



SUPREME AUDIT INSTITUTION OF INDIA  
लोकहितार्थं सत्यनिष्ठा  
Dedicated to Truth in Public Interest



# Steering India's Power Sector Towards Viksit Bharat

**Towards improved performance,  
accountability and resilience**

*Disclaimer. The insights and facts included in this background paper are based on an academic research exercise. These are not sourced from Audit Reports of the CAG and are not be construed as CAG's opinion.*



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# EXECUTIVE SUMMARY

The Indian power sector is the third largest and one of the most complex electricity systems in the world. Over the past decade, the sector has undergone a historic transformation: generation capacities have doubled, achieved universal electrification, transitioned to a net exporter of electricity and reached a milestone of near-zero outages. Notably, in 2025, India met its Nationally Determined Contribution (NDC) target of 50 *per cent* non-fossil capacity five years ahead of schedule.

As of December 2025, the total installed capacity stands at 514 GW, with non-fossil sources contributing to 267 GW (52 *per cent*) and solar alone accounting for 136 GW (26 *per cent*) of the total installed capacity mix. This progress provides the foundation for the Viksit Bharat Vision, positioning the power sector as the core enabler of a developed economy by 2047.

To operationalise this vision, the [Draft National Electricity Policy 2026](#), (NEP 2026), was released on 20 January 2026, serving as an operational blueprint for Viksit Bharat by 2047 and Net Zero by 2070. It comes at a pivotal time and outlines a long-term plan for power generation, pricing, distribution and grid management. NETP 2026 aims<sup>1</sup> to increase India's per capita electricity consumption from the current 1,460 kWh to 2,000 kWh by 2030 and 4,000 kWh by 2047; setting ambitious milestones for:

- 1. Decarbonisation and Low Carbon Anchors:** Establish over 80 *per cent* of installed capacity and generate two-thirds of total from non-fossil fuel sources by 2047. To expand nuclear capacity to 100 GW by 2047 and establish 100 GW of Pumped Storage capacity<sup>2</sup> by 2035–36 to ensure grid stability against intermittent renewables.
- 2. Electrification:** Double electricity's share in final energy consumption, driven by large-scale electrification of transport, industry and cooking.
- 3. Energy Storage:** Achieve 300 GWh storage capacity target by 2030.
- 4. Investments:** Require a massive capital of ₹50 lakh crore by 2032, scaling to ₹200 lakh crore by 2047 for generation, transmission and distribution strengthening.

Achieving these milestones would require constantly analysing the challenges which can hamper the progress including operational, financial and structural challenges of power utilities in India. Despite rapid capacity expansion, the sector faces persistent challenges in the areas of cost

<sup>1</sup> [https://powermin.gov.in/sites/default/files/webform/notices/Seeking\\_comments\\_on\\_Draft\\_National\\_Electricity\\_Policy\\_2026.pdf](https://powermin.gov.in/sites/default/files/webform/notices/Seeking_comments_on_Draft_National_Electricity_Policy_2026.pdf)

<sup>2</sup> [https://cea.nic.in/wp-content/uploads/hp\\_\\_\\_i/2026/01/Roadmap\\_to\\_100\\_GW\\_of\\_Hydro\\_Pumped\\_Storage\\_Projects.pdf](https://cea.nic.in/wp-content/uploads/hp___i/2026/01/Roadmap_to_100_GW_of_Hydro_Pumped_Storage_Projects.pdf)

recovery, grid preparedness, service quality and institutional capacities, amongst others. Renewable capacity is currently expanding faster than the supporting grid infrastructure, creating risks related to grid congestion, insufficient storage, limited thermal plant flexibility and need for real-time market mechanisms.

Some of these issues were planned to be addressed through the [Draft Electricity \(Amendment\) Bill](#) released in October 2025. The Bill proposes comprehensive rewriting of the Electricity Act, 2003, with ambitious and comprehensive new strategies in the areas of tariffs, network sharing, open access, renewable integration and consumer protection.

## The path ahead

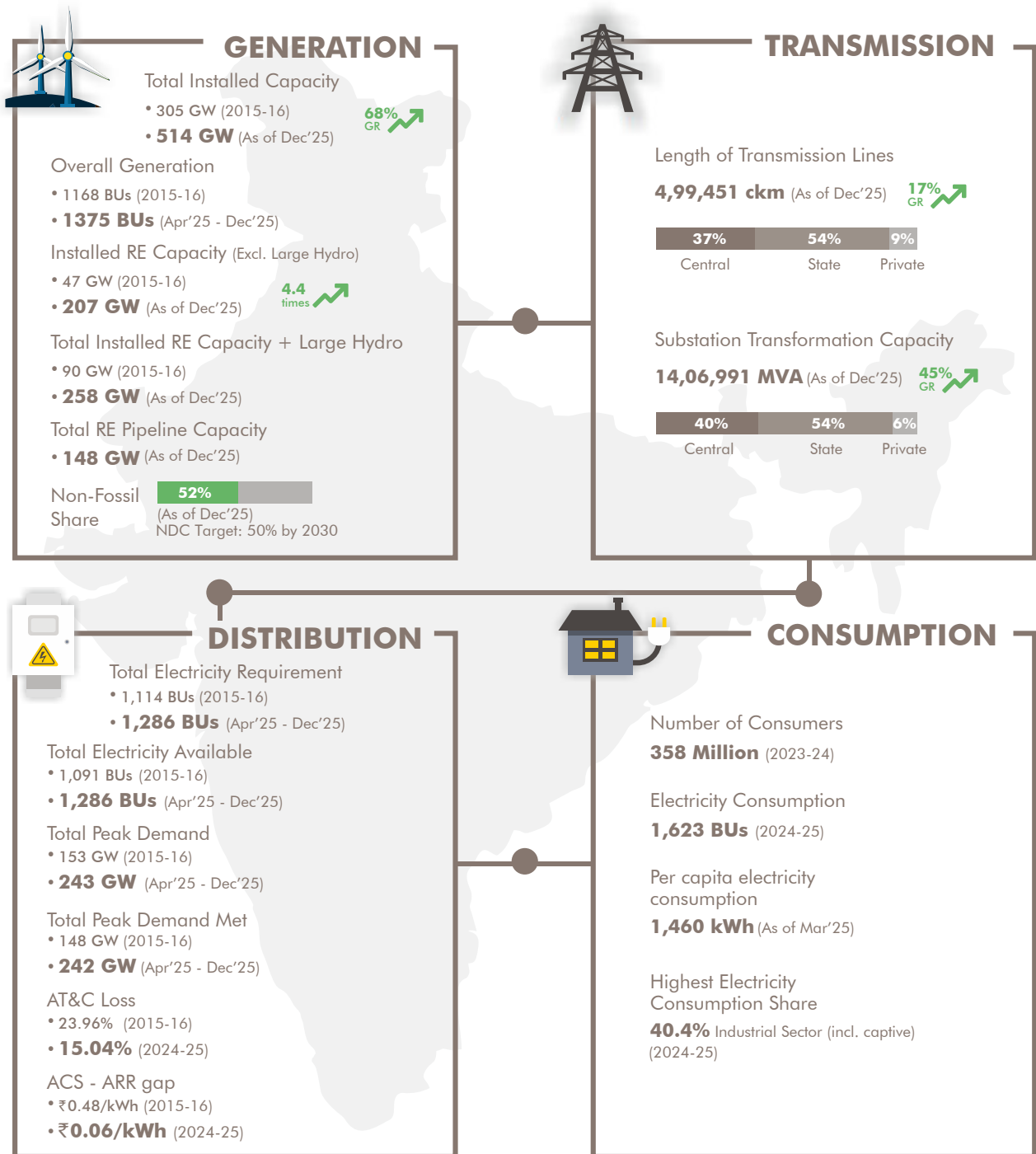
[The Economic Survey 2026](#) places climate action and clean energy transition firmly at the heart of India's economic strategy. It reinforces that a balanced mitigation pathway is a historic opportunity to reduce import dependence and create new industrial ecosystems. Despite a positive upward trend in utility performance, the recovery remains fragmented and inconsistent, with significant performance disparities persisting across various states and DISCOMs. It is critical that the reform programmes/schemes move beyond a one-size-fits-all approach towards targeted, state/DISCOM-specific interventions.

It is clear that clean energy is India's strategic advantage, but only if markets, finance and institutions evolve together. As variable renewables, decentralised generation, storage and electrification expand, the sector should transition from legacy grid operations to data-driven, resilient and consumer-centric power systems. This transformation requires a coordinated and multidimensional approach by various institutions such as power utilities, regulators, policymakers and financial institutions to align infrastructure investments, regulatory reforms, market design and sustainable financing.

**Against this background, this one-day National Conference hosted by the Comptroller and Auditor General of India (CAG) will provide a strategic platform to bring high-level stakeholders to deliberate on the strategies for dealing with these challenges with focus on digitalisation, renewable integration and financial sustainability of the power sector, particularly the DISCOMs. The discussion will aim to bring together learnings, good practices and the much-needed discourse to spearhead a new wave of transformation around performance, accountability and service quality.**

# INDIA'S POWER SECTOR

## A Snapshot



### Key Players in the Power Sector in India

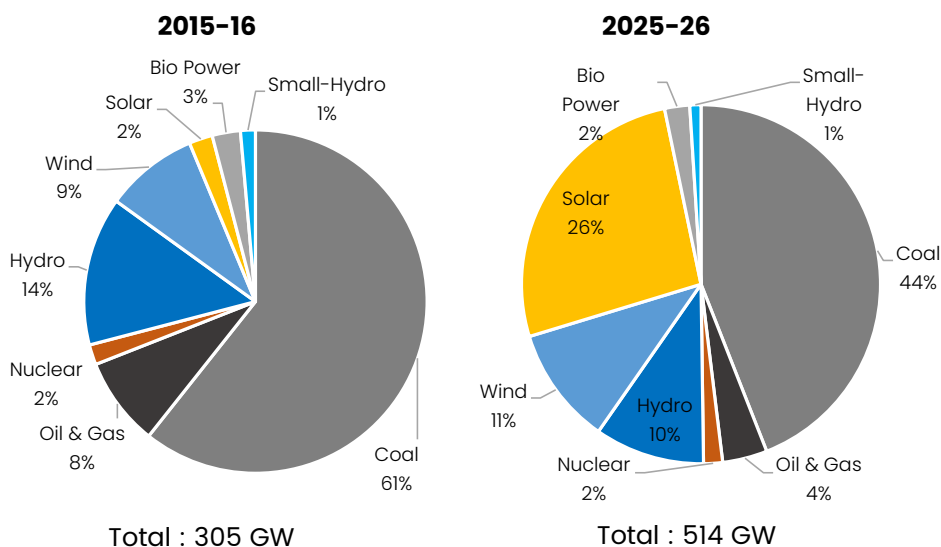
 <b>Generation</b>	<p><b>Central</b></p>  <p><b>State</b></p>  <p><b>Private</b></p> 	 <b>Transmission</b>	<p><b>Central</b></p> <p><b>State</b></p>  <p><b>Private</b></p> 
 <b>Distribution</b>	<p><b>State</b></p>   <p><b>Private</b></p> 	 <b>Financiers</b>	<p><b>Central</b></p>  
		 <b>Regulators</b>	<p><b>Central</b></p> <p><b>State</b></p> 

\* Illustrative list of prominent public and private sector institutions; not exhaustive.

# 1 GENERATION

India's power generation sector underpins economic growth, infrastructure expansion and enhanced household welfare. The nation connected over 2.8 crore additional households to the grid, dropping electricity shortages from 3.6 *per cent*<sup>3</sup> in 2014-15 to 0.1 *per cent*<sup>4</sup> in 2024-25. This progress has boosted per capita electricity consumption by ~45 *per cent*, rising to 1,460 kWh<sup>5</sup> in 2024-25 from 1,010 kWh in 2014-15.

India ranks third globally, being one of the most diversified power systems, with total installed capacity standing at 514 GW as of December 2025. Coal remains the dominant source at 44 *per cent*, followed by solar (26 *per cent*), wind (11 *per cent*), large hydro (10 *per cent*) and other sources making up the rest. This reflects the need for firm and dispatchable capacity, with coal plants providing the bulk of baseload generation and large hydro and nuclear stations supporting peaking and balancing requirements.



**Figure 1:** India's Power Generation Capacity Mix for 2015-16 and 2025-26 (as of Dec'2025)<sup>6</sup>

3 [https://cea.nic.in/wp-content/uploads/2020/03/psp\\_energy-03-9.pdf](https://cea.nic.in/wp-content/uploads/2020/03/psp_energy-03-9.pdf)

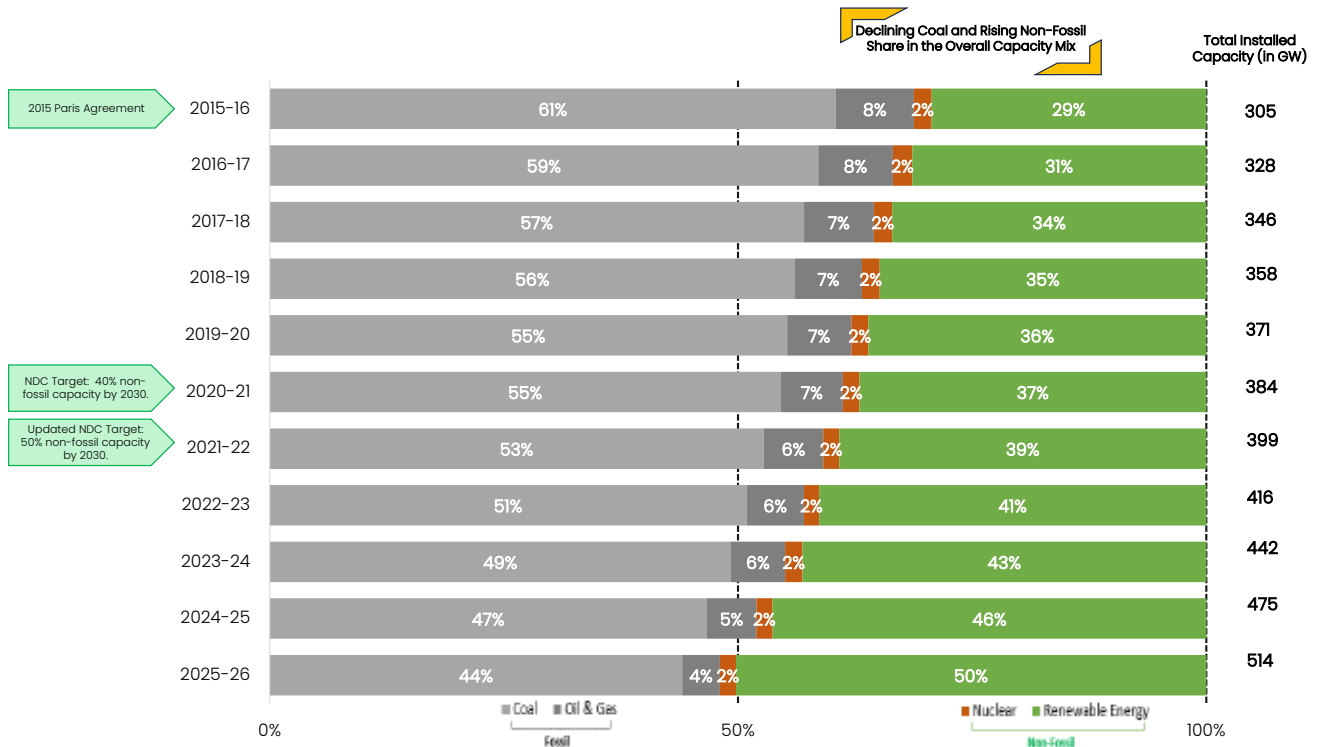
4 <https://www.pib.gov.in/PressNoteDetails.aspx?NotelId=154717&ModuleId=3&reg=3&lang=2>

5 [https://cea.nic.in/wp-content/uploads/notification/2026/01/Growth\\_Book\\_2025.pdf](https://cea.nic.in/wp-content/uploads/notification/2026/01/Growth_Book_2025.pdf)

6 <https://iced.niti.gov.in/energy/electricity/generation/capacity>

## 1.1 Non-Fossil Energy Capacity Growth Post 2015 Paris Agreement

While India's power sector has expanded rapidly to meet growing demand, it is also undergoing a profound shift towards sustainability. The fossil fuel share has declined sharply from 69 per cent in 2015-16 to about 48 per cent in 2025-26 (up to Dec'2025), as non-fossil capacity has tripled over the decade. India achieved its updated NDC target of 50 per cent non-fossil-based capacity by 2030, five years ahead of schedule, in June 2025 and reached 52 per cent by December 2025.



