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THE INTERSECTION OF POWER SECTOR

REGULATION & SUSTAINABILITY GOALS IN INDIA

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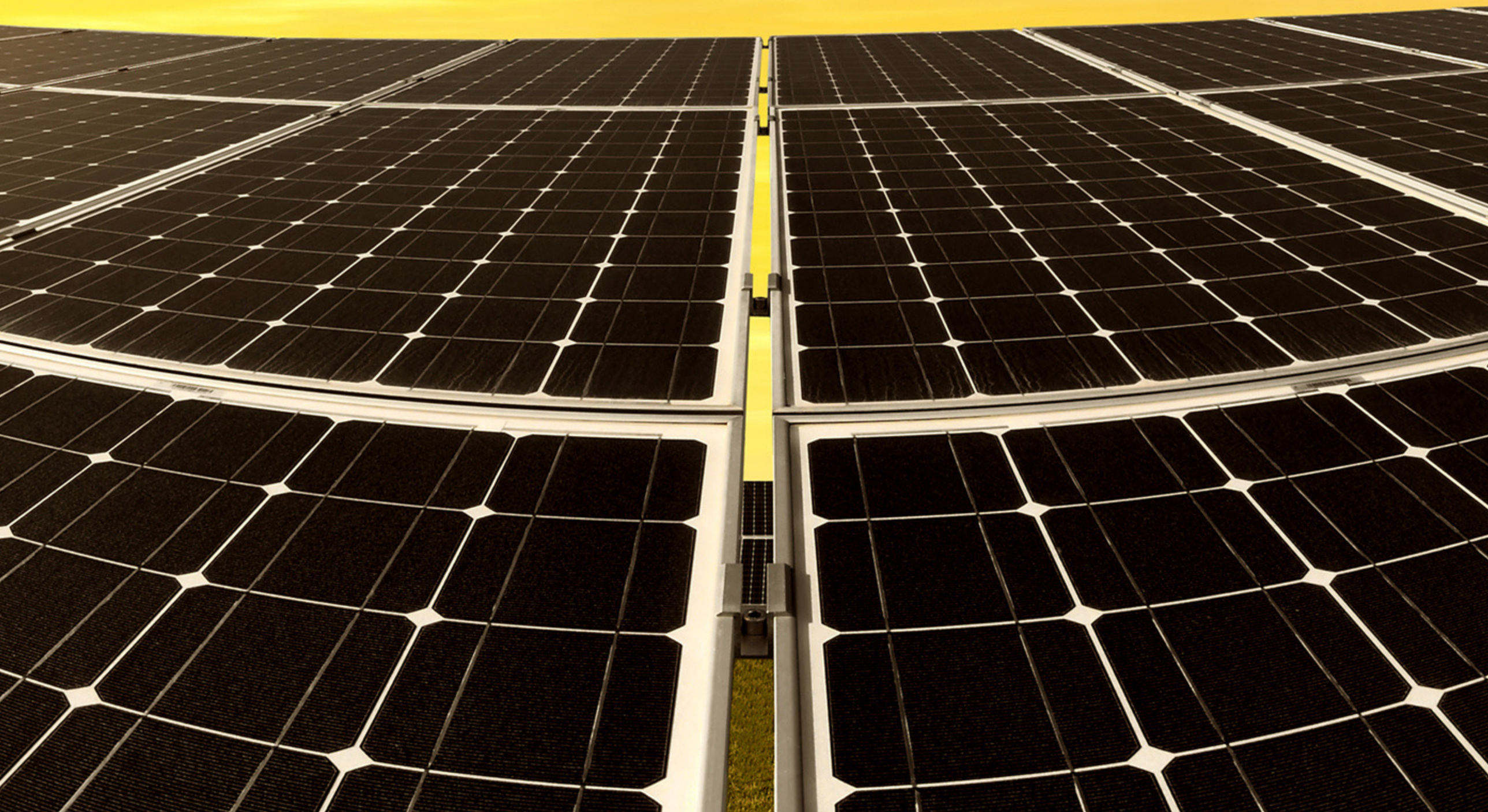

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Executive Summary

India's power sector is undergoing a **major shift,** adapting to the demands of **economic growth, energy security, and sustainability.** The country has steadily restructured its electricity market, promoting **competition, independent regulation, and an expanded role for renewable energy.** A key turning point was the **Electricity Act of 2003**, which introduced **open access, electricity trading, and Renewable Purchase Obligations (RPOs),** accelerating renewable energy adoption. However, **discom financial struggles, regulatory uncertainties, and grid integration hurdles** remain critical challenges in the sector's transition.

Over the past two decades, India has steadily aligned its **power sector regulations with sustainability goals**. Policies like the **National Action Plan on Climate Change (NAPCC, 2008)** and the **Energy Conservation Act amendments (2022)** have **expanded renewable energy targets, introduced market-based incentives, and laid the foundation for a national carbon market.** Meanwhile, mechanisms like **Renewable Energy Certificates (RECs), Viability Gap Funding (VGF), and Production-Linked Incentives (PLIs)** have been instrumental in attracting investment into clean energy projects, including **solar PV, wind, battery storage, and green hydrogen.**

India is also advancing **smart grid technology, decentralized energy solutions, and corporate procurement models** to enable a more efficient and competitive energy market. **Virtual Power Purchase Agreements (VPPAs)** are gaining traction as corporations seek **renewable energy sourcing,** while **peer-to-peer energy trading and net metering reforms** are expanding decentralized solar adoption. At the same time, **smart meters, Green Energy Corridors, and large-scale battery storage projects** are improving **grid efficiency and renewable energy integration.**

Despite this progress, several challenges **threaten the clean energy transition:**

- **Discom Financial Crisis –** State-run discoms remain financially distressed, with **over ₹6.77 lakh crore (~$82 billion) in accumulated losses** due to **subsidized tariffs, high transmission losses, and poor cost recovery.** This impacts their ability to **procure and pay for renewable energy on time.**

- **Transmission Delays –** Many **solar and wind projects face evacuation bottlenecks,** increasing costs and discouraging investment.

- Regulatory Inconsistency – State-level policies on **open access, net metering, and banking of renewable energy** vary widely, affecting investor confidence.

- **Contract Sanctity – States have attempted to renegotiate renewable PPAs and** have hurt India's reputation for policy stability, deterring long-term investment.

India's **clean energy push is deeply linked to its international climate commitments.** Under the **Paris Agreement (2015), COP26 "Panchamrit" pledge (2021), and updated Nationally Determined Contributions (NDCs, 2022),** India has committed to:

- **500 GW of non-fossil capacity by 2030**
- **Reducing emissions intensity by 45%** (from 2005 levels)
- **Net-zero emissions by 2070**

These commitments have **driven policy reforms, expanded climate finance, and strengthened partnerships,** including the **International Solar Alliance (ISA) and collaborations with the World Bank and ADB** for grid infrastructure development.

The Path Forward: Reform Priorities

To **unlock the full potential of India's clean energy transition**, the following key reforms are necessary:

1. **Strengthen Discom Finances –** Improve cost recovery through **tariff rationalization, direct benefit transfers (DBT) for subsidies, and operational efficiency.**

2. **Enhance Transmission Planning –** Synchronize **grid expansion with renewable growth targets** and **enforce faster transmission approvals.**

3. **Ensure Regulatory Consistency –** Standardize **open access rules, wheeling charges, and net metering policies** across states.

