Energy Efficiency Council

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ENERGY TRANSITION SUMMIT

Integrating Innovation, Infrastructure & Investment for Energy Transition in Southern India

A Report on Energy Transition in South India

January 2026

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1. Conventional Energy to Clean Energy

India has undergone a phenomenal shift in its power generation landscape over the past decade. A system which was once dominated by coal-based thermal power generation is now transitioning towards a diversified, low-carbon energy mix. Clean energy has emerged as the central driver of capacity addition, investment flows, and grid expansion in India. Installed power generation capacity[1] in the country as on 30th November 2025 is tabulated as follows.

Power Source	Installed Power Generation Capacity (GW)	Percentage (%)
Coal	219.61	48.4
Lignite	6.62	
Gas	20.12	
Diesel	0.59	
Total Fossil Fuel	**246.94**	
Large Hydro	50.42	51.6
Solar Power	132.85	
Wind Power	53.98	
Biomass Power/Cogen	10.75	
Waste to Energy	0.86	
Small Hydro	5.16	
Nuclear	8.78	
Total Non-Fossil Fuel	**262.80**	
Total Installed Capacity	**509.74**	**100.0**

This transition is being propelled by multiple factors, including rising electricity demand, declining costs of generation from renewable technologies, climate commitments, energy security and strong domestic policy support. Solar, wind and other non-fossil fuel sources are increasingly shaping India's energy transition. In addition, the focus has also shifted from merely adding capacity to ensuring reliability, flexibility, and integration of variable renewable energy into the national grid. The total electricity generation in the country, including output from grid-connected renewable energy sources, has shown a consistent upward trend over the past decade and is tabulated as follows.

S.No.	Year	Electricity Generation[2] (BU)
1	2014-15	1,110.46
2	2015-16	1,173.60
3	2016-17	1,241.69
4	2017-18	1,308.15
5	2018-19	1,376.09
6	2019-20	1,389.12

[1] https://powermin.gov.in/sites/default/files/uploads/power_sector_at_glance_Nov_2025.pdf
[2] https://powermin.gov.in/en/content/overview

7	2020-21	1,381.85
8	2021-22	1,491.86
9	2022-23	1,624.46
10	2023-24	1,739.09
11	2024-25	1,829.70

It is worthwhile noting that the generation from renewable sources including solar and wind has increased substantially by 12.92% and thermal generation has increased marginally by 2.81% during 2024-25 (when compared to 2023-24). Some of the important highlights of clean energy transition in India are as follows:

1.1 Crossing the 50% Non-Fossil Threshold

At the COP 26 Summit in Glasgow, India announced five key climate commitments, known as the 'Panchamrit Mission', guiding the country's path to net zero emissions by 2070. Key commitments related to renewable energy are as follows:

- Reach 500 GW of non-fossil fuel based power generation capacity by 2030.
- Meet 50% of energy requirements from renewable sources by 2030.

India has surpassed its COP26 commitment well ahead of schedule. As of 31st November 2025, the country's installed non-fossil capacity, including solar, wind, hydro, and nuclear power reached 262.80 GW, accounting for approximately 51.6% of the total installed capacity of around 510 Gw[3].

1.2 Record Renewable Additions in 2025

The calendar year 2025 marked a historic high for renewable energy deployment in India. Nearly 44.5 GW of new renewable capacity was added during the year (till November 2025), almost doubling the additions recorded in 2024 and setting a new benchmark for annual growth[4].

1.3 Decline in Fossil Fuel Generation

According to the data[5] available from the Ministry of Power, fossil fuel based generation has declined by 6.35% in 2025-26 (till November 2025) whereas the non-fossil fuel based generation has increased by 16.54% (till November 2025) when compared to 2024-25. Further, as per an analysis by the Centre for Research on Energy and Clean Air (CREA), coal-based power generation declined by 3% in 2025. This is only the second full-year decline in more than five decades and notably, the first driven by sustained clean energy expansion rather than an external shock such as an economic lock down[6].

1.4 Solar at the Forefront

Solar power continues to lead India's energy transition. Installed solar capacity reached 135.81 GW[7] as on 31st December 2025, reflecting the fastest annual growth rate the sector has recorded to date and reinforcing the role of solar energy as the backbone of new capacity additions[8].

[3] https://www.pib.gov.in/PressReleasePage.aspx?PRID=2183866&reg=3&lang=2
[4] https://www.pib.gov.in/PressReleasePage.aspx?PRID=2209478&reg=3&lang=2
[5] https://powermin.gov.in/en/content/overview
[6] India power sector review 2025: Record clean energy deployment drives historic decline in coal generation_Centre for Research on Energy and Clean Air
[7] https://mnre.gov.in/en/physical-progress/
[8] https://www.pib.gov.in/PressReleasePage.aspx?PRID=2209478&reg=3&lang=2

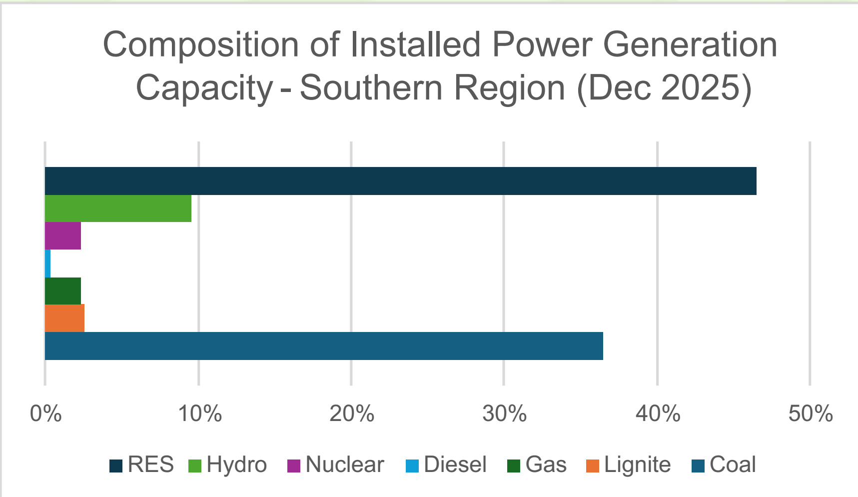
1.5 Southern Region Leading India's Energy Transition

Southern Region including States/ UTs such as Andhra Pradesh, Karnataka, Kerala, Puducherry, Tamil Nadu and Telangana have contributed significantly to India's clean energy journey. Out of 258 GW of installed renewable energy capacity in the country, 80 GW is in Southern Region contributing to more than 31% of the total renewable capacity. State-wise installed RE capacity[9] in the Southern Region is as follows:

S.No	State/ UT	Small Hydro (MW)	Wind Power (MW)	Bio Power (MW)	Solar Power (MW)	Large Hydro (MW)	Total Capacity (MW)
1	Andhra Pradesh	164	4,398	594	6,389	3,290	14,835
2	Karnataka	1,285	8,414	1,917	10,679	3,689	25,984
3	Kerala	277	72	2	2,032	2,008	4,391
4	Puducherry				74		74
5	Tamil Nadu	123	12,075	1,047	11,665	2,203	27,113
6	Telangana	90	128	222	5,052	2,406	7,898
	Total						**80,295**

S.No	State/ UT[10]	Total Installed Capacity (GW)	Thermal Capacity (GW)	Non-Fossil Capacity (GW), incl. Nuclear	Share of Non-Fossil Capacity (%)
1	Andhra Pradesh	28.98	14.25	14.73	51
2	Karnataka	37.29	10.81	26.48	71
3	Kerala	7.82	3.07	4.75	61
4	Puducherry	0.45	0.29	0.16	36
5	Tamil Nadu	44.54	16.14	28.40	64
6	Telangana	21.02	12.90	8.12	39

* Data as of 31st November 2025 (Source: CEA)



[9] https://mnre.gov.in/en/physical-progress/
[10] https://cea.nic.in/executive-summary-report/?lang=en

1.6 Andhra Pradesh

Andhra Pradesh is currently implementing Andhra Pradesh Integrated Clean Energy Policy, 2024 for meeting its commitments towards climate action. As of 31st November 2025, the state's total installed power generation capacity stands at 28.98 GW, with non-fossil sources making up 51% of the mix. A significant milestone was achieved on 7th January 2026, when APGENCO recorded a record thermal output of 6,009 MW to meet industrial surges[11]. While the thermal core of the state remains vital for grid inertia, Andhra Pradesh has also greenlit new renewable energy projects worth INR 15,800 crore in January 2026.

1.7 Karnataka

Karnataka has emerged as one of the leading states in India's energy transition, successfully operating a grid where non-fossil fuel sources now dominate the installed capacity. As of 31st November 2025, the state's total installed capacity reached approximately 37.29 GW, clean energy mainly solar, wind, and hydro makes up over 71% of the state's power mix. This shift became especially clear in August 2025, when renewables met 80% of Karnataka's daily electricity demand (143 MU) in a single day[12]. The traditional sources of electricity are taking on a new role as flexible balancers in the system. Based on real-time data from KPTCL-SLDC the state still operates a thermal base of close to 11,000 MW[13].

1.8 Kerala

Kerala has a total installed power generation capacity of 7.82 GW, with non-fossil sources including large hydro and solar contributing to more than 61% of its energy mix. Due to geographical constraints, Kerala focuses on a "high-efficiency" rather than "high-acreage" model. The state is investing INR 648 crore into its TransGrid 2.0 program to modernize its network, allowing it to handle a growing share of decentralized rooftop solar while managing its thermal imports more effectively.

1.9 Puducherry

Puducherry has a generation capacity of 0.45 GW including its allocated share in joint and central sector utilities. Puducherry serves as the Southern Region's laboratory for smart infrastructure and is now scaling its Smart Grid Pilot to 34,000 consumers. The Union Territory is targeting 225 MW of solar by the end of the year to reduce its dependency on central thermal allocations[14].

1.10Tamil Nadu

Tamil Nadu remains a heavyweight in the Indian energy landscape, holding the highest renewable energy capacity among Southern states. As of 31st November 2025, the state's installed capacity reached 44.54 GW, with clean energy (wind, solar, and hydro) accounting for nearly 64% of the mix. The state is a global leader in wind energy with over 12.07 GW of installed capacity. Similar to Karnataka, Tamil Nadu is pivoting its thermal assets including the recently modernized North Chennai Stage III (800 MW) to act as a strategic reserve to balance its renewable generation[15].

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[11] Andhra Pradesh achieves record 6,000 MW thermal power generation
[12] Karnataka hits 80 per cent renewable power mark on August 18, sets record
[13] State Generation
[14] https://electricity.py.gov.in/puducherry-region-power-scenario-availability
[15] Tamil Nadu to augment power generation by 2,640MW; thermal and green projects in the mix | Chennai News - The Times of India

1.11 Telangana

Telangana has one of the fastest-growing power demands in India, with peak demand projected to hit 18.8 GW by the end of 2026. Currently, the installed power generation capacity in the state is 21.02 GW. While it maintains a strong thermal base, the state is unique in its focus on distributed solar. Under the Clean and Green Energy Policy 2025, the state is solarizing agricultural feeders to shift 4,000 MW of irrigation load to the daytime, effectively reducing the "peak stress" on its conventional thermal units[16].