**Figure 2:** India's Power Generation Capacity Mix Trends from 2015-16 to 2025-26 (up to Dec'2025)<sup>7</sup>

Nuclear power's steady 2 per cent share highlights the need for accelerated expansion to reach 100 GW by 2047, which requires an average annual addition of ~4.14 GW. A pivotal milestone came on 17 December 2025, when the Lok Sabha passed the Sustainable Harnessing and Advancement of Nuclear Energy for Transforming India (SHANTI) Bill<sup>8</sup>, 2025, modernising the nuclear framework with the objective of enabling faster growth, enhanced safety and private participation.

## 1.2 Renewable Energy Progress: Solar Taking the Centre Stage

India's commitment to a net-zero future has driven a threefold increase in Renewable Energy (RE) capacity over the past decade, positioning the country fourth<sup>9</sup> globally in total renewable installed capacity. As of December 2025, renewable energy capacity stands at 258 GW, accounting for 50 per cent of the total installed power capacity of 514 GW. Out of 50 per cent, solar leads with 26 per

<sup>7</sup> <https://iced.niti.gov.in/energy/electricity/generation/capacity>

<sup>8</sup> <https://static.pib.gov.in/WriteReadData/specificdocs/documents/2025/dec/doc20251222741701.pdf>

<sup>9</sup> <https://www.pib.gov.in/PressNoteDetails.aspx?id=155063&NotelId=155063&ModuleId=3&reg=3&lang=2>

cent, followed by wind (11 per cent), large hydro (10 per cent), bio-power (2 per cent) and small hydro (1 per cent).

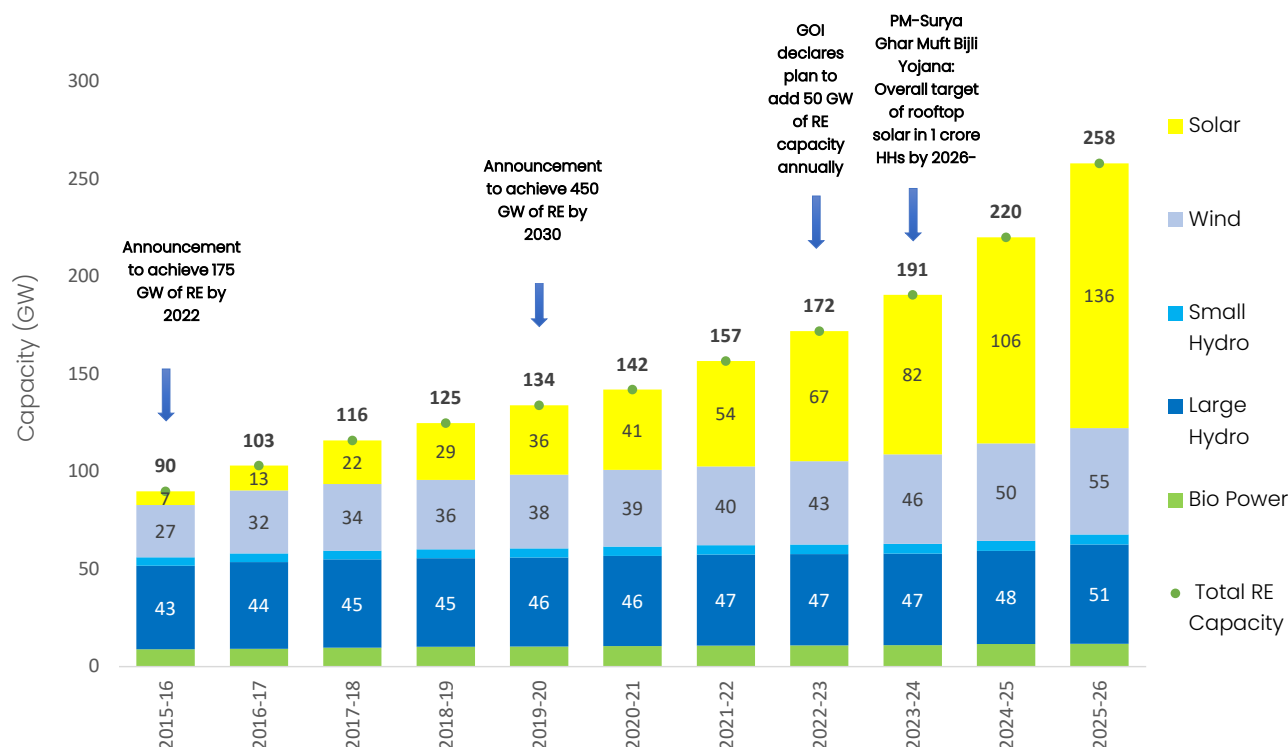


Figure 3: Source-wise Renewable Energy Capacity Mix Trends from 2015-16 to 2025-26 (up to Dec'2025)<sup>10</sup>

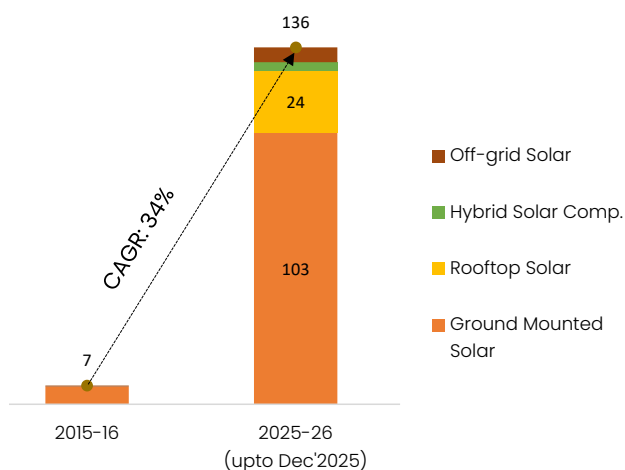


Figure 4: Solar Installed Capacity (GW)<sup>11</sup>

Solar has witnessed a sharp rise in installed capacity of nearly 20 times over the past decade, making the country stand in third position worldwide. Its share rose from 2 per cent in 2015-16 to 26 per cent in 2025-26 (up to Dec'2025) in total installed capacity. Further, solar rooftop installations, which began at 1 GW in 2017-18, reached 24 GW by December 2025, reflecting an annual growth rate of 47 per cent<sup>11</sup>.

Various policy initiatives have been taken recently in this area which include PM Surya Ghar Muft Bijli Yojana to promote household rooftop solar; PM-KUSUM for farmers to shift from diesel to solar irrigation; PM JANMAN to extend solar electrification to Particularly Vulnerable Tribal

Groups; the Solar Parks and Ultra Mega Solar Power Projects schemes, which targets 40 GW<sup>12</sup> by March 2029; and the Production-Linked Incentive (PLI) scheme for domestic solar manufacturing to reduce import dependence.

Wind power has doubled over the decade, making India the fourth largest wind power producer. It contributes 21 per cent to renewables (55 GW) and has risen from 9 per cent to 11 per cent in

<sup>10</sup> <https://iced.niti.gov.in/energy/electricity/generation/capacity>

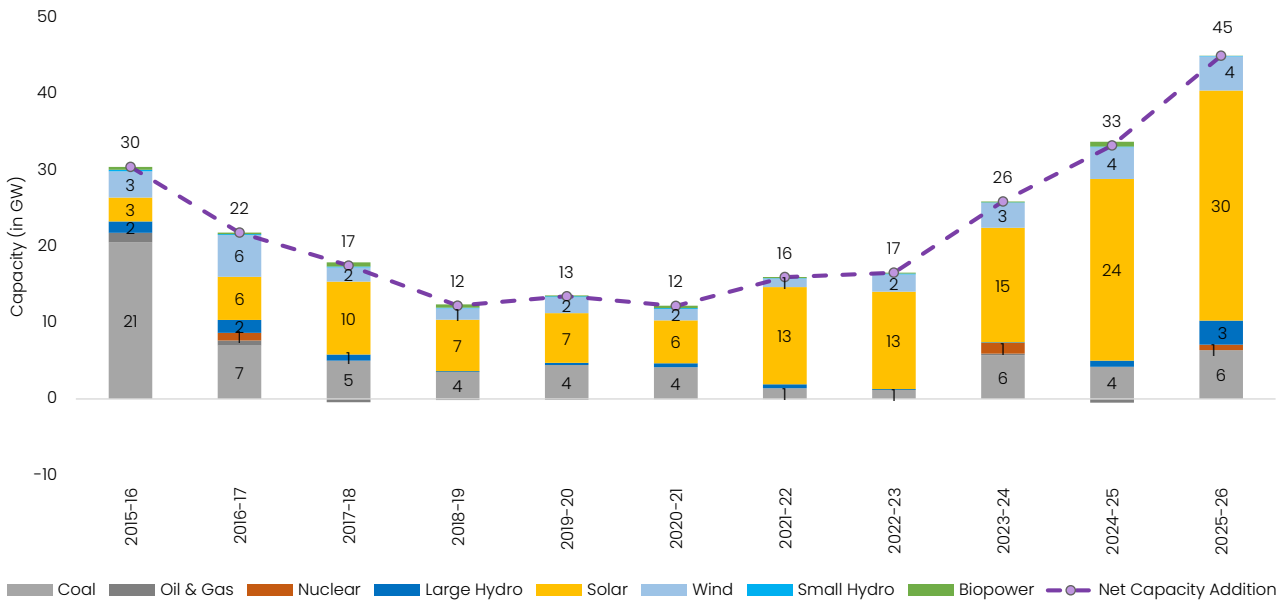
<sup>11</sup> <https://iced.niti.gov.in/>

<sup>12</sup> <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2199729&reg=3&lang=1>

overall installed capacity. Some of the challenges leading to a slower growth rate included higher tariffs, supply chain disruptions, reduced investments, waning off-taker interest, land acquisition challenges, variable wind patterns and grid infrastructure gaps<sup>13</sup>.

### 1.3 Capacity Addition and Retirement

India has added 243 GW of new power generation capacity over the past decade, with 45 GW commissioned in 2025-26 (up to Dec'2025). Solar led the surge, contributing 67 per cent of this recent capacity, followed by coal (14 per cent), wind (10 per cent) and large hydro (7 per cent)<sup>14</sup>.



**Figure 5:** India's Net Electricity Capacity Addition from 2015-16 to 2025-26 (up to Dec'2025)<sup>15</sup>

**Note:** Temporarily Closed Capacity is not included in Net Capacity Additions.

RE additions have accelerated significantly, registering a fourfold increase over the decade and totalling 177 GW collectively. In the first nine months of 2025-26, renewables accounted for 38 GW, with 84 per cent of total new capacity, underscoring the structural shift towards clean energy. Solar capacity additions have grown tenfold, from around 3 GW in 2015-16 to 30 GW in 2025-26 (up to Dec'2025), aligning with the ambitious target of 50 GW RE per year by 2027-28.

Meanwhile, coal capacity additions have declined sharply, peaking at 21 GW in 2015-16 before dropping to just 6 GW in 2025-26. On the retirement front, 16 GW of thermal capacity was decommissioned over the decade, with 92 per cent being coal-based and 8 per cent oil and gas. Additionally, the CEA has temporarily removed 6.5 GW from service due to prolonged outages (2 GW coal, 4.4 GW gas and 0.1 GW nuclear)<sup>16</sup>.

13 [https://beeindia.gov.in/sites/default/files/BEE\\_India\\_Energy\\_Scenario\\_Report-2024\\_web\\_version-rev2.pdf](https://beeindia.gov.in/sites/default/files/BEE_India_Energy_Scenario_Report-2024_web_version-rev2.pdf)

14 <https://iced.niti.gov.in/energy/electricity/generation/capacity>

15 <https://iced.niti.gov.in/energy/electricity/generation/capacity>

16 <https://cea.nic.in/wp-content/uploads/installed/2025/12/website.pdf>

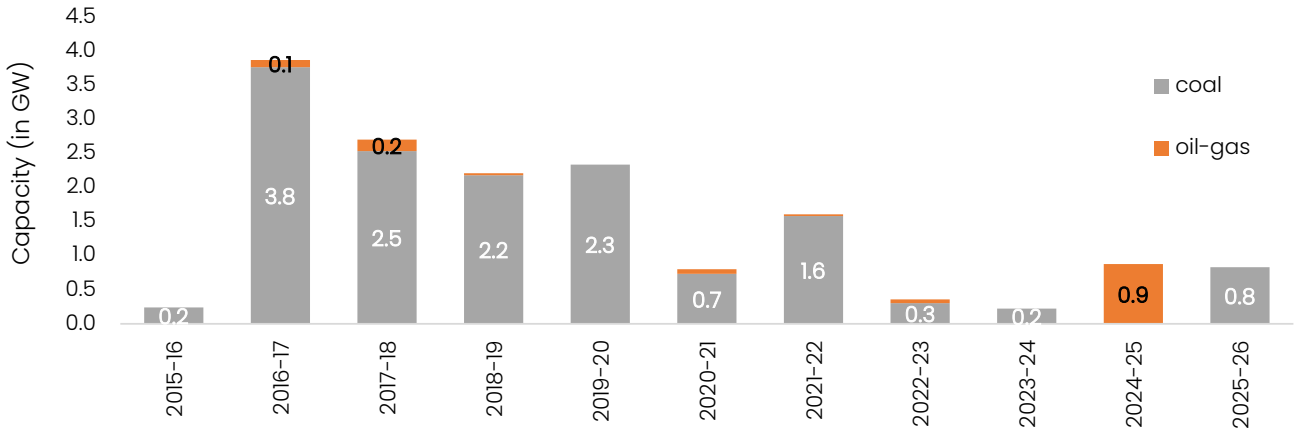


Figure 6: Year-on-Year Retirement of Thermal Power Plants<sup>17</sup>

## 1.4 Power Generation Shift

India’s electricity generation has shown consistent growth over the past decade, with an annual growth rate of 5 per cent, rising from 1,168 BU in 2015-16 to 1,824 BU in 2024-25. A minor dip of 1 per cent occurred in 2020-21 due to the COVID-19 pandemic’s impact on commercial and industrial demand. Coal remains the dominant source for baseload reliability, but its share has declined from about 77 per cent in 2015-16 to around 69 per cent in 2025-26. Oil and gas shares have halved over the same period.

