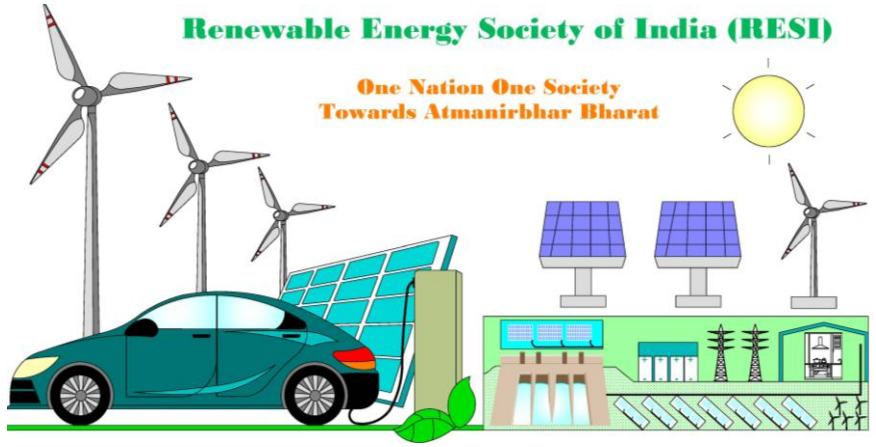
Renewable Energy Chronicles: The Power Saga Vol. 03/2025

"India's Renewable Energy Ambitions: Confronting Ground Realities"

(The Unsold Power Paradox and Tightrope Walk in Achieving 500 GW by 2030)



Renewable Energy Society of India (RESI)

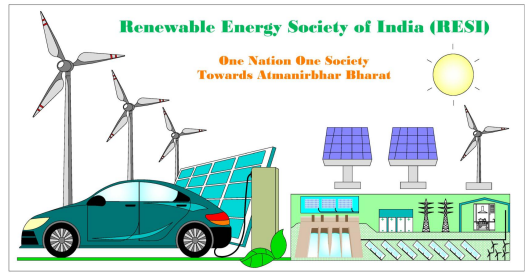
Abstract

