Educational Administration: Theory and Practice
2024, 30(3), 3320-3325
ISSN:2148-2403
https://kuey.net/

Research Article

India's Road To Sdg 7: An Analytical Review Of Energy Access, Renewable Growth, And Policy Challenges

Dr. Sindhu K.P.*

*Assistant Professor Department of Commerce N.S.S. Arts and Science College Kappur Parakkulam Palakkad, Kerala, India-679551. Affiliated to University of Calicut Email: sindhukartha.kp36@gmail.com, drsindhukp@nssparakkulam.ac.in, Mobile: 9745677178

Citation: Dr. Sindhu K.P., (2024) India's Road To Sdg 7: An Analytical Review Of Energy Access, Renewable Growth, And Policy Challenges, *Educational Administration: Theory and Practice, 30(3), 3320-3325*
Doi: 10.53555/kuey.v30i3.10087

ARTICLE INFO

ABSTRACT

Sustainable Development Goal 7 (SDG 7) aims to ensure access to affordable, reliable, sustainable, and modern energy for all by 2030. India, as a rapidly developing nation, plays a critical role in global efforts to meet energy-related targets while transitioning toward a low-carbon economy. This paper critically analyzes India's progress on SDG 7 using data up to 2023, focusing on electricity access, renewable energy deployment, and improvements in energy efficiency. Drawing from credible national and international sources, the study highlights significant advancements such as near-universal electrification, rapid solar capacity expansion, and improvements in energy intensity. However, the analysis also uncovers persisting challenges—regional disparities, unreliable rural supply, financial stress in distribution companies, and slow uptake of rooftop solar. By applying a mix of descriptive statistics and trend analysis, this research identifies both achievements and structural gaps. The paper concludes with targeted policy recommendations to accelerate India's transition toward inclusive, affordable, and sustainable energy by 2030.

KEYWORDS: SDG 7, renewable energy, electricity access, energy efficiency, India energy policy, sustainable development

I. INTRODUCTION

Access to energy is fundamental to achieving socio-economic development and environmental sustainability. India's commitment to SDG 7 aligns closely with its national objectives of energy self-reliance, inclusive economic growth, and climate goals under the Paris Agreement. By 2023, India has emerged as one of the world's leading renewable energy markets. However, disparities in energy affordability and clean energy access continue to undermine inclusive energy security.

Moreover, energy access serves as a critical enabler of other SDGs, including poverty alleviation (SDG 1), health (SDG 3), and education (SDG 4). Schools, hospitals, and industries cannot function efficiently without reliable power supply, making SDG 7 a cornerstone of sustainable development across sectors.

II. STATEMENT OF THE PROBLEM

While India has achieved near-universal electricity access on paper, critical challenges remain regarding the quality, reliability, and affordability of energy supply. Rural and remote regions continue to face intermittent service and infrastructure gaps. Financial distress in power distribution companies (discoms) undermines service delivery, while renewable energy adoption remains uneven across states. These issues collectively threaten the country's ability to meet the targets under SDG 7 by 2030 unless addressed through comprehensive, inclusive, and targeted interventions.

III. OBJECTIVES

- To assess India's progress on SDG 7 indicators up to 2023.
- To analyze the growth of renewable energy capacity and energy efficiency improvements.
- To examine regional disparities and challenges in energy access.
- To recommend strategic interventions for achieving SDG 7 targets by 2030.

IV. RESEARCH METHODOLOGY

This analytical research is based on secondary data from credible national and international agencies. Major sources include:

- World Bank SDG Indicator Database
- Ministry of New and Renewable Energy (MNRE)
- Central Electricity Authority (CEA)
- International Energy Agency (IEA)
- NITI Aayog Energy Dashboard

The study utilizes descriptive statistics, compound annual growth rate (CAGR), and regional comparative analysis to evaluate India's progress from 2010 to 2023.

V. SDG 7 TARGETS AND KEY INDICATORS

Target	**Indicator**	Current Status (2023, India)
7.1	Universal access to electricity	100% household electrification claimed, but with quality issues
7.2	Share of renewables in final energy consumption	42.2% in power capacity, ~24% in total final energy consumption
7.3	Energy efficiency	5.1 MJ/USD (PPP) energy intensity
7.A	International support for renewables	$2.9 billion cumulative FDI in renewables (FY 2023–24)
7.B	Infrastructure for renewables in LDCs	India provides technical support via ISA

***Source*:** United Nations. (n.d.). SDG 7 Targets & Indicators.

VI. DATA ANALYSIS AND DISCUSSION

6.1. ELECTRICITY ACCESS: India has achieved near-universal electrification, with nearly 100% of households connected by 2023. However, disparities remain in supply quality and reliability, particularly in low-income and rural regions.