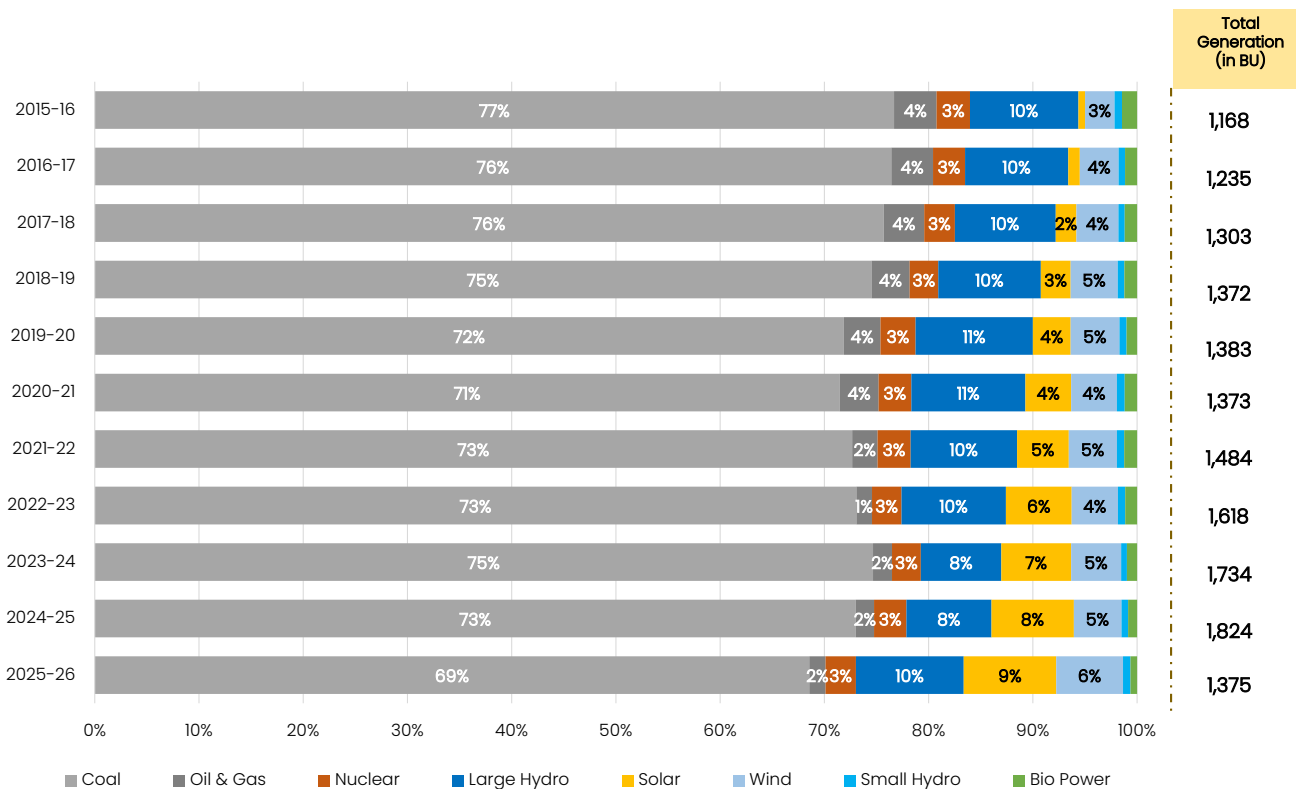


Figure 7: India’s Power Generation Mix Trends from 2015-16 to 2025-26 (up to Dec’2025)<sup>18</sup>

<sup>17</sup> <https://iced.niti.gov.in/energy/electricity/generation/capacity>

<sup>18</sup> <https://iced.niti.gov.in/energy/electricity/generation/power-generation>

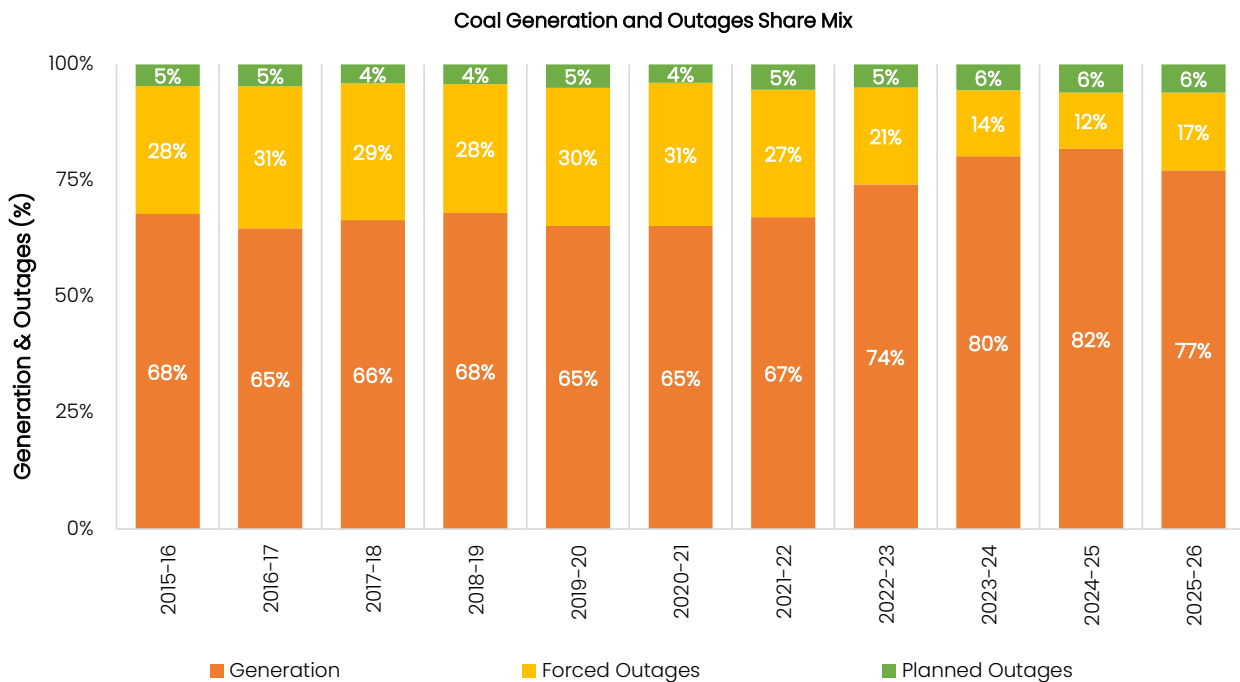
## Steering India's Power Sector Towards Viksit Bharat

The generation mix has shifted notably towards cleaner sources. Solar's share has surged from 1 per cent in 2015-16 to 9 per cent in 2025-26, while wind roughly doubled its contribution. Non-fossil sources overall have increased from 19 per cent (2015-16) to 30 per cent (2025-26), with renewables (excluding large hydro) driving much of the increase. Stable contributors include nuclear at a consistent 3 per cent, bio-power and small hydro at 1 per cent each and large hydro fluctuating between 8-11 per cent.

This transition aligns with India's accelerated non-fossil targets and clean energy ambitions, even as coal's absolute generation remains substantial and important to support peak demand and grid stability. The evolving mix underscores the growing emphasis on flexibility, energy storage integration and balanced planning to ensure long-term reliability amid rising demand.

### 1.5 Improving Coal Power Plant Performance

Coal power plants in India have shown improving trends in performance over the decade from 2015-16 to 2025-26. The share of forced outages (as a percentage of total expected generation) declined from 28 per cent in 2015-16 to 12 per cent in 2024-25, before a slight rise to 17 per cent in 2025-26 (up to Dec'2025).



**Figure 8:** India's Coal Generation and Outages Share Mix from 2015-16 to 2025-26 (up to Dec'2025)<sup>19, 20, 21</sup>

Major contributors to forced outages include reserved shutdowns/no demand from DISCOMs/ low scheduling, along with technical issues, collectively accounting for around 24 per cent loss in expected generation in 2015-16 but reducing to 16 per cent in 2025-26 (up to Dec'2025). This improvement reflects better electricity generation planning and the adoption of more structured maintenance practices, including both preventive and predictive.

<sup>19</sup> <https://iced.niti.gov.in/energy/electricity/generation/power-generation>

<sup>20</sup> <https://iced.niti.gov.in/energy/electricity/generation/forced-outage>

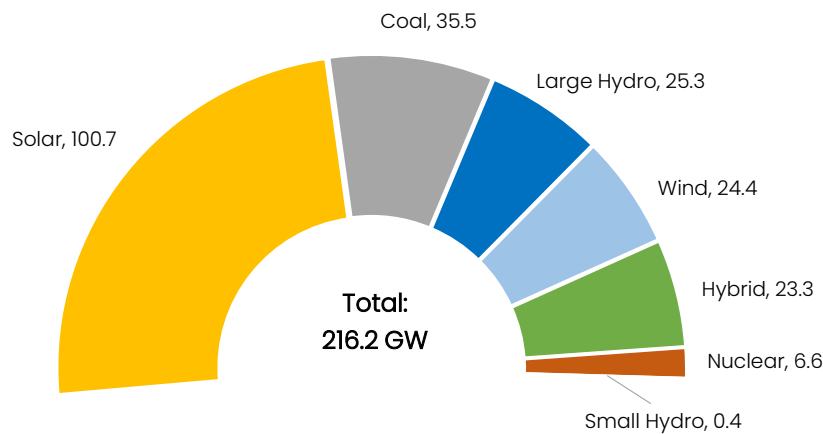
<sup>21</sup> <https://iced.niti.gov.in/energy/electricity/generation/planned-outage>

Planned outages for scheduled maintenance have remained stable, consistently ranging from 4 per cent to 6 per cent across the period. These efficiency gains in the existing coal fleet should support grid stability during the ongoing energy transition. Looking ahead, upcoming capacity additions will further shape the sector's reliability and flexibility.

## 1.6 Under Construction and Upcoming Power Generation Capacity

India's power sector pipeline reflects a dynamic balance between sustaining fossil fuel reliability and accelerating non-fossil expansion, with over 35.5 GW of coal<sup>22</sup> and 180.7 GW of non-fossil<sup>23</sup> of projects under construction or in advanced planning as of December 2025. This development plan supports the nation's goals of energy security, demand growth and a net-zero trajectory by 2070, amid surging electricity needs projected to hit 366 GW<sup>24</sup> peak by 2031-32.

As of December 2025, around 35.5 GW of coal-based capacity is under construction, while nearly 22 GW remains stalled. Of the stalled capacity, only 0.5 GW is state-owned, with the remaining 21.4 GW comprising private sector projects. To meet rising electricity demand and maintain grid stability, India plans to add an additional 24 GW<sup>25</sup> of coal capacity by 2031-32, over and above projects currently under construction, with the private sector expected to contribute roughly one-third of this expansion.



**Figure 9:** Under-Construction Capacity as of December 2025 (numbers are in GW)<sup>26, 27</sup>

Non-fossil sources dominate the pipeline with 500 GW targeted by 2030<sup>28</sup> and focus on renewables, hydro and nuclear for flexibility and decarbonisation.

The under-construction capacity of RE continues to expand with around 174 GW of capacity currently under construction. Solar has the largest contribution at 101 GW, followed by 25 GW of large hydro, 24 GW of wind and 23 GW of hybrid projects, with large solar parks concentrated in Rajasthan and Gujarat. Upcoming additions also include offshore wind pilot projects in Gujarat and Tamil

<sup>22</sup> <https://iced.niti.gov.in/energy/electricity/generation/pipeline-capacity/coal>

<sup>23</sup> [https://cea.nic.in/wp-content/uploads/rpm\\_division/2026/02/Quarterly\\_Report\\_on\\_Under\\_Construction\\_Renewable\\_Energy\\_Projects\\_as\\_on\\_December\\_2025.pdf](https://cea.nic.in/wp-content/uploads/rpm_division/2026/02/Quarterly_Report_on_Under_Construction_Renewable_Energy_Projects_as_on_December_2025.pdf)

<sup>24</sup> <https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2023/09/202309011256071349.pdf>

<sup>25</sup> Ibis

<sup>26</sup> [https://cea.nic.in/wp-content/uploads/thermal\\_broad/2025/12/BS\\_Dec\\_25.pdf](https://cea.nic.in/wp-content/uploads/thermal_broad/2025/12/BS_Dec_25.pdf)

<sup>27</sup> [https://cea.nic.in/wp-content/uploads/rpm\\_division/2026/02/Quarterly\\_Status\\_Report\\_on\\_Development\\_of\\_Solar\\_Parks\\_\\_UMREPPs\\_in\\_the\\_Country\\_as\\_on\\_December\\_2025.pdf](https://cea.nic.in/wp-content/uploads/rpm_division/2026/02/Quarterly_Status_Report_on_Development_of_Solar_Parks__UMREPPs_in_the_Country_as_on_December_2025.pdf)

<sup>28</sup> <https://powermin.gov.in/en/content/500gw-nonfossil-fuel-target>

## Steering India's Power Sector Towards Viksit Bharat

Nadu, supported by a dedicated offshore wind strategy and Viability Gap Funding (VGF) for the first 1 GW. There is a growing recognition that installed renewable capacity must be complemented by timely grid upgrades at transmission and sub-transmission levels to ensure effective evacuation and utilisation.

Recently, the Government directed Renewable Energy Implementing Agencies to close legacy bids and cancel letters of award for projects where signing of Power Purchase and Power Sale Agreements (PPAs/PSAs) were not feasible by 30 November 2025. This action was due to low state demand, particularly for solar, affecting a combined 42 GW of awarded renewable projects<sup>29</sup>.

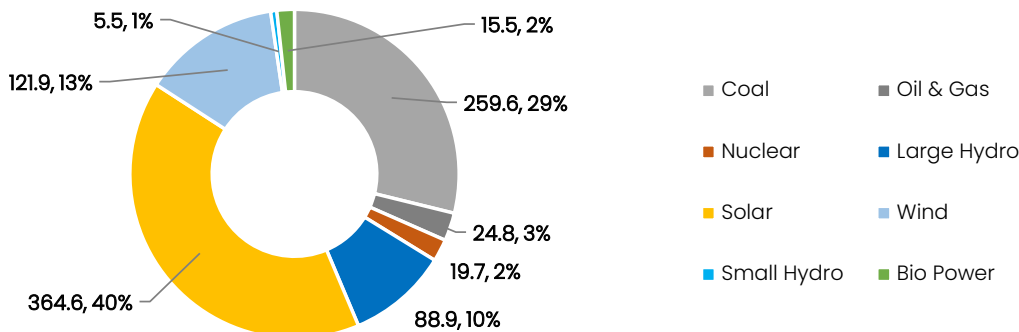
Large-scale deployment of Battery Energy Storage Systems (BESS) and Pumped Storage Projects (PSP) is essential to firm renewable output and provide grid-balancing services. To strengthen this, 13.22 GWh of Battery Energy Storage Systems capacity is under implementation under the VGF scheme approved in September 2023, while an additional 30 GWh of BESS capacity was approved in June 2025 with ₹5,400 crore support from the Power System Development Fund<sup>30</sup>. Additionally, 10 Pumped Storage Projects totalling 11.87 GW are under construction to enhance grid stability.

Further, to complement the above emerging technologies, the Government of India has introduced National Green Hydrogen Mission which targets 5 MMT per annum of green hydrogen production by 2030, backed by around 125 GW of associated renewable energy capacity, reinforcing India's long-term clean energy expansion.

## 1.7 NEP Projections: Additional Capacity and 2031-32 Outlook

The National Electricity Plan (NEP) Volume-I Generation (2022-32), notified in May 2023, outlines a least-cost pathway to add 504 GW to meet rising demand while boosting non-fossil share from 52 per cent (2025-26) to 68 per cent (2031-32).

