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# Policy Sequencing and Institutional Governance in India's Clean Energy Transition: A Policy-Analytical Assessment of Progress toward Sustainable Development Goal 7

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***Abstract:*** *India's clean energy transition has emerged as one of the most significant structural transformations among emerging economies, driven by deliberate policy design, institutional reform, and regulatory sequencing. As the world's third-largest energy consumer, India's progress toward Sustainable Development Goal 7 (SDG 7)ensuring access to affordable, reliable, sustainable, and modern energyhas substantial implications for global climate mitigation and sustainable development. This paper develops a policy-analytical framework to examine how regulatory restructuring, demand-creation mechanisms, infrastructure strengthening, and strategic industrial measures have collectively shaped India's renewable energy expansion.*

*Drawing upon updated government data for 2025-26, the study highlights that India added approximately 44.5 GW of renewable capacity in 2025, raising total renewable installed renewable capacity to nearly 254 GW and non-fossil capacity to over 50 percent of total installed electricity capacity. Solar energy has emerged as the dominant contributor, exceeding 132 GW, while wind capacity has approached 54 GW. These outcomes are examined within a chronological policy trajectory beginning with foundational reforms under the Electricity Act, 2003; scaling through the Jawaharlal Nehru National Solar Mission and competitive bidding frameworks; consolidating through grid and distribution sector reforms; and deepening through industrial measures such as domestic manufacturing incentives and the National Green Hydrogen Mission.*

*The paper argues that India's renewable expansion is best understood through a model of policy sequencing and institutional layering, wherein regulatory credibility, mandated renewable procurement, infrastructure readiness, and strategic industrial policy reinforce one another. By integrating governance analysis with measurable capacity outcomes, the study contributes a policy-oriented perspective to energy transition literature and offers insights relevant to emerging economies pursuing SDG 7 commitments.*

***Keywords:*** *Clean Energy Transition, SDG 7, Renewable Energy Policy, Institutional Governance, Policy Sequencing, India.*

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## I. Introduction

The global transition toward clean energy has become a defining policy challenge of the twenty-first century. Rising greenhouse gas emissions, fossil fuel dependence, and increasing electricity demand in developing economies have intensified the urgency of restructuring energy systems. The adoption of Sustainable Development Goal 7 (SDG 7) by the United Nations in 2015 formally embedded energy access and sustainability within the broader global development agenda (United Nations, 2015). SDG 7 emphasizes universal access to affordable, reliable, sustainable, and modern energy services, alongside a substantial increase in the share of renewable energy in the global energy mix. For rapidly growing economies, the pursuit of this goal requires not only technological adoption but also coherent institutional and regulatory reform.

India represents a critical case within this global transition. As one of the world's fastest-growing major economies and the third-largest consumer of electricity, India's energy choices significantly influence global emission trajectories. Historically, India's electricity sector has been dominated by coal-based generation, reflecting domestic resource availability and post-independence industrial policy priorities. For decades, energy security considerations reinforced fossil fueldependence. However, growing climate commitments, air pollution concerns, and technological advancements have progressively altered this trajectory.

India's commitments under the Paris Agreement include increasing the share of non-fossil fuel-based capacity and reducing emissions intensity relative to GDP (UNFCCC, 2015). In pursuit of these commitments, India announced a target of achieving 500 GW of non-fossil fuel-based installed capacity by 2030. Recent data indicate significant progress toward this goal. As of late 2025, India added approximately 44.5 GW of renewable energy capacity in a single year-the highest annual addition recorded. Total renewable installed capacity reached nearly 254 GW, while non-fossil capacity (including large hydro and nuclear) exceeded 262 GW, accounting for

more than 50 percent of the country's total installed power capacity of roughly 509 GW (Ministry of New and Renewable Energy [MNRE], 2025, Press Information Bureau [PIB], 2025). These achievements demonstrate accelerated momentum in renewable deployment.

Solar energy has emerged as the principal driver of this expansion. Installed solar capacity surpassed 132 GW by 2025, reflecting exponential growth over the past decade (MNRE, 2025). Wind energy capacity reached approximately 54 GW. Beyond installed capacity, grid integration has shown measurable improvement. On a peak day in July 2025, renewable sources met more than half of India's electricity demand, marking a significant operational milestone (Central Electricity Authority [CEA], 2025). Such outcomes suggest that renewable energy is no longer peripheral but increasingly central to India's power system.