TABLE 1: ELECTRICITY ACCESS (%)

Year	**Urban (%)**	**Rural (%)**	**National (%)**
2010	94.2	66.8	75.0
2018	99.1	94.8	97.2
2023	100	99.9	100

Sources: Retrieved & Compiled from https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?locations=IN, https://data.worldbank.org/indicator/EG.ELC.ACCS.RU.ZS?locations=IN & ttps://factodata.com/access-to-electricity-in-india-1993-to-2025/FactoData

The data in Table 1 illustrates a significant transformation in India's electricity access landscape over the past decade and a half. In 2010, access to electricity stood at 75% nationally, with a stark contrast between urban areas (94.2%) and rural regions (66.8%). This gap narrowed substantially by 2018, with rural access reaching 94.8% and urban access at 99.1%, bringing national access to 97.2%. By 2023, India reports near-universal electricity access, with both urban and rural areas exceeding 99.9%.

This rapid improvement is attributable to government initiatives like the Saubhagya scheme and Deen Dayal Upadhyaya Gram Jyoti Yojana, which focused on last-mile connectivity. However, it is important to note that while connectivity has improved on paper, issues related to the quality, reliability, and affordability of electricity—especially in rural and economically weaker areas—persist. These challenges must be addressed to fulfill the broader goals of SDG 7, which emphasize not only access but also the sustainability and reliability of energy services.

6.2. RENEWABLE ENERGY DEVELOPMENT

India's renewable energy capacity excluding large hydro reached 135.4 GW in 2023. The National Solar Mission and state-level incentives played key roles.

TABLE 2: GROWTH IN RENEWABLE CAPACITY (2014–2023)

Year	Solar (GW)	Wind (GW)	Total RE (GW)
2014	2.6	21.1	35.2
2019	28.2	35.6	80.5
2023	77.2	44.8	135.4

Source: Data compiled from the Ministry of New and Renewable Energy (MNRE), Government of India.

Table 2 reflects India's renewable energy transition over a decade (2014–2023), highlighting the accelerated deployment of solar and wind energy capacities.

- Solar power has witnessed an exponential rise, growing nearly 30-fold from just 2.6 GW in 2014 to 77.2 GW in 2023. This dramatic increase can be attributed to the National Solar Mission, falling solar panel costs, and government-led rooftop and utility-scale solar initiatives.
- Wind power also expanded significantly from 21.1 GW in 2014 to 44.8 GW in 2023, maintaining steady growth but at a relatively slower pace compared to solar. India's wind-rich states like Tamil Nadu, Gujarat, and Maharashtra remain key contributors.
- Total renewable energy capacity (excluding large hydro) grew from 35.2 GW in 2014 to 135.4 GW in 2023, marking an overall CAGR of approximately 14.5%. This expansion confirms India's leadership in clean energy transition among emerging economies.
- The relative **share of solar within total RE** has grown significantly, indicating a shift in technology preference due to lower levelized cost of electricity (LCOE) and scalability.

This growth trajectory places India on a strong path toward achieving its **2030 target of 500 GW non-fossil fuel capacity**, though sustained investment, integration, and policy reform are critical to maintain momentum.

6.3 ENERGY EFFICIENCY IMPROVEMENTS

Government programs such as PAT, UJALA, and the Energy Conservation Building Code have contributed to lowering energy intensity. Improving energy efficiency is critical for reducing energy demand, minimizing greenhouse gas emissions, and ensuring sustainable economic growth. India has made noteworthy progress in this domain, largely driven by the implementation of key government initiatives. These include the **Perform, Achieve and Trade (PAT)** scheme under the Bureau of Energy Efficiency (BEE), the **Unnat Jyoti by Affordable LEDs for All (UJALA)** program, and the **Energy Conservation Building Code (ECBC)**.

The PAT scheme, launched in 2012, created a market-based mechanism to enhance energy efficiency in large industries by setting sector-specific energy reduction targets. As of 2023, eight PAT cycles have been completed, resulting in cumulative energy savings of over 100 million tonnes of oil equivalent (Mtoe), significantly reducing carbon emissions.

The UJALA scheme, initiated in 2015, led to the distribution of more than 370 million LED bulbs nationwide by 2023. This program has not only lowered household electricity consumption but also catalyzed behavioral shifts toward energy-efficient practices.