By 2031-32, India's total installed electricity generation capacity is projected to reach ~900 GW, with thermal at 32 per cent, nuclear at 2 per cent and renewable energy at 66 per cent (including large hydro). Additionally, 47 GW of BESS and 5.9 GW of hydro imports from Nepal and Bhutan are planned to support grid flexibility. This mix intends to ensure resource adequacy with a 15-20 per cent planning reserve margin, emphasising flexibility to integrate variable renewables while curbing emissions from 0.712 kg CO<sub>2</sub>/kWh<sup>31</sup> in 2024-25 to 0.43 kg CO<sub>2</sub>/kWh in 2031-32.



**Figure 10:** Projected All India Installed capacity by the end of 2031-32 (all numbers are in GW)<sup>32</sup>

29 Circular from Ministry of Power No. 48-6/18/2025-NRE SECTION

30 <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2197199&reg=3&lang=2>

31 [https://cea.nic.in/wp-content/uploads/baseline/2025/12/User\\_Guide\\_v\\_21.0.pdf](https://cea.nic.in/wp-content/uploads/baseline/2025/12/User_Guide_v_21.0.pdf)

32 <https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2023/09/202309011256071349.pdf>

## 1.8 Key Policy Challenges and Priorities in the Generation Sector

India's power sector is estimated to grow rapidly, with peak demand projected to reach around 366 GW by 2031-32 (As per NEP 2022-32, 20<sup>th</sup> Electric Power Survey). While renewable-energy capacity has grown at an accelerated pace, ensuring adequacy during peak demand hours remains a key challenge. Key focus areas include balancing rapid renewable growth with grid reliability, flexibility and infrastructure synchronisation.

- **Flexibility of Existing Coal Fleet:** Coal plants provide essential baseload and peaking support. Upgrades for ramping, low-load operation and emission compliance are vital, but face investment prioritisation, cost balancing and life-extension decisions amid rising renewables.
- **Transmission Constraints and Stranded Capacity Risk:** Delays in inter-regional/intra-state transmission risk stranding renewable and conventional projects, causing curtailment and under-utilisation. Synchronised generation-transmission planning at the central and state levels is essential to mitigate this risk.
- **Energy Storage Deployment:** Pumped storage (PSP) and battery systems (BESS) are amongst the crucial requirements for firming renewables and grid balancing. Execution faces land, clearances, geological, water-sharing (PSP) and commercial/land-near-load hurdles (BESS).
- **Grid Stability, Market Design and Ancillary Services:** High renewable penetration increases complexity. Deepening market-based ancillary participation, refining price signals and integrating storage/flexible resources via the Resource Adequacy framework are important for reliability and time-varying capacity recognition.
- **Renewable Purchase Obligation (RPO) Enforcement and Regulatory Effectiveness:** Gaps in state-level RPO compliance hinders renewable uptake. Strengthening monitoring, enforcement and regulatory capacity is important for predictable demand and long-term planning.
- **Demand-Side Management and Load Flexibility:** In addition to the supply measures, Electric Vehicle (EV) smart charging, industrial shifting and demand response via smart meters offer potential, requiring enabling regulations, digital infrastructure and DISCOM/consumer participation for peak load management.
- **Capacity Addition and Planning Uncertainties:** Weak granular/seasonal demand forecasting risks shortfalls or over-contracting. Long gestation for coal/hydro/nuclear/PSP projects, plus delays, cost overruns and coordination gaps, challenge targets like 500 GW non-fossil. Improved project management and risk-sharing are essential.
- **Coordination and Data Gaps:** Robust institutional alignment across central/state/private entities is important for planning and operations. Non-standard data sharing and IT incompatibilities affect efficiency, merit-order adherence and real-time visibility for operators.

## Issues for Brainstorming

- Mechanism for preparing for resource adequacy
- Steps for improving the efficiency of capacity addition efforts
- Meeting challenges in ensuring adequate and appropriate “merchant” capacity at the regional/national level
- Setting/reinvigorating mechanisms for coordination amongst Central, State and Private Generators
- Capacity mix decisions – how to arrive at an optimum level
- Flexible operation of generation resources – technological constraints and mitigating measures
- Why do so many tendered RE projects remain without PPAs/PSAs and what reforms are needed to strengthen offtake and market design
- Next steps for regulatory bodies like CERC on BESS policy – defining market mechanisms, tariff structures and incentives to accelerate deployment

# 2

## TRANSMISSION

India's energy transition requires large-scale investment across the power value chain, with transmission playing a central enabling role. The evolution of the sector is projected to require ₹50 lakh crore by 2032, scaling to ₹200 lakh crore by 2047 for generation, transmission and distribution strengthening. Within this, transmission is critical for linking geographically dispersed generation with load centres and enabling renewable energy (RE) integration at scale.

The transmission system establishes the link between the source of generation on one side and the distribution system, which is connected to the ultimate consumer, on the other side. India's transmission network is expanding rapidly to meet rising power demand and to align with the growth in generation capacity, particularly for solar and wind power, which are largely concentrated in states such as Andhra Pradesh, Gujarat, Karnataka, Rajasthan and Tamil Nadu. In contrast, the major load centres, characterised by high electricity demand, are situated in the central part of the country. This geographical disparity necessitates a robust and efficient transmission network to facilitate optimal resource utilisation and balanced power supply across regions. Additionally, the transmission system has been continuously strengthened with the addition of transmission lines and inter-regional capacity that enhance grid reliability and resilience.

India plans to integrate 500 GW of non-fossil capacity by 2030. Achieving this target requires a strong and flexible transmission network. As per the National Electricity Plan<sup>33</sup> (released in October 2024), the network is planned to expand from 4.85 lakh to 6.48 lakh circuit kilometres by 2032. This expansion will be supported by higher voltage upgrades, increased digitalisation and improved climate resilience to enable large-scale renewable integration and ensure a reliable 24x7 power supply.

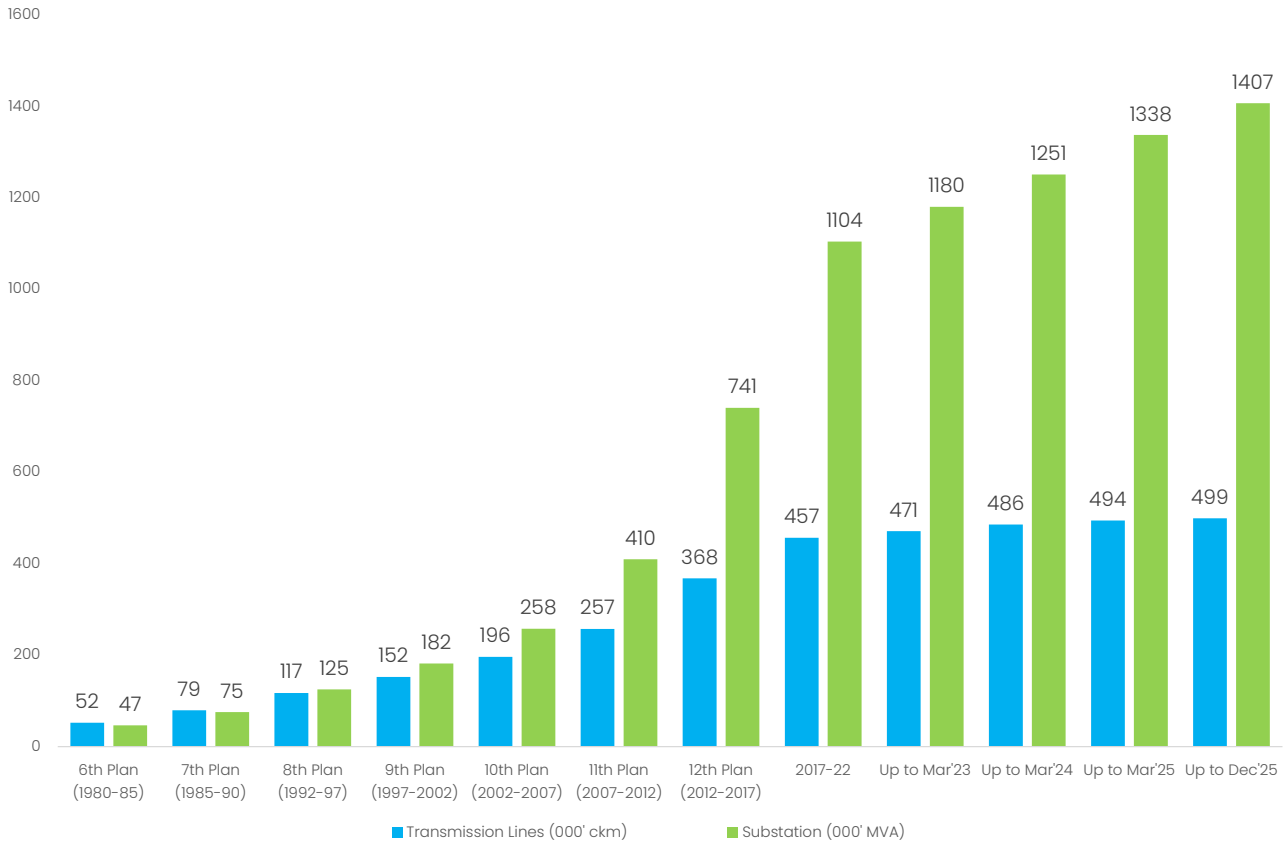
### 2.1 Current Transmission and Substation Infrastructure

The rising penetration of intermittent renewable energy introduces operational challenges related to grid stability, reliability and system flexibility, necessitating sustained transmission capacity expansion and system strengthening as outlined by the Central Electricity Authority (CEA).

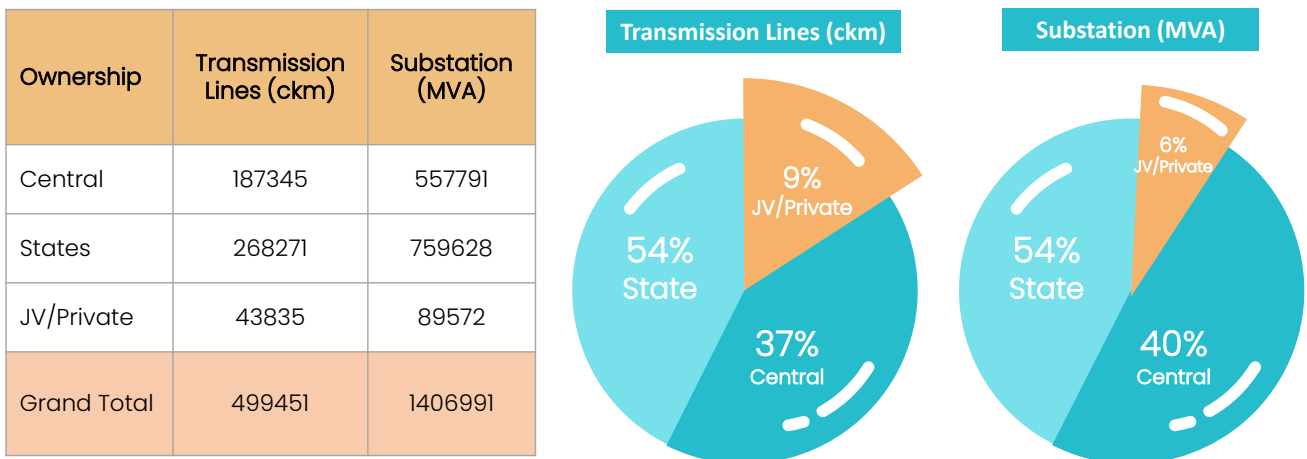
<sup>33</sup> [https://ctuil.in/uploads/cms\\_documents/NEP-Transl.pdf](https://ctuil.in/uploads/cms_documents/NEP-Transl.pdf)

## Steering India's Power Sector Towards Viksit Bharat

As of December 2025, the total length of transmission lines at the 220kV and above levels stood at 499,451 ckm and the substation (transformation capacity) stood at 1,406,991 MVA.



**Figure 11:** Plan-wise Growth of Transmission Lines and Substations (220kV and above) (up to Dec'2025)<sup>34</sup>



**Figure 12:** Ownership-wise Growth Summary of Transmission Lines and Substations (220kV and above)<sup>35</sup>

<sup>34</sup> [https://cea.nic.in/wp-content/uploads/transmission/2025/12/SS\\_GS\\_December\\_2025.pdf](https://cea.nic.in/wp-content/uploads/transmission/2025/12/SS_GS_December_2025.pdf), [https://cea.nic.in/wp-content/uploads/transmission/2025/12/TL\\_GS\\_December\\_2025.pdf](https://cea.nic.in/wp-content/uploads/transmission/2025/12/TL_GS_December_2025.pdf)

<sup>35</sup> [https://cea.nic.in/wp-content/uploads/transmission/2025/12/TL\\_GS\\_December\\_2025.pdf](https://cea.nic.in/wp-content/uploads/transmission/2025/12/TL_GS_December_2025.pdf), [https://cea.nic.in/wp-content/uploads/transmission/2025/12/SS\\_GS\\_December\\_2025.pdf](https://cea.nic.in/wp-content/uploads/transmission/2025/12/SS_GS_December_2025.pdf)

## Key Insights

- States hold the largest share of both transmission lines and substations, reflecting the importance of intra-state networks in delivering electricity to local loads.
- Central utilities, responsible for inter-regional and inter-state corridors, account for 37 per cent of total lines and 40 per cent of substations
- Joint Venture/Private sector is also contributing to the transmission network. It has grown due to tariff bidding frameworks and private investment in strategic corridors.