4. **Protect Contract Sanctity –** Enforce **PPA obligations, reduce payment delays, and streamline legal dispute resolution.**

5. **Encourage Market-Based Mechanisms –** Expand **carbon credit trading, ancillary service markets, and flexible power procurement models.**

6. **Strengthen Investment Climate –** Provide **long-term policy stability, incentives for domestic manufacturing, and clear tax structures.**

India's power sector is at a pivotal moment. **Renewables are now the cheapest source of new electricity,** and policy reforms are actively shaping a **more competitive, investment-friendly market.** However, **regulatory certainty, financial discipline, and infrastructure modernization** will be key to **achieving 500 GW of clean energy by 2030 and long-term sustainability goals.** With the right policies in place, **India can position itself as a global leader in clean energy and carbon reduction,** while ensuring reliable and affordable power for all.

02

Introduction

The intersection of power sector regulation and sustainability in India is a dynamic, evolving story – one of ambitious targets, pragmatic problem-solving, and collaborative effort across government, industry, and society. Historically dominated by coal, over the past decades, India's power sector has undertaken major regulatory reforms to expand electricity access, improve reliability, and integrate cleaner energy sources into the grid. Today the country faces the challenge of balancing rapid demand growth with commitments to climate change mitigation, as embodied in international agreements. This report explores the role of regulatory bodies in driving renewable energy adoption, implementing carbon pricing mechanisms and overcoming hurdles in the transition. The report also delves into emerging business models such as virtual power purchase agreements and decentralized energy solutions.

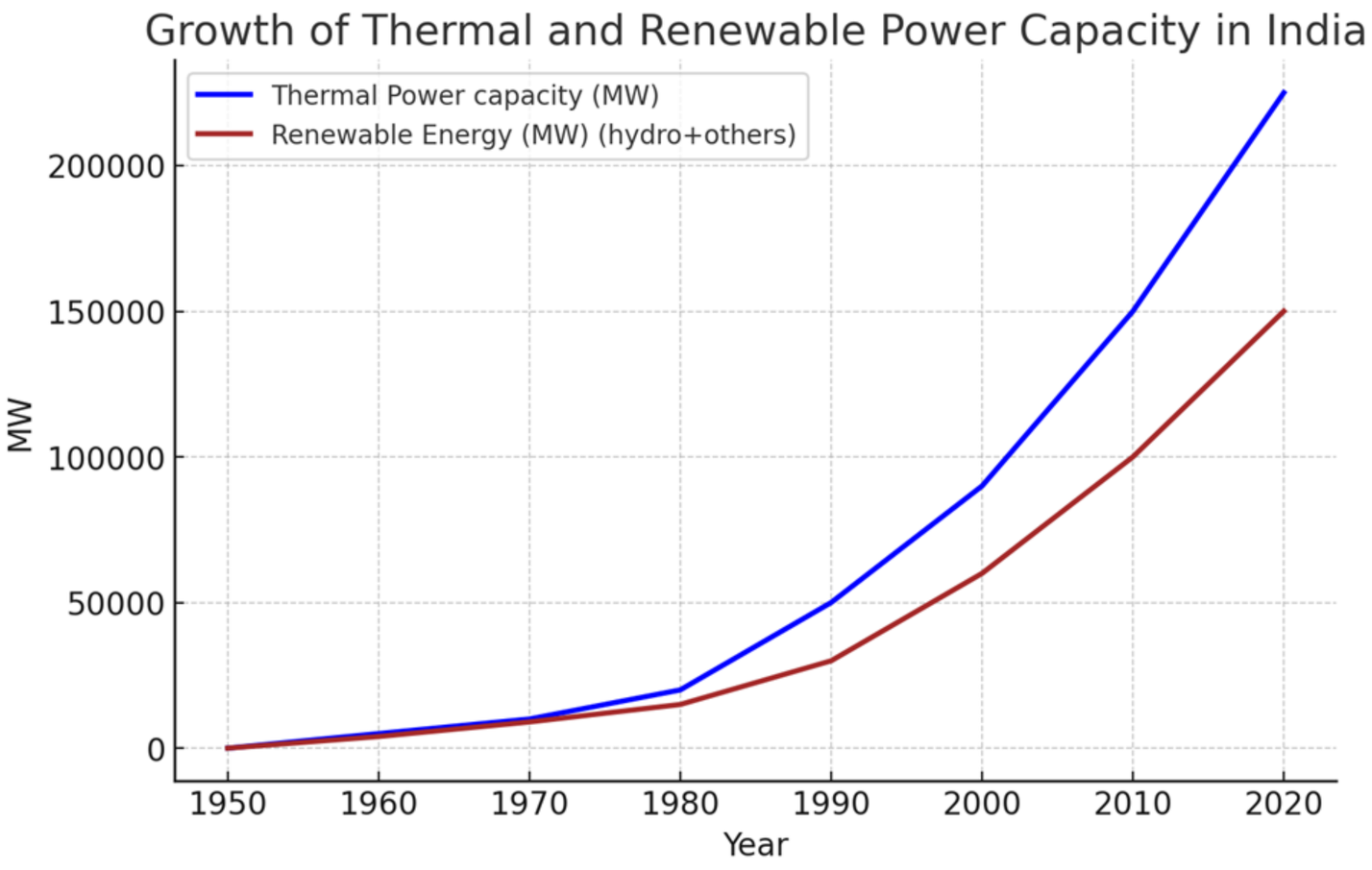


Figure 1 Energy Mix through the Decades

03
History

After independence in 1947, electricity was made a concurrent subject and the Electricity (Supply) Act of 1948 established State Electricity Boards (SEBs) to develop generation, transmission and distribution at the state level. Through the 1960s and 70s, these state-run monopolies expanded rural electrification but often fell prey to political interference, populist tariffs and mounting losses. By the 1980s, issues like high transmission and distribution losses, underinvestment, and chronic power shortages were common. Some early reforms included the creation of the Central Electricity Authority (CEA) in 1950 to guide uniform policy, and experiments with private licenses in a few cities. However the sector largely remined vertically integrated in state hands, with cross subsidized tariffs (industrial/commercial sers paying more to subsidize farmers and households) a practice that strained SEB finances over time.