While falling global technology costs and private investment flows have contributed to this growth, a purely market-based explanation is insufficient. India's clean energy transition has been shaped by deliberate policy sequencing and institutional reform. The foundation for electricity sector restructuring was established under the Electricity Act 2003, which introduced competition, independent regulation, and statutory backing for renewable purchase obligations. This legislation marked a structural shift from state-controlled electricity boards toward a more regulated market framework.

The launch of the Jawaharlal Nehru National Solar Mission in 2010 further accelerated renewable deployment by introducing reverse auctions, long-term power purchase agreements, and solar park development models. These mechanisms facilitated price discovery and reduced tariffs while enhancing investor confidence. As renewable capacity expanded, grid readiness and distribution sector viability became critical concerns. Infrastructure strengthening through green transmission corridors and financial restructuring initiatives such as UDAY aimed to address these systemic constraints.

More recently, India's policy framework has evolved toward strategic industrial deepening. The Production Linked Incentive Scheme seeks to strengthen domestic solar manufacturing capabilities and reduce import dependence. Likewise, the National Green Hydrogen Mission reflects a forward-looking commitment to diversify clean energy pathways and position India within emerging global green hydrogen markets. These initiatives indicate a transition from deployment-centric policy to integrated energy-industrial strategy.

Despite notable progress, challenges persist. Coal continues to account for a significant share of actual electricity generation due to baseload requirements. Energy storage deployment remains limited relative to projected demand growth. Distribution company financial health and transmission congestion remain structural bottlenecks. Thus, while capacity indicators demonstrate progress, ensuring reliability and affordability requires sustained institutional reform.

Existing literature on India's renewable expansion often emphasizes investment trends, tariff competitiveness, or technology cost reductions. However, relatively fewer studies integrate policysequencing, institutional governance, and measurable capacity outcomes within a unified analytical framework. This paper addresses that gap by conceptualizing India's clean energy transition as a function of structured policy evolution rather than isolated market forces.The central argument of this study is that India's renewable energy growth reflects a sequential governance model consisting of foundational regulatory reform, mandated demand creation, infrastructure consolidation, and strategic industrial policy. By mapping policy evolution against empirical outcomes, the paper offers a policy-analytical explanation of India's progress toward SDG 7.The remainder of the paper proceeds as follows. The next section reviews relevant literature on energy governance and policy sequencing. Subsequent sections present the conceptual framework, methodology, chronological policy evolution, empirical performance assessment, and policy implications before concluding.

## II. Literature Review

### 2.1 Global Energy Transition and Governance

The global discourse on energy transition has evolved from technology-centered narratives to governance-driven frameworks. Early transition literature largely emphasized technological innovation and market diffusion (Grubler, 2012; Sovacool, 2016). However, more recent scholarship recognizes that large-scale energy transformation requires coordinated institutional reform, regulatory stability, and state-led policy direction (Geels, 2014; Kern & Rogge, 2018).The multi-level perspective (MLP) framework, developed within socio-technical transition theory, conceptualizes energy transition as an interaction between niche innovations, regime structures, and landscape pressures (Geels, 2002). While influential, this framework often underestimates the role of state capacity and policy sequencing in emerging economies. Developing countries frequently rely on deliberate institutional restructuring to create markets for renewable technologies rather than waiting for spontaneous niche diffusion.

Energy governance literature further emphasizes that regulatory design, long-term targets, and institutional coherence are critical determinants of renewable energy success (Meadowcroft, 2009). Stable policy signals reduce investor risk, improve capital flows, and enable technological learning (Aklin & Urpelainen, 2018). Empirical studies across Europe and China demonstrate that feed-in tariffs, renewable

portfolio standards, and competitive auctions can significantly accelerate renewable deployment when embedded within credible institutional frameworks (del Río & Mir-Artigues, 2014).However, cross-national research also highlights that policy instruments alone are insufficient without institutional readiness. Transmission infrastructure, regulatory enforcement, and financial health of utilities strongly influence renewable integration outcomes (IEA, 2022). These insights suggest that energy transition is not purely a technological or economic phenomenon but a governance-dependent process.