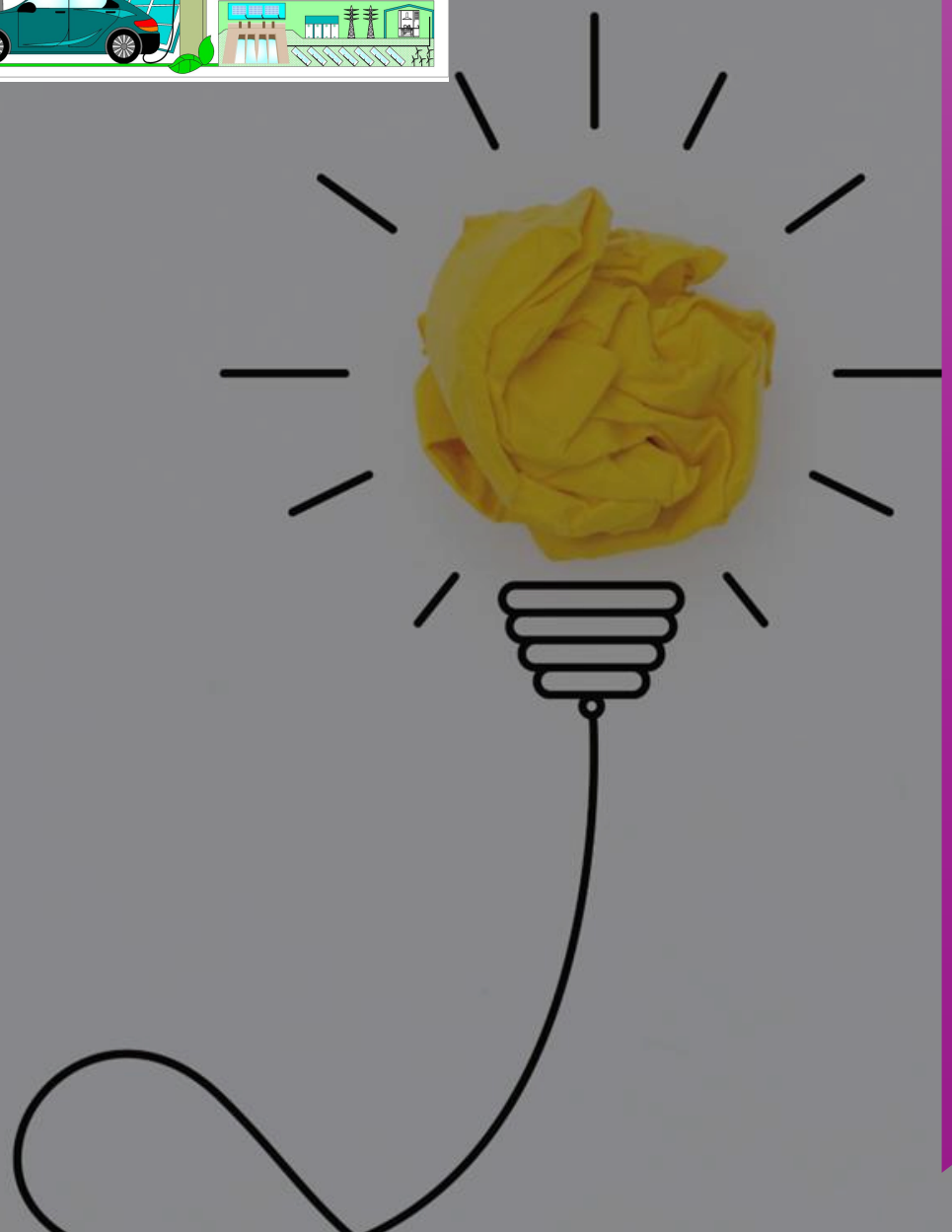
India's energy shift is accelerating, with renewables at 45.65% of 464 GW installed capacity, while fossil fuels have dropped to 52% (from 68% in 2014). Solar and wind dominate RE growth, with solar alone surging 3454% since 2014, driving India's 280 GW solar target and a 100 GW domestic module push for self-sufficiency by 2030.