1.12 Factors Driving Energy Transition in Southern Region

The following sectors are expected to play an important role in driving energy transition in the southern region.

Datacenters

Datacenters consume vast amounts of electricity and water, either directly or indirectly. As of 31st December 2025, India's datacenter capacity is around 1.5 GW, and they consume around 0.5% of India's electricity generation. As per a recent analysis[17], datacenter capacity in the country is expected to increase to 9 GW, and their electricity consumption is expected to reach 3% by 2030. India's global capability centers (GCCs) including Bengaluru, Chennai and Hyderabad will play an important role contributing to clean energy transition in Southern Region.

Green Hydrogen

Green hydrogen is an important lever for decarbonizing industry, especially hard to abate sectors. India has a National Green Hydrogen Mission with the objective of setting up projects for generating 5 million metric tons of green hydrogen by 2030. 125 GW of renewable energy capacities are expected to be come up for meeting the clean energy demand for generating green hydrogen. Considering the RE and port infrastructure in the Southern Region, States in the region have the potential to become green hydrogen hubs. Many developers have committed to green hydrogen investments in the region (for e.g., NTPC is developing a green hydrogen hub in Andhra Pradesh at an investment of USD 21 billion[18]; a private developer has initiated activities for setting up green ammonia plant in Tamil Nadu at an investment of around USD 4.5 billion[19]).

Industrial and Commercial Buildings

Southern Region is one of the industrialized regions in the country contributing significantly to India's industrial output. Southern Region is also home to some of the largest cities namely Bengaluru, Chennai, Hyderabad, and Visakhapatnam contributing significant growth in commercial buildings including IT parks, shopping malls, hotels, hospitals etc. Increased industrial and commercial demand for electricity in the region will be one of the major drivers for energy transition.

Electric Vehicles

As per the data extracted from Vahan Dashboard[20], total sale of electric vehicles in India for FY 2024-25 is 2.04 million. Sale of EVs grew at 15.68% in FY 2024-25 when compared to FY 2023-24

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[16] Telangana_Clean_and_Green_Energy_Policy_2025.pdf

[17] https://ieefa.org/resources/blue-seas-and-green-electrons-powering-indias-ai-data-centres

[18] https://ntpcrel.co.in/verticals/green-hydrogen/

[19] https://www.sembcorp.com/news-and-insights/insights-and-stories/corporate/driving-decarbonisation-through-the-green-hydrogen-economy/

[20] https://evreporter.com/wp-content/uploads/2025/05/EVreporter-India-EV-Report-FY24-25.pdf

2. Solar, Wind & Grid Readiness

The Southern Region has emerged as India's principal testbed for large-scale renewable energy integration. As of 31st December 2025, the region has crossed 80 GW of installed renewable capacity (including large hydro), with non-fossil sources now accounting for almost 60% of the overall generation mix. This scale of deployment has pushed grid preparedness beyond conventional transmission expansion, driving a shift towards digitized grid management, advanced forecasting, and high-precision operational practices.

Wind and solar dominate the energy mix in the Southern Region, with the region consistently setting national benchmarks for both installed capacity and operational penetration[21]. State/ UT wise wind and solar capacities installed in the Southern Region are as follows.

S.No	State/ UT	Wind Power (MW)	Solar Power (MW)
1	Andhra Pradesh	4,398	6,389
2	Karnataka	8,414	10,679
3	Kerala	72	2,032
4	Puducherry		74
5	Tamil Nadu	12,075	11,665
6	Telangana	128	5,052

According to South Regional Power Committee (SRPC) records for December 2025, the instantaneous renewable energy penetration in the Southern grid hit a peak of 47% on November 1, 2025, managed within the strict IEGC frequency band of 49.90 Hz to 50.05 Hz[22]. Wind and solar generation in the Southern States/ UTs from April to December 2025 are tabulated below.

S.No	State/ UT	Wind Power Generation (MU), Apr-Dec 2025	Solar Power Generation (MU), Apr-Dec 2025
1	Andhra Pradesh	7,636	5,901
2	Karnataka	15,170	12,743
3	Kerala	109	1,603
4	Puducherry	0	9
5	Tamil Nadu	21,684	14,077
6	Telangana	243	4,998

The physical readiness of the Southern Regional grid is underpinned by the Green Energy Corridor (GEC), a national transmission initiative designed to enable large-scale renewable energy integration by creating dedicated high-capacity evacuation corridors from renewable-rich zones to load centers.

In the Southern Region, Intra-State GEC Phase-II is actively integrating 20 GW of renewable capacity across seven states as of January 9, 2026[23], significantly strengthening last-mile connectivity. Karnataka and Tamil Nadu have emerged as frontrunners, having completed all

[21] https://www.srldc.in/var/ftp/RemcReports/Renewable%20Energy%20in%20Southern%20Region%20Annual%20Report%202024-25.pdf
[22] mom233occm.pdf
[23] Intra-State GEC Phase-II | MINISTRY OF NEW AND RENEWABLE ENERGY | India

State/ UT	Key Grid Readiness Achievement	Primary Technical Focus
Andhra Pradesh	Pooling Station Excellence	• Optimization of the Kurnool-3 (765/400 kV) Pooling Substation, the largest RE evacuation point in the region • The State is focused on setting up 160 GW of renewables by 2030, as per Andhra Pradesh Integrated Clean Energy (ICE) Policy 2024
Karnataka	80% RE Operational Record	• First in India to meet 80% of daily demand via RE (Aug 2025) • Now focusing on the 3 GW Bellary-Davanagere transmission corridor awarded in Jan 2026 [25]
Kerala	TransGrid 2.0 & Digitalization	• Implementing INR 647.8 crore investment in TransGrid 2.0 [26] aiming to modernize State's intra-state transmission network and improve power reliability
Puducherry	Smart Grid Pilot Leader	• First in the region to complete a 34,000 consumer Smart Grid pilot with Advanced Metering Infrastructure (AMI) • Targeting solarization for 150,000 households by end of 2026 [27]
Tamil Nadu	Wind-Solar Stability Hub (12.3 GW Wind Peak)	• Leading the installation of Static Synchronous Compensators (STATCOMs) and reactive power support for its 10 GW+ wind fleet • Currently reconductoring the Udumalpet–Madurai (400kV) lines for high-capacity flow [28]
Telangana	Agricultural Load Shifting	• Using the newly established REMC at TSTRANSCO to shift 4,000 MW of agricultural load to daylight hours to utilize surplus solar [29]

2.1 Challenges and Opportunities

The rapid surge in Inverter-Based Resources (IBRs) - primarily solar PV, wind turbines with full-scale converters, and battery energy storage systems, has fundamentally altered the electrical characteristics of the Southern Regional grid. Unlike conventional synchronous generators, IBRs interface with the grid through power electronics, introducing new operational complexities. Southern Region Load Dispatch Centre (SRLDC) has identified three principal technical frictions arising from this transition.

- **Harmonic Distortions:** The increasing density of power-electronic converters has led to elevated harmonic injection levels across the transmission network, particularly in renewable-rich pockets. These harmonics can cause overheating of equipment, malfunction of protection systems, and degradation of power quality if left unmanaged. In response, SRLDC has strengthened grid-code enforcement by mandating the installation of harmonic filters at the Point of Interconnection (PoI) for renewable energy projects. This requirement is aimed at preserving long-term grid health and ensuring compliance with permissible distortion limits under evolving technical standards [30].

[24] Green Energy Corridor | Government of India | Ministry of Power
[25] https://www.tndindia.com/pgcil-named-winner-of-bellary-davanagere-interstate-scheme-under-tbcb/
[26] https://www.saurenergy.com/solar-energy-news/kseb-approves-inr-6478-cr-plan-for-fy-2026-27-inr-170-cr-earmarked-for-bess-10955018
[27] SG Projects | National Smart Grid Mission, Ministry of Power, Government of India
[28] srpc.kar.nic.in/website/2025/meetings/srpc/aaa56srpc-53tcca.pdf
[29] TGREDCO - Telangana Renewable Energy Development Corporation Ltd.,
[30] Renewable Energy in Southern Region Annual Report 2024-25.pdf

- **Low System Inertia:** As thermal generation backs down during periods of high renewable output, the Southern grid experiences a measurable reduction in system inertia, or the inherent ability of synchronous machines to resist rapid frequency changes. Lower inertia increases the rate of change of frequency (RoCoF), leaving the system more vulnerable to sudden disturbances such as generation trips or load variations. Addressing this challenge necessitates the deployment of Fast Frequency Response (FFR) resources particularly battery energy storage systems capable of injecting or absorbing power within milliseconds to arrest frequency deviations and maintain system stability[31].
- **Reactive Power Non-Compliance:** Another persistent operational issue relates to inadequate reactive power support from several renewable energy installations. Despite regulatory requirements to operate within a 0.95 lag/ lead power factor, many plants fail to dynamically support voltage during high generation or low demand conditions. This non-compliance has resulted in localized voltage instability and increased operator intervention, especially in wind-dense corridors. Strengthening reactive power compliance through equipment retrofits, STATCOM deployment, and stricter enforcement remain a critical priority for stable high-RE operations[32].

2.2 Strategies for Improving Grid Readiness

The Southern Region is uniquely positioned to convert these constraints into strategic advantages through coordinated market, infrastructure, and digital interventions.

- **Market Coupling:** The implementation of market coupling from January 2026 represents a structural shift in India's power markets, enabling unified price discovery across exchanges. For the Southern Region, this reform is expected to significantly improve the export of surplus solar and wind energy to deficit regions, particularly the Northern Grid. By aligning economic signals across regions, market coupling can reduce renewable energy curtailment, enhance generator revenues, and improve overall system efficiency[33].
- **Long-Duration Storage (LDES):** The Southern Region has emerged as a national leader in long-duration energy storage, particularly through Pumped Storage Projects (PSPs). The 2,000 MW Sharavathi PSP exemplifies the role of storage in enabling diurnal balancing absorbing excess renewable generation during off-peak hours and supplying firm power during evening demand peaks. As renewable penetration rises, such assets will become central to maintaining reliability and reducing dependence on thermal flexibility[34].
- **Digitalization:** Ongoing modernization of Renewable Energy Management Centres (REMCs) has significantly enhanced situational awareness and decision-making capabilities. The adoption of AI-driven forecasting tools has pushed renewable generation forecast accuracy beyond 95%, reducing uncertainty in scheduling and reserve procurement. This digital transformation has materially lowered the cost of grid balancing while enabling operators to manage higher levels of variability with confidence[35].

Strengthening evacuation and transmission infrastructure is one of the important requirements for meeting the renewable energy targets on time. Planning and timely execution of transmission projects must be done accordingly.

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[31] https://www.niti.gov.in/sites/default/files/2022-06/Harnessing-Green-Hydrogen_V21_DIGITAL_29_06.pdf
[32] srldc.in/var/ftp/RemcReports/Renewable Energy in Southern Region Annual Report 2024-25.pdf
[33] https://cercind.gov.in/2025/orders/8-SM-2025.pdf
[34] https://cea.nic.in/hpi-report/?lang=en
[35] https://www.srldc.in/var/ftp/RemcReports/Renewable%20Energy%20in%20Southern%20Region%20Annual%20Report%202024-25.pdf

3. Hydrogen & Emerging Fuels

India has set its sights on becoming a global hub for the production, use, and export of green hydrogen. This ambition is being driven through the National Green Hydrogen Mission, which is currently in its first phase (2022–2026). The focus right now is on kick-starting demand and putting the core manufacturing and supply ecosystem in place.

