

India's Power Sector - Transitioning From Coal Backbone to Renewable Dominance For Net Zero

February 15, 2026 • vajiramandravi.com



India's Power Sector Latest News

- A new study by NITI Aayog titled “Scenarios Towards Viksit Bharat and Net Zero” outlines possible pathways for India's electricity transition up to 2070.
- While coal currently dominates India's electricity generation, the report projects a long-term structural shift toward renewable energy (RE).
- This shift will be supported by nuclear expansion, storage technologies, and possible decarbonisation of coal through Carbon Capture, Utilisation and Storage (**CCUS**).
- The study examines two pathways: Current Policy Scenario (**CPS**) – Continuation of existing policies, and Net Zero Scenario (**NZS**) – Accelerated pathway aligned with India's 2070 net-zero target.

Present Electricity Landscape - Coal Still the Backbone

- Coal accounts for about **74%** of electricity generation, providing low-cost base-load power, grid stability, and round-the-clock reliability.
- **Installed capacity (December 2025):**
 - Total: 513 GW
 - Fossil-based: 48%
 - Renewable: 50%
 - Nuclear: 1.7%
- However, despite renewables constituting 50% of installed capacity, their contribution to actual electricity generation remains only about **22%** (2024-25).

Structural Constraints in Renewable Energy

- The gap between renewable capacity and actual generation is due to following structural challenges –
 - **Low capacity utilisation factor (CUF):** Solar and wind operate below maximum potential output.
 - **Intermittency and variability:** Solar and wind are weather-dependent, leading to curtailment, dispatch challenges, and grid instability risks.
 - **Grid constraints:** Limited transmission capacity, and inadequate system flexibility.
 - **Storage deficit:** Lack of large-scale long-duration energy storage.
- Because of these constraints, coal continues to provide essential balancing power.

Electricity Mix Projections up to 2070

- **Under CPS:**
 - Renewable share in generation is expected to increase from 20% (2024-25) to over **80%** (2070). The respective share of coal and nuclear will be coal share [74% → 6–10%], and nuclear [3% → 5–8%].
 - Coal capacity may rise from 268 GW (2025) to peak at 450–470 GW by 2050, and gradually decline afterward.
- **Under NZS:**
 - Coal-based generation could fall to zero by 2070, and coal capacity may peak earlier at 420–435 GW by 2045, and decline sharply thereafter.
 - Renewables become the dominant backbone of the grid.

Massive Storage Expansion Required

- A renewables-heavy grid demands unprecedented storage capacity.
- Battery Energy Storage Systems (**BESS**) to scale up from less than 50 GW in 2030 to about 1,300-1,400 GW under CPS and up to 2,500-3,000 GW under NZS by 2070.
- **Pumped Storage Plants** are also expected to play a crucial role in providing long-duration storage and grid stability, growing from 13-19 GW in 2030 to about 110 GW in CPS and 150-165 GW in NZS.
- Storage becomes central to grid **reliability**, load balancing, and round-the-clock power supply.

Nuclear Power as Strategic Pillar

- **Targets:**

- The study identifies nuclear energy as crucial in a renewable-dominated grid.
- It projects nuclear power capacity to grow from the current **8.18 GW** in 2025 to 90-135 GW by 2070 under CPS — an increase of 10 to 15 times.
- Under the NZS, nuclear capacity could touch 295-320 GW.

- **Key roles of nuclear energy:**

- Firm low-carbon base-load power
- Industrial high-temperature heat
- Power supply for green hydrogen electrolyzers
- Grid balancing support

- **The report recommends:**

- Advanced reactors
- Small Modular Reactors (SMRs)
- Transition of captive coal plants to SMRs. This helps reuse existing land, transmission connectivity, and industrial infrastructure.

Coal's Continuing Role in Transition

- Despite the clean energy push, coal remains **indispensable** in the near to medium term because storage remains expensive; nuclear projects have high capital cost, long gestation period; and renewables face land and clearance challenges.
- In some pathways, coal continues even in 2070 with deep decarbonisation via:
 - **CCUS**: Captures CO₂ from coal plants. Stores underground or reuses it. Prevents atmospheric emissions.
 - This pathway becomes relevant if nuclear expansion slows, renewable deployment faces cost or grid barriers.

Alternative Pathway Risks

- If nuclear growth remains limited, solar capacity may need to exceed 5,500 GW, storage requirements would rise dramatically, and grid stability risks would intensify.
- This creates financial stress, infrastructure bottlenecks, and land acquisition challenges.

Challenges and Way Forward

- **Intermittency of renewables:** Rapid scale-up of BESS and Pumped Storage. Improve market mechanisms for flexible dispatch.
- **High storage costs:** Develop domestic manufacturing ecosystem for storage technologies. Promote CCUS research and pilot deployment.
- **Grid infrastructure inadequacy:** Accelerate grid modernization and transmission expansion.

- **Nuclear capital intensity:** Fast-track nuclear expansion including SMRs. Encourage industrial shift to nuclear-based captive power.
- **Managing stranded coal assets:** Strategic planning to avoid stranded coal assets.

Conclusion

- India's electricity transition will not be a simple coal-to-solar swap. It will require a carefully calibrated mix of renewables, storage, nuclear expansion, grid reform, and transitional coal support.
- Coal may remain the backbone in the medium term, but by 2070, renewables — supported by large-scale storage and nuclear power — could decisively reshape India's energy architecture.
- The real challenge lies not in installing capacity, but in ensuring **reliability, flexibility, affordability**, and system **stability** in a net-zero compatible electricity grid.

Source: IE

Source: <https://vajiramandravi.com/current-affairs/indias-power-sector-transitioning-from-coal-backbone-to-renewable-dominance-for-net-zero/>

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