Despite progress, unsold RE power and grid bottlenecks pose challenges. DISCOM financial stress, tariff reluctance, and FDRE costs hinder adoption. Transmission gaps persist in the Green Energy Corridor completed and delays in Khavda PS-III, Barmer HVDC, and Ladakh's 13 GW HVDC projects.

To meet 500 GW RE by 2030, India must fast-track ISTS expansion, integrate solar plus storage, and boost offshore wind. Policy clarity on BCD-GST and standardized penalties is crucial. Linking DISCOM support to PPA commitments, rationalizing tariffs, and strengthening the Eastern Grid will unlock RE potential, ensuring reliable, market-ready green energy.

Global and Indian Electricity Demand Outlook





Global electricity demand surged by 4.3% in 2024 and is projected to maintain an annual growth rate of nearly 4% through 2027, adding approximately 3,500 TWh over the next three years. Emerging economies will drive 85% of this additional demand, with China and India as the key contributors.

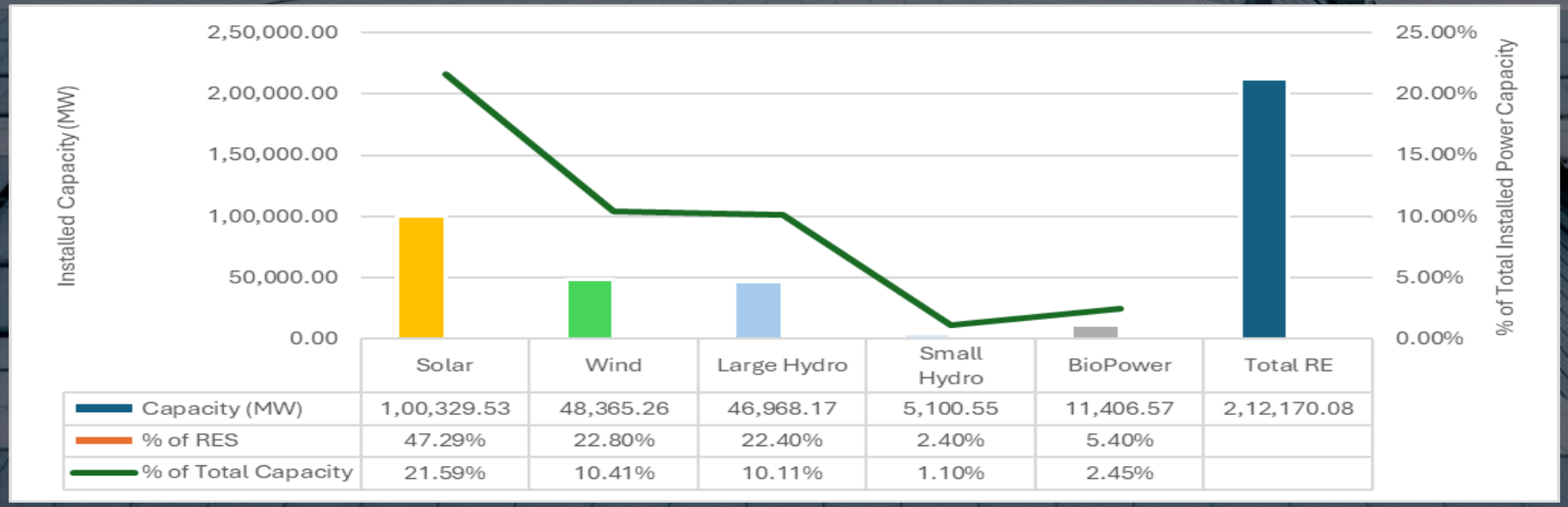
India's electricity consumption is set to grow at an average annual rate of 6.3%, exceeding the previous decade's 5% growth trend. In 2024 alone, demand increased by 5.8%, pushing the peak load to 250 GW, a 68% rise since 2014. This rapid growth underscores the country's accelerating energy requirements amid industrial expansion and urbanization.

On the renewable energy (RE) front, India's installed RE capacity has reached 212.18 GW, now forming 45.5% of the total power capacity. However, systemic bottlenecks, such as unsold RE projects and grid integration challenges, pose significant hurdles to further progress. Despite these constraints, RE's share in electricity generation has climbed to 22.49%, up from 17% in 2014–15, highlighting India's transition toward a more sustainable energy mix.

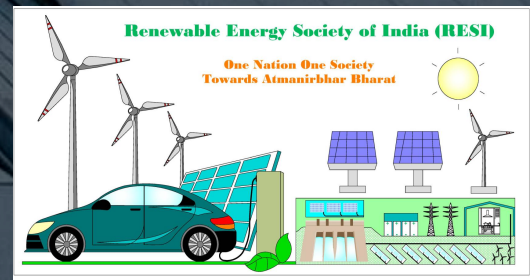
As demand continues to surge, addressing infrastructure bottlenecks and enhancing grid flexibility will be critical in ensuring reliable and sustainable power availability.

India’s Clean Energy Transition: A Decade of Growth and Future Ambitions

- India’s power sector is undergoing a rapid transformation, with renewables now comprising 45.65% of the country’s 464 GW installed capacity. Meanwhile, the share of fossil fuels has declined to 52%, a significant drop from 68% in 2014. Non-fossil sources, including nuclear energy (1.8%), collectively account for 47%, marking a decisive shift toward cleaner energy alternatives.
- The country’s renewable energy (RE) capacity—excluding large hydro—has surged from 35.8 GW in 2014 to 165.2 GW by January 2025, reflecting a 4.6-fold increase over the past decade. Solar and wind remain the backbone of this expansion, contributing 60.7% and 29.3%, respectively, to India's total RE portfolio. Solar power, in particular, has seen explosive growth, soaring by 3,454% between 2014 and 2025, positioning India on track for its ambitious 280 GW solar target by 2030.
- Beyond capacity expansion, India is strategically advancing solar manufacturing independence, with a target of 100 GW module production by 2030—ensuring self-sufficiency and export readiness in the global solar supply chain. This bold vision underscores India's commitment to energy security, sustainability, and leadership in the global renewable energy transition.