3.1 Mission Goals and Funding

- To support this effort, Government of India approved an initial budget of INR 19,744 crore (around USD 2.4 billion). By 2030, the mission aims to deliver:
- Green hydrogen production of at least 5 million metric tonnes per year
- Renewable energy capacity of roughly 125 GW dedicated to hydrogen production
- Economic impact exceeding INR 8 lakh crore in investments
- Creation of 6 lakh new jobs
- Environmental benefits, including the reduction of nearly 50 million tonnes of greenhouse gas emissions annually.

3.2 SIGHT Program: Driving the Hydrogen Value Chain[SS1.1]

The Strategic Interventions for Green Hydrogen Transition (SIGHT) program is the primary financial engine of the Mission, with a total allocation of INR 17,490 crore. As of January 2026, two major incentive components have demonstrated significant commercial progress through competitive bidding:

I. Electrolyser Manufacturing (Tranche I & II)

Manufacturing incentives were designed to build a localized supply chain.

Awarded Capacity: Over 3,000 MW per annum of manufacturing capacity has been awarded across Tranche I and II.

Key Players: Contracts were awarded to 15 companies, including Reliance Electrolyser Manufacturing, Adani New Industries, L&T Electrolysers, and John Cockerill Greenko Hydrogen Solutions.

Technology Mix: Technologies planned to be promoted include diverse mix of Alkaline, PEM, and Solid Oxide electrolysers to ensure long-term technological resilience[36]

II. Green Hydrogen Production (Mode-1)

Aggregated Capacity: Tenders for 412,000 tonnes per annum (TPA) were finalized in the first tranche, followed by an additional 450,000 TPA in Tranche-II awarded in March 2025

Dominant Winners: Reliance Green Hydrogen and Green Chemicals holds the highest cumulative awarded capacity at 139,000 MT, followed by ACME, Greenko, and L&T with 90,000 MT each[37]

III. Green Ammonia for Fertilizers (Mode-2A)

This component is the most advanced in terms of price discovery, as it aggregates demand from 13 major fertilizer units.

Record Price Discovery: The auction (Mode-2A, Tranche-I) achieved a landmark low of ₹49.75 per kg (approximately $572 per ton) for supply to IFFCO, Paradeep

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[36] National Green Hydrogen Mission Portal of India
[37] https://jmkresearch.com/seci-awards-450000-mt-annual-capacity-under-sight-tranche-ii-for-green-hydrogen-production/

Weighted Average Price: The weighted average across all 13 fertilizer plants was discovered at ₹53.27 per kg, confirming that green ammonia is nearing price parity with conventional grey ammonia

Parity Milestone: These results indicate that domestic green ammonia is nearing Green ammonia is only 10% costlier than grey in the latest SIGHT Mode 2A auctions[38]

3.3 Pilot Projects and Emerging Infrastructure

Several pilot projects[39] are already demonstrating how green hydrogen can be applied in hard-to-abate sectors:

- **Transport:** India's first hydrogen-powered train on the Jind–Sonipat route is in the final stages of commissioning as of January 10, 2026.
- **Shipping and exports:** Dedicated Green Hydrogen Hubs have been identified at Kandla (Gujarat), Paradip (Odisha), and Tuticorin (Tamil Nadu) to support large-scale production and exports.
- **Steel:** Five pilot projects have been approved to test hydrogen-based Direct Reduced Iron (DRI) production, a critical step toward decarbonizing steelmaking. The Southern Region is the centerpiece of India's ambition to produce 5 MMT of Green Hydrogen annually by 2030. Leveraging its 50 GW renewable base and strategic coastline, the region is transitioning from early-stage MoUs to the commissioning of "Hydrogen Valleys" and port-led manufacturing hubs.

3.4 The Regional Policy Pivot: 2024–2026

Over the last 15 months, the Southern states have introduced specific fiscal frameworks to de-risk investments planned for generation of green hydrogen:

- Andhra Pradesh Integrated Clean Energy Policy 2024: Andhra Pradesh targets production of 1.5 MTPA of Green Hydrogen and derivatives by 2030. Support provided under the project includes INR 1,00,000/ acre/ year lease rate for GH2 hubs at ports and a 100% SGST reimbursement for 5 years
- Tamil Nadu Green Hydrogen Policy: Tamil Nadu aims to develop the state as a leading hub for green hydrogen and green ammonia. The state is focusing on the Tuticorin Green Hydrogen Hub, which integrates the port infrastructure with nearby wind-solar hybrid parks

3.5 Strategic Infrastructure & Pilot Milestones

Grid-scale pilots are now testing the commercial viability of hydrogen in transport and shipping

- **Kochi Green Hydrogen Valley (Kerala):** This project developed by Agency for New and Renewable Energy Research and Technology (ANERT) and Bharat Petroleum Corporation Limited (BPCL), is South India's first integrated cluster. As of early 2026, the 1,000-kW plant at Kochi Airport is operational, fueling the Kochi Water Metro and e-feeder buses.
- Tuticorin Green Bunkering (Tamil Nadu): In late 2025, the Ministry of Ports commissioned a Green Hydrogen pilot at V.O. Chidambaranar Port. It is currently testing India's first Green Methanol Bunkering facility (750 m³ capacity) to serve international shipping routes.

[38] https://jmkresearch.com/green-ammonia-is-only-10-costlier-than-grey-in-the-latest-sight-mode-2a-auctions/
[39] https://sansad.in/getFile/annex/269/AS99_hZ5qM0.pdf

4. Capital, Credit & Energy Financing

India's energy transition has entered a decisive phase. With national non-fossil capacity targets already established, the focus has now shifted to execution, especially focused on the scale and structure of capital required to deliver the next phase of power system transformation in the country.

As per various estimates, achieving India's clean energy objectives through 2030 would require investments of approximately INR 30.5 lakh crore (USD 360 billion[40]). This capital requirement covers setting up renewable power projects, large-scale expansion of transmission infrastructure and the deployment of high-capacity energy storage systems for ensuring grid stability, reliability, and flexibility in view of increased renewable energy penetration.

India's Southern Region with states/ UTs such as Andhra Pradesh, Karnataka, Kerala, Puducherry, Tamil Nadu and Telangana is home to one of the most vibrant renewable energy ecosystems in the country. Accordingly, the region has emerged as the primary market for renewable energy financing in the country. Capital markets in the region are no longer focused solely on renewable capacity deployment; they are increasingly focused on flexibility, dispatchability, and execution risk. This evolution is reshaping project finance away from standalone solar assets towards integrated manufacturing hubs, hybrid generation platforms, and dispatchable green debt structures.

4.1 Capital Inflows for Renewable Energy

As per a recent study, renewable energy now accounts for roughly 8% of India's total Foreign Direct Investment (FDI), up from just 1% in 2021. In the first three quarters of FY 2025-26 alone, the sector attracted USD 3.4 billion in inflows, matching previous full-year records and signaling sustained global interest[41].

Despite this momentum, the cost of capital remains highly sensitive to project delays. Grid connectivity and commissioning risks continue to exert upward pressure on financing costs, with the Institute for Energy Economics (IEEFA) estimating that such delays can add up to 400 basis points to project Cost of Capital (CoC). As a result, sustaining the competitive tariffs observed especially in 2025 auctions (₹2.60–₹2.80/kWh) increasingly depends on the availability of "plug-and-play" transmission and evacuation infrastructure to compress risk premiums[42].

4.2 The Southern Power Grid: Financing a High-RE System

Southern Region faces a distinct financial scenario considering the high penetration of renewables in the energy mix. Funding is not only focused on new generation capacity, but also the transmission and distribution infrastructure and the provisions required for grid stabilization and flexibility. Consequently, the credit health of state distribution utilities (DISCOMs) has also become one of the decisive factors in financing outcomes.

Credit performance varies widely across states. Karnataka's utilities continue to secure strong ratings, enabling access to the lowest borrowing costs in the region[43]. Tamil Nadu has shown signs of financial recovery, including a INR 600 crore provisioning reversal tied to rating

[40] https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=2105857&reg=3&lang=2
[41] Clean Energy Sees 8-fold Surge in FDI, hits USD 3.4 billion in FY25
[42] Cost of capital for Indian renewable energy projects: A review of methodologies, risk drivers, and policy evolution | IEEFA
[43] Annual rating & ranking of discoms FY24: 11 utilities get highest grade - Your Gateway to Power Transmission & Distribution
[44] 2025-08-04 Performance Review.pdf

4.3 State-Level Financing Patterns

The above credit dynamics is translating into differentiated financing strategies across the Southern Region. Andhra Pradesh is positioning itself as an integrated clean energy and manufacturing hub, with a growing focus on industrial-scale financing. In January 2026, the state approved INR 15,800 crore in clean energy investment proposals, including large integrated manufacturing facilities.

Tamil Nadu's market is shifting towards dispatchable assets, with increased emphasis on hybrid and storage-linked tenders. The state recently raised INR 205 crore through an oversubscribed green municipal bond, reflecting rising investor confidence in sub-sovereign green debt. Karnataka remains a leader in asset recycling, using Infrastructure Investment Trusts (InvITs) to monetize operational solar assets and redeploy equity towards new project development aligned with 2030 targets. Kerala's investment focus is skewed towards digitally enabled grid infrastructure, with INR 6,478 crore capital plan approved for prioritizing transmission upgrades and battery storage. Puducherry, by contrast, is pursuing a grant-led transition, leveraging National Smart Grid Mission funding to pilot advanced technologies without increasing debt burdens.

State/ UT	Market Preference & Landscape	Strategic Financing Highlights
Andhra Pradesh	Industrial Hub Finance	• Greenlit INR 15,800 Crore in proposals; includes Tata Power's 10 GW Nellore manufacturing site and ACME's Anantapur solar-plus-storage project
Tamil Nadu	Dispatchable Debt	• Shifting to Hybrid/ Storage; • Raised INR 205 Crore via oversubscribed Green Municipal Bond for Kodungaiyur environmental infrastructure
Karnataka	Asset Recycling	• Market leader in InvITs; • Secured INR 654 Crore PM-KUSUM order for solar pumps; focusing on de-risking equity for the 2030 RE pipeline
Telangana	High-Growth Deals	• Secured INR 5.75 Lakh Crore in MoUs at Dec 2025 Summit; includes Evren/ Axis Energy's INR 31,500 Crore hybrid RE deal and Brookfield's INR 75,000 Crore Net-Zero hub
Kerala	Digital Capital	• KSEB cleared INR 6,478 Crore Capital Investment Plan for FY27; prioritizes TransGrid 2.0 (INR 599 Crore) and BESS (INR 170 Crore) to manage prosumer surge
Puducherry	Grant-led Transition	• Utilizing NSGM Grants (MoP share of INR 17.76 Crore) for the INR 35.53 Crore Smart Grid Pilot covering 34,000 consumers with AMI infrastructure.

