal pressures but also strengthens national energy security.

3.3 Employment Creation and Skill Development: The renewable energy sector is highly labor-intensive during construction and installation phases, particularly in solar and wind energy projects. IRENA estimates that the global renewable energy sector employed over 13.7 million people in 2022, with potential for 38 million by 2030. Many of these jobs will be in emerging markets with high solar radiation, wind corridors, and hydropower potential.

Renewable jobs include engineers, technicians, electricians, system installers, and project managers. Importantly, these jobs are often more inclusive and accessible in rural areas, promoting local employment and reducing urban migration.

In Kenya, the off-grid solar sector has created thousands of jobs in assembly, sales, customer support, and servicing. The expansion of green jobs can also stimulate vocational training and technical education systems, fostering long-term human capital development.

3.4 Stimulating Domestic Industries and Innovation: Investments in renewable energy can catalyze local manufacturing ecosystems. Countries like China, India, and Brazil have developed domestic industries for solar panels, wind turbines, inverters, batteries, and biomass stoves. This industrial expansion not only creates jobs but also enhances technological self-reliance and export potential.

Innovation in clean energy is also advancing rapidly. Emerging economies are developing indigenous technologies tailored to local conditions—such as solar-powered cold storage for farmers, smart micro grids, and AI-based energy management systems. These innovations open

up new markets and can be scaled regionally.

Governments and startups in Vietnam, for instance, are investing in floating solar and battery storage technologies, supporting both domestic needs and export potential. The clean energy transition thus supports economic diversification and reduces overdependence on traditional sectors.

3.5 Catalyzing Sustainable Agriculture and Rural Development: Agriculture is the backbone of many emerging economies. Renewable energy, especially solar and biogas, has revolutionized agricultural practices. Solar pumps reduce dependence on diesel, increase irrigation efficiency, and cut costs for farmers.

Biogas plants provide clean cooking fuel while generating organic fertilizer, enhancing soil fertility and reducing deforestation. Solar-powered dryers and cold chains reduce post-harvest losses, improving farmers' incomes.

In countries like Nepal, decentralized hydro and biomass systems have powered agro-processing mills, enabling value addition and rural entrepreneurship. Renewable energy thus becomes an enabler of rural transformation and agrarian modernization.

3.6 Leveraging Climate Finance and Foreign Direct Investment: Renewables are at the heart of global climate finance. Funds such as the Green Climate Fund (GCF), Clean Technology Fund (CTF), and bilateral grants from countries like Germany and Japan are increasingly supporting renewable energy in the Global South.

Emerging economies with robust renewable energy policies attract foreign direct investment (FDI). South Africa's Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) attracted over \$10 billion in private investment, while Brazil received significant investments in biomass and wind energy.

These investments stimulate local economies, support infrastructure development, and signal long-term commitment to sustainability.

4. CASE STUDIES OF SUCCESS

Understanding the real-world impact of renewable energy deployment in emerging economies requires examining country-specific experiences. This section elaborates on successful case studies where renewable energy has significantly contributed to economic development, energy access, and sustainability goals.

4.1 India: Accelerated Renewable Transition: India's journey in renewable energy transformation is one of the most ambitious globally. The launch of the National Solar Mission in 2010, under the broader National Action Plan on Climate Change (NAPCC), marked a significant policy shift. Initially aimed at achieving 20 GW of solar capacity by 2022, the target was revised to 100 GW of solar and 175 GW of total renewables by the same year. By 2024, India had exceeded 180 GW of renewable capacity—including solar (72 GW), wind (46 GW), small hydro (5 GW), and bioenergy (10 GW)—making it the third-largest producer of renewable energy after China and the USA.

The government's aggressive push for renewable energy involved innovative schemes:

- **Ujjwala Yojana** provided over 90 million clean LPG connections to women from low-income households, reducing dependence on biomass.
- **PM-KUSUM Scheme** aimed to install 30 GW of solar pumps and solarize existing grid-connected pumps, helping farmers reduce diesel costs and increase irrigation access.
- The **Rooftop Solar Programme** encouraged decentralized solar adoption among residential, commercial, and institutional users.