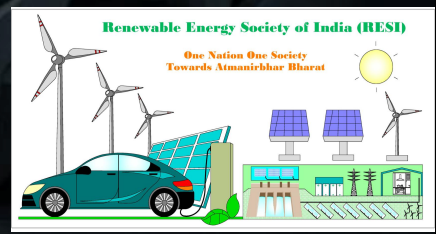


	Solar	Wind	Large Hydro	Small Hydro	BioPower	Total RE
Capacity (MW)	1,00,329.53	48,365.26	46,968.17	5,100.55	11,406.57	2,12,170.08
% of RES	47.29%	22.80%	22.40%	2.40%	5.40%	
% of Total Capacity	21.59%	10.41%	10.11%	1.10%	2.45%	



The Unsold Power Dilemma

- India’s solar energy sector is on the brink of unprecedented expansion, with an installed capacity of 100.33 GW as of early 2025. However, the real momentum lies in the massive project pipeline, which is set to nearly triple the nation’s solar footprint by 2030, targeting 292 GW of total solar capacity.
- Notably, projects under development already account for 84% (~80 GW) of the current installed capacity, playing a crucial role in meeting this ambitious goal. However, a major bottleneck exists—over 50% of these projects have received a Letter of Award (LoA) but are yet to sign Power Purchase Agreements (PPAs) with utilities. These tenders, spearheaded by leading Renewable Energy Implementing Agencies (REIAs) such as SECI, NTPC, NHPC, and SJVN, remain in limbo, alongside state-level tenders from Gujarat, Rajasthan, Maharashtra, Madhya Pradesh, and Karnataka.
- Compounding the challenge, nearly 50 GW of tendered capacity still awaits the issuance of LoAs and subsequent PPA finalization, further delaying project execution. SECI alone, as of February-end, holds over 5 GW of unsold capacity, reflecting a critical market hurdle—5,446 MW of allocated renewable energy capacity across 11 schemes remains uncontracted. This stagnation highlights persistent structural issues, including grid readiness concerns, demand-supply mismatches, and financial constraints, exacerbated by DISCOMs’ reluctance to absorb premium tariffs. Addressing these challenges is imperative for unlocking India's full solar potential and ensuring a smooth trajectory toward its 2030 renewable energy commitments.



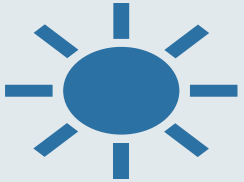
Why Is Renewable Power Going Unsold?

- India's renewable energy sector faces a critical bottleneck despite ambitious targets. A substantial portion of newly auctioned capacity remains unsold due to financial, economic, and policy barriers, slowing the transition to clean energy.
- Currently, 180 GW of projects are at the implementation stage, with a Letter of Award (LoA) issued but yet to be commissioned. Alarmingly, over 50% of these projects lack signed Power Purchase Agreements (PPAs), leading to prolonged delays. Of this, more than 50 GW is from solar alone, where PPA signings remain stalled despite LoA issuance.
- Similarly, ~80 GW of capacity is in the tendering stage, with ~90% comprising solar and hybrid projects. However, without clear interventions and financial certainty, these projects risk facing the same execution challenges.
- To unlock the full potential of India's renewable energy pipeline, resolving PPA bottlenecks, ensuring financial viability, and accelerating transmission infrastructure expansion will be crucial for meeting the 500 GW RE target by 2030.The key challenges include:

DISCOM Financial Stress

PPA Reluctance: Power distribution companies (DISCOMs) are hesitant to sign power purchase agreements (PPAs) for high-cost renewable energy projects. For instance, SECI's FDRE-IV (680 MW) and Hybrid Tranche VI (600 MW) auctions remain uncontracted due to concerns over premium tariffs (up to ₹8.50/kWh) and stringent penalty clauses (1.5x PPA tariff for supply shortfalls).

State-Specific Preferences: Leading states like Maharashtra, Gujarat, Rajasthan, and Madhya Pradesh favor their own renewable auctions (wind, solar, and battery storage) over central agencies' (SECI, NTPC, NHPC, SJVN) schemes, citing trading margins as unaffordable.



Storage & Hybrid Project Hurdles

Unviable Solar+ESS Tariffs: SECI's 1.2 GW Solar+Energy Storage (ESS) tender (600 MW/1,200 MWh) failed to attract interest, with developers citing unsustainable tariffs of ₹3.42/kWh, which do not adequately compensate for storage costs of ₹0.50–0.70/kWh.