Meanwhile, the ECBC, mandated for commercial buildings in several states, has laid the foundation for integrating energy efficiency into the construction sector. Implementation remains inconsistent across states, but its adoption has accelerated post-2020, with several urban municipalities incorporating ECBC norms into their building approval processes.

These initiatives have collectively contributed to a consistent decline in India's energy intensity—defined as energy use per unit of GDP—highlighting decoupling between economic growth and energy consumption. Table 3 illustrates this trend over time.

TABLE 3: ENERGY INTENSITY OF GDP (MJ/USD PPP)

Year	Value
2010	7.8
2015	6.4
2020	5.4
2023	5.1

Source: World Bank. (2023). *Energy intensity level of primary energy (MJ/$2017 PPP GDP) – India*. Retrieved from https://data.worldbank.org/indicator/EG.EGY.PRIM.PP.KD?locations=IN

India's 2023 energy intensity level of 5.1 MJ/USD (PPP) compares favorably with the global average and indicates continued improvement. However, significant potential for further gains exists, particularly in the transport, residential, and small- and medium-enterprise (SME) sectors, which remain under-penetrated by current efficiency programs.

The challenge now lies in deepening these gains by ensuring broader adoption across sectors, scaling up technology deployment (e.g., smart meters, energy-efficient appliances), and tightening enforcement mechanisms. Sustained reductions in energy intensity will be crucial for meeting SDG 7.3, which targets a doubling of the global rate of energy efficiency improvement by 2030.

6.4. REGIONAL ANALYSIS TOP STATES IN RENEWABLE CAPACITY (2023)

India's renewable energy expansion has been marked by significant regional variation, with certain states emerging as frontrunners in capacity addition. Factors such as natural resource availability, proactive state-level policies, robust grid infrastructure, and investor-friendly regulatory environments have propelled states like Rajasthan, Gujarat, and Tamil Nadu to the top. This section examines the leading contributors to India's renewable energy capacity as of 2023, highlighting both their achievements and the strategic advantages that facilitated their progress. Understanding these regional dynamics is critical for replicating success across less developed states and ensuring balanced national progress toward SDG 7.

TABLE 4 REGIONAL ANALYSIS TOP STATES IN RENEWABLE CAPACITY (2023)

Rank	State	Installed RE Capacity (GW)
1	Rajasthan	21.2
2	Gujarat	19.1
3	Tamil Nadu	16.4
4	Maharashtra	12.7
5	Karnataka	11.9
6	Kerala	4.2

Least Developed States (RE capacity <1 GW)

- Tripura: 135 MW
- Nagaland: 52 MW
- Arunachal Pradesh: 180 MW
- Mizoram: 90 MW

Source: MNRE. (2023). State-wise Renewable Energy Installed Capacity Report (as of March 2023). https://mnre.gov.in

The data reveals that states like Rajasthan, Gujarat, and Tamil Nadu have leveraged favorable geographical conditions and policy frameworks to achieve high levels of renewable capacity. Kerala has also made commendable progress, particularly in small hydro and rooftop solar segments. In contrast, northeastern and Himalayan states have installed less than 1 GW of RE capacity due to geographic, infrastructural, and investment challenges. Bridging these regional disparities is essential for inclusive energy development aligned with SDG 7.

This analysis has directly addressed the four key objectives outlined at the outset of the study. Firstly, the assessment of India's progress on SDG 7 indicators revealed significant strides in household electrification, renewable energy capacity growth, and improved energy efficiency up to 2023. Secondly, detailed examination of renewable energy developments highlighted the impressive scale-up in solar and wind power, supported by policy and investment initiatives. Thirdly, the regional analysis illuminated persistent disparities between states, emphasizing the uneven distribution of clean energy access and infrastructure. Finally, the study's discussion of key challenges and policy recommendations offers targeted, strategic interventions designed to bridge existing gaps and accelerate India's progress toward achieving SDG 7 by 2030. This comprehensive approach ensures that the research findings are not only data-driven but also actionable within India's broader sustainable development agenda.

VII. KEY CHALLENGES

India's progress toward SDG 7, while commendable, is hindered by several persistent and emerging challenges:

1. Grid Congestion and Transmission Bottlenecks in RE-Rich States

States like Rajasthan and Gujarat, which are rich in solar and wind energy, often face grid saturation due to insufficient transmission infrastructure. The lack of "green corridors" to evacuate power from generation hubs to demand centers leads to curtailment of renewable energy and discourages further investments.