**2.2 Policy Sequencing and Institutional Layering**

The concept of policy sequencing originates from comparative political economy literature, where reform outcomes depend on the order and timing of institutional changes (Mahoney & Thelen, 2010). Gradual institutional transformation, or "institutional layering," allows governments to introduce new policy instruments while retaining existing structures, thereby minimizing systemic disruption.In the energy sector, sequencing has been shown to influence reform sustainability. Foundational legal reform often precedes market liberalization and technology deployment (Victor & Heller, 2007). For example, electricity market restructuring in several OECD countries began with regulatory independence before introducing renewable mandates. Without initial regulatory credibility, subsequent policy instruments lacked enforcement capacity.

Emerging economy studies emphasize that premature market liberalization without distribution sector reform can generate financial instability and slow renewable adoption (Dubash & Rajan, 2001). Thus, sequencing matters: legal restructuring, demand creation mechanisms, infrastructure expansion, and industrial policy must follow a coherent trajectory.Despite its relevance, policy sequencing remains under-theorized in India's renewable transition literature. Most analyses treat policy instruments as isolated measures rather than components of a structured reform pathway.

**2.3 Renewable Energy Policy Instruments**

Renewable energy policy instruments are broadly categorized into price-based and quantity-based mechanisms (REN21, 2023). Feed-in tariffs, renewable purchase obligations (RPOs), competitive auctions, tax incentives, and capital subsidies are among the most widely used tools globally.Competitive auctions have emerged as the dominant procurement mechanism in many developing economies due to their ability to reduce tariffs through transparent bidding (IRENA, 2022). India's adoption of reverse auctions under the Jawaharlal Nehru National Solar Mission significantly lowered solar tariffs over time, making renewables cost-competitive with conventional sources.

Renewable purchase obligations (RPOs), backed by statutory authority under the Electricity Act 2003, created mandated demand for renewable electricity in India. Literature suggests that RPO compliance enforcement varies across states, influencing differential renewable deployment (Bhattacharya & Palit, 2014).Recent scholarship also highlights the importance of transmission planning and storage integration in sustaining renewable growth (IEA, 2022). Without grid modernization, rapid renewable capacity additions may face curtailment risks.

**2.4 India's Renewable Energy Transition: Empirical Studies**

India's renewable energy expansion has attracted growing academic attention. Several studies emphasize declining solar tariffs and improved auction design as primary drivers of growth (Sharma et al., 2019). Others examine state-level variation in renewable deployment and policy effectiveness (Ghosh & Nanda, 2020).Research also highlights the importance of distribution company financial health. Payment delays and debt accumulation have historically constrained renewable procurement (Tongia & Gross, 2018). The UDAY reform initiative attempted to address these structural weaknesses by restructuring DISCOM debt and improving operational efficiency.

More recent analyses evaluate India's progress toward its 175 GW renewable target (2015-2022) and subsequent 500 GW non-fossil target for 2030 (NITI Aayog, 2022). As of 2025, India's renewable installed capacity has approached approximately 254 GW, with non-fossil capacity exceeding 50 percent of total installed capacity (MNRE, 2025). Solar capacity alone has crossed 132 GW, while wind stands near 54 GW.

The introduction of industrial policies such as the Production Linked Incentive Scheme and the National Green Hydrogen Mission signals a shift from deployment-focused policy toward domestic manufacturing and strategic diversification. Emerging literature recognizes this as a transition from demand-side incentives to supply-side industrial strengthening (Chaudhary & Sagar, 2022).

**2.5 SDG 7 and Emerging Economies**

SDG 7 research emphasizes three dimensions: energy access, renewable share, and energy efficiency (United Nations, 2015). For emerging economies, balancing rapid electrification with decarbonization presents unique challenges (Sovacool et al., 2020).

India has achieved near-universal household electrification while simultaneously expanding renewable capacity. However, literature cautions that installed capacity does not automatically translate into reduced coal generation due to demand growth and system inertia (IEA, 2023).Studies also note that policy coherence across central and state governments determines the effectiveness of SDG 7 implementation (Dubash et al., 2018). Multi-level governance coordination is therefore critical.