Wind Tariff Instability: After dropping to ₹2.43/kWh (2017–18), wind power tariffs rebounded to ₹3.18/kWh (2023–24) due to supply chain disruptions and GST-related uncertainties, making them less attractive to DISCOMs.

Policy & Implementation Gaps

Tax & Duty Uncertainties: Adani Green's 1,799 MW manufacturing-linked solar project remains uncontracted due to disputes over Basic Customs Duty (BCD) and GST liabilities, leading to stalled procurement.

Offshore Wind Delays: Against an ambitious 37 GW offshore wind target by 2030, only 500 MW (Gujarat coast) has been tendered under a ₹7,453 crore Viability Gap Funding (VGF) scheme, highlighting policy execution gaps in offshore wind deployment.

While India's renewable energy sector continues to expand, DISCOM financial stress, tariff misalignment, and regulatory uncertainties are slowing procurement. Addressing these bottlenecks through financial restructuring, cost-reflective tariffs, and clearer policy frameworks will be essential to ensuring a sustainable transition to clean energy.

Transmission Constraints for Renewable Energy Projects in India

India's ambitious target of integrating 500 GW of renewable energy (RE) by 2030 faces a critical bottleneck—transmission infrastructure readiness. While solar and wind capacity are expanding rapidly, transmission availability in high-potential zones remains inadequate, leading to curtailment risks and slower project implementation. Key Challenges & Infrastructure Gaps are as under:

Green Energy Corridor (GEC) Progress Lag

The Green Energy Corridor (GEC) is crucial for evacuating RE power, yet progress remains slow.

Out of 19,520 ckm targeted under Phases I & II, only 9,136 ckm is operational.

GEC Phase-II, designed to evacuate 20 GW of RE, has commissioned just 221 ckm out of 10,753 km, creating a severe transmission bottleneck.

Ladakh's 13 GW Ultra-Mega RE Project Delays

The HVDC transmission corridor for Ladakh's 13 GW RE project is facing tendering delays.

The award is expected only by August 2025, pushing overall completion to 2030, delaying grid integration of this massive RE project.

Transmission Saturation in High-RE States

Solar and wind-rich states such as Rajasthan, Gujarat, and Tamil Nadu face limited bay availability and congested margins at ISTS substations (e.g., Bhadla, Fatehgarh, and Khavda PS).

The Bhadla Solar Park (Rajasthan) has already granted 9.5 GW, but further evacuation beyond 2026 requires additional HVDC corridors, which are yet to be developed.

Delayed Infrastructure Projects:

Critical transmission projects such as Khavda PS-III (Gujarat) and Barmer HVDC (Rajasthan) face delays due to: Land acquisition hurdles, Right-of-way (ROW) disputes, Environmental clearance issues

Regional Transmission Disparities:

Southern and Western India dominate RE capacity deployment, yet Northern and Eastern India suffer from inadequate transmission expansion, leading to imbalanced grid capacity.

Grid Congestion in Downstream Networks:

Overloading in 220kV downstream networks (e.g., Rajgarh Substation in Madhya Pradesh) restricts new connectivity and adds grid congestion risks, further complicating RE integration.

Actionable Solutions to Strengthen Transmission for RE

Accelerate	Accelerate GEC Phase-II execution with strict commissioning timelines to support high-RE states.
Fast-track	Fast-track land acquisition & ROW approvals for key transmission projects.
Expand	Expand ISTS substation capacity in high-demand zones (e.g., Bhadla, Fatehgarh, and Khavda).
Enhance	Enhance grid flexibility through HVDC corridors & hybrid transmission models for large-scale evacuation.
Prioritize	Prioritize Northern & Eastern India's transmission infrastructure to balance national RE distribution.

India risks RE curtailment and slower clean energy adoption without urgent transmission upgrades.