2. Insufficient Energy Storage Infrastructure

Renewable energy sources such as solar and wind are inherently intermittent. Without adequate storage systems—like battery storage or pumped hydro—it becomes difficult to maintain grid stability. As of 2023, India's storage capacity lags far behind its growing renewable output, posing a serious barrier to further integration.

3. Financial Distress of Distribution Companies (Discoms)

Power distribution companies in many states operate under financial stress due to high aggregate technical and commercial (AT&C) losses, delayed subsidy reimbursements, and poor tariff recovery. Their inability to invest in infrastructure upgrades or procure renewable power impedes reliable and affordable energy delivery.

4. Slow Uptake of Rooftop Solar in Residential Sector

Despite government incentives, the adoption of rooftop solar—especially in the residential sector—remains limited due to high upfront costs, complex regulatory procedures, and limited awareness. This underutilization constrains decentralized energy access, particularly in urban and peri-urban areas.

5. Regional Inequalities in Clean Energy Access

Northeastern and Himalayan states continue to lag in renewable energy infrastructure due to geographic challenges, sparse population, and limited private investment. These disparities highlight the need for tailored, region-specific clean energy interventions to ensure no state is left behind.

VIII. POLICY RECOMMENDATIONS

1. Accelerate Investments in Battery and Pumped Hydro Storage

To address the intermittency of renewable energy sources like solar and wind, India needs to invest heavily in grid-scale storage solutions. Battery storage technologies and pumped hydro projects are essential for maintaining grid stability, ensuring round-the-clock power, and reducing curtailment of renewable energy. Schemes like the National Green Hydrogen Mission and energy storage tenders must be fast-tracked with clear regulatory frameworks and financial support.

2. Reform Discoms for Financial Sustainability

The financial health of power distribution companies (discoms) is central to reliable energy access. Policy measures should include reducing Aggregate Technical and Commercial (AT&C) losses, rationalizing tariffs, ensuring timely subsidy disbursement, and promoting public-private partnerships. The Revamped Distribution Sector Scheme (RDSS) must be monitored for results-based funding and accountability.

3. Promote Decentralized Energy Solutions in Remote Areas

While grid extension has reached most parts of the country, many remote and hilly areas still suffer from unreliable supply. Off-grid and decentralized renewable energy systems—such as mini-grids, solar home systems, and biomass gasifiers—should be incentivized in these regions, especially the northeastern and tribal belts. Community ownership models and local capacity building should be emphasized.

4. Enhance Green Financing Mechanisms

Mobilizing private capital is crucial for scaling up renewable infrastructure. Instruments like green bonds, blended finance, viability gap funding (VGF), and credit guarantees can attract investors. The role of multilateral agencies, green banks, and ESG-aligned institutional investors must be strengthened to ensure affordable financing for clean energy projects.

5. Monitor SDG 7 through Integrated Governance Tools

Achieving SDG 7 requires coordinated governance across energy, environment, finance, and rural development ministries. India should adopt an integrated monitoring framework using real-time data analytics, outcome-based progress indicators, and spatial dashboards. State-level energy action plans aligned with SDG targets should be developed, implemented, and evaluated annually.

IX. CONCLUSION

India's journey toward achieving Sustainable Development Goal 7 (SDG 7)—ensuring access to affordable, reliable, sustainable, and modern energy for all—has witnessed remarkable progress over the past decade. By 2023, the country has nearly achieved universal electricity access and emerged as one of the global leaders in renewable energy deployment. Solar and wind capacities have grown substantially, supported by proactive government policies and international collaborations.

However, despite this progress, several challenges persist that threaten to derail the pace of achievement. While access has expanded, the quality, affordability, and sustainability of energy supply remain inconsistent across regions. Disparities between advanced and lagging states in renewable energy development, the financial vulnerability of power distribution companies (discoms), and the underutilization of energy efficiency programs are major concerns.

The analysis of national indicators and regional trends clearly shows that India needs targeted and inclusive interventions to bridge these gaps. It must invest in storage infrastructure, modernize grids, promote decentralized clean energy models, and incentivize private sector participation. Equally important is the need for stronger governance mechanisms and transparent monitoring tools to ensure that progress is measurable and equitable.

In conclusion, India stands at a pivotal point in its energy transition. With strategic planning, robust implementation, and inclusive policymaking, it has the potential not only to meet the SDG 7 targets by 2030 but also to become a model for sustainable energy transformation in the Global South.

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