## Regulatory, Institutional and Planning Framework for Transmission Sector

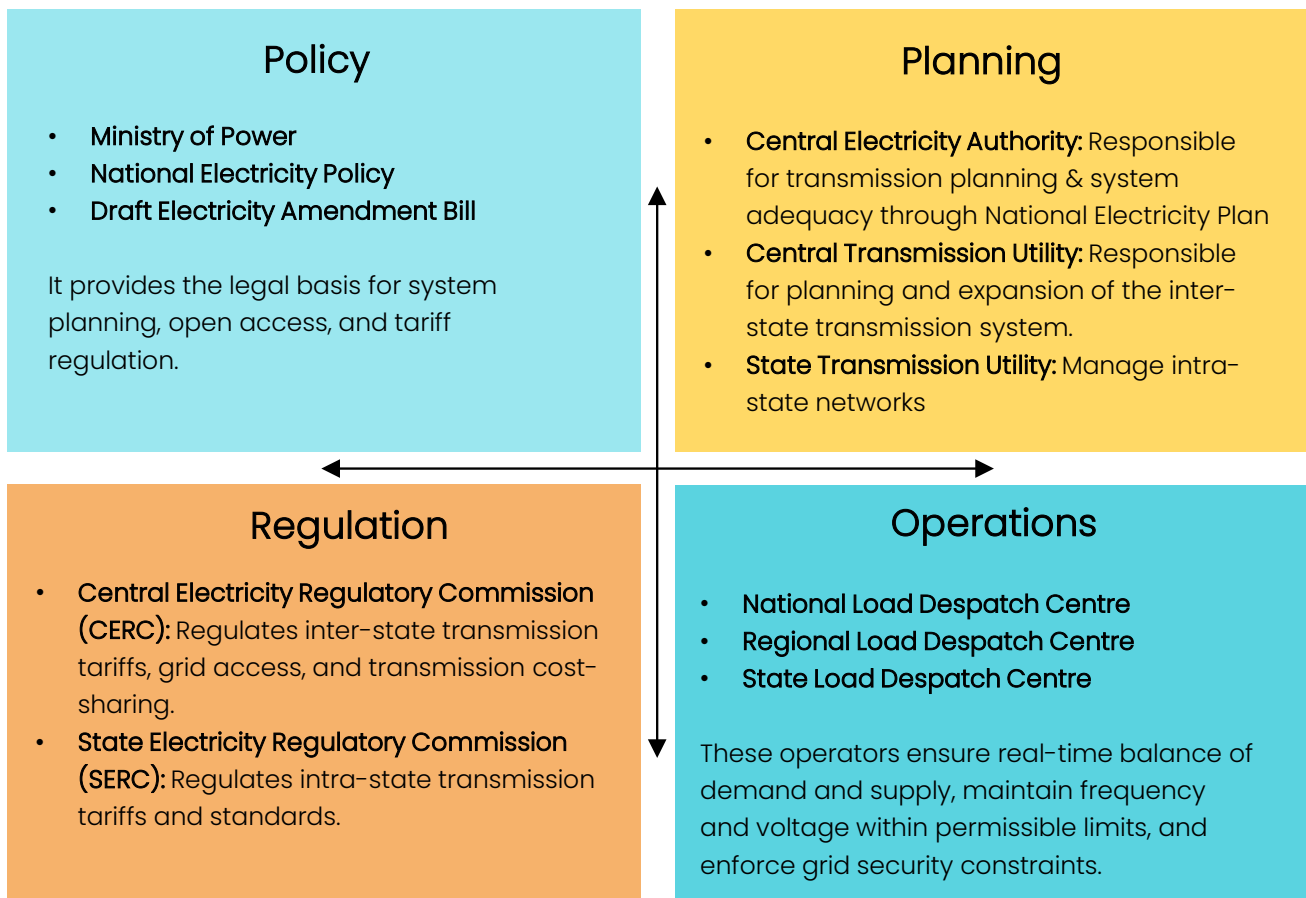


Figure 13: Organisational Structure of Transmission Sector

## 2.2 Green Energy Corridor at a Glance

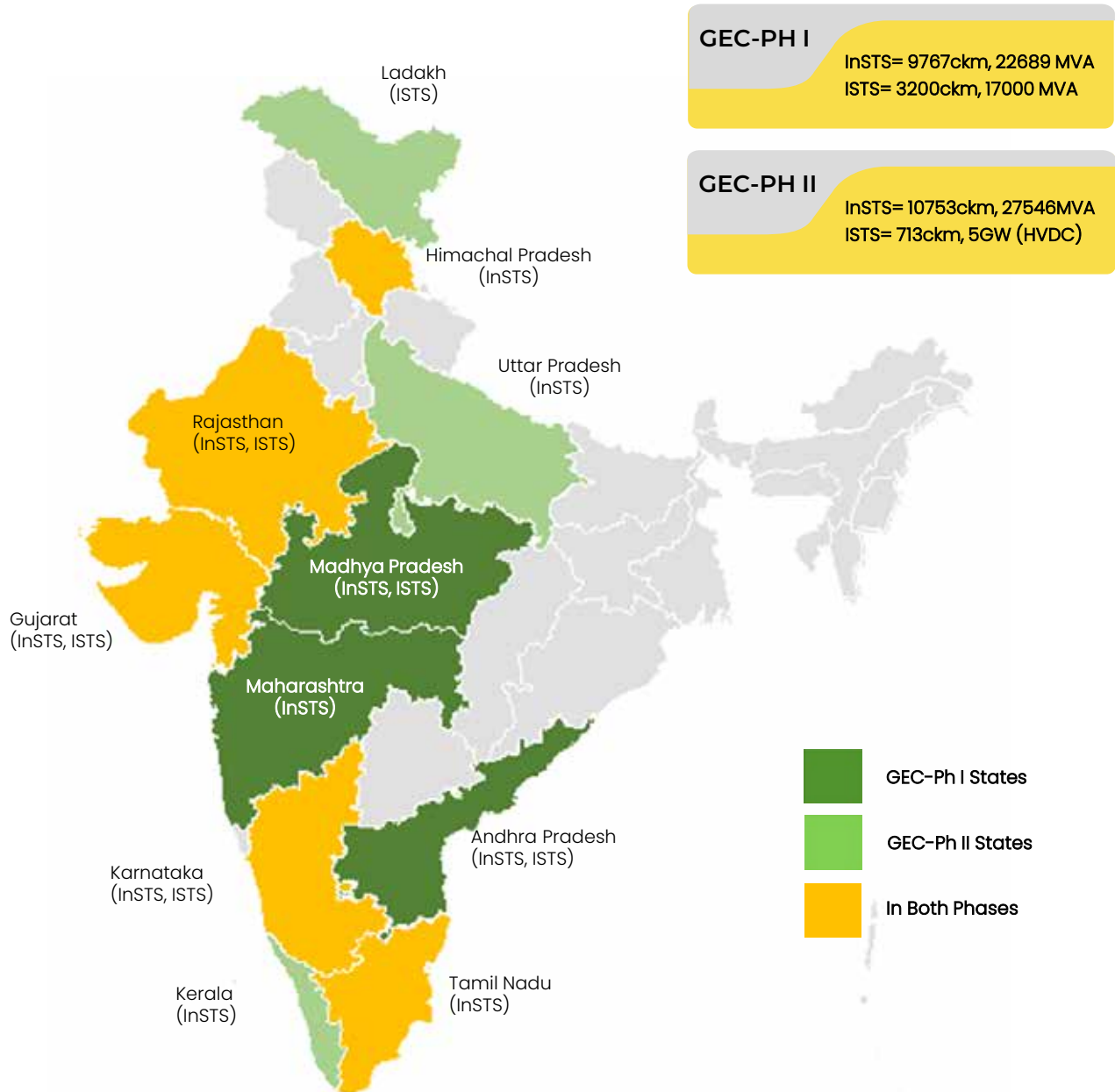
The Green Energy Corridor (GEC) is a key national initiative focused on strengthening the transmission network to support the large-scale integration of renewable energy. By expanding and upgrading grid infrastructure, the programme enables the smooth evacuation of solar and wind power from generation hubs to demand centres across the country.

The GEC encompasses both intra-state and inter-state transmission infrastructure to support renewable energy integration. **Intra-state networks** enable the evacuation of power from renewable generation sites to the state grid, while **inter-state corridors** facilitate the transfer of surplus renewable power across regions. The programme also deploys advanced grid management tools,

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including smart grid technologies and energy storage, to enhance system stability and manage renewable variability.

**GEC Phase-I** involves the development of about 9,767 ckm of transmission lines along with a substation capacity of approximately 22,689 MVA in eight states. Implementation has been reported as completed in Madhya Pradesh, Rajasthan, Tamil Nadu and Karnataka, while the remaining four states (Himachal Pradesh, Andhra Pradesh, Gujarat and Maharashtra) have sought timeline extensions due to various challenges<sup>36</sup>. As of now, around 9,136 ckm of transmission lines and 21,413 MVA of substation capacity have been commissioned.



**Figure 14:** State-wise Distribution of GEC Phase I and II

**GEC Phase-II** expansion for the evacuation of 20 GW of renewable energy is now underway across seven states and one union territory : Gujarat, Himachal Pradesh, Karnataka, Kerala, Rajasthan, Tamil

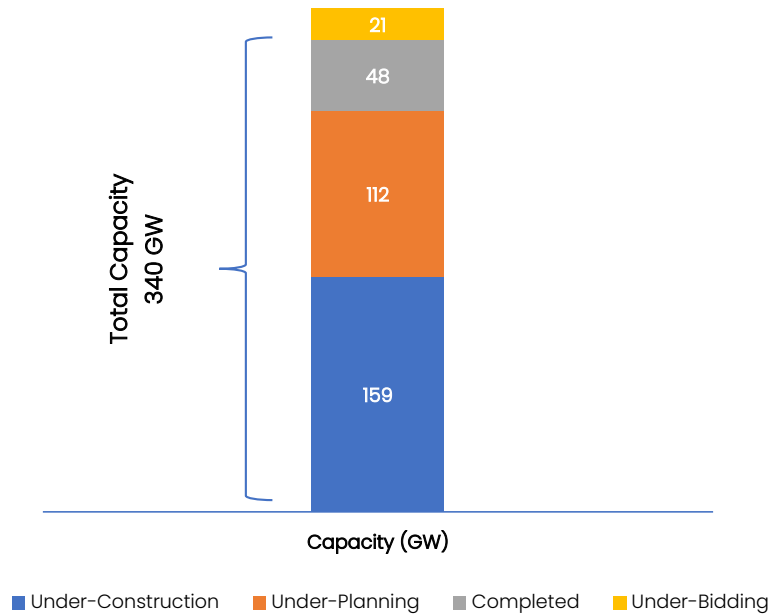
<sup>36</sup> MNRE, <https://mnre.gov.in/en/gec-1/>

Nadu, Uttar Pradesh and Ladakh. The target under phase II is 10,753 ckm of transmission lines and 27,546 MVA of substation capacity<sup>37</sup>.

Phase I cost is around ₹1,0141.68 crore and Phase II cost is around ₹12,031.33 crore.

Despite the significant progress that has been made, Phase I faced delays and challenges related to land acquisition, Right of Way (RoW) issues and environmental cases<sup>38</sup>.

Government of India has announced that a 340 GW Inter-State Transmission System (ISTS) network is being planned to evacuate 230 GW of solar and wind capacity.<sup>39</sup>



**Figure 15:** Break-up of 340 GW ISTS expansion to enable 230 GW Solar and Wind Capacity.<sup>40</sup>

## 2.3 Strengthening Grid Stability in a High-Renewable Energy Integration

As renewable energy grows, keeping the power grid stable has become more challenging. The grid needs sufficient inertia so that the electricity frequency does not change too fast, even when large amounts of solar and wind power are added. To address this challenge, the grid should increasingly depend on modern solutions which can respond almost instantly to changes in grid conditions. Recognising this need, the Ministry of Power has recommended that all new solar and wind projects install battery storage equal to at least 10 per cent of their capacity, with a minimum storage duration of two hours.

This approach aligns with the NEP for Transmission target mentioned above. As renewable penetration increases, energy storage has been identified as a critical tool to absorb surplus generation and reduce curtailment. Accordingly, the plan projects battery storage capacity to reach about 8.7 GW by 2026-27 and expand to nearly 47.2 GW<sup>41</sup> by 2031-32.

37 <https://www.pib.gov.in/PressReleasePage.aspx?PRID=1968733&reg=3&lang=2>

38 [https://www.dailyexcelsior.com/first-phase-of-green-energy-corridor-project-facing-delays-due-to-multiple-reasons-naik/#google\\_vignette](https://www.dailyexcelsior.com/first-phase-of-green-energy-corridor-project-facing-delays-due-to-multiple-reasons-naik/#google_vignette)

39 [https://sansad.in/getFile/annex/268/AUI53\\_wsXlii.pdf?source=pqars](https://sansad.in/getFile/annex/268/AUI53_wsXlii.pdf?source=pqars)

40 [https://sansad.in/getFile/annex/268/AUI53\\_wsXlii.pdf?source=pqars](https://sansad.in/getFile/annex/268/AUI53_wsXlii.pdf?source=pqars)

41 <https://www.pib.gov.in/PressReleaseSelfframePage.aspx?PRID=1928750&reg=3&lang=2#:~:text=The%20storage%20capacity%20>

By storing excess electricity during periods of high renewable generation and releasing it during peak demand, BESS helps reduce congestion on transmission corridors and improves the overall use of grid infrastructure. Its fast response capability also plays a vital role in managing the variability of renewables, supporting frequency control and ensuring reliable and secure grid operations as India moves towards a high-renewable power system.

## 2.4 Key Challenges in Transmission System

Despite notable progress in expanding transmission infrastructure, several systemic and operational challenges continue to constrain effective grid performance. Gaps between planning and execution, procedural delays and rising system complexity are limiting the seamless integration of renewable energy. The following constraints increase system inefficiencies, elevate costs and pose risks to the timely achievement of India's clean energy transition goals:

- 1. Misalignment between Generation and Transmission Planning:** Rapid renewable capacity addition has often outpaced transmission development, leading to stranded or underutilised generation assets. Delays in land acquisition, Right-of-Way (RoW) clearances and coordination challenges exacerbate this mismatch.
- 2. Congestion and Renewable Curtailment:** Congestion in key corridors results in frequent curtailment of renewable energy. This issue is particularly acute during high renewable generation periods.
- 3. Land, Right-of-Way and Environmental Clearances:** Transmission projects face persistent delays due to land acquisition challenges, forest clearances and public resistance, especially for high-voltage corridors passing through densely populated or environmentally sensitive areas.
- 4. Financing and Cost Recovery Risks:** Although transmission tariffs are regulated, delays in commissioning affect cash flows for developers. In some states, delays in transmission cost pass-through to DISCOMs create payment risks.
- 5. Integration of Variable Renewable Energy:** High penetration of intermittent renewables increases the need for dynamic line ratings, real-time monitoring, advanced forecasting and close coordination with storage and ancillary services – capabilities that are still evolving.

## Issues for Brainstorming

- Challenges in ensuring connectivity with the transmission network, especially in remote areas, resulting in stranded generation capacity. Further ensuring evacuation readiness for tendered RE projects
- Challenges in RE Integration, given that India is in Phase 3 of energy transition
- Road ahead for Market-Based Economic Dispatch
- Government schemes for revamping the transmission sector – lessons learned
- Development of Green Energy Corridors – Pros and Cons
- Use of energy storage systems for optimal usage of transmission networks
- Role of DISCOMs, State transmission utilities, RE developers in developing the capacities needed for electrification and ensuring reliability of power
- Prioritising the key challenges in the transmission sector

# 3

## DISTRIBUTION

India's electricity distribution sector is the critical last-mile link in the power value chain, serving over 350 million consumers and accounting for nearly three-fourths of sectoral financial flows. It is the most consumer-facing segment of the sector, directly shaping the reliability, affordability and quality of electricity supply across households, agriculture and industry.

The sector is dominated by state-owned Distribution Companies (DISCOMs), which account for nearly 90 *per cent* of electricity sales in India. Private licensees and franchisees operate in selected urban pockets, but their footprint remains limited. DISCOMs are not merely interfaces for electricity delivery, they are the financial anchor of the entire power sector, responsible for collecting revenues from consumers and channelling payments upstream to generators and transmission utilities. Their role extends beyond billing and collections. DISCOMs are tasked with balancing political and economic pressures, subsidy flows and regulatory mandates, while simultaneously ensuring service standards across diverse consumer categories, from high-demand industrial clusters to heavily subsidised agricultural consumers. This makes their performance central not only to the financial sustainability of the sector, but also to the credibility of India's energy transition, where reliable distribution is a critical enabler for integrating renewables, advancing electrification and enabling consumer centric reforms.

Despite 100 *per cent* electrification<sup>42</sup>, DISCOMs continue to face challenges of technical and commercial losses, high accumulated losses, inefficiencies in service delivery and tariff distortions – making distribution historically the weakest link in the power sector value chain.

At the same time, the sector is undergoing a gradual transformation. Digitalisation initiatives such as smart metering, prepaid billing and consumer grievance redressal platforms are being rolled out with the objectives of improving transparency and efficiency. Regulatory oversight by State Electricity Regulatory Commissions (SERCs) is evolving to balance cost recovery with consumer protection, while central schemes like UDAY and RDSS aim to strengthen operational and financial performance.

In short, India's distribution sector stands at the intersection of policy, regulation and consumer experience, making it both the most complex and the most pivotal segment of the power sector.