India's large-scale solar parks, with plug-and-play infrastructure, facilitated rapid project development. The use of reverse auctions made solar tariffs among the lowest globally—reaching as low as ₹1.99/unit (~\$0.027). As a result, India attracted over \$75 billion in renewable energy investments between 2015 and 2023.

Socio-economically, the sector created over 300,000 direct jobs, and estimates suggest over 1 million indirect employment opportunities through ancillary industries, logistics, and construction. Environmentally, India avoided over 40 million metric tons of CO₂ emissions annually, aligning with its Updated Nationally Determined Contributions (NDCs) under the Paris Agreement.

Further, initiatives like the International Solar Alliance (ISA)—championed by India—have positioned the country as a global leader in renewable diplomacy and South-South cooperation.

4.2 Kenya: Leadership in Decentralized Solar: Kenya exemplifies how decentralized renewable energy can drive inclusive development in Sub-Saharan Africa. With over 30% of rural households relying on off-grid solar systems, Kenya leads Africa in off-grid electrification. This achievement was made possible by a synergistic relationship between government policy, innovation, and private entrepreneurship.

Companies like M-KOPA Solar, d. light, and Azuri Technologies have revolutionized access through Pay-As-You-Go (PAYG) solar kits. These kits typically include solar panels, LED lights, mobile charging ports, radios, and sometimes TVs—impacting household productivity, education, and quality of life. As of 2023, M-KOPA had served over 1.5 million households, mostly in Kenya, Uganda, and Tanzania.

The Kenyan government's Vision 2030 incorporates renewable energy as a strategic priority. The Energy Act 2019 created a more structured regulatory environment, enabling grid and off-grid investments. Kenya's Geothermal Development Company (GDC) has also made the country a geothermal leader in Africa, accounting for over 45% of national electricity supply.

Crucially, Kenya's mobile money revolution, led by M-PESA, enabled solar firms to collect micro-payments from customers, ensuring affordability and financial inclusion. The intersection of fintech and renewable energy created a powerful ecosystem that spurred micro-entrepreneurship and energy democratization.

The sector has also generated over 10,000 jobs, particularly in local solar sales, servicing, and installations. Additionally, the World Bank and African Development Bank have supported Kenya through clean energy finance and technical assistance, ensuring long-term sustainability.

4.3 Brazil: Bioenergy and Hydro Innovation: Brazil stands out for its diversified and renewable-dominant energy matrix. As of 2023, over 83% of Brazil's electricity came from renewable sources, particularly hydropower, bioenergy, and wind. Brazil's emphasis on energy self-sufficiency, dating back to the 1970s oil shocks, led to its pioneering sugarcane ethanol program under the Proálcool initiative.

Today, Brazil is the second-largest producer of ethanol globally, after the United States. Ethanol accounts for over 45% of the fuel used by cars in Brazil, with flex-fuel vehicles dominating the market. This model reduced oil imports, improved rural incomes, and enhanced energy security.

The bioenergy industry employs over 1.2 million people, including farmers, factory workers, transport operators, and scientists. The sugarcane sector promotes circular economy practices—bagasse (the fibrous residue) is used for cogeneration, and vinasse (a by-product) is used as fertilizer, reducing waste and increasing productivity.

Hydropower remains the backbone of Brazil's electricity system, contributing to cheap and reliable power. However, the country is increasingly investing in wind energy in the northeast and solar energy in the semi-arid zones to diversify the grid and mitigate hydrological risks due to climate variability.

Brazil's integrated energy planning, robust public institutions (like ANEEL), and strong agribusiness sector have enabled renewable energy to play a central role in economic development. Moreover, Brazil's experience demonstrates how agro-energy systems can align rural development with national energy goals.

5. CHALLENGES TO RENEWABLE ENERGY DEPLOYMENT

5.1 Financing and Capital Constraints: Renewable projects are capital-intensive. Many developing nations face high-interest rates, credit access issues, and risk-averse banking sectors. Lack of credit guarantees or green financial products limits the growth of independent power producers (IPPs).

5.2 Grid Infrastructure and Integration: A major technical barrier is the lack of grid capacity to absorb intermittent renewables. Grid stability, load balancing, and transmission capacity are often weak, especially in rural or remote areas.