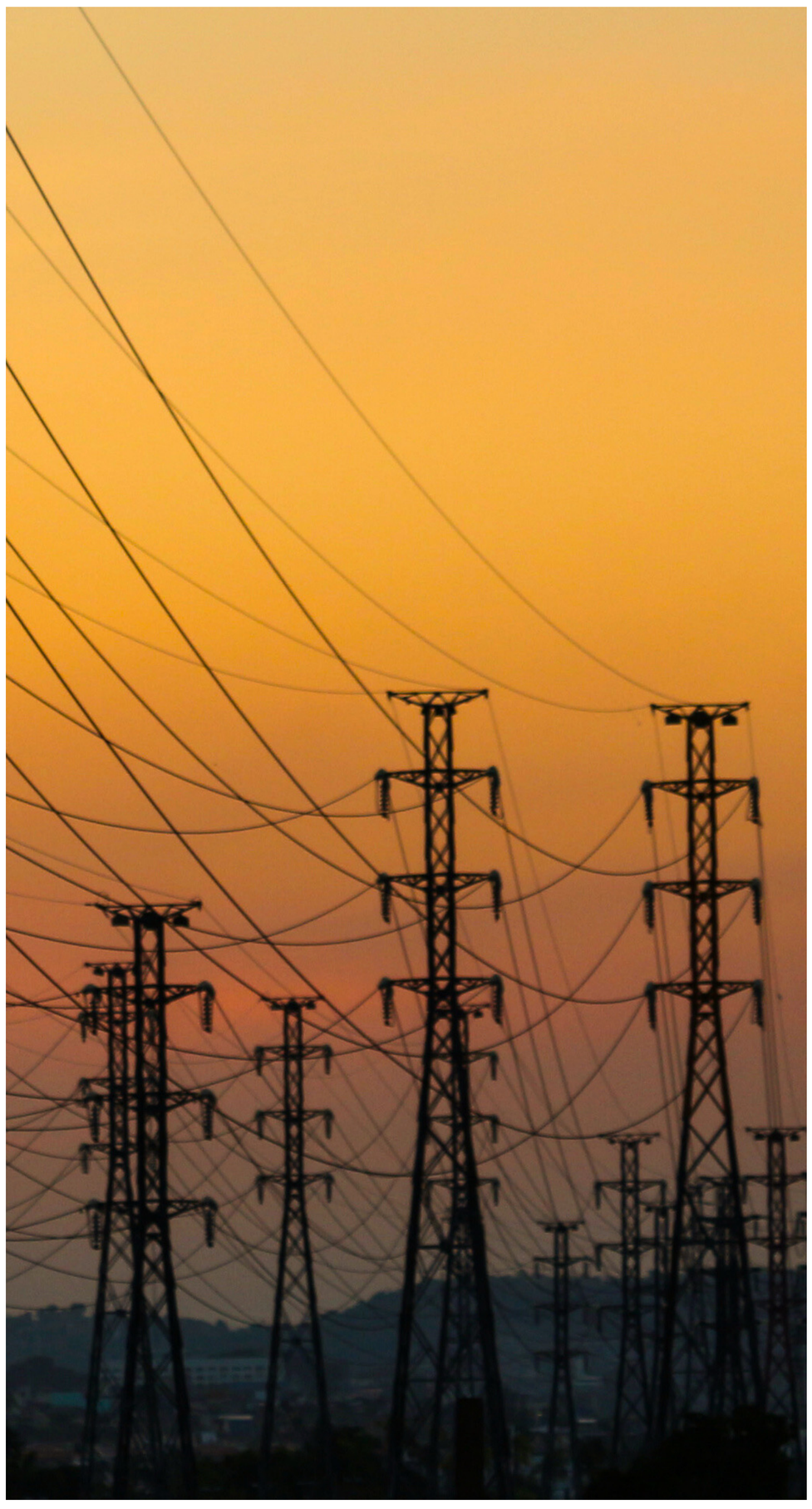
The 1990s ushered in broader economic liberalization of India and with it, the first steps to reform the power sector. In 1991, the central government opened power generation to private investment through the Independent Power Producers (IPP) policy) to augment capacity. This broke the government monopoly on generation.
In 1998 the Electricity Regulatory Commissions Act was passed, which established independent regulatory bodies at the centre (Central Electricity Regulatory Commission: CERC) and in states (State ERCs). The aim was to depoliticize tariff setting and instil regulatory oversight.

Electricity Act, 2003

The Electricity Act 2003 was a transformative milestone, consolidating older laws and introducing competition, open access, and electricity trading. It delicensed generation, freed captive power from controls, and unbundled state electricity boards into separate entities to improve efficiency and reduce conflicts of interest. The Act also required State Commissions to promote renewable energy, laying the groundwork for Renewable Purchase Obligations (RPOs) and power markets. By the mid-2000s, nearly all states had corporatized their boards, and some, like Delhi, privatized distribution. Complementary policies like the National Electricity Policy (2005) and Tariff Policy (2006) encouraged feed-in tariffs and RPOs, accelerating renewable energy adoption.

Over the past decade, India's power regulation has shifted toward sustainability and market efficiency. The National Action Plan on Climate Change (2008) set a 15% renewable energy target by 2020, leading to renewable mandates and the Renewable Energy Certificate (REC) market. From 2010–2015, many states introduced solar policies, while the central government transitioned to competitive bidding, drastically reducing tariffs by the late 2010s. Power markets also matured, with Green Term-Ahead Market (GTAM) in 2020 and Green Day-Ahead Market (GDAM) in 2021 facilitating short-term renewable energy trading.

Legislative amendments continue to refine competition and sustainability. Proposed Electricity Act amendments (2014, 2018, and 2022) seek multiple distribution licensees, stricter RPO enforcement, and enhanced contract reliability. The Electricity (Promoting Renewable Energy Through Green Energy Open Access) Rules, 2022, lowered the open access threshold from 1 MW to 100 kW, boosting renewable capacity by 90% year-on-year in FY 2023-24. Meanwhile, the Energy Conservation (Amendment) Act, 2022 introduced a carbon trading scheme, mandating large consumers to use a minimum share of non-fossil power, signaling India's transition toward carbon markets and clean energy mandates.



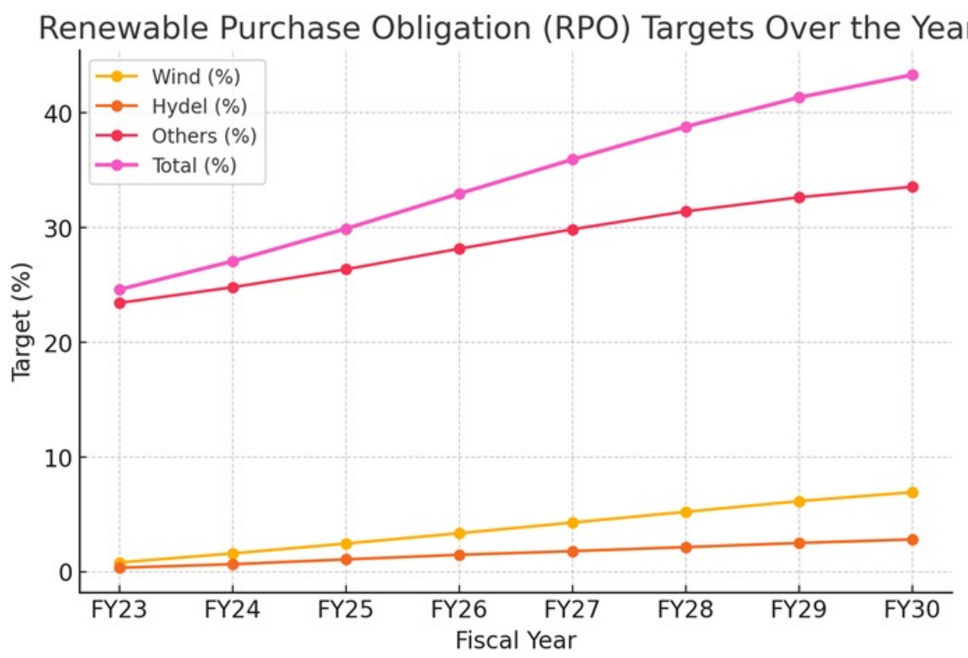
04

Regulatory Approaches to Emissions and Renewable Energy

India has increasingly integrated climate and sustainability goals into power sector governance through quasi-carbon pricing, emission standards, and mandates for renewable energy growth. While it lacks a nationwide carbon tax or emissions trading system, surrogate measures have been implemented. The coal cess, introduced in 2010 and raised to ₹400/ton by 2016, initially funded clean energy projects but was later repurposed, reducing its climate impact. The Perform, Achieve, Trade (PAT) scheme, launched in 2012, set efficiency targets for industries, including power plants, allowing energy-saving certificate trading. More recently, the Energy Conservation Amendment (2022) laid the groundwork for a carbon credit trading scheme, expected to integrate mechanisms like Renewable Energy Certificates (RECs) and PAT into a unified market. Regulations adopted in 2024 outline an intensity-based carbon market, requiring sectors like cement, steel, and later power generation to meet greenhouse gas intensity targets through tradable Carbon Credit Certificates (CCCs). While a full-fledged carbon tax is absent, these initiatives align with global trends in carbon pricing.