### 2.6 Research Gap

Existing studies on India's renewable energy transition primarily emphasize tariff competitiveness, investment trends, and individual policy instruments. However, limited attention has been given to how the sequencing of reforms and institutional governance structures collectively shape renewable expansion outcomes. Policy measures such as regulatory reform, demand mandates, grid strengthening, and industrial initiatives are often examined separately rather than as part of an integrated transition pathway. Furthermore, there is insufficient linkage between chronological policy evolution and measurable capacity milestones in assessing India's progress toward SDG 7. This study addresses this gap through a governance-centered, policy-sequencing perspective.

## III. Research Methodology

This study adopts a qualitative policy-analytical research design to examine India's clean energy transition through a policy sequencing and institutional governance framework. The analysis relies on secondary data from authoritative government sources, including the Ministry of New and Renewable Energy (MNRE), Central Electricity Authority (CEA), Ministry of Power, and Press Information Bureau (2025-26). Major policy interventionssuch as the Electricity Act 2003 and the Jawaharlal Nehru National Solar Missionare mapped chronologically and assessed in relation to updated renewable capacity outcomes. The study emphasizes institutional sequencing and target–achievement evaluation.

## IV. Theoretical Framework

### 4.1 Policy Sequencing and Institutional Governance

Energy transition in emerging economies is not merely a technological shift but a structured institutional transformation. This study adopts a **policy sequencing and institutional governance framework** to explain India's clean energy transition. Policy sequencing refers to the structured ordering of reforms in which earlier institutional changes create enabling conditions for subsequent policy instruments. Institutional governance, in this context, refers to the regulatory, administrative, and infrastructural mechanisms that shape policy implementation and market response.

Rather than viewing renewable energy expansion as an outcome of market forces alone, this framework assumes that regulatory credibility, mandated demand, infrastructure readiness, and industrial strategy evolve through phased reform. The interaction among these phases determines the pace and sustainability of transition.

### 4.2 Phases of Policy Sequencing in Clean Energy Transition

The framework conceptualizes India's clean energy transition through four sequential and reinforcing phases:

**Phase I: Foundational Regulatory Reform**

Structural reform of the electricity sector establishes legal and regulatory certainty. The Electricity Act 2003 introduced competition, independent regulation, and statutory backing for renewable purchase obligations. This created the institutional foundation for renewable market development.

**Phase II: Market Creation and Demand Mandates**

Once regulatory foundations are established, policy instruments create predictable demand for renewable energy. The Jawaharlal Nehru National Solar Mission introduced competitive bidding and long-term procurement mechanisms that accelerated solar deployment. Renewable Purchase Obligations further institutionalized demand.

**Phase III: Infrastructure and System Consolidation**

Rapid renewable deployment requires transmission expansion, grid modernization, and financially viable distribution companies. Institutional measures targeting grid evacuation and DISCOM reform strengthen absorption capacity and reduce systemic bottlenecks.

**Phase IV: Strategic Industrial Deepening**

After market stabilization, policy focus expands toward domestic manufacturing, technological upgrading, and diversification. Initiatives such as the Production Linked Incentive Scheme and the National Green Hydrogen Mission represent this phase, linking clean energy expansion with industrial strategy.

### 4.3 Linking Framework to SDG 7

SDG 7 emphasizes renewable expansion, affordability, and reliability. The sequencing framework suggests that achieving these objectives requires more than capacity addition. Regulatory reform ensures affordability through competitive procurement; infrastructure readiness ensures reliability; and industrial strategy enhances long-term sustainability. Thus, progress toward SDG 7 is interpreted as an outcome of coordinated institutional sequencing rather than isolated policy measures.

## V. Evolution of Clean Energy Policy in India: A Chronological Analysis

India's clean energy transition has evolved through distinct but interlinked reform phases. Rather than emerging abruptly, renewable expansion reflects structured institutional sequencing beginning in the early 2000s and deepening through successive policy layers. This section maps that evolution chronologically and links it to measurable capacity outcomes.

### 5.1 Phase I: Foundational Regulatory Reform (2003-2010)

The modern restructuring of India's electricity sector began with the enactment of the Electricity Act 2003. This legislation marked a structural break from vertically integrated, state-controlled electricity boards and introduced:

- Unbundling of generation, transmission, and distribution
- Independent regulatory commissions at central and state levels
- Open access provisions
- Statutory backing for Renewable Purchase Obligations (RPOs)

The Act created regulatory certainty and formalized renewable procurement within the legal framework. Although renewable capacity during this period remained modest, the institutional foundations necessary for scaling were established. By 2010, India's total renewable installed capacity was approximately 18–20 GW, largely dominated by wind energy.