5.3 Policy Uncertainty and Institutional Gaps: Inconsistent policies, abrupt tariff changes, or delays in payment from utilities undermine investor confidence. Weak regulatory institutions and limited technical expertise further slowdown renewable energy expansion.

5.4 Social Acceptance and Land Issues: Large-scale wind or hydro projects may lead to land disputes, displacement, or biodiversity loss. Without stakeholder engagement, such conflicts can stall projects and create resistance.

5.5 Technological and Skill Limitations: Many countries face shortages of skilled labor for system installation, repair, and maintenance. Lack of R&D funding and weak industry-academia links also limit domestic innovation in renewable technologies.

6. POLICY RECOMMENDATIONS

To harness the full economic potential of renewables, emerging economies should:

1. Establish Long-Term Renewable Energy Targets: Setting clear, long-term renewable energy targets is crucial for building investor confidence and demonstrating national commitment to clean energy. These targets guide policy frameworks, infrastructure investments, and technology roadmaps. For example, when governments commit to achieving specific renewable capacity (e.g., 500 GW by 2030), it helps attract domestic and international investment, reduces policy uncertainty, and signals market stability to developers and financiers.

2. Develop Green Finance Ecosystems: Green finance refers to financial investments flowing into sustainable development projects and initiatives. Emerging economies need to establish green finance mechanisms such as dedicated green banks, risk-sharing instruments, and concessional loans. These tools help lower the perceived risks of renewable energy investments and mobilize private capital. Public-private partnerships, climate bonds, and blended finance models can also unlock significant funding for clean energy infrastructure, particularly in countries with limited fiscal space.

3. Invest in Grid Modernization: As more intermittent energy sources like solar and wind are added to the mix, energy grids must be upgraded to become smarter, more flexible, and resilient. Smart grids can monitor energy flow in real time and optimize supply-demand balance. Energy storage technologies like batteries ensure reliability, especially during periods when renewable generation is low. Additionally, regional interconnections between countries can help balance renewable power supply across borders, allowing for a more stable and integrated energy system.

4. Encourage Domestic Manufacturing: Developing local manufacturing capacity for renewable energy components (like solar panels, wind turbines, batteries) can reduce import dependency, lower project costs, and create jobs. Governments can offer tax incentives, subsidies, and infrastructure support to attract manufacturers. Policies promoting joint ventures with global companies and facilitating technology transfers help build industrial capabilities. Over time, this also fosters innovation and supports the creation of green industrial clusters in emerging economies.

5. Prioritize Skill Development: Renewable energy technologies require specialized skills in installation, operation, maintenance, and system integration. Investing in technical education and vocational training programs ensures the availability of a skilled workforce. Training centers, certification programs, and partnerships with industry players can enhance local capacity, promote employment, and enable smooth deployment of clean technologies. Furthermore, retraining workers from fossil fuel industries can support a just transition and reduce resistance to change.

6. Ensure Social Inclusivity: Renewable energy projects should be designed and implemented in a socially inclusive manner. This involves engaging with local communities early in the planning process, respecting land rights, ensuring environmental sustainability, and providing fair compensation when land is acquired. Environmental Impact Assessments (EIAs) should be mandatory and transparent. Projects that involve local populations are more likely to be successful and sustainable, as they gain community acceptance and deliver shared socio-

economic benefits.

7. Leverage International Cooperation: International cooperation plays a key role in accelerating renewable energy deployment in emerging economies. Countries can join multilateral platforms (like the International Solar Alliance or IRENA), enter into bilateral agreements, or participate in climate finance mechanisms (e.g., the Green Climate Fund). Such collaborations can provide access to advanced technologies, best practices, technical expertise, and concessional finance. They also facilitate harmonized standards and regional integration, making renewable energy markets more efficient and attractive.

7. CONCLUSION

Renewable energy is not merely an environmental strategy—it is an economic imperative for emerging economies. From expanding energy access to stimulating innovation, creating jobs, and improving trade balances, renewables offer a multi-dimensional development path.

Despite the challenges, the global momentum for clean energy presents a golden opportunity. Emerging economies must seize this moment through visionary policy, international collaboration, and inclusive planning. By doing so, they can leapfrog to a sustainable future that is not only greener but also fairer and more prosperous for all.

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