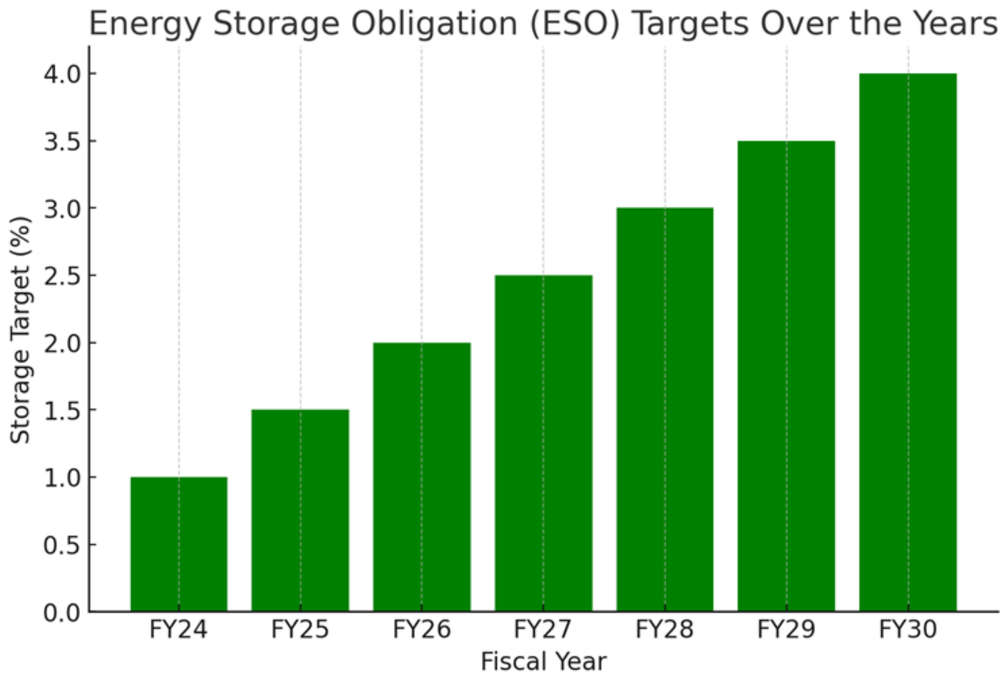
Regulators have also enforced emission standards for coal-fired plants. In 2015, the government mandated retrofitting pollution control equipment for SO_2, NO_x, and particulate matter, indirectly encouraging the retirement of inefficient coal plants. The Central Electricity Authority (CEA) plans to phase out 11 GW of old coal capacity by 2030, further reducing emissions. Some regulators are piloting carbon cost adders in tariffs, integrating emission costs into power pricing, though such initiatives remain in early stages.

A key driver of India's renewable expansion is the Renewable Purchase Obligation (RPO) framework, requiring discoms and large consumers to source a minimum percentage of power from renewables. The National Action Plan on Climate Change (NAPCC, 2008) set a 15% renewable share target by 2020, but many states lagged. India's Paris Agreement commitment in 2016 raised the goal to 40% non-fossil capacity by 2030, later revised to 43% renewable electricity by 2030



To facilitate RPO compliance, the REC market, launched in 2010, allowed trading of 1 MWh renewable energy certificates to meet obligations. However, weak enforcement and low RPO targets led to oversupply and price crashes, with REC prices falling from ₹7,800/MWh in 2011 to ₹1,000/MWh by 2023. By 2021, 80% of states had RPO targets 30% lower than national recommendations, further reducing compliance.

In response, REC reforms in 2022 removed price floors and ceilings, making certificates valid indefinitely to boost trading. However, with a carbon market on the horizon, RECs may eventually be subsumed by carbon credits for compliance. Despite these challenges, RPOs have driven India's renewable growth, with 125 GW of renewables (excluding large hydro) installed by 2023, largely due to mandated procurement. Leading states like Karnataka, Tamil Nadu, Rajasthan, and Gujarat generate 15–30% of their



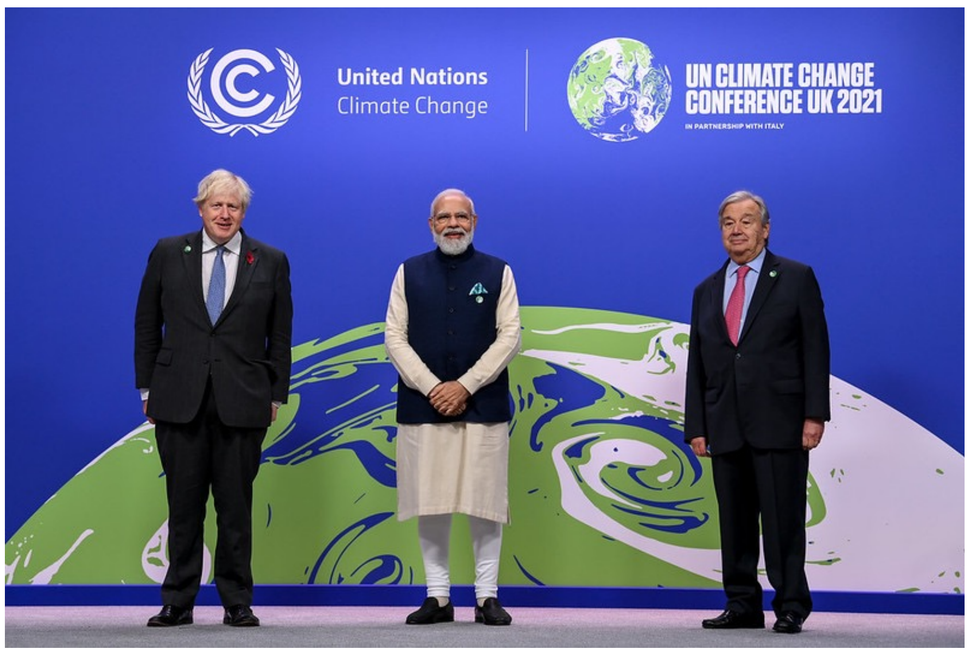
electricity from wind and solar, surpassing many countries. This rapid expansion has necessitated grid integration measures, such as forecasting and scheduling regulations and protocols for curtailment. While solar and wind enjoy "must-run" status, some curtailment has occurred due to grid congestion, highlighting the need for further infrastructure and market reforms.