This phase reflects the first step in policy sequencing: institutional restructuring before market acceleration.

### 5.2 Phase II: Market Creation and Deployment Expansion (2010-2015)

A major inflection point occurred with the launch of the Jawaharlal Nehru National Solar Mission in 2010. The mission introduced:

- Reverse competitive bidding
- Long-term power purchase agreements (PPAs)
- Solar Park development models
- Generation-based incentives

The adoption of competitive auctions significantly reduced solar tariffs over time and increased investor participation. Renewable Purchase Obligations were gradually strengthened, creating mandated demand for renewable electricity across states.

During this phase, renewable capacity began accelerating, with solar emerging as a rapidly growing segment. By 2015, total renewable capacity had crossed approximately 35 GW. Policy credibility improved as tariff discovery mechanisms demonstrated cost reductions.

This phase corresponds to the "market creation" stage of the sequencing framework.

### 5.3 Phase III: Consolidation and Infrastructure Strengthening (2015-2020)

In 2015, India announced an ambitious target of achieving 175 GW of renewable capacity by 2022. This announcement marked a scaling-up moment in policy ambition. However, rapid capacity addition exposed systemic constraints, particularly in transmission infrastructure and distribution company finances.

To address these bottlenecks:

- Green Energy Corridor projects were initiated to strengthen interstate transmission.
- Financial restructuring measures such as UDAY were implemented to stabilize DISCOMs.
- RPO targets were revised upward.
- Solar and wind auction volumes increased.

By 2020, renewable installed capacity had crossed approximately 87 GW. Solar tariffs reached record-low levels globally. However, distribution sector payment delays and curtailment issues highlighted persistent structural weaknesses.
This stage reflects infrastructure consolidation - ensuring that rapid deployment did not destabilize the system.

**5.4 Phase IV: Strategic Industrial Deepening and Target Expansion (2020-2025)**

The post-2020 period marked a transition from deployment-focused policy to strategic industrial and technological deepening. India expanded its ambition to 500 GW of non-fossil fuel-based capacity by 2030 under its updated climate commitments.
Key initiatives included:

- Production Linked Incentive Scheme to strengthen domestic manufacturing capacity in solar modules and components.
- National Green Hydrogen Mission to position India as a major producer and exporter of green hydrogen.
- Rooftop solar expansion under PM Surya Ghar initiatives.
- Strengthening of renewable energy certificate (REC) mechanisms.

This period witnessed record-breaking deployment. According to the Ministry of New and Renewable Energy (MNRE, 2025) and Press Information Bureau (2025):

- India added approximately **44.5 GW of renewable capacity in 2025 alone**, the highest annual addition recorded.
- Total renewable installed capacity reached nearly **254 GW**.
- Non-fossil fuel-based capacity exceeded **262 GW**, accounting for more than **50 percent of total installed power capacity (~509 GW)**.
- Solar capacity crossed **132 GW**, while wind capacity approached **54 GW**.

Additionally, renewable sources met over 50 percent of electricity demand on certain peak days in 2025 (CEA, 2025), reflecting improved grid integration.
This phase illustrates the fourth stage of sequencing: industrial strengthening and technological diversification integrated with capacity expansion.

**5.5 Linking Policy Evolution to Capacity Outcomes**

The chronological progression of reforms reveals a structured trajectory:

**Table 1:** Phased Evolution of India's Clean Energy Transition

| Phase | Key Policy Instruments | Governance Focus | Institutional Objective | Observable Capacity Outcome |
|---|---|---|---|---|
| Phase I 2003-2010 | Electricity Act 2003; RPO framework; Regulatory unbundling | Regulatory restructuring | Establish market-based electricity governance | Initial renewable expansion; wind-led growth (~20 GW by 2010) |
| Phase II 2010-2015 | Jawaharlal Nehru National Solar Mission; Competitive bidding; Long-term PPAs | Market creation | Stimulate renewable demand and investor participation | Rapid solar scaling; total RE capacity >35 GW by 2015 |
| Phase III 2015-2020 | 175 GW target; Green Energy Corridor; DISCOM reforms (UDAY) | Infrastructure consolidation | Strengthen grid integration and financial stability | Renewable capacity ~87 GW by 2020; tariff reductions |
| Phase IV 2020-2025 | Production Linked Incentive (PLI); National Green Hydrogen Mission; Expanded RE targets (500 GW by 2030) | Industrial deepening & strategic diversification | Enhance manufacturing capacity and long-term transition resilience | ~254 GW renewable capacity; >50% non-fossil installed share (2025) |