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42 <https://www.pib.gov.in/PressReleaselframePage.aspx?PRID=1989801&reg=3&lang=2>

Electricity Distribution Sector – A Sneak Peek<sup>43</sup>

<p><b>Net Accumulated Financial Losses</b></p> <p>₹6.47 Lakh Cr (FY25) from ₹3.59 Lakh Cr (FY15) ↑1.8x</p>	<p><b>Net Financial Profit</b></p> <p>₹2,701 Cr (FY25)</p>	<p><b>Total Outstanding Debt</b></p> <p>₹7.26 Lakh Cr (FY25) from ₹4.04 Lakh Cr (FY15) ↑1.8x</p>	<p><b>Outstanding Debt (Discom)</b></p> <p>Highest: TANGEDCO</p> <p>Lowest: MGVCL (FY25)</p>	<p><b>State Govt. Loans</b></p> <p>₹0.60 Lakh Cr (FY24) from ₹0.30 Lakh Cr (FY14) ↑2.0x</p>	<p><b>State Govt. Loans as % of Total Outstanding Debt</b></p> <p>8% (FY24)</p>
<p><b>ACoS-ARR Gap</b></p> <p>₹0.06 per kWh (FY25) from ₹0.48 per kWh (FY16) ↓88%</p>	<p><b>ACoS &gt; ARR: 27 DISCOMs</b></p> <p>Highest – A&amp;N PD Lowest – MPPoKVVCL &amp; JdVVNL (FY25)</p>	<p><b>ACoS &lt; ARR: 36 DISCOMs</b></p> <p>Highest – AEML Lowest – APSPDCL (FY25)</p>	<p><b>Regulatory Assets</b></p> <p>₹0.92 Lakh Cr (FY24) from ₹0.38 Lakh Cr (FY16) ↑2.5x</p>	<p><b>Regulatory Assets State DISCOM</b></p> <p>Highest: MSEDCL (43%) (FY24)</p>	<p><b>Regulatory Assets Private DISCOM</b></p> <p>Highest: BRPL (14%) (FY24)</p>
<p><b>Tariff Subsidy Received</b></p> <p>₹2.35 Lakh Cr (FY25) from ₹0.46 Lakh Cr (FY15) ↑5.2x</p>	<p><b>DISCOM with Subsidy Realised</b></p> <p>Highest: CSPDCL Lowest: HPSEB (FY25)</p>	<p><b>DISCOM with Highest Subsidy (Booked)</b></p> <p>MSEDCL (₹0.23 Lakh Cr) (FY25)</p>	<p><b>AT&amp;C Loss</b></p> <p>15.04% (FY25) from 23.98% (FY15) ↓8.9%</p>	<p><b>AT&amp;C Losses</b></p> <p>Lowest: TPL Ahmedabad (3.24%) Highest: Nagaland PD (48.86%) (FY25)</p>	<p><b>Collection Efficiency</b></p> <p>97% (FY25) DISCOMs with 100% Collection Efficiency: 17</p>
<p><b>Highest Coal Power Procurement Share within State</b></p> <p>Jharkhand (88%) (FY24)</p>	<p><b>Highest Power Procurement Share within State (FY24)</b></p> <p>Solar: Karnataka (15%) Wind: Puducherry (13%)</p>	<p><b>Highest RE (incl. Large Hydro) Power Procurement Share within State/UT</b></p> <p>Chandigarh (88%) (FY24)</p>	<p><b>Highest Industrial Load</b></p> <p>DNHDD, PD (95%) DGVCL (82%) (FY24)</p>	<p><b>Highest Domestic Load</b></p> <p>DEL (71%) BRPL (64%) (FY24)</p>	<p><b>Highest Agriculture Load</b></p> <p>HESCOM (61%) (FY24)</p>

43 Report on Performance of Power Utilities, <https://www.pfcindia.co.in/ensite/Home/Vs/29> and <https://iced.niti.gov.in/>

### 3.1 Financial Stress and Debt Dependence

#### 3.1.1 Accumulated Profit and Loss

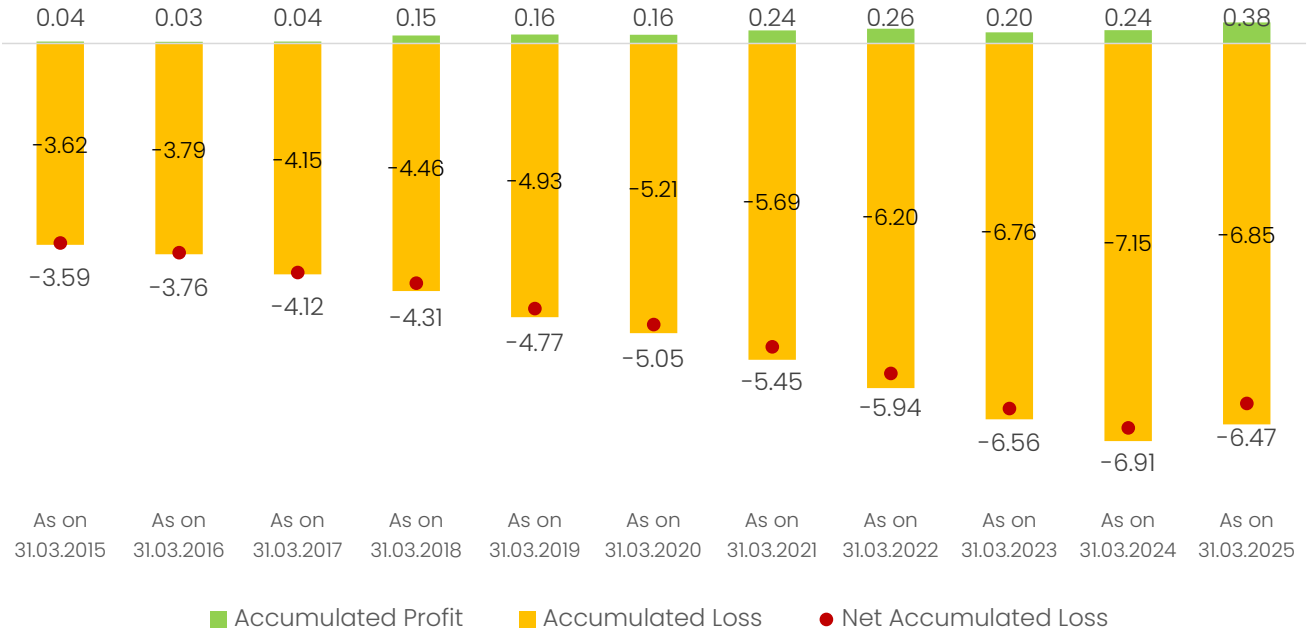


Figure 16: Accumulated profit and loss (in ₹ Lakh Cr)<sup>44</sup>

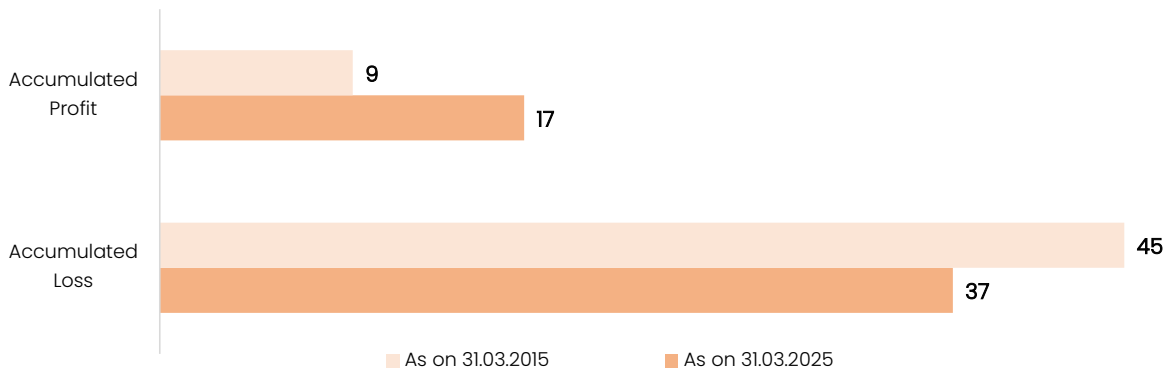
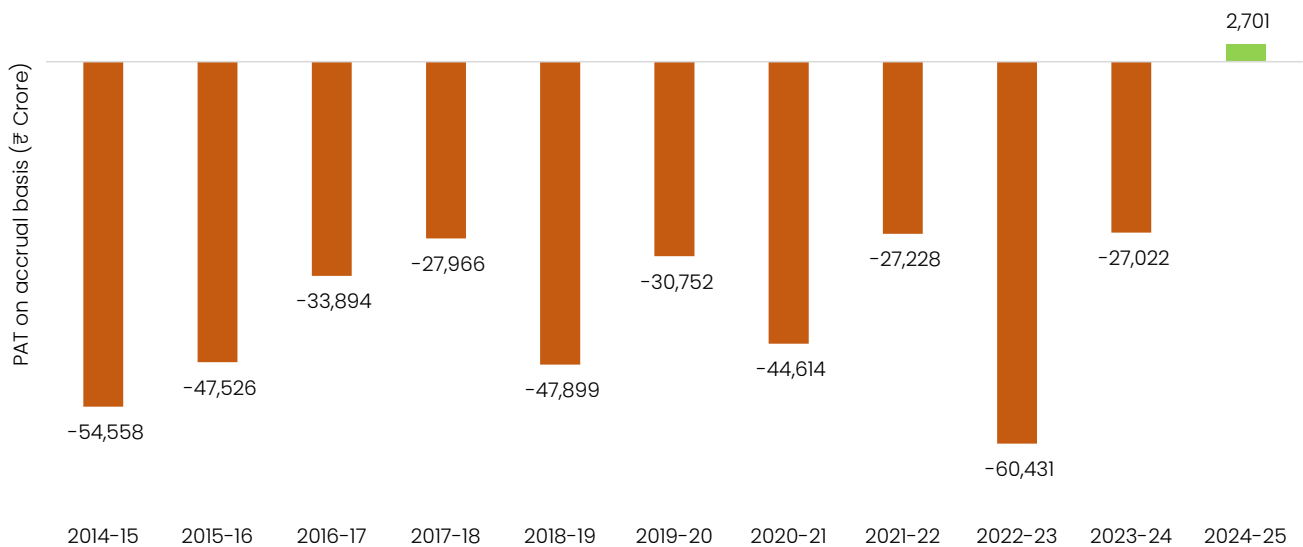


Figure 17: No. of DISCOMs with accumulated profit and loss

- Despite successive financial bailout packages and reform schemes, the accumulated losses of DISCOMs have continued to rise, climbing from ₹3.59 lakh crore in 2014–15 to ₹6.91 lakh crore in 2023–24, before reducing slightly to ₹6.47 lakh crore in 2024–25. The steady rise in accumulated losses highlights the deep-rooted fragility of DISCOM finances.
- The distribution of profitability across DISCOMs has shown some improvement. In 2014-15, only 9 DISCOMs reported overall profit, while 45 carried accumulated losses. By 2024-25, the number of profitable DISCOMs had increased to 17, yet 37 remain loss-making.

44 Report on Performance of Power Utilities, <https://www.pfcindia.co.in/ensite/Home/vs/29> and <https://iced.niti.gov.in/>

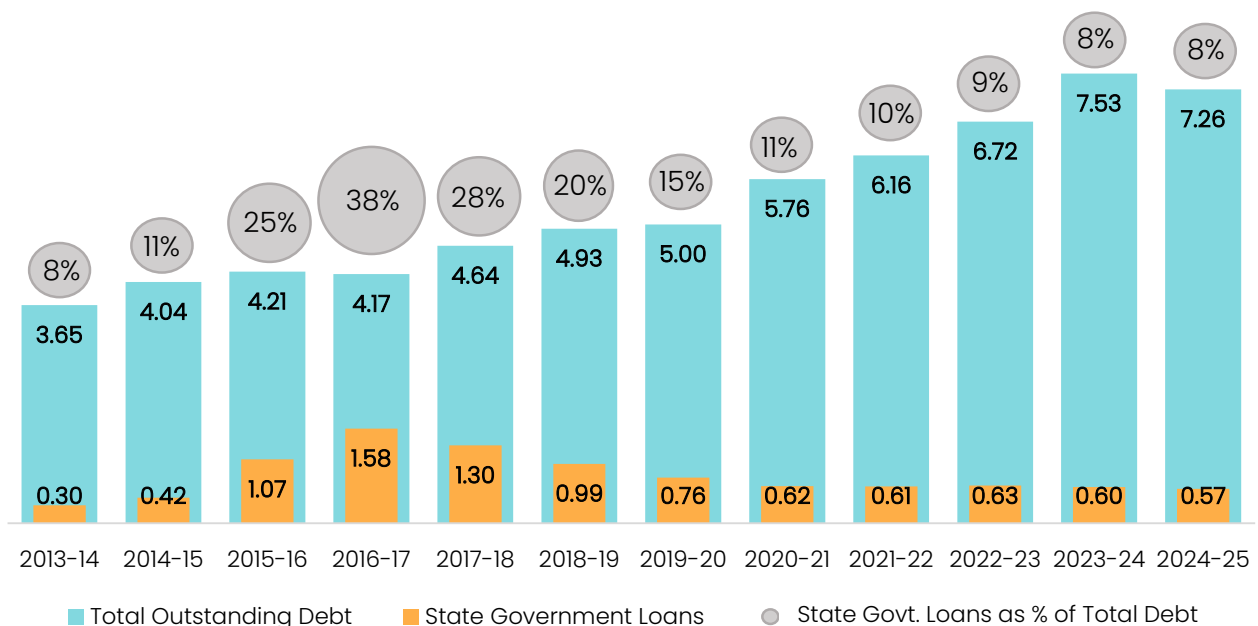
### 3.1.2 Net profit/loss after tax on an accrual basis



**Figure 18:** Profit/Loss after tax on accrual basis (in ₹ Crore)<sup>45</sup>

- DISCOMs recorded their first cumulative net profit of ₹2,701 crore in 2024-25, marking a historic turnaround after a decade of persistent losses and reversing a loss of ₹27,022 crore in 2023-24.
- Out of 64 DISCOMs, 41 reported profits while 23 remained loss-making in 2024-25, highlighting uneven progress across states but a shift towards improved financial discipline.
- This turnaround has been enabled by reduced technical and commercial losses and improved cost recovery, though profitability remains fragile and state-specific.

### 3.1.3 Outstanding Debts



**Figure 19:** Outstanding debt of DISCOMs (in ₹ Lakh Cr)<sup>46</sup>

45 Report on Performance of Power Utilities, <https://www.pfcindia.co.in/ensite/Home/vs/29>, and 14th Annual Integrated Rating & Ranking Report, 14th\_Annual\_Integrated Rating and Ranking of Power Distribution\_Uilities.pdf

46 Report on Performance of Power Utilities, <https://www.pfcindia.co.in/ensite/Home/vs/29>

## Steering India's Power Sector Towards Viksit Bharat

The outstanding debt of DISCOMs has nearly doubled over the past decade, rising from ₹4.04 lakh crore in 2014-15 to ₹7.26 lakh crore in 2024-25. While state government loans accounted for only about 8 per cent of the total debt in 2023-24, the majority of borrowings continue to be sourced from institutional lenders such as REC, PFC, banks and financial institutions.

This rising debt highlights the structural dependence of DISCOMs on external financing, reflecting both persistent cash flow stress and the limited internal accruals to fund operations or capital expenditure. Importantly, debt sustainability is increasingly state-specific, shaped by fiscal discipline, subsidy release practices and regulatory environments.