05

Influence of International Agreements on Domestic Policy

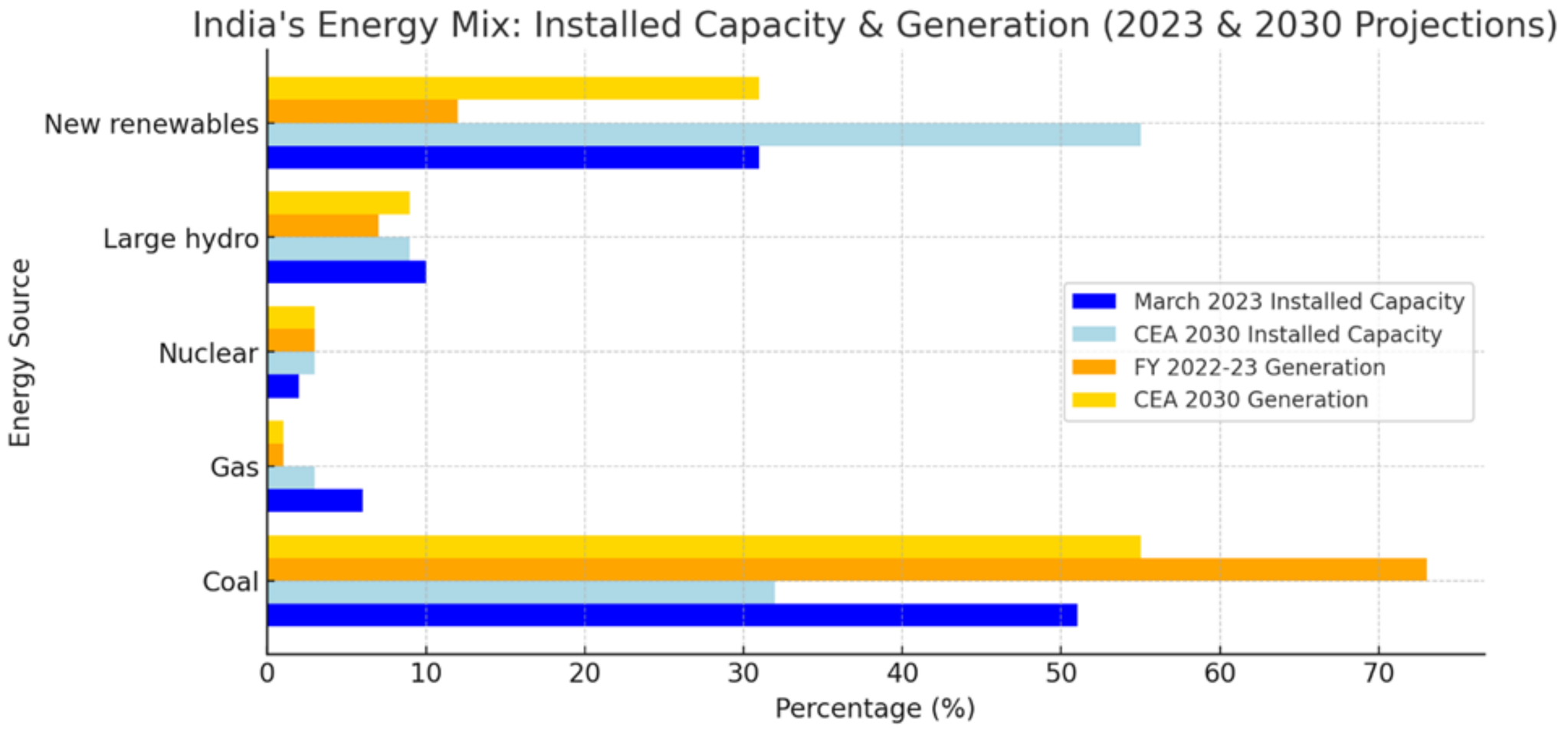
India’s power sector transformation is closely tied to its commitments under global climate agreements, particularly the Paris Agreement (2015), which set clear, measurable targets. Under its Nationally Determined Contributions (NDCs), India pledged to reduce emissions intensity by 33–35% by 2030 (relative to 2005 levels) and ensure 40% of installed capacity comes from non-fossil fuel sources. These commitments directly influenced domestic policy, leading to the 175 GW renewable energy target for 2022, of which 120 GW (excluding hydro) was achieved by early 2025. The Paris Agreement also spurred policy mechanisms like competitive renewable energy auctions, solar park development, and financial incentives to accelerate deployment.

At COP26 in Glasgow (2021), India raised its ambition with the “Panchamrit” pledge, targeting 500 GW of non-fossil capacity by 2030 and sourcing 50% of energy from renewables, along with a net-zero emissions goal for 2070. These commitments were formalized in India's 2022 NDC update, raising its emissions intensity reduction target to 45%. To align with these goals, the central government set annual renewable addition targets, expanded solar and wind bidding rounds, and strengthened state Renewable Purchase Obligations (RPOs).



COP26 in Glasgow (2021) ; Credit: ©Karwai Tang/ UK Government

International climate finance has played a key role, with World Bank and ADB-backed grid upgrades enabling renewable integration. Initiatives like the International Solar Alliance (ISA) have fostered technology transfer and global investment. States, too, have integrated climate goals into State Action Plans on Climate Change, often exceeding national targets. India’s push for green hydrogen, through the 2023 National Green Hydrogen Mission, is driven by global decarbonization efforts and India’s ambition to be a key player in the clean energy economy.



Global frameworks have also shaped India’s policy direction. The EU’s Emissions Trading Scheme (ETS) influenced India’s carbon market design, while UN Sustainable Development Goal 7 reinforced India’s focus on energy access alongside sustainability. The Paris Agreement’s transparency mandates improved energy data tracking, reflected in periodic NDC updates and the Integrated Energy Policy. Domestic policies, like the Green Energy Open Access Rules (2022), explicitly cite international commitments as justification for stricter clean energy mandates.

International agreements have served as both a catalyst and an accountability mechanism, ensuring India pursues ambitious clean energy policies while securing financial and technical support. This interplay between global commitments and domestic action continues to shape India’s power sector, accelerating its transition toward a low-carbon future.

06

Financial and Policy Incentives for Clean Energy

India has employed a range of financial and policy incentives to accelerate renewable energy adoption, including tradable certificates, subsidies, production-linked incentives (PLIs), and tax benefits. These mechanisms have played a crucial role in driving investment and reducing renewable energy costs.

Renewable Energy Certificates (RECs) were introduced to facilitate Renewable Purchase Obligation (RPO) compliance, but weak enforcement led to low demand and price crashes. While REC reforms in 2022, such as perpetual validity and corporate voluntary purchases, aim to revive interest, their long-term role remains uncertain with the potential integration of a national carbon market. Meanwhile, International RECs (I-RECs) remain less attractive due to lower prices compared to domestic RECs.

Particular	Local REC	I-REC
Value of a certificate	1 MWh (with multiplier)	1 MWh (no multiplier)
Technology	Hydro, pumped hydro, wind, solar, biomass, biofuel, waste to energy	Hydro, wind, solar, biomass, wave, tide
Issuance	Grid-India	Accredited third-party issuers
Transaction	Power exchange	Over the counter
Redemption	Single transfer only	Single transfer only
Sellers	Renewable generators, DISCOMs, open-access / captive consumers, traders	Renewable generators
Buyers	Obligated consumers (DISCOMs, open access / captive), voluntary buyers	Voluntary buyers
Verification	Not applicable	Third-party verification

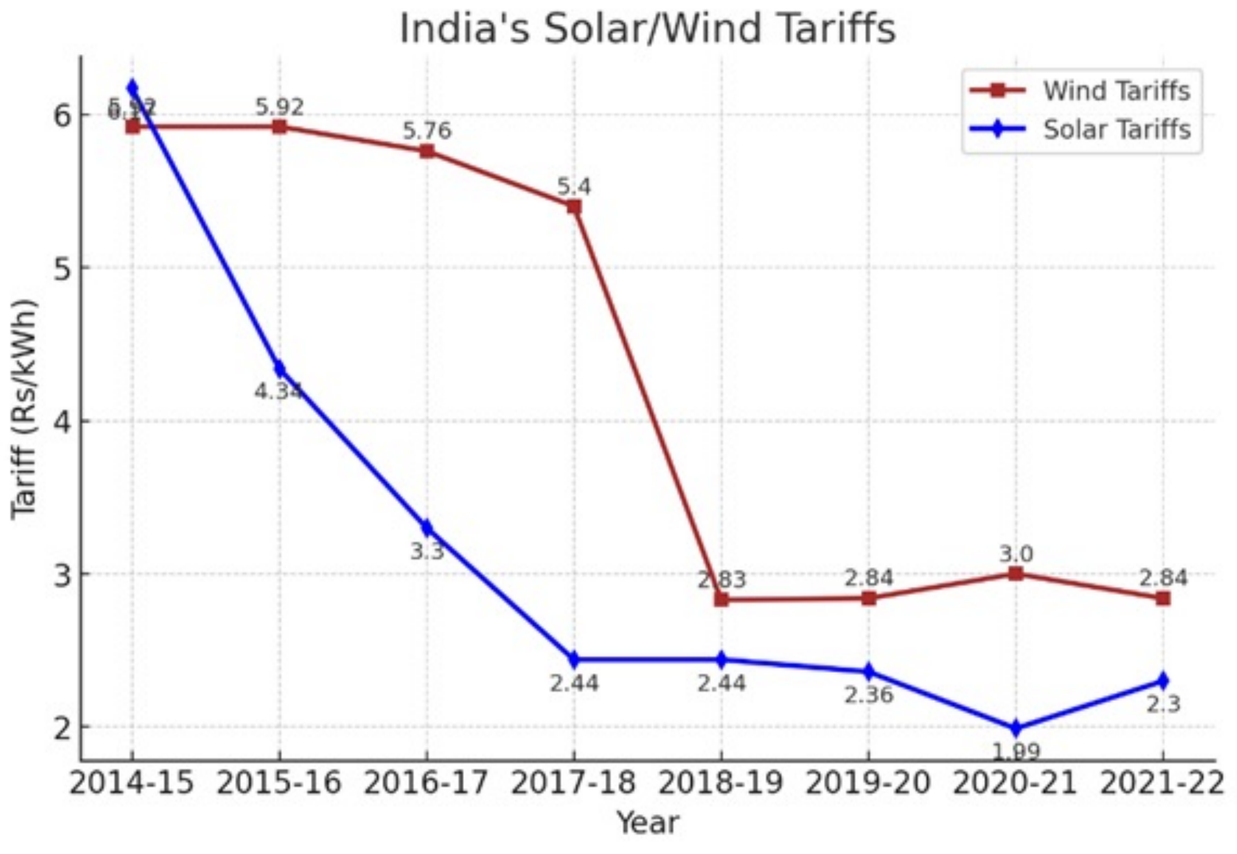
Viability Gap Funding (VGF) has supported high-cost emerging technologies like offshore wind and battery storage. A ₹7,453 crore (~$890 million) package was recently allocated for 1 GW of offshore wind in Gujarat and Tamil Nadu, alongside ₹600 crore for port upgrades. A separate battery storage VGF supports 4,000 MWh of energy storage projects. VGF has historically jump-started new sectors, with subsidies tapering off as costs decline—evident in solar PV and onshore wind, which no longer require direct support.