**Source:** Author's compilation based on MNRE (2025), CEA (2025), and PIB (2025).

The progression supports the central theoretical claim: renewable expansion in India has followed structured policy sequencing rather than isolated policy shocks.

## VI. Empirical Performance Assessment: Capacity Trends and Progress toward SDG 7

India's clean energy transition can be evaluated through installed capacity growth, sectoral distribution, and the increasing share of non-fossil sources in the electricity mix. Updated government data for 2025–26 indicate measurable structural progress aligned with national climate commitments and SDG 7 targets.

**6.1 Growth in Renewable Installed Capacity**

Renewable energy capacity in India has expanded significantly over the past decade. From less than 40 GW in 2015, total renewable installed capacity reached approximately **254 GW by late 2025** (MNRE, 2025).

The year 2025 alone recorded an addition of nearly **44.5 GW**, representing the highest annual expansion in India's renewable history.

This acceleration suggests not only technological diffusion but also improved policy coordination and regulatory certainty. The increase reflects the cumulative impact of competitive bidding mechanisms, strengthened renewable purchase obligations, and enhanced transmission infrastructure.

**6.2 Sectoral Composition**

Solar energy has emerged as the dominant driver of growth. Installed solar capacity surpassed **132 GW** by 2025, accounting for more than half of total renewable capacity (MNRE, 2025). Wind energy capacity approached **54 GW**, while hydro and bioenergy contributed additional capacity.

The rapid scaling of solar capacity corresponds with the policy mechanisms introduced under the Jawaharlal Nehru National Solar Mission and subsequent auction-based procurement frameworks. Wind capacity expansion reflects sustained state-level implementation and hybrid auction models.

**6.3 Non-Fossil Share in Total Installed Capacity**

A significant milestone was achieved when non-fossil fuel-based capacity (including large hydro and nuclear) crossed **262 GW**, accounting for more than **50 percent of India's total installed electricity capacity (~509 GW)** in 2025 (Press Information Bureau, 2025).

Crossing the 50 percent threshold indicates that renewable and other non-fossil sources now represent a structural component of India's power system rather than a supplementary segment. This achievement aligns directly with India's commitment to achieve 500 GW of non-fossil capacity by 2030.

**6.4 Renewable Integration and Grid Performance**

Installed capacity growth is meaningful only if accompanied by operational integration. Data from the Central Electricity Authority (CEA, 2025) indicate that renewable sources supplied more than **50 percent of electricity demand on certain peak days in 2025**, demonstrating improved grid management and transmission readiness.

However, coal continues to dominate actual electricity generation due to baseload requirements and intermittency constraints. This underscores the importance of storage deployment and further transmission expansion to ensure reliability and affordability under SDG 7.

**6.5 Target–Achievement Assessment**

India's updated non-fossil capacity target stands at **500 GW by 2030**. With more than 262 GW achieved by 2025, the country has already crossed the halfway mark five years ahead of schedule.This trajectory suggests that the sequencing of regulatory reform, market creation, infrastructure strengthening, and industrial policy has contributed to sustained acceleration.

**6.6 Implications for SDG 7**

SDG 7 emphasizes:

1. Increased renewable energy share
2. Reliable and affordable electricity access
3. Sustainable long-term energy systems

India's renewable expansion addresses the first objective directly. Near-universal electrification programs complement access goals. Competitive auctions have contributed to declining solar tariffs, supporting affordability.

However, achieving the reliability and sustainability components of SDG 7 requires continued institutional strengthening, including storage incentives, grid modernization, and financial stabilization of distribution companies.