Transmission Status & Roadmap for 500 GW RE by 2030

- India's RE growth is outpacing transmission infrastructure readiness, creating a critical challenge in achieving the RE target by 2030. The table below highlights the current transmission capacity bottlenecks:

Region	Existing RE Capacity (GW)	Granted/ Agreed (GW)	Under Process (GW)	Additional Margin Needed (GW)
Northern	21.9	43.4	11.6	13.3
Southern	16.6	57.0	21.2	14.3
Western	28.2	71.3	17.6	6.3
All India	85.5	230.3	50.3	28.8

2025–2027: Immediate Transmission Priorities

- Commission 50 GW of under-construction ISTS projects, including Kurnool-III & Ananthapuram-II.
- Expand 765kV & 400kV networks in RE-rich zones to ensure seamless evacuation.

2028–2030: Scaling Up Transmission for 500 GW RE

- Operationalize HVDC corridors, such as 6 GW Barmer-II & 5 GW Bhadla-IV, to strengthen interstate connectivity.
- Deploy decentralized storage solutions to integrate intermittent renewables efficiently.

India's transition requires rapid transmission expansion (~300 GW via ISTS), policy agility, and grid modernization. India can ensure seamless renewable integration and a resilient power grid by bridging transmission gaps, adopting advanced technologies, and accelerating storage deployment.

Key Solutions to Bridge the Transmission Gap

Accelerate ISTS Expansion

Fast-track Green Energy Corridor (GEC) projects, such as Rajasthan's 6 GW HVDC links for Bhadla and Fatehgarh.

Expedite the 8 GW Khavda evacuation system (Gujarat) with 765kV transmission lines and ICT augmentation.

Enhance Grid Resilience

Deploy dynamic line rating & reconductoring to optimize existing transmission capacity.

Develop large-scale energy storage systems (ESS), such as the 4 GW BESS at Fatehgarh-III, to manage intermittency and peak loads.

Strengthen Policy & Regulatory Framework

Implement single-window clearances to streamline approvals and reduce transmission delays.

Encourage private investment through tariff-based competitive bidding (TBCB), especially for under-subscribed regions.

Optimize Transmission Utilization via Hybrid & Decentralized RE

Scale up solar-wind-storage hybrid projects to reduce transmission dependency and improve grid stability.

Expand rooftop solar & microgrids in high-demand states (e.g., Maharashtra, Karnataka) to reduce reliance on ISTS networks.

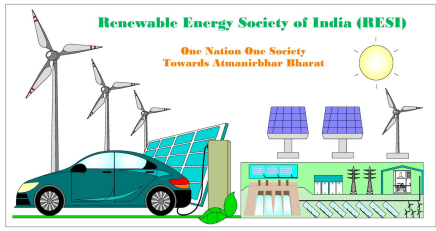
Leverage Advanced Transmission Technologies

Deploy HVDC lines for long-distance transmission, such as the Leh-Kaithal HVDC link for Ladakh's 13 GW solar project.

Implement smart grids & real-time load management systems to prevent congestion and curtailment.

Strengthen Regional Balancing & Grid Connectivity

Expand the Eastern Grid (e.g., Odisha's 2.5 GW Angul PS) to absorb surplus RE from Western & Northern regions.



Budget 2025–26: Ambition vs. Absorption

"The allocation for Solar Power (Grid) has been increased to ₹1,500 crores (up from ₹1,300 crores) under the National Solar Mission and other related schemes. Consequently, the total budget for solar energy in FY 2025-26 stands at ₹24,224.36 crores. The allocations for Wind and Bioenergy are ₹551 crores and ₹325 crores, respectively. The total budget for the Ministry of New & Renewable Energy (MNRE) amounts to ₹26549.38 crores, including for support programme."

PM-Surya Ghar (₹20,000 crore): Targeting 35 lakh rooftop installations, but current monthly installations (~1.8 lakh) must triple to meet deadlines.

PM-KUSUM (₹2,600 crore): Focus on 10 lakh pumps, but Component-C's slow progress (5% installed) needs urgent DISCOM collaboration.

Green Hydrogen Mission (₹600 crore): Targets 5 MMT annual production by 2030, but only 4,12,000 TPA awarded so far.

Storage & Transmission (₹600 crore): Critical for GEC Phase-II and Ladakh projects, but historical underspending (67% of 2024–25 RE budget utilized) raises concerns.

Overall Budget Growth:

Net Allocation rises from ₹7,928.89 Cr (2023-2024) to ₹26,549.38 Cr (2025-2026), reflecting a 235% increase over three years.