### 3.2 Tariff and Cost Recovery

#### 3.2.1 Average Cost of Supply (ACoS) and Average Revenue Realised (ARR) Gap

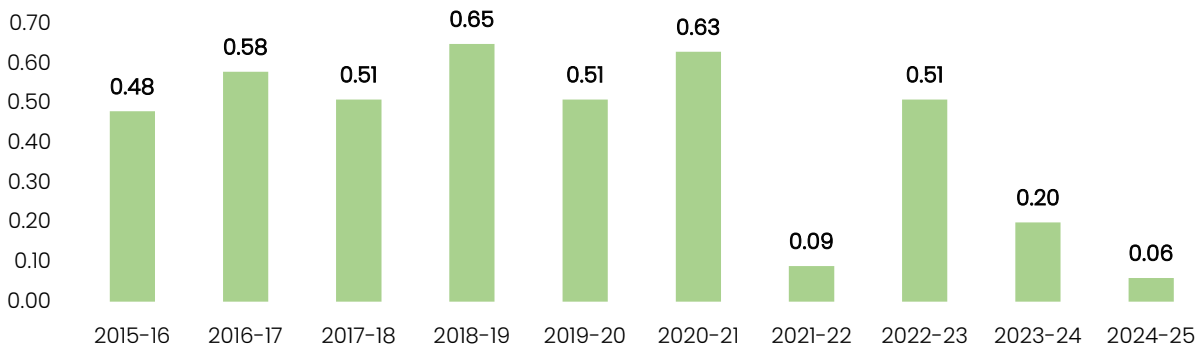


Figure 20: National ACoS-ARR Gap (Input Energy) Trends (in ₹/kWh)<sup>47</sup>

Note: ACoS and ARR Gap is calculated on tariff subsidy received, excluding regulatory income and UDAY grant.

- The ACoS-ARR gap has narrowed by 88 per cent over the past decade, falling from ₹0.48/kWh in 2015-16 to ₹0.06/kWh in 2024-25. Major improvement came between 2020-21 and 2021-22, when the gap reduced from ₹0.63/kWh to ₹0.09/kWh, one of the lowest levels recorded in recent years.
- In 2024-25, 19 DISCOMs achieved an improvement of over ₹0.50/kWh compared to the previous year, reflecting stronger revenue realisation and improved billing efficiency.

#### 3.2.2 Regulatory Assets

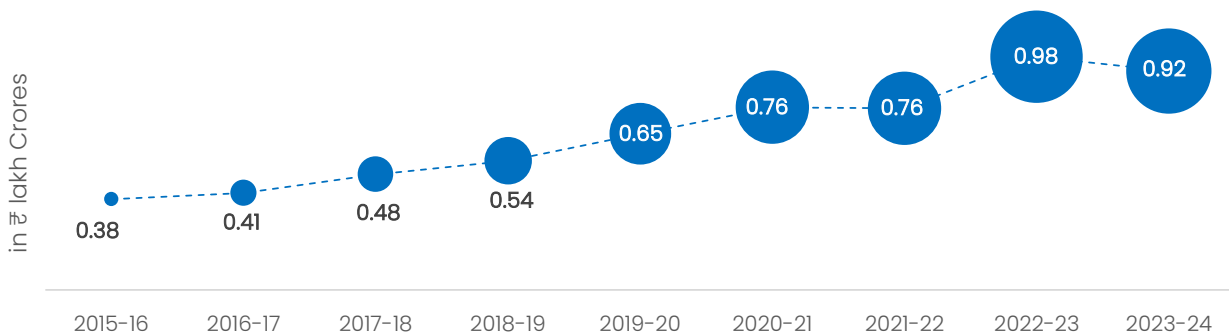
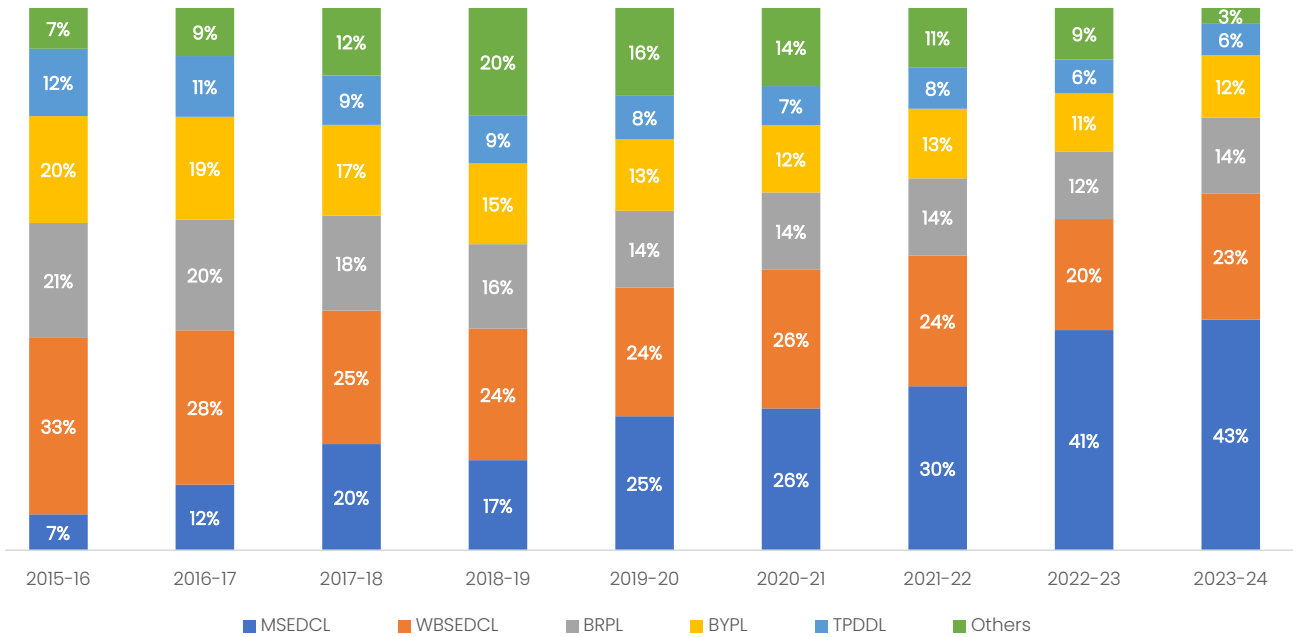


Figure 21: All India Regulatory Assets (in ₹ lakh Crores).<sup>48</sup>

47 Report on Performance of Power Utilities, <https://www.pfcindia.co.in/ensite/Home/Vs/29> & <https://iced.niti.gov.in/>

48 Report on Performance of Power Utilities, <https://www.pfcindia.co.in/ensite/Home/Vs/29>

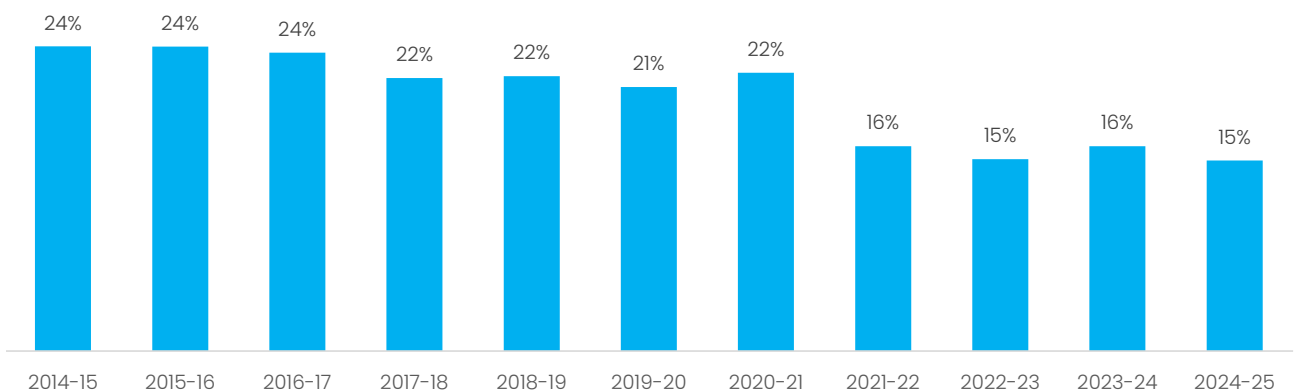


**Figure 22:** Distribution of Regulatory Assets among DISCOMs (in per cent)<sup>49</sup>

- Regulatory assets have increased ~2.5 times between 2015-16 and 2023-24.
- DISCOMs carry regulatory assets<sup>50</sup> worth ₹91,675 Cr, arising from unrecovered costs due to delayed tariff revisions and subsidy commitments. These assets represent deferred revenue and pose a contingent risk, as their realisation depends on timely tariff adjustments and regulatory approvals.

### 3.3 Operational Efficiency

#### 3.3.1 Aggregated Technical & Commercial (AT&C) Losses



**Figure 23:** Yearly AT&C Losses (in per cent)<sup>51</sup>

<sup>49</sup> Report on Performance of Power Utilities, <https://www.pfcindia.co.in/ensite/Home/VS/29>

<sup>50</sup> Regulatory assets of Discoms are, in essence, deferred revenue gaps representing the difference between the actual cost of supplying electricity and the revenue generated from consumer tariffs and subsidies.

<sup>51</sup> Report on Performance of Power Utilities, <https://www.pfcindia.co.in/ensite/Home/VS/29>, and 14<sup>th</sup> Annual Integrated Rating & Ranking Report, 14<sup>th</sup>\_Annual\_Integrated Rating and Ranking of Power Distribution\_Uilities.pdf



Figure 24: Range of AT&C Losses in 2024-25

- In 2024-25, the AT&C losses improved to 15 per cent, down from 22 per cent in 2020-21. Out of the 65 utilities, a total of 38 power utilities (33 DISCOMs and 5 power departments) reported AT&C losses below 15 per cent, aligning with the RDSS target of reducing losses to 12-15 per cent.

### 3.3.2 Billing and Collection Efficiency

- Billing efficiency improved from 79 per cent in 2014-15 to 87.6 per cent in 2024-25, with 46 utilities showing gains over 2023-24. This steady progress reflects the impact of smart metering and digital billing, though the national average still falls short of the 100 per cent target.
- Collection efficiency reached 97 per cent in 2024-25, with 17 DISCOMs achieving 100 per cent and 43 above 90 per cent. Notably, 29 utilities improved their performance compared to 2023-24, showcasing how digital payment adoption strengthens revenue realisation.

## 3.4 Power Procurement Portfolio

### 3.4.1 Power Procurement Portfolio of States and UTs

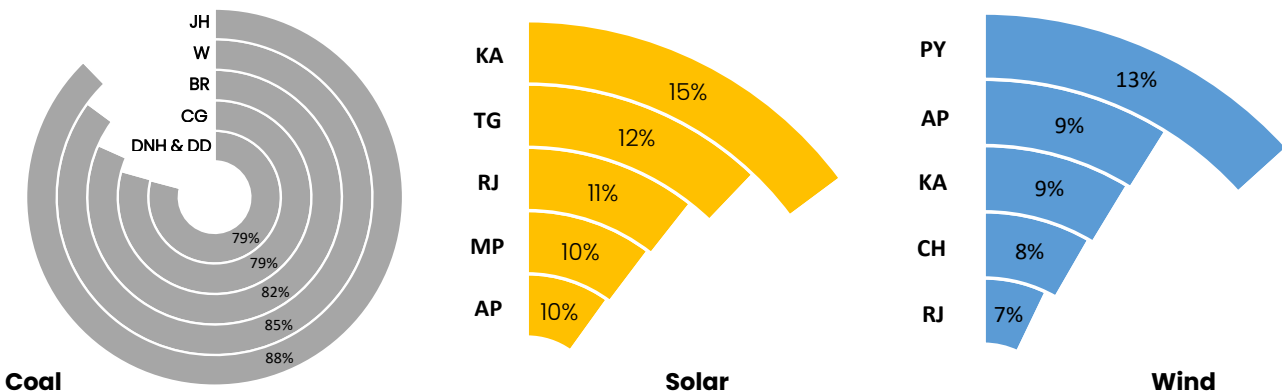
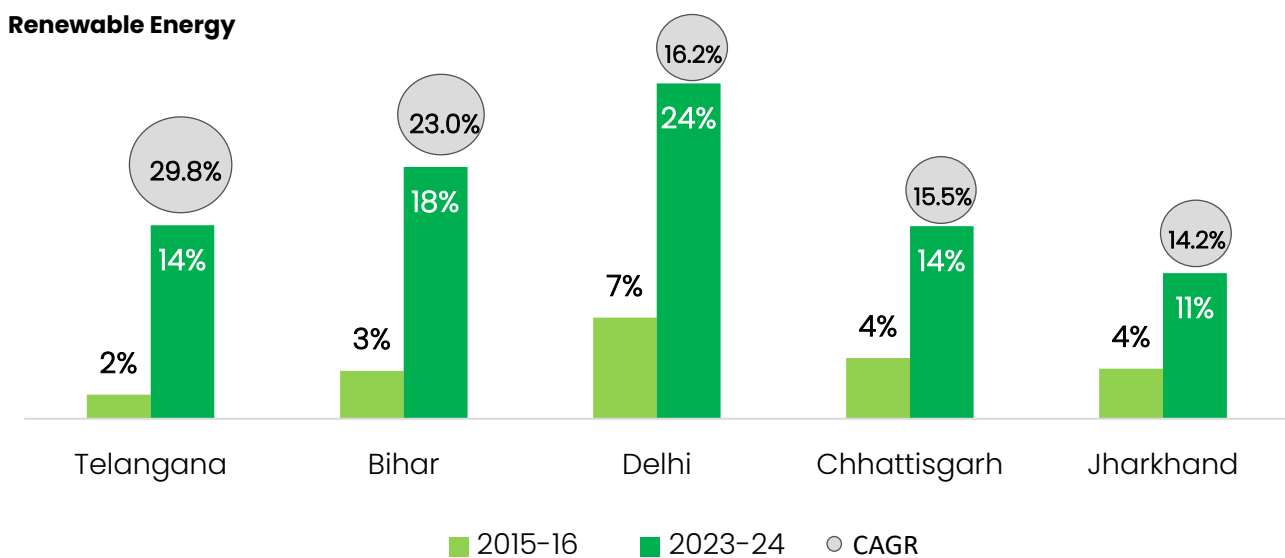
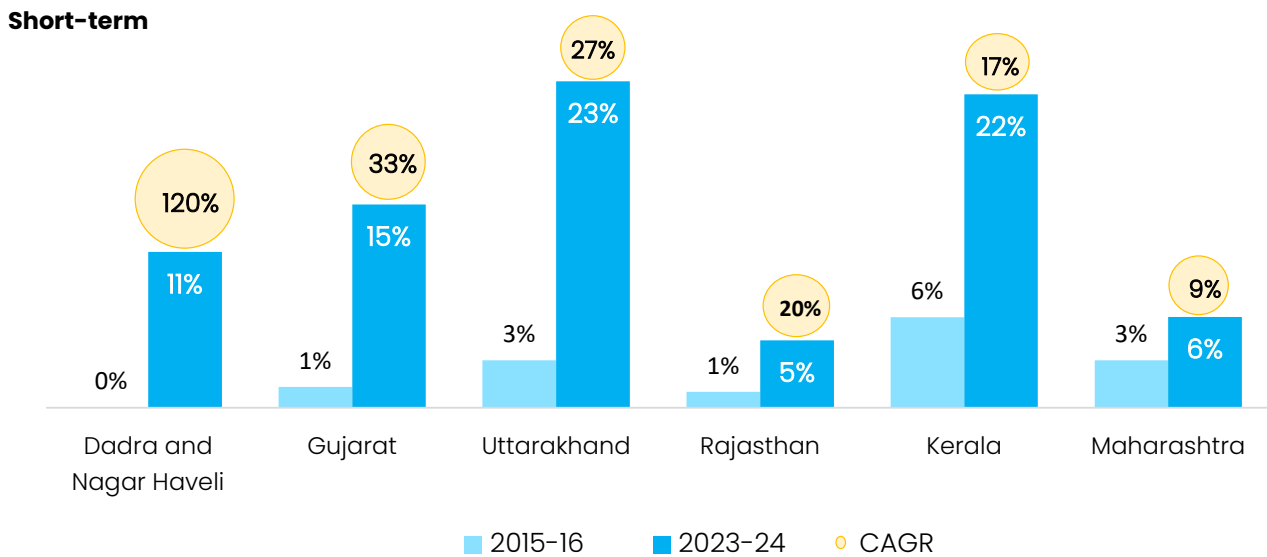