## VII. Analysis and Discussion

**7.1 Interpreting Renewable Expansion through Policy Sequencing**

The empirical trends presented in the previous section support the central theoretical claim of this study: India's clean energy transition has followed a structured policy sequencing trajectory rather than a spontaneous market-led expansion.

The first phase of reform, initiated through the Electricity Act 2003, created the regulatory foundation necessary for renewable market development. By establishing independent regulatory commissions and providing statutory backing for Renewable Purchase Obligations (RPOs), the Act enhanced institutional credibility. This foundational reform reduced regulatory uncertainty, which is widely recognized as a major barrier in infrastructure sectors.

The second phase, driven by the Jawaharlal Nehru National Solar Mission, operationalized market creation. Competitive bidding frameworks and long-term procurement contracts facilitated cost discovery and investor participation. The rapid growth of solar capacity-surpassing 132 GW by 2025-corresponds directly with this policy intervention. The sequencing is evident: without regulatory restructuring, large-scale auction-based procurement would have lacked institutional support.

The third phase emphasized infrastructure consolidation and distribution sector stabilization. Transmission expansion through green corridors and reforms targeting DISCOM financial viability were necessary to absorb large volumes of renewable capacity. The crossing of the 50 percent non-fossil installed capacity threshold in 2025 reflects not only deployment but also system readiness. This demonstrates that renewable scaling was sustained by parallel institutional adjustments rather than isolated policy announcements.

The fourth phase, characterized by industrial deepening through the Production Linked Incentive Scheme and the National Green Hydrogen Mission, represents a strategic shift toward long-term resilience. By linking renewable deployment with domestic manufacturing and green hydrogen development, India has moved from capacity expansion to ecosystem building.

### 7.2 Governance Strengths in India's Clean Energy Transition

Several governance strengths emerge from the analysis:

1. **Regulatory Credibility and Policy Continuity**Despite political and administrative changes, India has maintained continuity in renewable targets and procurement mechanisms. Long-term policy signalling has supported investor confidence.
2. **Target-Based Strategic Planning**The announcement of progressively ambitious targets-175 GW (2022) and 500 GW non-fossil capacity (2030)-created directional clarity. Updated 2025-26 data indicate that more than half of the 2030 non-fossil target has already been achieved.
3. **Institutional Layering Rather Than Policy Replacement**New initiatives have generally complemented, rather than replaced, earlier reforms. For instance, industrial incentives were introduced after market stabilization, not before.
4. **Improved Grid Integration** Renewable supply exceeding 50 percent of electricity demand on certain days in 2025 suggests improved operational management and transmission planning.

These factors indicate that India's renewable expansion reflects coordinated governance rather than isolated sectoral growth.

### 7.3 Persistent Structural Challenges

Despite notable achievements, several structural challenges remain:

- **CoalDependence in Generation Mix**Although non-fossil capacity exceeds 50 percent of installed capacity, coal continues to dominate actual electricity generation due to baseload demand and intermittency constraints.
- **Storage and Flexibility Gap**Rapid renewable expansion necessitates greater deployment of battery storage and flexible generation capacity.
- **Distribution Company Financial Stress** Payment delays and revenue gaps continue to affect renewable project viability in certain states.
- **Transmission Bottlenecks** Grid congestion in renewable-rich states highlights the need for continuous transmission investment.

Addressing these constraints will determine whether India can sustain its current acceleration toward the 2030 target.

### 7.4 Implications for SDG 7

The analysis suggests that progress toward SDG 7 in India has been driven by coordinated institutional reform rather than purely technological diffusion. Renewable capacity growth directly contributes to increasing the share of sustainable energy, while competitive procurement supports affordability objectives. However, reliability and system stability depend on continued governance strengthening.

Thus, achieving SDG 7 requires not only ambitious targets but also sustained institutional sequencing, infrastructure readiness, and industrial diversification.

## VIII. Policy Implications

The preceding analysis demonstrates that India's clean energy transition has been driven by structured policy sequencing and institutional consolidation. However, sustaining progress toward the 500 GW non-fossil capacity target by 2030 and achieving the broader objectives of SDG 7 requires continued governance strengthening. Based on the findings, the following policy implications emerge.

**8.1 Strengthening Grid Flexibility and Storage Deployment**

While installed renewable capacity has expanded rapidly, system flexibility remains a critical constraint. As renewable penetration increases, variability management becomes central to ensuring reliability and affordability.