4.4 Emerging Market Signals

Several structural trends are now shaping the Southern Region's renewable finance landscape. Asset recycling through InvITs is becoming a core capital-management strategy, allowing developers to channel funds into the broader INR 30.5 lakh crore investment pipeline required through 2030 . At the same time, government-backed viability gap funding (VGF) has materially improved storage economics, driving battery energy storage tariffs down by approximately 54% from 2024 levels to as low as INR 1.84 per unit rendering storage bankable for commercial

5. Regulatory & Smart Infrastructure

India's renewable energy transition is increasingly shaped not only by generation targets, but by the strength of its regulatory frameworks and the deployment of smart infrastructure that can manage variability in renewable energy generation, decentralization of RE assets, and rising electricity demand. Together, these two pillars are enabling the integration of large-scale renewable energy projects in the grid while maintaining its reliability and stability.

5.1 Regulatory Framework Supporting Renewable Energy

India has developed a layered regulatory ecosystem led by the Government of India, with policy direction from the Ministry of Power and the Ministry of New and Renewable Energy, and implementation by regulators at central and state levels.

The following are the key regulatory pillars that have significantly contributed to the deployment of renewable energy systems in the country.

- Renewable Consumption Obligation (RCO) mandates certain categories of consumers such as captive consumers of fossil power, open access consumers of fossil power and distribution companies (DISCOMs) to procure a minimum share of electricity from renewable sources, creating sustained demand. Ministry of Power has notified RCO trajectory till 2029-30, and by this year obligated entities are expected to meet 43.33% of their electricity requirement through renewable sources.
- Green Open Access Rules have simplified access to renewable power for commercial and industrial consumers, encouraging decentralised procurement and corporate renewable adoption. Through Green Open Access Rules notified in 2022, any energy consumer with a contract demand 100 kVA or more can procure renewable power from a 3rd party other than DISCOM through open access.
- Tariff-based competitive bidding has driven down renewable energy costs while ensuring transparency and market efficiency. Tariffs discovered in India for solar and wind projects are amongst the lowest in the world, with tariffs also reaching less than INR 2.00 per kWh for solar projects in few cases.
- Must-run status for solar and wind power protects renewable generators from arbitrary curtailment.
- Together, these regulations shift renewable energy from a niche resource to a core component of India's power system.

5.2 Grid Codes and Market Reforms

As renewable penetration increases, regulations are evolving from static compliance to dynamic system management.

- Indian Electricity Grid Code (IEGC) provisions now recognise the operational characteristics of renewables and energy storage.
- Resource Adequacy planning requires states and utilities to plan generation and storage capacity in advance, considering peak demand and variability.
- Power market reforms, including real-time markets and high-price day-ahead segments, allow renewables and storage to respond to price signals.
- Ancillary services regulations enable frequency control and balancing services, opening new revenue streams for flexible resources.

These reforms are critical for moving from capacity-based planning to flexibility-based planning.

5.3 Smart Infrastructure as an Enabler

Smart infrastructure forms the physical and digital backbone of renewable energy integration.

Transmission and Distribution Infrastructure

- **Green Energy Corridors** are strengthening inter-state and intra-state transmission networks to evacuate renewable power from resource-rich regions.
- **High-capacity substations** and dynamic line rating systems are improving grid utilisation.

Digital and Automation Systems

- **Supervisory Control and Data Acquisition (SCADA) and Energy Management Systems (EMS)** enable real-time monitoring of renewable generation.
- **Advanced forecasting tools** for solar and wind are being integrated into load dispatch centres to reduce uncertainty.
- Artificial intelligence and analytics are increasingly used for grid optimisation and outage prediction.

Smart Distribution Networks

- **Advanced Metering Infrastructure (AMI)** supports time-of-day tariffs, demand response, and distributed renewable integration.
- Smart substations and feeder automation improve reliability in renewable-heavy distribution networks.

Role of Energy Storage and Hybrid Systems

Energy storage is emerging as a key element of smart infrastructure.

- **Battery Energy Storage Systems (BESS)** provide short-duration flexibility for peak shaving, frequency support, and renewable firming.
- Pumped hydro storage offers long-duration and seasonal balancing capabilities.
- **Hybrid renewable projects** (solar-wind-storage) coupled with energy storage components are increasingly favoured in tenders to deliver round-the-clock and firm power.

Decentralisation

The following aspects are also playing a key role in the renewable energy journey of the country.

- **Rooftop solar systems** with options such as netmetering, virtual netmetering, group netmetering, gross metering and net billing mechanisms allow consumers to become prosumers.
- **Electric vehicles,** smart charging, and vehicle-to-grid pilots are beginning to link mobility with renewable integration.
- **Microgrids and distributed storage** enhance resilience in remote and disaster-prone areas.

This decentralisation reduces system stress while improving energy access and resilience.

5.4 Implementation Gaps & Potential Opportunities

While all the States are doing well in renewable energy; there are certain gaps which if addressed properly can result in accelerated adoption of renewable energy.

- **Smart Meter Implementation:** As per the Revamped Distribution Sector Scheme (RDSS), target is to reach 250 million smart meters by March 2026. However, the current national installation rate stands at only ~23% (52.8 million[45]). Acceleration is required for meeting the targets.
- Rooftop Solar Policy: Rooftop solar policies are prevalent in all the States/ UTs in the Southern Region. Though multiple options such as netmetering, gross metering, net billing and behind-the-meter solutions are available, there are certain restrictions that hamper the growth of the sector and they are as follows

    Non-uniformity of rooftop solar regulations across States/ Uts.

    Availability of netmetering only for domestic consumers in certain states; also, capacity of the rooftop solar PV system is restricted by contract demand and capacity of the distribution transformer.

    Virtual netmetering and group netmetering options are not widely promoted and implemented.

    Non-availability of a comprehensive 360-degree framework for evaluating the quality, safety and performance of rooftop solar PV systems.

    Levy of open access/ grid charges for rooftop solar PV systems; restrictions on installation under RESCO model.

- **DISCOM Perception & Resistance:** In many states, DISCOMs feel that they are burdened by high-paying energy consumers moving away to captive RE generation and/ or open access RE procurement. Open access charges including cross subsidy surcharge, additional surcharge, transmission charge, wheeling charge, and banking charge are prohibitive in many states and must be rationalized.
- **New Load Shocks:** The grid is facing localized stress from high-density loads such as Data

State/ UT	Regulatory Framework	Smart Infrastructure
Andhra Pradesh	• Progressive clean energy and pumped storage policies • Storage recognised in planning and regulatory frameworks • Supports hybrid RE & storage procurement • Alignment with national market reforms	• Renewable evacuation infrastructure linked to Green Energy Corridors • Strengthening SLDC forecasting and scheduling systems • Grid planning focused on large-scale RE integration
Karnataka	• RE Policy 2022–27 promotes storage and smart grids • Supports ToD tariffs and demand-side management • Encourages hybrid and flexible generation models	• Advanced SCADA and EMS at SLDC • Smart distribution networks in urban areas • Automation and digital grid pilots

[45] https://www.nsgm.gov.in/en/sm-stats-all
[46] https://cxotoday.com/news-analysis/indias-datacentre-capacity-to-reach-9-2gw-by-2030-govt-report/

State/ UT	Regulatory Framework	Smart Infrastructure
Kerala	• Regulatory focus on reliability and import reduction • Storage integrated into utility planning documents • Gradual shift toward resource adequacy approach	• Emphasis on digital grid management tools • Smart distribution systems for rooftop solar • Forecasting and EMS upgrades at KSEB
Puducherry	• Pilot-based regulatory approach • Uses central schemes and PSU frameworks • Focus on demonstrative regulatory models	• Smart distribution focus rather than large transmission assets • Digital monitoring at substations and feeders • Rooftop solar integration support
Tamil Nadu	• Advanced regulatory ecosystem for RE and storage • Enables large-scale BESS and PSP procurement • Clear frameworks for hybrid and firm power	• Extensive Green Energy Corridor investments • Advanced forecasting, real-time monitoring, analytics • High-capacity substations and smart grid tools
Telangana	• Clean & Green Energy Policy integrates storage • Emphasis on resource adequacy and firm RE • Regulatory backing for standalone BESS	• Digital SLDC upgrades and forecasting systems • Smart grid planning for load growth • Integration of RE with flexibility assets

6. Energy Storage

India has installed solar and wind capacities of 135 GW and 54 GW respectively, the resources for which are variable. While this rapid growth of renewable capacity addition has supported India's decarbonization journey, new challenges have emerged related to grid stability, solar and wind curtailment, peak demand management, and transmission congestion. In this scenario, energy storage is expected to play a critical role in India's energy transition journey.

As per National Electricity Plan[47] (NEP) 2023 of Central Electricity Authority (CEA), requirement of energy storage capacity is expected to be 82.37 GWh in 2026-27 (47.65 GWh from Pumped Storage Hydro Power (PSP) and 34.72 GWh from Battery Energy Storage System (BESS)). This is further expected to increase to 411.4 GWh in 2031-32 (175.18 GWh from PSP and 236.22 GWh from BESS).

Further, CEA has also projected that by the year 2047, energy storage requirement is expected to increase to 2,380 GWh (540 GWh from PSP and 1,840 GWh from BESS), due to the further addition of huge quantities of renewable energy capacities[48].

6.1 Relevance of Energy Storage for Southern States

Southern States such as Andhra Pradesh, Karnataka, Kerala, Puducherry, Tamil Nadu, and Telangana are amongst the top renewable energy states in the country.

- Tamil Nadu and Karnataka are the leaders in the region in terms of installed renewable energy capacity
- Andhra Pradesh has made rapid strides in both solar and wind
- Telangana has excellent ground mounted solar capacity
- Kerala is leading in rooftop solar capacity addition while Puducherry has also seen some development in rooftop solar.

While Southern States have contributed significantly to country's RE journey, certain challenges have also emerged and they are as follows:

- Variability in renewable generation across seasons and time of day
- Evening peak demand occurs when there is no solar generation
- Transmission bottlenecks within and between states
- Limited flexible generation capacity.

These factors enable Southern States to be strong candidates for grid-scale and distributed energy storage solutions.

6.2 Advantages of Energy Storage Systems

The following are the unique advantages offered by energy storage systems:

- **Energy Arbitrage:** Storing low-cost electricity generated from solar and wind sources during off-peak periods and supplying it for meeting peak demand.
- **Renewable Firming:** Smoothing output from wind and solar plants to provide firm power.
- **Peak Shaving:** Reducing peak demand on the grid and lowering reliance on peaking power plants.

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[47] https://mnre.gov.in/en/energy-storage-systemsess-overview/
[48] https://mnre.gov.in/en/energy-storage-systemsess-overview/

- **Ancillary Services:** Providing ancillary services such as frequency regulation, spinning reserve, and voltage control.
- **Grid Resilience:** Supporting black-start capability (grid's ability to self-restart after a total blackout) and emergency backup.

6.3 Government of India's Initiatives on Energy Storage

The following are some of the initiatives of the Government of India on energy storage:

National Framework for Promoting Energy Storage Systems

The Ministry of Power released a National Framework[49] for Promoting Energy Storage Systems, which lays down a clear roadmap for adopting battery storage, pumped hydro storage, and emerging technologies. The framework focuses on technology-agnostic deployment, transparent bidding, grid integration, and long-term planning.