Figure 25: Leading States by Share of Coal, Solar and Wind Power Procurement, 2023-24

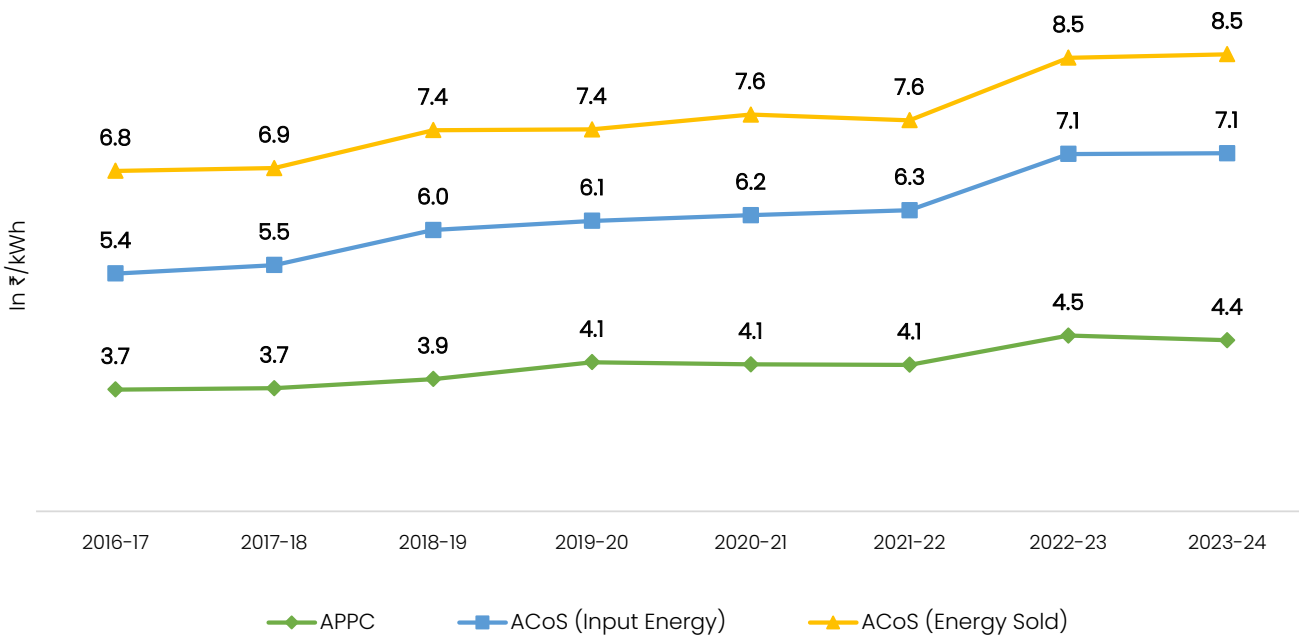


**Figure 26:** States with Highest Growth in Short-Term Power and RE Procurement Share (2015-16 to 2023-24)<sup>52</sup>

Energy transition will affect different states differently. For example, the energy transition will disproportionately affect coal-heavy states with a potential of creating stranded assets and other transition risks that are concentrated more regionally. Whereas RE-rich states would need to increasingly make fresh investments into energy storage and local grid upgrades to balance the integration of large-scale RE.

<sup>52</sup> <https://iced.niti.gov.in/energy/electricity/distribution/power-purchase>

### 3.4.2 Average Power Purchase Cost (APPC) vs Average Cost of Supply (ACoS)



**Figure 27:** Trends in APPC Vs ACoS (in ₹/kWh)<sup>53</sup>

- The APPC rose from ₹3.7/kWh in 2016-17 to ₹4.4/kWh in 2023-24 (at a CAGR of 2.5 per cent), while the ACoS (input energy) grew faster, from ₹5.4/kWh in 2016-17 to ₹7.1/kWh in 2023-24 (at a CAGR of 4 per cent). This indicates losses and overheads are inflating supply costs faster than procurement costs.
- Over the same period, the share of APPC in ACoS declined from 69 per cent to 63 per cent, underscoring the rising weight of non-power costs. Higher growth in interest, depreciation and other costs indicates rising borrowings, capital investments and overheads, which are pushing up the fixed cost burden on DISCOMs.
- In addition, the persistent gap of about ₹1.4/kWh between ACoS (input energy) and ACoS (energy sold) highlights the financial burden of AT&C losses.

Over the years, DISCOMs have made significant strides in improving technical and operational efficiency through successive reform programmes such as RAPDRP, UDAY, IPDS, RDSS and related initiatives. The recent milestone of several state utilities reporting net positive profit after tax represents an important achievement and signals tangible progress in sector reforms.

However, growing performance variation across DISCOMs indicates need for targeted governance, operational turnaround and financial restructuring strategies for the continued defaulters. Moreover, debt sustainability remains closely linked to the fiscal health of states. With large number of Governments tying DISCOM viability to sovereign and state balance sheets, it creates significant fiscal risks. Mounting regulatory assets and debt further indicate latent financial vulnerabilities, underscoring the need for sharper state-level reforms, stronger fiscal discipline and a regionally differentiated energy transition strategy to reboot sector sustainability.

<sup>53</sup> <https://iced.niti.gov.in/energy/electricity/distribution/power-purchase>, <https://iced.niti.gov.in/energy/electricity/distribution/pages/operational-performance#aggregate-technical-and-commercial-loss>

## 3.5 Challenges in the Indian Distribution sub-sector

Despite considerable improvement at the national level of aggregation, the ACoS-ARR gap and AT&C losses remain significantly higher in certain states than the national average. Power Procurement, Inflexible pricing, mounting subsidies and limited institutional capacities continue to weaken the functioning of the DISCOMs. The financial losses incurred by DISCOMs affect their ability to invest in distribution networks and to make efficient procurement decisions.

The government of India has taken several policy initiatives and strategic interventions to make the DISCOMs financially viable. Revamped Distribution Sector Scheme (RDSS), 2021 is one such initiative, aimed at making the distribution sector both financially sustainable and operationally efficient. Some of the challenges in the distribution sub-sector are presented in the following paragraphs.

### Managing AT&C losses

The effectiveness of the design of the electricity distribution network and its operational practices in reducing technical losses needs to be evaluated. It involves examining transformer loading, conductor sizing, feeder routing, maintenance practices and whether the design is optimal for current and future load patterns. It also includes various incentives provided to the DISCOMs by state governments or the Government of India for creating infrastructure, which will reduce AT&C losses.

There may be cases of outdated network design, lack of preventive maintenance, inefficient feeder routing, etc., as well as issues of poor targeting of capital investment, inadequate energy auditing and non-segregation of technical and commercial losses.

### Strengthening regulatory capability to monitor DISCOMs

Traditionally, regulators were responsible for ensuring power system safety and reliability, energy security, rationalising tariffs and ensuring compliance. The Central Electricity Regulatory Commission (CERC) regulates inter-state transmission, central generating stations and wholesale power markets, while State Electricity Regulatory Commissions (SERCs) regulate intra-state tariffs, licensing and performance standards. Technical planning and system adequacy assessments are undertaken by the Central Electricity Authority (CEA), which prepares the National Electricity Plan (NEP) and sets technical standards.

The role of the regulators is evolving with the changing energy landscape, with the need to provide oversight on demand forecasting, resource adequacy, procurement planning by DISCOMs, as well as financial sustainability of DISCOMs. The clean energy transition goal in the power sector has further tasked the regulatory bodies with building a regulatory framework that supports RE integration, attracts investments in the sector and protects consumer interests.

### Norms for Quality of Supply

Section 50 of the Electricity Act, 2003, requires the SERCs to come up with a supply code prescribing various aspects relating to the power sector and, more specifically, to distribution. Various state Regulatory Commissions (established under Section 86 of the said act) have come up with their respective supply codes, which specify the quality of supply in their respective jurisdictions. The DISCOMs are meeting the supply standards generally, but there is always scope for improvement, which needs to be aimed at.

### Cost-reflective Tariff Design

The electricity tariff design and subsidy distribution mechanisms affect both the financial health of DISCOMs and the consumption behaviour of different consumer categories. It is important that the tariff is cost-reflective and that the subsidies are targeted, transparent and sustainable. The framework for ensuring that tariffs are cost-reflective and subsidies are appropriately targeted is in place, but the implementation of the framework faces various practical difficulties, given the need for electricity in everyday life and its impact on people's lives.

### Demand forecasting by the DISCOMs

The first step in ensuring future energy and power availability is demand forecasting by consumer-serving entities, such as DISCOMs. This helps plan for the procurement of adequate capacities which not only meet energy requirements but are also cost-optimised, keeping in mind the constraints such as availability, RE and RPO commitments, transmission capacity, ramp rates, etc. The demand forecasts need to be for a period longer than the longest gestation period (typically 10 years) of any investment required for meeting energy requirements.

The demand forecasting exercise has to be completed in order to ensure that the future actions in the sector are executed in an efficient and cost-effective manner.

### Power Procurement Costs

Power purchase accounts for over 75 *per cent* of the total revenue requirement. Poor planning leads to investments in high costs and longer-term power purchase agreements. PPAs are take-or-pay contracts, where payments must be made regardless of whether the power is actually used. This causes problems in situations where power demand has clearly been overestimated. There is a need to re-look at power procurement strategies that align with the electricity demand from future consumers.

### Digitalisation and Smart Infrastructure

Digitalisation of the distribution sector is central to India's reform trajectory, as highlighted in the Draft NEP 2026. The policy calls for GIS-based asset mapping, consumer indexing and phased installation of substation automation equipment, alongside a nationwide rollout of smart meters to enable real-time energy management, audits and demand-side management. The RDSS set an ambitious target of 250 million prepaid smart consumer meters by March 2026, along with mandates for smart metering of all feeders and distribution transformers<sup>54</sup>.

However, smart meter deployment has been slow. As of 15 January 2026, only 53 million smart meters have been installed, representing 21 *per cent* of the target. While 224 million meters have been sanctioned and 150 million awarded<sup>55</sup>, actual installations lag due to various challenges, including high upfront costs, vendor bottlenecks, integration with legacy billing systems and consumer resistance to prepaid metering. Achieving the 250 million targets will require accelerated procurement, stronger vendor management and better consumer engagement. Success in this area is critical not only for reducing AT&C losses and improving billing efficiency, but also for enabling advanced demand-side management and renewable integration.

54 <https://www.pib.gov.in/PressReleaseDetailm.aspx?PRID=1992405&reg=3&lang=2>

55 <https://www.nsgm.gov.in/en/sm-stats-all>

## Issues for Brainstorming

- Strengthening of processes at DISCOMs to plan for and procure adequate capacity, factoring in Renewable Consumption Obligations (RCOs)
- Use of hedging instruments by DISCOMs – Pros and Cons
- Development of mechanisms for ensuring higher norms of quality of supply
- Incentives to DISCOMs and States to manage AT&C losses – transparency and timeliness of the disbursement of the incentives
- Establishing cost-reflective tariffs
- Strengthening regulatory capability to monitor DISCOMs
- Demand forecasting and procurement strategies to avoid costly short-term purchases and over-contracting risks
- Coordination between DISCOMs, State transmission utilities and RE developers in developing the capacities needed for electrification and ensuring reliability of power
- Promoting green energy, open access for large consumers and captive consumers
- How can utilities look at building capacities for integrating Artificial Intelligence (AI) and Machine Learning (ML) to improve the existing process of scheduling and dispatch of power

## GLOSSARY

ACoS	Average Cost of Supply	KSEBL	Kerala State Electricity Board Limited
ACoS-ARR Gap	Average Cost of Supply and Average Revenue Realised gap	kWh	Kilo-Watt hour
AEML	Adani Electricity Mumbai Limited	MESCOM	Mangalore Electricity Supply Company Limited
APPC	Average Power Purchase Cost	MGVCL	Madhya Gujarat Vij Company Limited
APSPDCL	Andhra Pradesh Southern Power Distribution Company Limited	MMT	Million Metric Tonne
ARR	Average Revenue Realised	MNRE	Ministry of New & Renewable Energy
Arunachal Pradesh PD	Power Department of Arunachal Pradesh	MSEDCL	Maharashtra State Electricity Distribution Company Limited
AT&C Losses	Aggregate Technical and Commercial Losses	MVA	Mega Volt-Ampere
BESS	Battery Energy Storage System	NDC	Nationally Determined Contribution
BRPL	BSES Rajdhani Power Limited	NEP	National Electricity Plan
BU	Billion Unit	PFC	Power Finance Corporation
CAGR	Compound Annual Growth Rate	PGVCL	Paschim Gujarat Vij Company Limited
CEA	Central Electricity Authority	PM-JANMAN	Pradhan Mantri Janjati Adivasi Nyaya Maha Abhiyan
CERC	Central Electricity Regulatory Commission	PM-KUSUM	Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan
ckm	Circuit Kilo meter	PPA	Power Purchase Agreement
CO <sub>2</sub>	Carbon Dioxide	PSA	Power Sale Agreement
COVID-19	Coronavirus Disease of 2019	PSP	Pumped Storage Project
CSPDCL	Chhattisgarh State Power Distribution Company Limited	PuVVNL	Purvanchal Vidyut Vitran Nigam Limited
DGVCL	Dakshin Gujarat Vij Company Limited	RAPDRP	Restructured Accelerated Power Development and Reforms Programme
DISCOM	Distribution Company	RDSS	Revamped Distribution Sector Scheme
DNHDD	Dadra and Nagar Haveli and Daman and Diu Power Distribution Corporation Limited	RE	Renewable Energy
GEC	Green Energy Corridor	RoW	Right of Way
GW	Giga-Watt	RPO	Renewable Purchase Obligation
GWh	Giga-Watt hour	SERC	State Electricity Regulatory Commission
HESCOM	Hubli Electricity Supply Company Limited	TANGEDCO	Tamil Nadu Generation and Distribution Corporation Limited
HPSEB	Himachal Pradesh State Electricity Board Limited	TGSPDCL	Telangana State Southern Power Distribution Company Limited
ICED	India Climate & Energy Dashboard	TPLA	Torrent Power Limited- Ahmedabad
InSTS	Intra-state Transmission System	UDAY	Ujwal DISCOM Assurance Yojana
IPDS	Integrated Power Development Scheme	UGVCL	Uttar Gujarat Vij Company Limited
ISTS	Inter-State Transmission System	WBSEDCL	West Bengal State Electricity Distribution Company Limited





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