Policy focus should therefore prioritize:

- Accelerated deployment of battery storage systems
- Clear regulatory frameworks for storage procurement
- Market mechanisms for ancillary services
- Flexible thermal plant retrofitting

Institutional coordination between the Ministry of Power and regulatory commissions will be crucial to prevent renewable curtailment and maintain grid stability.

**8.2 Enhancing Distribution Sector Financial Sustainability**

The financial health of distribution companies (DISCOMs) remains a structural vulnerability. Payment delays can undermine investor confidence and slow renewable procurement.

Policy reforms should emphasize:

- Strict enforcement of payment security mechanisms
- Cost-reflective tariff rationalization
- Reduction of aggregate technical and commercial (AT&C) losses
- Digitalization of billing and metering systems

Strengthened distribution governance will ensure that renewable expansion translates into reliable electricity supply.

**8.3 Consolidating Industrial and Manufacturing Capacity**

The introduction of the Production Linked Incentive Scheme and the National Green Hydrogen Mission marks a strategic shift toward industrial deepening. However, long-term competitiveness requires:

- Stable multi-year procurement pipelines
- Domestic supply chain development
- Research and development support
- Export-oriented manufacturing incentives

Industrial policy must remain aligned with renewable deployment targets to avoid supply-demand mismatches.

**8.4 Strengthening Federal–State Coordination**

Energy governance in India operates within a federal structure. Variations in Renewable Purchase Obligation compliance and distribution reforms across states can create uneven transition trajectories.

Improved coordination mechanisms between central and state governments, standardized compliance monitoring, & transparent reporting frameworks will enhance policy coherence and support uniform progress toward SDG 7.

**8.5 Long-Term Integrated Energy Planning**

To ensure that renewable expansion contributes to decarbonization rather than parallel fossil growth, integrated energy planning is essential. This includes:

- Alignment of coal retirement strategies with renewable scaling
- Integration of green hydrogen within industrial decarbonization pathways
- Cross-sector electrification strategies

Policy coherence across energy, industry, and climate planning institutions will determine long-term sustainability.

**8.6 Governance as the Central Driver**

The core implication of this study is that renewable expansion in India has been governance-driven. Sustained progress toward SDG 7 will depend on maintaining policy credibility, regulatory transparency, and institutional layering rather than relying solely on market signals.

Future reforms should therefore preserve sequencing discipline-ensuring that infrastructure, distribution reform, and industrial policy evolve in coordination with renewable deployment.

## IX. Conclusion

This study examined India's clean energy transition through a policy sequencing and institutional governance framework. Moving beyond purely descriptive capacity statistics, the analysis demonstrated that

India's renewable expansion has been shaped by structured institutional reforms rather than isolated market developments.

The foundational restructuring introduced under the Electricity Act 2003 established regulatory credibility and market-oriented electricity governance. Subsequent policy interventions, particularly the Jawaharlal Nehru National Solar Mission, operationalized renewable market creation through competitive procurement and mandated demand mechanisms. Infrastructure consolidation and grid strengthening further enabled absorption of large-scale renewable capacity. More recently, strategic industrial initiatives such as the Production Linked Incentive Scheme and the National Green Hydrogen Mission reflect a transition from deployment-focused expansion toward ecosystem deepening and technological self-reliance.

Government data for 2025-26 indicate that renewable capacity has crossed 250 GW, and non-fossil fuel capacity now constitutes over 50 percent of total installed electricity capacity. These achievements position India among the leading emerging economies in clean energy deployment and demonstrate measurable progress toward the 500 GW non-fossil capacity target for 2030.

However, structural challenges remain. Coal continues to dominate electricity generation, grid flexibility and storage deployment require acceleration, and distribution sector financial stress persists in several states. Addressing these constraints will determine whether current momentum can be sustained without compromising reliability and affordability-core components of SDG 7.

Overall, the study concludes that India's clean energy transition represents a governance-driven transformation characterized by phased reform, regulatory credibility, and institutional coordination. Continued adherence to sequencing discipline-aligning infrastructure readiness, distribution reform, and industrial strategy with renewable targets-will be essential to achieving long-term energy sustainability and climate commitments.

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