Production-Linked Incentives (PLI) focus on domestic manufacturing, reducing import dependence on China. The ₹19,500 crore (~$2.5 billion) solar PLI scheme aims to establish 48 GW of new manufacturing capacity across polysilicon, wafers, cells, and modules, attracting investment from major players like Reliance, Adani, and Tata. A ₹18,100 crore PLI for Advanced Chemistry Cell (ACC) batteries supports local battery production for grid storage and electric vehicles, aligning industrial policy with clean energy goals.

Tax and fiscal incentives have historically encouraged investment, including accelerated depreciation for wind farms, interest subsidies via IREDA, and interstate transmission charge waivers (extended through 2025). Sovereign green bonds, first issued in 2023, provide lower-cost financing for renewable projects, reflecting innovative approaches to sustainability-aligned investment.

India's market-based incentives also include energy banking, allowing renewables to store excess generation and withdraw later, but many states have restricted these benefits to protect discom revenues. This ongoing balancing act highlights the challenge of encouraging renewables while maintaining utility financial stability.

As renewable technologies mature, India is shifting from direct subsidies to performance-linked and market-driven mechanisms. Future incentives will focus on grid stability, energy storage, and green hydrogen, with PLI and VGF strategies for these emerging sectors being closely monitored as models for sustainable energy finance.



07

Emerging Business Models and Smart Grid Innovations

India’s clean energy transition is driving new business models and technological innovations, from corporate procurement mechanisms to decentralized energy solutions and grid modernization.

Virtual Power Purchase Agreements (VPPAs) are emerging as a way for corporations to meet renewable energy commitments without direct access to green power. In a VPPA, a corporate buyer and a renewable developer agree on a fixed energy price, with the developer selling power into the grid at market rates. The buyer then pays or receives the difference, enabling them to claim renewable energy credits (RECs). While VPPAs are common globally, they remain nascent in India due to regulatory uncertainties. A WWF India study estimates that with proper regulatory support, VPPAs could drive up to 62 GW of renewable capacity by 2030.

Decentralized energy solutions, especially rooftop solar and microgrids, are expanding access to clean power. The 40 GW rooftop solar target for 2022 fell short, with only 7 GW installed, but net metering policies have driven adoption. The Green Open Access Rules (2022) mandate net metering up to 500 kW, and Delhi’s virtual net metering allows residents to invest in offsite solar plants. Microgrids remain essential in remote areas, with

government schemes like Decentralized Distributed Generation (DDG) supporting solar and battery projects. The PM-KUSUM scheme, launched in 2019, promotes solar water pumps and small-scale solar plants for farmers, turning them into energy entrepreneurs. Emerging innovations, such as peer-to-peer solar trading using blockchain, are being piloted in states like Uttar Pradesh and Gujarat.

Smart grids and modernization are crucial for integrating renewables. The National Smart Grid Mission (NSGM, 2015) is upgrading distribution networks with automated outage management and voltage control. India is also deploying smart meters, with 12–18 million installed by 2024 and a goal of 250 million replacements in the coming years. Smart meters enable time-of-day pricing, helping optimize solar and wind energy use. Grid transmission is improving through Green Energy Corridor projects, co-funded by international banks, to move power from resource-rich states like Rajasthan and Tamil Nadu to high-demand areas. India is also piloting Battery Energy Storage Systems (BESS), treating storage as a grid asset for frequency regulation and peak supply. Regulatory amendments in 2022 recognized storage as part of open access markets, cementing its role in the energy transition.

These innovations reflect India’s evolving power sector, blending market-driven models, decentralized solutions, and smart infrastructure to accelerate renewable energy adoption.

08

Regulatory Bottlenecks in India’s Clean Energy Transition

8.1 Discom Financial Challenges and Impact on Clean Energy

No discussion of India’s power sector is complete without addressing the financial malaise of distribution companies. These state owned utilities are the lynchpin: they buy power from generators and sell to consumers. If they are financially distressed, they can become a bottleneck for clean energy development – delaying payments, not signing new contracts, or not investing in necessary upgrades. Unfortunately, many Indian discoms are indeed in trouble. As of FY2022-23, accumulated losses of India’s discoms stood at a staggering ₹6.77 lakh crore (about $82 billion). Six states account for 75% of these losses, with Tamil Nadu, Rajasthan, and Uttar Pradesh being the largest contributors. India’s discom financial crisis stems from the gap between power supply costs and revenue recovery, driven by subsidies, inefficiencies, and rigid cost structures.

8.2 Why Discoms Lose Money ?

- Subsidized Tariffs: Electricity for agriculture and low-income consumers is heavily subsidized, with states often delaying payments. In 2022-23, subsidies accounted for ₹1.66 lakh crore (18% of discom revenue), with some states relying on subsidies for 40-50% of expenses.

- High Losses: Technical and commercial losses remain 20-30% in some states, causing revenue leakage.

- Cost Inflexibility: Long-term coal power contracts force discoms to pay for unused capacity, even when renewables are cheaper.

- Operational Inefficiencies: Overstaffing, outdated infrastructure, and poor planning raise costs beyond regulatory allowances.

8.3 Impact on Clean Energy

- Delayed Payments: Discoms owe renewable developers billions, delaying payments for over a year, raising financing costs, and discouraging investment.
- Reluctance to Sign PPAs: States have renagotiated or canceled renewable Power Purchase Agreements (PPAs), undermining investor confidence.
- Curtailment & Grid Neglect: Some discoms curtail solar and wind power due to cash shortages, despite regulatory “must-run” protections.
- Blocking Distributed Energy: Fearful of losing high-paying industrial consumers to rooftop solar and open access renewables, discoms lobby for restrictions like extra surcharges and net metering limits.