Viability Gap Funding (VGF) for BESS

The Government is implementing two Viability Gap Funding (VGF) schemes[50] for accelerating deployment of large-scale BESS. These schemes are expected to implement 43 GWh of BESS and significantly reduce upfront project costs, encouraging private participation.

Power System Development Fund (PSDF)

Funding support through PSDF[52] is being used to help states and central utilities implement energy storage projects, particularly where commercial viability is still evolving.

Waiver of Inter-State Transmission Charges

A 100% waiver on inter-state transmission system (ISTS) charges has been extended for co-located BESS projects commissioned and pumped hydro projects awarded until June 2028[52], lowering operational costs and improving project economics.

Participation in Power Markets

Battery energy storage systems are allowed to participate in India's power markets[53], including high-price segments of the Day-Ahead Market. This allows storage operators to earn revenue through energy arbitrage and grid services.

Inclusion in Resource Adequacy Planning

Energy storage has been formally included in national and state-level resource adequacy planning[54] to help manage peak demand, variation in renewable generation, and grid stability.

Storage with Renewable Energy Tenders

Government advisories recommend integrating a minimum duration of energy storage with new solar and wind tenders to ensure reliable and dispatchable renewable power. As per the advisory issued by CEA on co-location of BESS with solar power projects, storage capacity of at least 10%[55] of installed solar capacity for a minimum duration of two hours has been recommended to improve dispatchability of solar power

[49] https://powermin.gov.in/sites/default/files/National_Framework_for_promoting_Energy_Storage_Systems_August_2023.pdf
[50] https://pib.gov.in/PressReleasePage.aspx?PRID=2205959
[51] https://powermin.gov.in
[52] https://www.pib.gov.in/PressReleasePage.aspx?PRID=2205959&reg=3&lang=2
[53] https://www.iexindia.com
[54] https://pib.gov.in/PressReleasePage.aspx?PRID=2206356
[55] https://powermin.gov.in

Production-Linked Incentive (PLI) Scheme

To build a domestic energy storage ecosystem, the Government is promoting advanced battery manufacturing through PLI schemes[56] and domestic content requirements. This aims to reduce import dependence and strengthen India's clean-energy supply chain. The total outlay of the PLI Scheme implemented by the Government of India is INR 18,100 Crores for establishing 50 GWh of Advanced Chemistry Cell manufacturing capacity, of which 10 GWh is earmarked for grid-scale storage.

6.4 Long-Duration Energy Storage (LDES)

A critical strategic gap persists in India's energy storage ecosystem due to the absence of a formally standardized definition of "Long-Duration Energy Storage (LDES)". At present, most storage procurement and market bids are centered on 2–4 hour BESS (predominantly Li-ion based technology), which are primarily optimized for short-term balancing and peak shaving. Recognizing this limitation, the NITI Aayog Expert Committee is currently deliberating on a standardized definition of LDES to align policy, procurement, and investment signals with long-term system needs.

Duration Benchmarking and Global Alignment

In line with international practice such as frameworks adopted in California and by the U.S. Department of Energy (DOE) there is growing consensus that LDES should be defined as storage systems capable of 8–12 hours or more of continuous discharge. Such durations are essential to address multi-hour renewable variability, seasonal mismatches, & extended peak demand periods, functions that short-duration batteries are structurally unsuited to perform[57].

Implications for Economic Viability and Technology Neutrality

Establishing a clear duration threshold is critical for ensuring technology-neutral valuation of storage solutions. In the absence of a standardized LDES definition, capital-intensive but system-critical assets such as Pumped Storage Projects (PSPs) and emerging non-lithium technologies including flow batteries remain economically disadvantaged relative to short-cycle lithium-ion systems. This misalignment risks under investment in assets required for deep renewable penetration and long-term reliability. Standardization of LDES duration is therefore a prerequisite for scalable deployment and fair market participation[58].

6.5 State-wise Initiatives on Energy Storage

The following table provides state-wise initiatives on energy storage for the Southern States:

State/ UT	Initiatives
Andhra Pradesh	**Policy & regulation:** • State policy promotes pumped storage power; regulations recognise BESS and enable procurement and tariff treatment. • Encourages co-location of storage with renewables and participation in market mechanisms. **Projects:** State-level BESS procurements take place in coordination with central agencies for pilot/ large tenders (For e.g., SECI and Government of Andhra Pradesh have joined hands for 1,200 MWh BESS project[59] at Nandyal)

[56] https://mnre.gov.in
[57] https://www.cleanegroup.org/what-is-long-duration-energy-storage/
[58] https://www.mercomindia.com/long-duration-energy-storage-must-scale-50-times-to-meet-net-zero-demands
[59] https://www.pib.gov.in/PressReleasePage.aspx?PRID=2190326&reg=3&lang=2

State/ UT	Initiatives
Karnataka	**Policy & regulation:** • Renewable Energy Policy 2022–27 of Government of Karnataka supports energy storage (BESS and pumped hydro) and encourages private investment. • Guidance has been provided to include storage in new solar/ hybrid tenders; exploring retiring assets & renewable parks as storage sites. **Projects:** Tenders and pilots for pumped hydro and BESS; utility-level BESS rollouts are planned. Some of the major energy storage projects[60] planned in the State of Karnataka include 2,000 MW pumped storage facility at Sharavathi; 1,500 MW at Varahi; 1,000 MW at Pavagada, and a 2,000 MW battery storage facility at Rapte.
Kerala	**Policy & regulation:** • State power policy and planning by Kerala State Electricity Board (KSEB) includes BESS and pumped storage power; focus is also provided to distributed storage for management of peak demand. • KSEB is issuing EoIs/ tenders for BESS pilots; resource adequacy planning by KSEB now considers storage as well. **Projects:** Pilot BESS tenders and PSP feasibility studies are under evaluation for long-term balancing needs.
Puducherry	**Policy & regulation:** • For demonstrating the benefits of storage at distribution level, small-scale/ pilot BESS projects are planned. • RfS/ NIT issued for standalone BESS pilots to test grid integration and time-shifting with solar assets. **Projects:** Pilot tenders are being invited (for example, 50 MW/ 200 MWh scale standalone BESS)[61].
Tamil Nadu	**Policy & regulation:** • Roadmap has been developed for energy storage projects in the state; multiple sites have been identified for pumped hydro projects and procurement frameworks have been developed for large-scale BESS. • Regulator and utilities allow land-lease[62] (portions of substation land) for BESS projects, and integration of storage with renewables[63] to reduce curtailment. **Projects:** Sites for major PSPs have been identified (e.g., Upper Bhavani planning). Large BESS tenders and pilots are planned at thermal sites, renewable parks and substations[64].
Telangana	**Policy & regulation:** • Clean & Green Energy Policy (2025) explicitly includes large-scale storage (BESS & pumped hydro) to enable round-the-clock RE and resource adequacy. • State utilities preparing tenders and frameworks for large standalone BESS procurement; assessment of hydro sites for PSP potential. **Projects:** Bids have been invited for large-scale BESS (examples: 250 MW/500 Mwh[65], 375 MW/ 1,500 MWh scale) and feasibility work on PSP at existing reservoir sites.

[60] https://bioenergytimes.com/battery-energy-storage-systems-bess-to-be-installed-in-solar-power-plants-across-karnataka-k-j-george/
[61] https://electricity.py.gov.in/request-selection-rfs-setting-pilot-projects-50-mw-200-mwh-standalone-battery-energy-storage-systems
[62] https://www.mercomindia.com/tamil-nadu-electricity-regulator-allows-land-lease-for-bess-projects
[63] https://www.resiindia.org/post/tamil-nadu-clears-landmark-1-000-mwh-battery-storage-procurement-to-stabilize-renewable-heavy-grid
[64] https://www.enerdata.net/publications/daily-energy-news/tamil-nadu-india-announces-375-mw15-gwh-battery-storage-tender.html
[65] https://jmkresearch.com/wp-content/uploads/2025/01/TGGENCO-250-MW-with-500-MWh-Standalone-BESS-Telangana-Jan-2025.pdf

6.6 Recommendations for Accelerated Adoption of Energy Storage

Some of the recommendations for widespread adoption of energy storage by the Southern States are as follows:

- Create state-level energy storage roadmaps aligned with CEA resource adequacy plans, with technology-neutral targets focused on BESS and pumped hydro.
- Standardise procurement & contracting frameworks for BESS and PSP projects to reduce bid uncertainty and speed up project execution.
- Facilitate market participation by allowing storage for participation in power markets, ancillary services, and distribution support.
- Fast-track land, water, and environmental clearances through single-window systems, especially for pumped hydro projects.
- Promote domestic manufacturing and local supply chains by linking state tenders to national PLI and skill-development programs.
- Invest in pilot and demonstration projects at substation, distribution, and urban levels to build operational confidence.

7.Transforming Carbon Liabilities into Monetizable Assets

India's clean energy transition is reshaping how carbon emissions are viewed i.e., from an unavoidable cost to a strategic economic opportunity. As climate policies tighten and markets evolve, carbon liabilities (emissions from power, industry, transport, and infrastructure) can increasingly be converted into monetizable assets through markets, technology, and smart regulation.

7.1 Indian Carbon Market

India is establishing a national carbon trading framework that allows entities to:

- Reduce emissions below mandated levels
- Generate carbon credits
- Monetise these credits through trading

The Carbon Credit Trading Scheme framework (CCTS)[66] issued by the Ministry of Power is the institutional backbone for converting emissions reductions into Carbon Credit Certificates and trading them under the Indian Carbon Market. This is the core "liability asset" mechanism through which emission reduction/ removal becomes quantifiable and monetizable instrument, improving project bankability and corporate decarbonisation economics.

7.2 Carbon Border Adjustment Mechanism (CBAM)

CBAM is the EU's policy that puts a carbon price on certain imported goods (like steel, aluminum, cement) to match the cost of carbon paid by EU producers under the EU Emissions Trading System (ETS). CBAM payment phase from 1st January 2026 turns embedded emissions into direct commercial risk/ opportunity.

This makes credible Measurement, Reporting and Verification (MRV), product-level measurement of emissions, and decarbonisation actions commercially monetizable (protecting export margins, enabling green premiums, and supporting carbon-asset strategies).

7.3 Voluntary Carbon Markets

Indian projects already participate in global voluntary markets by:

- Deploying renewable energy
- Improving energy efficiency
- Setting up green hydrogen and carbon capture projects

As standards mature, high-quality credits from India can attract global demand, creating new revenue streams. This provides a secondary revenue stream by allowing projects/ project owners to sell credits to international and domestic buyers looking to meet net zero goals.

7.4 Greenhouse Gases Emission Intensity Target Rules, 2025

A major regulatory inflection point in India's climate and energy governance framework was the notification of the Greenhouse Gas (GHG) Emission Intensity Target Rules, 2025 by the Ministry of Environment, Forest and Climate Change (MoEFCC) on October 8, 2025. These rules establish the foundational architecture of India's compliance-based carbon market and represent a shift from voluntary disclosures toward enforceable, output-linked emissions regulation[67].