2025-2026 Budget (₹31,749.38 Cr) recovers after a dip in the revised 2024-2025 (₹21,905.90 Cr), signaling renewed fiscal commitment.

Sectoral Allocation:

Solar Energy dominates (76% of Central Schemes in 2025-2026), with ₹24,224.36 Cr allocated, emphasizing grid projects and the **PM Surya Ghar Muft Bijli Yojana** (₹1,000 Cr for 1 crore households).

Hydrogen Mission retains ₹600 Cr (2025-2026), targeting global green hydrogen leadership.

Bio Energy sees reduced focus (₹325 Cr), while **Green Energy Corridor** (₹600 Cr) aims to bolster transmission infrastructure.

Institutional Funding:

Public Enterprises:

- **IREDA** receives ₹34,974.99 Cr (2025-2026), up 16% from 2024-2025, highlighting its role in renewable financing.
- **SECI** funding drops to ₹485 Cr (2025-2026), indicating shifted priorities.

R&D Institutes: Modest increases (e.g., National Solar Energy Institute: ₹28.4 Cr in 2025-2026).

Economic Implications

Strategic Shifts: Reduced allocations to International Solar Alliance (₹0 Cr in 2025-2026) suggest domestic prioritization.

Sovereign Green Fund Dependency: Transfers and recoveries (e.g., ₹1,500 Cr for Solar) highlight reliance on external financing mechanisms.

Employment & Rural Impact:

Schemes like **KUSUM** (solar pumps) and off-grid biogas aim to boost agrarian incomes and decentralized energy access.

Technical Focus

Infrastructure: Green Energy Corridor targets 6,000 CKM transmission lines for renewable integration.

Innovation: R&D allocations (₹46 Cr) and hydrogen missions align with India's net-zero goals.

Challenges

Execution Risks: Sustaining momentum for large solar/hydrogen projects amid evolving policies.

Fund Utilization: Ensuring efficient deployment of increased budgets to avoid underspending like NE States.

MNRE's 2025-2026 budget prioritizes solar expansion, hydrogen innovation, and rural electrification, balancing infrastructure scaling with strategic R&D. Fiscal prudence and execution efficiency will determine success.

Recommendations for Course Correction

Accelerate

Accelerate Grid Upgrades

- Fast-track Green Energy Corridor (GEC) Phase-II and the Ladakh HVDC transmission project to remove evacuation constraints.
- Leverage Public-Private Partnership (PPP) models to attract private investment in transmission expansion.

Revive

Revive DISCOMs with Targeted Reforms

- Link central grants to Power Purchase Agreement (PPA) signings to ensure demand certainty for RE projects.
- Reduce cross-subsidy burdens on industrial consumers to improve financial viability and increase RE adoption.

Rationalize

Rationalize Tariffs & Market Mechanisms

- Introduce storage-specific tariffs to incentivize Battery Energy Storage Systems (BESS) and flatten peak-hour pricing volatility.
- Revive incentives for wind power, such as the Generation-Based Incentive (GBI) and GST waivers, to boost investor confidence.

Ensure

Ensure Policy Certainty & Regulatory Stability

- Clarify Basic Customs Duty (BCD) & GST liability on solar and wind components to prevent cost escalation.
- Standardize penalty clauses across tenders and policies to minimize project risks and investor uncertainty.

Strengthen

Strengthen R&D & Domestic Manufacturing

- Boost funding for domestic polysilicon production to reduce dependence on imports and stabilize module prices.
- Accelerate offshore wind technology development to tap into India's 70 GW offshore wind potential.

- India's renewable energy (RE) sector is at a critical juncture. Despite ranking 4th globally in installed RE capacity, grid bottlenecks, unsold power, and DISCOM financial stress pose significant challenges to achieving the 500 GW target by 2030. Addressing these issues requires decisive policy interventions, infrastructure acceleration, and market reforms.
- India's renewable transition requires more than just megawatts on paper—it demands robust transmission, financial sustainability, and market-driven reforms. By implementing agile policies, expanding energy storage, and revitalizing DISCOMs, India can convert green generation capacity into reliable, market-ready energy, ensuring a resilient and self-sufficient clean energy future.

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