8.4 Government Interventions

Multiple bailouts—UDAY (2015), liquidity infusions (2020), and RDSS (2021)—have attempted to stabilize discoms. RDSS ties ₹3 trillion in modernization grants to loss reduction targets and mandates smart meters and cost recovery reforms. Policies like Letter of Credit (LC) requirements (2019) and Late Payment Surcharge rules have improved payment discipline.

Deeper reforms—tariff rationalization, direct benefit transfer (DBT) of subsidies, independent regulation, and privatization—are needed for a sustainable turnaround. Discom solvency is critical for scaling renewables, paying on time, integrating EVs, and modernizing the grid. Some states, like Punjab, have already replaced costly coal projects with cheaper solar, signaling a path toward financial recovery through renewable procurement.

09

Case Studies

Gujarat: Power Sector Turnaround and Renewable Leadership

Gujarat is often cited as a model for power sector reform in India. In the early 2000s, Gujarat's electricity board was financially crippled. It was posting annual losses over ₹2,200 crore in 2000-01, with T&D losses above 35%. Private supply was unreliable and private investment was nil. The state undertook a sweeping turnaround with key measures which included financial restructuring and cracking down on theft by establishing dedicated police stations for power theft cases. By segregating agricultural feeders from residential feeders in rural areas through the Jyotigram Scheme launched in 2003, it allowed rural residents to receive round the clock electricity with farmers getting limited but predictable supply drastically reducing illegal contraptions to get extra power. By 2006, Gujarat had nearly eliminated load shedding for all consumers, a rarity in India then.

The state also unbundled its SEB into functional companies and privatized distribution in cities like Ahmedabad and Surat (to Torrent Power). By the late 2000s, Gujarat's distribution losses had dropped to among the lowest in India, collection efficiency hit 100%, and the utilities became profitable. This sound financial base enabled Gujarat to be an early mover in renewable energy. It was one of the first states to establish a dedicated renewable energy agency and announce a solar policy (2009) offering feed-in tariffs, which led to Asia's then-largest solar park in Charanka.

The state met its RPO targets consistently – its regulator enforced compliance, which not all states did. By 2020, Gujarat had built 5 GW of solar and 7 GW of wind, and it has since aggressively bid out new capacity (including India's first round of offshore wind sites). Notably, Gujarat in 2021-22 also led in emerging areas like green open access, hosting many new corporate PPA projects once the rules eased.

Figure 2 Khavda, World's Largest Renewable Energy Park

By solving basics (reducing losses, ensuring cost recovery, targeting subsidies better), it freed up resources and capacity to invest in renewables. Gujarat also demonstrated the value of policy certainty – its early solar developers were attracted by a clear 25-year tariff policy in 2009 and later the state smoothly shifted to auctions as costs fell. The Gujarat Electricity Regulatory Commission has been relatively proactive e.g., formulating intra-state forecasting regulations for wind/solar early, which helped integrate a high share of renewables with minimum curtailment. The lesson is that consistent policy and reform-oriented approach can turn a power sector from deficit to surplus while greening the grid. Gujarat today often has more power than it needs, and exports to other states – a far cry from two decades ago.

Madhya Pradesh: Rewa Ultra Mega Solar Park and the Economics of Scale

Madhya Pradesh, historically reliant on coal-fired power, has emerged as a leader in large-scale solar energy, leveraging its vast solar potential to transition towards a cleaner electricity mix. The state's shift aligns with national targets for renewable energy growth and the increasing role of solar in meeting India's climate commitments. While the state has developed solar and wind capacity in multiple regions, no project has been as transformative as the Rewa Ultra Mega Solar Park (RUMS). RUMS is one of the first instances of a state government owned entity handling everything from project conceptualization, land identification, institutional arrangements, technical, market consultations, financial and legal structures and bid process management from the start. This 750 MW facility, developed in the Rewa district, set new benchmarks for tariff reduction, risk mitigation, and financial structuring, becoming a model for future large-scale solar parks across the country.

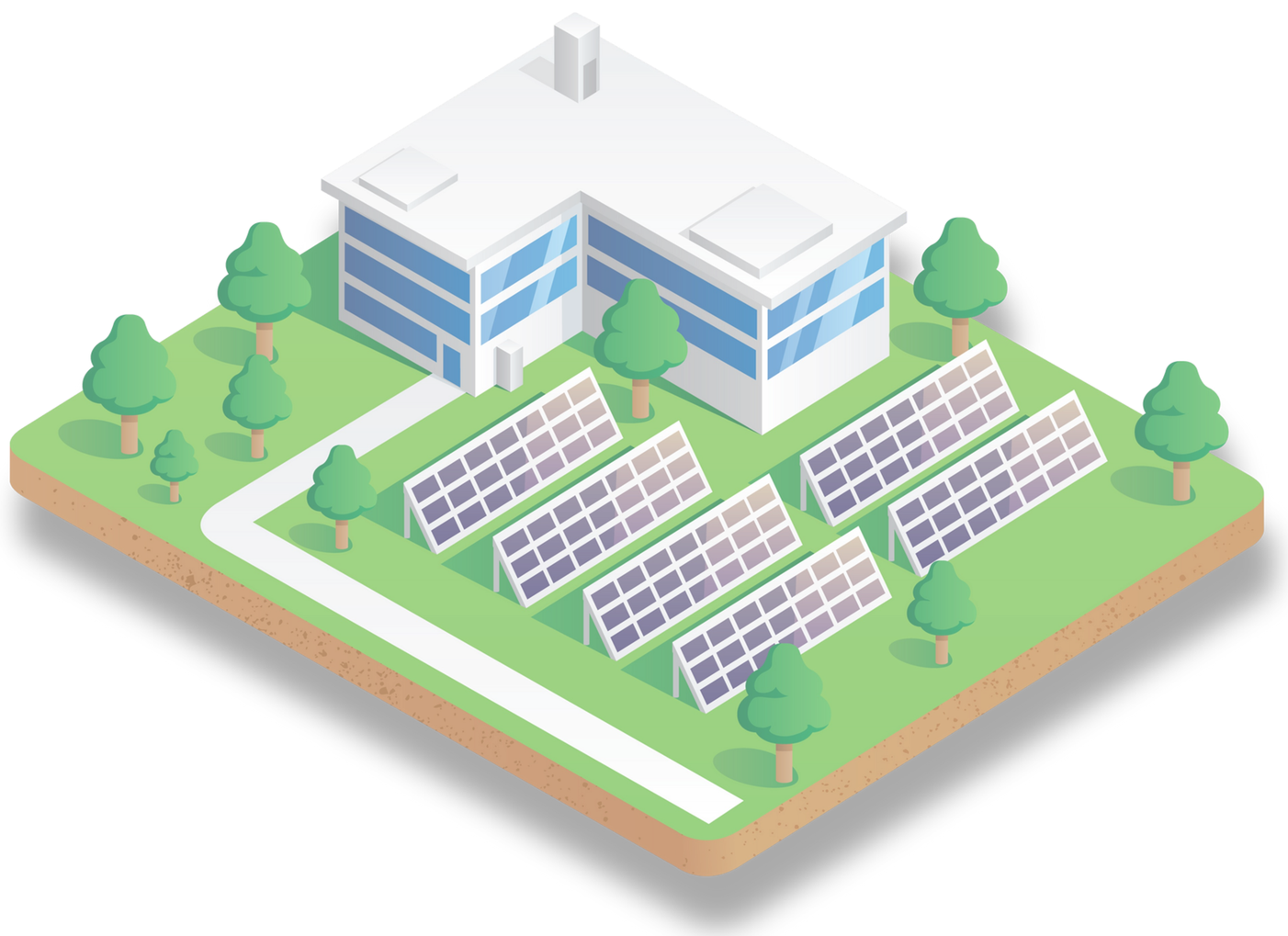
Located on 1,589 hectares of barren land, RUMS was conceptualized to minimize land acquisition challenges while maximizing the efficiency of large-scale solar generation. The project was spearheaded by Rewa Ultra Mega Solar Limited (RUMSL), a joint venture between Madhya Pradesh Urja Vikas Nigam Limited (MPUVNL) and the Solar Energy Corporation of India (SECI), with financial backing from the World Bank. The park followed a public-private partnership (PPP) model, ensuring smooth execution through coordinated efforts between the state and central governments, financial institutions, and private developers. The project introduced a reverse auction bidding process, which drove the first-year tariff down to Rs 2.97/kWh, a record low at the time. This pricing set a precedent for future solar projects in India, proving that competitive auctions could significantly lower renewable energy costs.