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[66] https://www.pib.gov.in/PressReleasePage.aspx?PRID=2198780&lang=1&reg=3
[67] https://beeindia.gov.in/sites/default/files/Greenhouse_Gases_Emission_Intensity_Target_Rules_2025.pdf

- These rules set a limit on GHG emissions per unit of product output for energy-intensive sectors (e.g., Cement, Aluminium, Pulp & Paper)
- A total of approximately 490 obligated entities is under the ambit of the national carbon market as per the above notification

7.5State-level Development

State level development regarding carbon emission reduction is summarized below.

Karnataka

- JSW Energy commissioned its first green hydrogen plant[68] near the JSW Steel facility at Vijayanagar, supplying hydrogen to the DRI unit under a seven-year offtake agreement. This directly converts carbon liability into monetizable value. Reduced emissions support compliance, export competitiveness, and premium positioning for low-carbon steel.

Tamil Nadu

- At VOC Port[69], a green hydrogen pilot (10 Nm^3/hr) was inaugurated to run port colony streetlights and EV charging; simultaneously, the foundation stone was laid for a pilot green methanol bunkering/ refueling facility. This is significant for monetization of carbon reduction. Ports can sell green fuel services, create demand anchors for green molecules, and enable future CCU/ green shipping corridors where decarbonisation becomes revenue-linked infrastructure.
- Sathyamangalam Biochar Facility[70]: The Forest Department launched INR 8.50 crore facility in the Sathyamangalam Tiger Reserve to convert invasive plants (like Lantana camara) into high-value biochar. Instead of burning invasive species (a liability), they use pyrolysis to create biochar. This is projected to sequester 3,000 tonnes of CO2e annually, generating credits for the Voluntary Carbon Market (VCM).

Kerala

- Energy Management Centre Kerala issued a Request for Proposal[71] to select a Carbon Project Developer for nature-based carbon credit initiatives of Kerala Forest Department. This is explicitly about creating high-integrity carbon assets (aggregation, trade and MRV). It makes Kerala's natural capital (forests/ wetlands/ mangroves etc.) economically legible and monetizable through carbon markets and structured project development.

Andhra Pradesh

- Andhra Pradesh is fast-tracking large-scale coastal plantations and moving to formalise protection of approximately 10,000 acres of previously "unnotified" mangroves identified via satellite surveys. From a carbon-asset angle, this expands potential blue carbon and forest carbon inventory and permanence which are critical prerequisites for credible future monetisation via carbon credits.
- CCUS in Heavy Industry: Andhra Pradesh is home to some of the first "Hard-to-Abate" pilot projects that utilize captured carbon as a feedstock for chemicals. Following the success of the Vindhyachal pilot, NTPC announced in October 2025 that its Simhadri Thermal Power

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[68] https://group.jsw.in/sites/default/files/assets/downloads/energy/Corporate%20Governance%20and%20Regulatory%20Information/Stock%20Exchange%20Releases/2025-26/Green-Hydrogen-Plant-commissioning-signed.pdf
[69] https://www.pib.gov.in/PressReleasePage.aspx?PRID=2164314&reg=3&lang=2
[70] https://biochartoday.com/news/south-indian-state-forest-department-and-str-deploy-pyrolysis-to-convert-invasive-biomass-into-carbon-credits/
[71] https://keralaenergy.gov.in/wp-content/uploads/2025/01/RFP-Selection-of-Carbon-Project-Developer.pdf

Plant (Visakhapatnam) would deploy a 25 tonnes per day (TPD) carbon capture system. The captured CO2 will be converted into Ethanol. This ethanol is then sold for fuel blending, effectively creating a "circular carbon" revenue model where a power plant's waste becomes a fuel merchant's inventory.

7.6 Recommendations for Turning Carbon into an Asset

Some of the recommendations for converting carbon into an asset are as follows:

- Build Carbon Asset Platforms: Southern States shall consolidate industrial decarbonisation, nature-based sinks, and clean fuel initiatives into large, diversified carbon portfolios that are bankable, and attractive to institutional buyers.
- **Anchor Monetisation Around Export Value Chains:** Focus on decarbonising export-linked industries (steel, fuels, shipping, shipping, chemicals) can create immediate monetisable value by protecting margins, accessing green premiums, and avoiding CBAM penalties.
- **Invest Aggressively in MRV & Verification Systems:** Create world-class MRV infrastructure: digital measurement, accredited verification, registry integration, and product-level carbon accounting. This is the single most important lever for monetising carbon.
- **Design High-Integrity Nature-Based Programs:** Implement stringent permanence safeguards, community benefit mechanisms, and third-party oversight for forest and mangrove projects to ensure long-term asset credibility and premium pricing.

8. Regulatory Catalysts for Accelerating the Energy Transition

Policy and regulatory environment in India have played an important role in India's clean energy transition.

8.1 Policy and Regulatory Developments

Some of the recent policy and regulatory developments are as follows:

- The RCO Mandate: Designated Consumers (DISCOMs, Captive, and Open Access Users of Fossil Power) must now meet a unified national target, starting at 29.91% in FY25 and escalating to 43.33% by FY30.
- **The 2026 Electricity (Amendment) Rules:** Notified on January 2, 2026, these rules introduce "Flexible Captive Power Regulations." Industries can now choose a specific "Assessment Period" within a year to prove their 51% captive status, significantly de-risking the use of wind-solar hybrids.
- **CERC-Virtual Power Purchase Agreements (PPAs):** CERC proposed/ rolled out a framework for Virtual PPAs as financial contracts letting consumers meet renewable targets via settlement against market prices. This is a major regulatory catalyst because it expands corporate demand participation, improves bankability of RE projects, and can unlock new procurement models for large buyers.
- **Power Market Coupling[72]:** CERC directed phased rollout of power market coupling, starting with the Day-Ahead Market by January 2026 in a round-robin Market Coupling Operator model. Coupling can improve market efficiency, reduce fragmentation, and support renewable integration by strengthening price discovery and dispatch coordination which are important system-level enablers for high-RE penetration.
- **GST cut on solar and wind equipment to 5%:** India reduced GST on solar PV modules and wind turbine generators from 12% to 5%, with experts estimating ~5% capex reduction and tariff pressure. This is a direct fiscal accelerator for deployment, though it can create short-term contract renegotiation friction for projects bid under old tax assumptions.
- **Unlocking stalled RE:** CERC examined reforms to address idle grid access (large GW-scale capacity lacking PPAs), including auctioning unused connectivity and stricter milestones/ performance guarantees. This is a classic regulatory catalyst: it reallocates scarce transmission to ready projects, improves pipeline discipline, and accelerates RE build-out by clearing congestion created by stalled awards.

8.2 State-level Developments

Some of the state-level recent developments regarding clean energy transition are as follows:

Kerala

Resource adequacy/ long-term resource mobilisation plan: KSERC provisionally approved KSEB's long-term resource plan (2025–26 to 2035–36). This institutionalises forward planning for renewables, storage, and procurement mix which are essential for renewable energy transition.

[72] https://cercind.gov.in/2025/orders/8-SM-2025.pdf

Telangana

- EV policy push: Telangana is drafting measures for a significant EV share in fleets used by IT/ Pharma/ Educational Institutions. The state also plans major growth in electric buses and charging infrastructure. Transport electrification is a demand-side regulatory catalyst which creates predictable electricity demand growth, supports clean power procurement, and strengthens the business case for grid upgrades and storage.

Puducherry

- Rooftop solar: SECI's tender for 13 MW rooftop solar on Puducherry government buildings (RESCO mode) is a near-term regulatory-program catalyst. It standardises procurement and de-risks adoption through tariff-based competitive bidding and BOO/ RESCO structures, accelerating distributed RE in public infrastructure and improving replicability for other UT/state programs.

Tamil Nadu

- The "First-Mover" Green Hydrogen Hub: MNRE officially designated V.O. Chidambaranar Port (Tuticorin) as one of India's three primary Green Hydrogen Hubs in October 2025. In September 2025, a INR 25 crore pilot facility was commissioned at the port. It is the first in India to test green hydrogen for maritime applications like street lighting and EV charging within a port ecosystem. The Green Hydrogen Certification Scheme (GHCI), launched in April 2025, provides a legal framework for "Green" labeling, allowing Tuticorin to negotiate export contracts with the EU, which requires strict emission tracking.

Karnataka

- Karnataka is the lead beneficiary of the government's push for "firm" (non-intermittent) renewable power through PSP. The 2,000 MW Sharavathi PSP received critical DPR concurrence from the Central Electricity Authority (CEA) in mid-2025. This project is now part of a record 7.5 GW of PSPs approved in the 2024-25 cycle, the highest in India's history.

Andhra Pradesh

- Anantapur-Ramayapatnam Corridor: The government is using transmission De-risking to prevent "curtailment" (where green power is wasted because the grid can't take it). The work accelerated on the Phase-3 Green Energy Corridor in late 2025 to connect the solar-rich Anantapur region to the industrial coast. The ISTS Waiver, which was extended and clarified in December 2025, ensures that projects commissioned before 2028 in this corridor will pay zero transmission charges for 25 years.

8.3 Recommendations

Some of the recommendations regarding regulations are as follows:

- **Align Reform With Implementation Readiness:** Synchronise regulatory rollout with legal frameworks, utility preparedness, and stakeholder consensus to increase investor confidence.

- **Strengthen Grid & Market Backbone:** Fast-track market coupling, transmission expansion, and connectivity reforms to ensure no lag between policy and development of physical infrastructure.

9. Energy-Water Nexus

India's clean energy transition is closely intertwined with water availability, management, and efficiency. Energy production requires water for various purposes (for e.g., in case of coal based thermal power station for steam generation/ cooling and in case of solar plants for cleaning of modules), while water supply and treatment depend on energy. This energy-water nexus is becoming increasingly critical as India expands renewable energy capacity, modernises infrastructure, and adapts to climate change. Building resource-efficient infrastructure that minimises water stress while supporting energy security is therefore central to India's sustainable development pathway.

9.1 Understanding the Energy–Water Nexus in India

India faces simultaneous energy demand growth and rising water stress, driven by urbanisation, climate change, and economic expansion. Thermal power plants, hydropower, bioenergy, and even parts of the renewable supply chain depend on water for cooling, processing, or storage.

At the same time, water infrastructure including pumping, desalination, wastewater treatment, and irrigation is energy intensive. Efficient planning must therefore treat energy and water as interdependent resources, rather than isolated sectors.

Policy leadership in this space is driven by the Government of India, with coordination across the Ministry of Power, Ministry of New and Renewable Energy, and Ministry of Jal Shakti.

9.2 Water Use Across India's Energy Mix

Thermal power

- Coal and gas plants are amongst the largest industrial water users, for cooling. Water shortages have already led to generation outages in several regions. Regulations increasingly mandate cooling water norms, zero liquid discharge, and use of treated wastewater.
- Coal plants consume 1,500–2,000 liters per MWh. By 2030, severe groundwater depletion in hubs like Chennai and Hyderabad will force energy-intensive sectors to shift toward closed-loop cooling and industrial effluent reuse[73].

Renewable energy

- Solar PV and wind have minimal operational water requirements, making them highly water efficient. Water requirement in solar power plants has significantly reduced with the help of robotic dry cleaning systems.
- Solar thermal and bioenergy are more water intensive and require careful siting and technology choices.
- Hydropower and pumped storage depend on water availability but can provide long-duration energy storage without consumptive water use.
- Emerging green hydrogen hubs require careful water planning. Producing 1 kg of Green Hydrogen typically requires 20-30 liters of demineralized water (including purification and cooling)[74]

[73] https://vajiramandravi.com/current-affairs/water-crisis-in-india/
[74] https://rmi.org/hydrogen-reality-check-distilling-green-hydrogens-water-consumption/

Energy Storage and the Water Dimension

Energy storage plays a dual role in the energy-water nexus.

- Pumped hydro storage power (PHP) uses water as a storage medium but recycles it, offering long-duration storage with low net water consumption.
- Battery Energy Storage Systems (BESS) require little to no operational water, making them ideal for deployment in water-stressed regions.
- Strategic deployment of storage reduces dependence on water-intensive peaking thermal plants.

A balanced mix of BESS & pumped hydro supports both grid flexibility and water sustainability.

9.3 Building Resource-Efficient Infrastructure for Clean Energy

Water-efficient power infrastructure

- Transition from once-through cooling to closed-cycle and air-cooled systems in thermal plants.
- Mandatory use of treated municipal wastewater for power plant cooling.
- Retrofitting older plants to meet modern water efficiency standards.

Smart and integrated planning

- Integrating water availability mapping into renewable energy zoning and site selection.
- Co-locating renewable energy projects with wastewater treatment facilities.
- Using digital monitoring and AI tools to optimise water and energy use across infrastructure.

Decentralised clean energy systems

- Rooftop solar and microgrids reduce stress on centralised, water-intensive power generation.
- Solar-powered water pumping improves irrigation efficiency while reducing diesel use.
- Distributed storage enhances resilience during floods and droughts.

Policy and Regulatory Enablers

- India's regulatory framework increasingly recognises the energy-water nexus.
- Water consumption norms for thermal power plants enforced through environmental and power-sector regulations.
- National missions promoting wastewater reuse for industrial and energy applications.
- Renewable energy policies prioritising low-water technologies such as solar PV and wind.
- Energy efficiency standards reducing water use indirectly by lowering overall energy demand.

These measures ensure that clean energy expansion does not exacerbate water stress.

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[75] https://www.niti.gov.in/sites/default/files/2023-08/COMPENDIUM-OF-BEST-PRACTICES-IN-WATER-MANAGEMENT-3.0_Water-Resources-Vertical_2_8_23.pdf
[76] https://www.mdpi.com/2073-4441/16/17/2473

9.4 Energy-for-Water: Optimizing the Invisible Cycle

Energy is consumed at every stage of the water value chain: abstraction, treatment, conveyance, and reuse.

- **Avoidable Losses:** In urban utilities, 25-40% energy consumption is avoidable through the optimization of pumping systems. In Tier-1 cities like Bengaluru and Chennai, outdated infrastructure leads to significant energy losses in distribution[75].
- **Municipal Impact:** In some municipalities globally, water services can account for over 30% of total public electricity consumption. Reimaging this as an integrated system can unlock massive cost savings for local governments[76].

9.5 Emerging Nexus-Intensive Sectors

The Energy-Water nexus is most prominent in some of the following high-growth areas:

- **Data Center Cooling:** A typical 100 MW hyperscale facility can consume up to 800,000 liters of water per day for evaporative cooling. With modern AI workloads increasing heat density, the transition to liquid cooling is essential to reduce the water-energy footprint[77].
- **Pharma & Food & Beverage:** These sectors require high-purity water, where energy-intensive treatment (RO/UV) is mandatory. Digital optimization using AI/ IoT sensors can reduce both water waste and the associated energy bill by up to 20%.

9.6 Recommendations for a Water-Smart Energy Transition

To strengthen the energy–water nexus in India's clean energy transition, recommendations include:

- Mainstreaming water impact assessments in energy planning and procurement.
- Scaling up battery storage and low-water renewables in water-stressed regions.
- Accelerating pumped storage projects where hydrological conditions permit.
- Strengthening institutional coordination between energy and water ministries.
- Promoting data-driven decision-making through integrated energy-water planning tools.

[77] https://www.ceew.in/blogs/why-is-water-based-cooling-a-big-issue-for-ai-data-centres-in-india

State/ UT	Market Preference & Landscape	Strategic Financing Highlights
Andhra Pradesh	Industrial Hub Finance	• Greenlit INR 15,800 Crore in proposals; includes Tata Power's 10 GW Nellore manufacturing site and ACME's Anantapur solar-plus-storage project
Tamil Nadu	Dispatchable Debt	• Shifting to Hybrid/ Storage; • Raised INR 205 Crore via oversubscribed Green Municipal Bond for Kodungaiyur environmental infrastructure
Karnataka	Asset Recycling	• Market leader in InvITs; • Secured INR 654 Crore PM-KUSUM order for solar pumps; focusing on de-risking equity for the 2030 RE pipeline
Telangana	High-Growth Deals	• Secured INR 5.75 Lakh Crore in MoUs at Dec 2025 Summit; includes Evren/ Axis Energy's INR 31,500 Crore hybrid RE deal and Brookfield's INR 75,000 Crore Net-Zero hub
Kerala	Digital Capital	• KSEB cleared INR 6,478 Crore Capital Investment Plan for FY27; prioritizes TransGrid 2.0 (INR 599 Crore) and BESS (INR 170 Crore) to manage prosumer surge
Puducherry	Grant-led Transition	• Utilizing NSGM Grants (MoP share of INR 17.76 Crore) for the INR 35.53 Crore Smart Grid Pilot covering 34,000 consumers with AMI infrastructure.

Industry Speak on Energy Transition in Southern India

Mr Nuguri Venu
Chairman, CII-SR Task Force on Energy Transition 2025-26 &
Managing Director & CEO, Hitachi Energy

Energy Transition: South India

South India is at the frontline of India's energy transition, with the southern region contributing the highest share of national renewable capacity - over 33% as of 2025 making it a test bed for high renewable, high growth systems. Yet rapidly rising demand, continued coal dependence and grid constraints are creating reliability and flexibility challenges, including curtailment of wind and solar in states like Tamil Nadu and Karnataka.

Current landscape and key challenges

South India has been an early mover in wind, solar and hydro, with Tamil Nadu targeting 20 GW of solar by 2030 and Kerala aiming for 100% renewable energy by 2040. Karnataka already meets more than 30% of its annual power generation from variable renewables, supported by a relatively strong grid and progressive policies. At the same time, intermittency, lagging storage deployment, limited transmission, and policy uncertainty around open access and grid integration continue to pose risks to system stability and investment flows.

Strategic priorities for industry

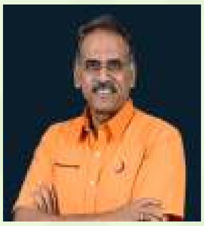
For industry, strategic priorities now go beyond adding megawatts to building integrated clean energy systems. Industrial and services clusters across South India need round the clock green power solutions that combine utility scale renewables with storage, flexible loads and energy efficiency, aligned with global supply chain decarbonisation pressures. Long term green PPAs, open access frameworks and pilot projects in green hydrogen and electrification of process heat will be key levers for competitiveness and resilience.

Role of technology, innovation, policy and finance

Technology and innovation are central enablers. Grid modernisation solutions such as HVDC links, digital substations and smart grids are critical to move large volumes of renewable power from resource rich zones to coastal and urban load centres in the south. The transition is now equally about supply security and affordability and depends on a robust HVDC and grid connectivity backbone to integrate clean energy at scale. Digitalisation, AI driven forecasting, and automation are improving renewable forecasting, congestion management and asset performance, while innovative business models (such as renewable plus storage, energy as a service, and peer to peer trading pilots in Karnataka) are widening access to clean power.

Way forward

The way forward is a collaborative, ecosystem driven model. Industry should commit to science based decarbonisation targets, invest in grid connected storage and digitalisation, and co create solutions with technology partners that strengthen the southern grid. Policymakers in South India should prioritise accelerated transmission build out, clear state level roadmaps for renewables and storage, and market mechanisms that reward flexibility and reliability. Financial institutions, academia and civil society must help de risk early stage projects and build skills, ensuring a just, secure and competitive energy transition for South India.



Mr S Vijayanand
Co-Chairman, CII-SR Task Force on Energy Transition 2025-26 &
President, Amara Raja Advanced Cell Technologies Pvt Ltd

Energy Transition: Industry Perspective

The global energy transition is at an inflection point, driven by the urgent need to address climate change, ensure energy security, and support sustainable economic growth. India stands out as one of the fastest-moving large economies in this transition, supported by strong policy intent, growing public awareness, and rapid technology adoption. With a national commitment to achieve 500 GW of non-fossil capacity by 2030 and net-zero emissions by 2070, India has already crossed 250 GW of installed renewable capacity (PIB), with solar and wind forming the backbone of new additions. Electric vehicle (EV) adoption is accelerating across two-wheelers, three-wheelers, buses, and commercial fleets, while battery energy storage systems (BESS) are increasingly recognized as essential for grid stability. Public sentiment towards clean energy is also shifting positively, with renewables and EVs now viewed not just as climate solutions but as economically viable and aspirational choices. From an industry standpoint, the energy transition landscape is robust but faces three key challenges, which are also the strategic priorities for the sector:

1. Domestic manufacturing scale and competitiveness, particularly in advanced battery technologies.
2. Supply chain localization, including raw material processing and component ecosystems.
3. Grid integration and storage readiness, to manage high renewable penetration reliably.

While the industry is confident of sustaining the transition, relooking at the ACC schemes can further strengthen India's position as a global manufacturing hub. A more flexible ACC PLI framework—covering broader chemistries, domestic value addition, and faster qualification—can boost investments, reduce imports, and enhance long-term competitiveness, with battery storage remaining central to a reliable and secure energy transition. India, along with other emerging economies, is also poised to become the growth engine of the Global South for both EVs and stationary energy storage. Rapid urbanization, rising electricity demand, and distributed renewable installations make storage indispensable across Africa, Southeast Asia, and Latin America—creating a massive opportunity for Indian technology and manufacturing leadership.

Within India, Southern states are leading the renewable transition. Karnataka and Tamil Nadu together account for significant amount of wind and solar capacity, driven by strong state policies and private investments. Tamil Nadu remains the country's largest wind power state, while Karnataka is a solar frontrunner. Telangana and Andhra Pradesh are rapidly expanding solar parks, green corridors, and hybrid renewable projects. Kerala, though constrained by land, is advancing rooftop solar, energy storage, and EV infrastructure.

These efforts are supported by recent government initiatives such as Green Energy Corridors, National Energy Storage Mission, PM Surya Ghar Yojana, and the National Electric Mobility Mission, positioning Southern India as a model for integrated clean energy development.

Technology, innovation, and finance will be the key enablers of the next phase of energy transition. The vision of Atmanirbhar Bharat must translate into deep localization across the entire battery value chain—not just cell manufacturing, but also materials, components, power electronics, and recycling. This presents a significant opportunity in raw material processing and domestic supplier ecosystems, driving jobs, cost competitiveness, and strategic resilience.

Strengthening ACC PLI and storage policies with flexible incentives for localization, R&D, and faster commercialization, along with long-term financing frameworks, will be critical to integrate clean energy at scale, with battery storage emerging as the backbone of a reliable, affordable, and sustainable energy transition.