Figure 3 Aerial View of Rewa Solar Park

One of the key factors behind Rewa's success was its multi-tiered payment security mechanism, designed to address investor concerns about the financial health of state utilities. Given the struggles of many discoms in meeting their financial obligations, the project incorporated a payment security fund, a letter of credit, and state-backed guarantees. These measures ensured timely payments to solar developers, boosting investor confidence in the project. Additionally, the power procurement structure was strategically designed, with long-term agreements signed with two major buyers—Delhi Metro Rail Corporation (DMRC) and Madhya Pradesh Power Management Company Limited (MPPMCL). The 25-year power purchase agreements (PPAs) provided a stable revenue stream, making the project financially viable.

Unlike some states that have faced grid congestion and curtailment issues when integrating large-scale renewables, Madhya Pradesh anticipated these challenges and planned accordingly. A dedicated 220/400 kV transmission substation was built to handle the large inflow of solar power, reducing curtailment risks and ensuring efficient evacuation of electricity. The state also worked closely with transmission companies to ensure that power from Rewa could reach high-demand areas, including Delhi. The fact that DMRC, a commercial entity outside Madhya Pradesh, procured power directly from Rewa marked a significant regulatory milestone, demonstrating that large-scale solar projects could successfully participate in interstate electricity supply without policy bottlenecks.

Madhya Pradesh's transformation from a coal-dependent state to a renewable energy leader underscore how policy innovation, financial structuring, and strategic planning can accelerate the clean energy transition. The Rewa Ultra Mega Solar Park has not only provided a blueprint for large-scale solar deployment but has also reinforced investor confidence in India's renewable energy market. As the country moves towards its 500 GW non-fossil capacity target by 2030, Rewa stands as a symbol of what is possible when governments, businesses, and financial institutions work together to scale up clean energy solutions.



10

Recommendations

Renewable energy developers in India have navigated a rapidly improving market, but they still face regulatory and policy hurdles that can create uncertainty. Removing these barriers and creating a more predictable, investment-friendly environment is crucial to sustain the momentum toward 500 GW of non-fossil capacity by 2030. Key hurdles and proposed strategies include:

1. **Policy Uncertainty & Contract Enforcement:** Developers need assurance that signed contracts remain valid. The proposed Electricity Contract Enforcement Authority aims to streamline PPA disputes, while mandating penalties for defaults and requiring payment security (LC) for dispatch are steps toward stronger contract sanctity. However, uncertain taxes and duties, such as fluctuating GST on equipment and the abrupt imposition of a 25-40% solar import duty (2022), have disrupted projects. A gradual and consultative approach to policy changes is needed.

2. **Grid Connectivity & Transmission Bottlenecks:** Many solar and wind projects face delays due to lack of grid readiness. This increases costs and discourages investment. To address this, CEA's 2030 transmission plan is synchronizing grid expansion with renewable growth. Some regulators propose compensating developers if transmission delays stall projects. Fast-tracking land acquisition and right-of-way clearances for power lines is also critical.

3. **Barriers to Open Access & Corporate Procurement:** Open access renewables for commercial and industrial (C&I) consumers are often hindered by high surcharges, unpredictable wheeling charges, and inconsistent state rules. The Green Open Access Rules (2022) streamlined approvals and a capped surcharges, but state-level implementation varies. Banking of renewable power—once a major incentive—has been restricted in many states, reducing project viability.

4. **Land & Permitting Challenges:** Large renewable projects struggle with land acquisition and environmental clearances. Solar parks have eased this for some projects, but states lack clear guidelines for land-use change and permitting. Expanding pre-cleared renewable zones and creating GIS-based approval systems (as Rajasthan has done) can streamline processes.

5. **Market Access & Flexible Power Sales:** As renewables grow, developers want to sell power beyond long-term PPAs, but market mechanisms remain underdeveloped. Green Day-Ahead and Term-Ahead Markets exist, but trading volumes are low, and some states restrict developers from selling power outside their jurisdiction. Allowing hybrid contracts (e.g., partial PPAs with some merchant sales) and expanding ancillary service payments for grid support could enhance revenue certainty.

6. **Strengthening Regulatory Consistency:** State regulators vary in their efficiency, tariff-setting, and enforcement. Some delay decisions or succum to political pressure, worsening discom finances. Strengthening SERCs through better training, independent appointments, and harmonizing key regulations across states would improve predictability.

7. **Stability in Manufacturing Policies:** Renewable manufacturers seek policy stability in duties and incentives. The government has provided 5-year roadmaps for customs duties, but further guarantees on domestic content requirements and market access would boost investor confidence.

Global Best Practices & India's Path Forward

Mature markets offer lessons: transparent interconnection norms, curtailment compensation, well-functioning wholesale markets, and stable pricing mechanisms. India's expansion of power exchanges, a real-time market, and a future capacity market are steps in this direction. The entry of global renewable giants into India's auctions shows that if policy remains stable and investor-friendly, capital will flow, accelerating India's clean energy transition.

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The Road Ahead

Decades of regulatory evolution have brought India's power sector from a state-controlled, deficit-ridden system to one that is increasingly competitive, financially aware, and oriented toward sustainability. The infusion of renewable energy into the grid is no longer a peripheral experiment but a central pillar of India's energy strategy, driven by robust targets and facilitated by regulatory frameworks like RPOs and open access rules. As this analysis detailed, significant strides have been made: independent regulators oversee the sector, transparent competitive bidding has unlocked ultra-cheap solar and wind power, and policies are in place to encourage everything from domestic manufacturing of solar equipment to adoption of electric vehicles that will boost electricity demand.

Yet, challenges remain complex. The financial viability of discoms emerged as a recurring theme affecting all other efforts – a reminder that technical and regulatory solutions must be paired with economic realism. The sustainability of the power sector transition hinges on aligning incentives such that what is good for the climate and consumers is also good for the utilities' balance sheets. Encouragingly, the government's recent reforms and schemes are attempting to do just that, by coupling bailout funds with loss-reduction milestones and pushing time-of-day pricing that rewards both the grid and the consumers for flexible, efficient use.

On the international stage, India's commitment to climate goals and its sheer scale of renewable deployment have made it a key player in global sustainability efforts. The Paris Agreement influences and validates India's policy direction, but India in turn is influencing global markets – for example, its success in driving solar prices down has benefited other countries by making photovoltaics more affordable worldwide. As India moves toward its 2030 goals (500 GW non-fossil, 50% renewable energy, etc.) and eventually the 2070 net-zero target, it will need to continuously refine its regulatory and market design. This means fostering innovation like energy storage integration, green hydrogen linkages with the power grid and ensuring reliability during the transition by investing in grid resilience and perhaps cleaner gas-based balancing power or regional power trade.

The road ahead calls for a delicate balancing act between centre and state, between incumbent interests and new players, and between short-term exigencies and long-term sustainability imperatives. The comprehensive overview in this analysis suggests cautious optimism – India has identified most of the critical levers be it discom reform, market liberalization, or incentive alignment and is acting on them. The pace of implementation and the ability to build consensus, especially with states, will decide how smooth the journey is.

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