Dr Nikhil S Tambe
Co-Chairman, CII-SR Task Force on Energy Transition 2025-26 &
CEO-The Energy Consortium, IIT-Madras

The energy transition conundrum! : India's ambitious march towards renewable energy continues as aggressively as it was intended to be! We have surpassed our COP promises ahead of 2030 timelines. As of 2025 year end, the total RE capacity in India surpassed 258 GW. With 135.8 GW of solar and 54.5 GW of wind we currently rank the 3rd highest producers of both in the world.

The important challenge of energy transition, however, continues to be the hard to abate and hard to electrify sectors. It is unlikely that we will be able to completely electrify some of the sectors such as refineries, mining, steel and aluminum production. On Oct 2025, the Ministry of Environment, Forest and Climate Change (MoEFCC) notified updated GHG Emission Intensity Target Rules covering multiple sectors - aluminum, cement, chlor-alkali, and pulp and paper - encompassing 282 industrial entities, and five additional sectors: iron and steel, fertilizer, petroleum refining, petrochemicals, and textiles, covering over 460 industrial installations.

To make calibrated progress for these sectors two important areas have to be unlocked - low carbon and no carbon fuels such as green hydrogen, and economically viable technologies for carbon capture and storage. While the National Green Hydrogen Mission has sustained promise over the last many months there is significant advancement that is to be expected in order to hit the targeted 5 MMT of green hydrogen by 2030. CCUS has had lot of promising developments, however, most of those are still at feasibility and proof of concept stages. The unveiling of the R&D roadmap for CCUS by the high-powered committee constituted by department of science & technology, GOI has helped provide strong guidance for investment as well as infrastructure development.

Even as the primary need for green hydrogen should be towards accelerating the transition by addressing the hard to abate sectors, there has been continued discourse over the last year on the application of green hydrogen towards powering data centers, primarily of course owing to the projected high landed cost for electro-catalytically generated hydrogen, compounded further with the uninterrupted reliable electricity demanded by data centers. This is a distraction and our studies suggest and encourage nuclear power for data center applications. The recent (Dec 2025) passing of the Sustainable Harnessing and Advancement of Nuclear Energy for Transforming India (SHANTI) Bill in the Indian Parliament, private sector investment in nuclear will get a boost.

The Energy Consortium at IIT Madras is leveraging its industry-academia-government stakeholder network in compiling and providing critical science-based inputs through an active representation on all committees constituted by Government of India and industry bodies. On research and innovation front we continue to make purpose driven large investments. We have built a containerized carbon capture demonstrator unit on our main campus that allows validating carbon capture technology at upto 2 ton per day scale. On hydrogen front we are partnering with Hyundai in setting up the 65,000 sq. ft. Hyundai HTWO Innovation Centre – a state-of-the-art R&D hub poised to serve as a catalyst for innovation in the field of green hydrogen technology and its ecosystem at our Thaiyur campus. We have constituted an interdisciplinary group of researchers involving multiple IITs are area leading a focused initiative on developing workforce capacity and capability for the upcoming modular nuclear reactors sector.

Ms Usha Subramaniam
Country President – India
Grundfos Pumps Ltd

Unleashing the Power of the Energy-Water Nexus: A Grundfos Perspective

1. The Landscape: Moving from Silos to Systems

Grundfos views India's energy transition not merely as a shift in power generation, but as a fundamental driver of economic growth to balance resource intensity. While South India has reached a historic threshold with over 51.5% non-fossil installed capacity, a critical challenge remains largely invisible: the Energy-Water Nexus.

Water and energy are deeply interdependent—energy is required to treat and distribute water, while water is an essential input for thermal power, green hydrogen, and biofuels. Historically, these sectors have operated in silos, leading to systemic inefficiencies where energy embedded in water systems remains unquantified.

2. Strategic Priorities for Industry

To accelerate a sustainable transition, we identify two critical levers:

- Optimizing Energy-for-Water: In India, approximately 25–40% of energy consumed in water utilities is avoidable through the optimization of pumping and treatment systems. Addressing outdated infrastructure in Tier-1 and Tier-2 cities is a priority to curb avoidable energy losses.
- Decarbonizing Water-for-Energy: Thermal power plants currently account for 80% of industrial freshwater withdrawal in India. As we pivot to green hydrogen and solar thermal, industries must adopt an efficiency-driven planning to reduce withdrawal through closed-loop systems and effluent reuse.

3. Enablers: Technology, Innovation, and Finance

- Technology & Innovation: Digitalization is the primary enabler. Sensor-driven intelligence, AI, and IoT are transforming water-energy footprints through real-time monitoring and predictive maintenance. Decentralized water-energy systems offer a path to resilience for remote infrastructure.
- Finance & Policy: Market signals, such as the Viability Gap Funding (VGF) for energy storage which reduced battery tariffs by 54% in 2024, show how policy can make new technologies bankable. Similar incentives are needed for water-efficient technologies to drive adoption.

4. Actionable Recommendations

- **For Policymakers:** Mainstream water impact assessments in all energy planning and procurement. Strengthen institutional coordination between energy and water sectors to break traditional silos.

- **For Industry:** Quantify and visualize the energy footprint of water use. Transition to smart, data-driven planning to reduce operational bills and meet ESG targets.
- **For Stakeholders:** Accelerate the adoption of low-water renewables (solar PV and wind) in water-stressed regions of South India to safeguard energy security.

5. Insights from Our Experience

Grundfos proposes anchoring sessions that place the energy-water nexus at the heart of the decarbonization agenda. Our experience suggests that by leveraging this nexus as a strategic lever, India can achieve climate-positive growth that balances resource efficiency with cost savings across cities and industrial infrastructure.

A case study that is worth looking at in this context is below –

A leading electric vehicle manufacturer aimed to enhance the efficiency and sustainability of its Manufacturing Process. To support its cooling lines, cooling infrastructure, and effluent management, the plant required a robust and intelligent cooling water circulation system for the body shop aligned with energy-saving and automation goals.

The Grundfos solution was custom-designed for the EV plant's critical operations:

- Dedicated Pumps: Ensure consistent water circulation and temperature control for cooling processes.
- Integrated Pumping Systems: Four distinct systems unified under a single control panel for streamlined operations and maintenance.
- Spray Pumps: Deliver targeted water flow for precision coding applications.
- Cooling Tower Fans: Controlled via a Grundfos panel, enabling automated speed regulation based on temperature and load.
- Effluent Water Transfer Pump: Manages exhaust water, supporting sustainable reuse and discharge protocols.

To enhance automation and energy efficiency, the entire system interfaces seamlessly with Building Management Systems (BMS) and Supervisory Control and Data Acquisition (SCADA) platforms, using advanced controllers to optimise processes and enable centralised monitoring and control. Additionally, Variable Frequency Drives (VFDs) are integrated with pump systems to optimise energy consumption, reduce mechanical wear, and improve responsiveness. Together, these components deliver a high-performance, sustainable water management solution tailored for modern EV manufacturing environments.

Major Energy Transition Players in Southern Region

Nature of Business	Name of the Player	Details
Independent Power Producers (IPPs) for Solar, Wind and Hybrid Projects	Adani Green Energy Ltd	Headquarted in Ahmedabad; has an operational RE portfolio of 14.5 GW with multiple projects in the Southern Region
	Greenko Group	Headquartered in Hyderabad; has an operational RE portfolio of 11 GW with multiple projects in the Southern Region
	ReNew Power	Headquartered in Gurgaon; has an operational RE portfolio of 11 GW with multiple projects in the Southern Region
	Hero Future Energies	Headquartered in Delhi; has an RE portfolio of 7.2 GW with multiple projects in the Southern Region
	JSW Energy	Headquartered in Mumbai; has an operational RE portfolio of 3.5 GW
Wind Turbine Manufacturers	Siemens Gamesa	Manufacturing facilities located across Tamil Nadu and Andhra Pradesh
	Envision Energy	Blade manufacturing in Tamil Nadu and nacelle and hub assembly in Maharashtra
	Suzlon Energy	Manufacturing facilities located across multiple states such as Tamil Nadu, Gujarat, Maharashtra, and Rajasthan
Solar Module Manufacturers	Waaree Energies	Manufacturing plants in Gujarat with a capacity of 22.3 GW of solar PV modules
	Adani Solar	Manufacturing plant in Mundra (Gujarat) with a capacity of 4 GW of solar PV modules
	First Solar	Manufacturing plant near Chennai (Tamil Nadu) with a capacity of 3 GW of solar PV modules
	Vikram Solar	Manufacturing plants in West Bengal and Tamil Nadu with a capacity of 9.5 GW of solar PV modules
	Swelect Energy	Manufacturing plant in Coimbatore (Tamil Nadu) with a capacity of 1 GW of solar PV modules
	Emmvee	Manufacturing plant in Bengaluru (Karnataka) with a capacity of 7.8 GW of solar PV modules
	Tata Power Solar	Manufacturing plants in Karnataka and Tamil Nadu with a capacity of 4.6 GW of solar PV modules
	RenewSys	Manufacturing plant in Hyderabad (Telangana) with a capacity of 2.5 GW of solar PV modules

Confederation of Indian Industry

2nd Edition
ENERGY TRANSITION SUMMIT

"Integrating Innovation, Infrastructure & Investment for Energy Transition in Southern India"

1st Edition of the
CII-SR Industrial Climate Action Competition

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T.EN TECHNIP ENERGIES

The Confederation of Indian Industry (CII) works to create and sustain an environment conducive to the development of India, partnering Industry, Government and civil society through advisory and consultative processes.

CII is a non-government, not-for-profit, industry-led and industry-managed organisation, with around 9,700 members from the private as well as public sectors, including SMEs and MNCs, and an indirect membership of over 365,000 enterprises from 318 national and regional sectoral industry bodies.

For 130 years, CII has been engaged in shaping India's development journey and works proactively on transforming Indian Industry's engagement in national development. CII charts change by working closely with the Government on policy issues, interfacing with thought leaders, and enhancing efficiency, competitiveness, and business opportunities for industry through a range of specialised services and strategic global linkages. It also provides a platform for consensus-building and networking on key issues.

Through its dedicated Centres of Excellence and Industry competitiveness initiatives, promotion of innovation and technology adoption, and partnerships for sustainability, CII plays a transformative part in shaping the future of the nation. Extending its agenda beyond business, CII assists industry to identify and execute corporate citizenship programmes across diverse domains, including affirmative action, livelihoods, diversity management, skill development, empowerment of women, and sustainable development, to name a few.

For 2025-26, CII has identified "Accelerating Competitiveness: Globalisation, Inclusivity, Sustainability, Trust" as its theme, prioritising five key pillars. During the year, CII will align its initiatives to drive strategic action aimed at enhancing India's competitiveness by promoting global engagement, inclusive growth, sustainable practices, and a foundation of trust.

With 70 offices, including 12 Centres of Excellence, in India, and 9 overseas offices in Australia, Egypt, Germany, Indonesia, Singapore, UAE, UK, and USA, as well as institutional partnerships with about 250 counterpart organisations in almost 100 countries, CII serves as a reference point for Indian industry and the international business community.

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