Kerala's Electricity Security and Peak-Hour Adequacy: Assessing Readiness for the 2040 Renewable Energy Transition

Preliminary Assessment

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By

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Executive Summary

Kerala's electricity demand is expected to grow by around 5% over the next decade, while the state pursues its ambition of becoming a 100% renewable energy-powered state by 2040. This transition presents a distinct challenge: Kerala's domestic electricity generation is predominantly renewable, but the state continues to depend substantially on electricity procured from other states. Ensuring reliable, affordable and adequate electricity—particularly during peak-demand periods—will therefore require more than expanding generation capacity.

The Central Electricity Authority's Resource Adequacy assessment projects electricity energy requirement to grow at a compound annual growth rate (CAGR) of 5.1% and peak demand at 3.7% between 2025–26 and 2035–36. Its initial assessment of existing and planned contracted capacity, excluding banking and short-term procurement, indicates an energy adequacy gap of 13,868 MU, or 24.8% of projected requirement, by 2035–36. This is a gap in the assessed contracted portfolio, rather than an inevitable future shortage. Although Kerala reported meeting its recorded electricity requirement of 31,157 MU and peak demand of 5,819 MW in FY2025–26, annual adequacy does not establish reliable supply in every hour or affordability during periods of stress. Short-term procurement at high prices and evening peak-hour outages illustrate these concerns.

The renewable energy assessment highlights a similar distinction between capacity and electricity supply. While around 88% of Kerala's installed capacity was renewable as of March 2025, domestic renewable generation in FY2025–26 was approximately 12.88 GU against an electricity requirement of 31.16 GU—meeting around 40% of demand. Kerala has an estimated in-state renewable energy potential of 18.92 GW, but the capacity additions envisaged under the state's Resource Adequacy Plan are substantially below this potential and are not guaranteed to be commissioned or available at the required hours.

The assessment concludes that Kerala's readiness for a reliable and affordable transition to 100% renewable electricity by 2040 is not yet demonstrated by the available evidence. The transition will require coordinated expansion of local renewable energy, renewable electricity procurement from other states, energy storage, grid strengthening, improved renewable integration, demand-side management and resource-adequacy planning. Kerala also needs to assess the feasibility and affordability of alternative electricity-mix pathways without treating any technology option as a foregone conclusion.

The overarching objective must remain the provision of reliable and affordable electricity to consumers as demand grows and the state advances its renewable energy ambition.

Introduction

Kerala is growing at an average real GSDP of around 6%. (Kerala ER 2025) Its electricity demand is expected to increase at around 5% for the next decade. The challenge of meeting growing electricity demand becomes extraordinary given the state's unique power situation - while it is powered predominantly by interstate electricity, the domestic power generation is based mostly on renewable energy. Renewable energy sources are cleaner than fossil fuels but some – particularly, solar and wind – are more variable and less inherently dispatchable. This situation puts the state at supply risk in terms of reliability and affordability of electricity supply, especially during peak hours. Further, Kerala's ambition to become a 100% renewable energy--powered state by 2040 brings with it, both opportunities and challenges. The question that remains, therefore, is:

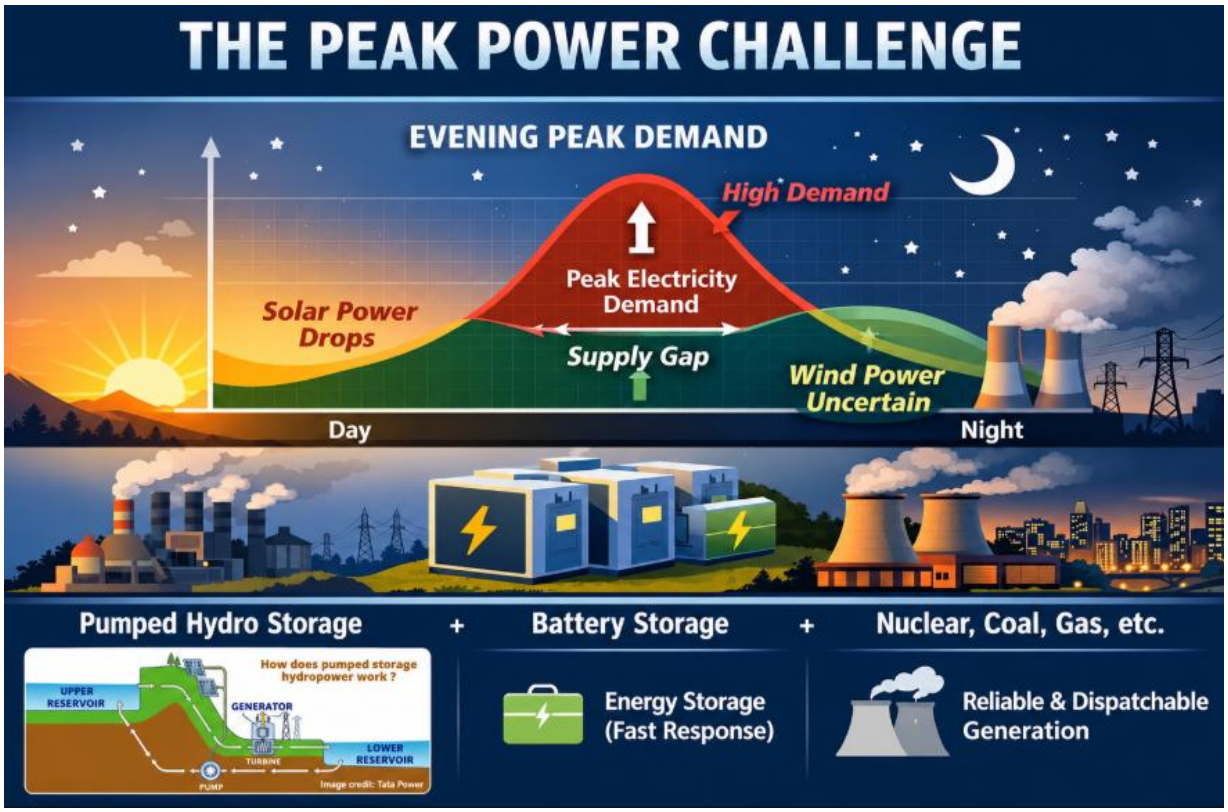
"**Is Kerala equipped to provide reliable, affordable and adequate electricity supply during peak-demand periods over the next decade while transitioning towards 100% renewable electricity by 2040?**"

Demand-Supply Assessment

1. As per the CEA's Resource Adequacy Report projections, the CAGR of electrical energy requirements from 2025-26 to 2035-36 is projected to be 5.1% exhibiting a decreasing trend. For the same range, peak demand CAGR is 3.7%. (KSERC, 2025)
2. Under the CEA's initial assessment of existing and planned contracted capacity, excluding banking and short-term procurement, the model indicates an energy adequacy gap that rises to 13,868 MU, or 24.8% of projected requirement, in 2035–36. This represents **a gap in the assessed contracted portfolio**. (CEA, 2025, p. 14)
3. While the above report projected an unserved energy projection for the year 2025-26, Kerala reported having fully met its recorded electricity requirement of 31,157 MU and a peak demand of 5,819 MW. (CEA, 2025, p. 75)
    a. However, this does not necessarily establish reliability and affordability of electrical supply during the year.
    b. A closer look throws light on the **cost pressures and high dependence on external procurement during the shortage periods for that year**. For instance, in the second part of 2025, electricity shortages and peak demand deficit were expected and accordingly, approvals were taken to procure additional short-term power for peak hours at prices that were 'excessively high' as noted by KSERC. (KSERC, 2025) These pressures were again manifested during September, 2026 in the form of evening peak hour outages. (Pandey, 2026)

These observations point towards the already existing stress on Kerala's electricity system in terms of reliability and affordability, especially to meet peak demand.

4. The stress becomes pronounced due to a combination of one or more of trigger factors, like weak monsoon resulting in reduced water availability for dependable hydropower generation; reduced external power availability as a result of central generating station outages, fuel constraints and competing demand in other states; demand exceeding available supply, particularly during evening and night-time peaks and inherent unavailability of solar power during evening and night hours. Short-term procurement is resorted to that can be expensive or uncertain or both.



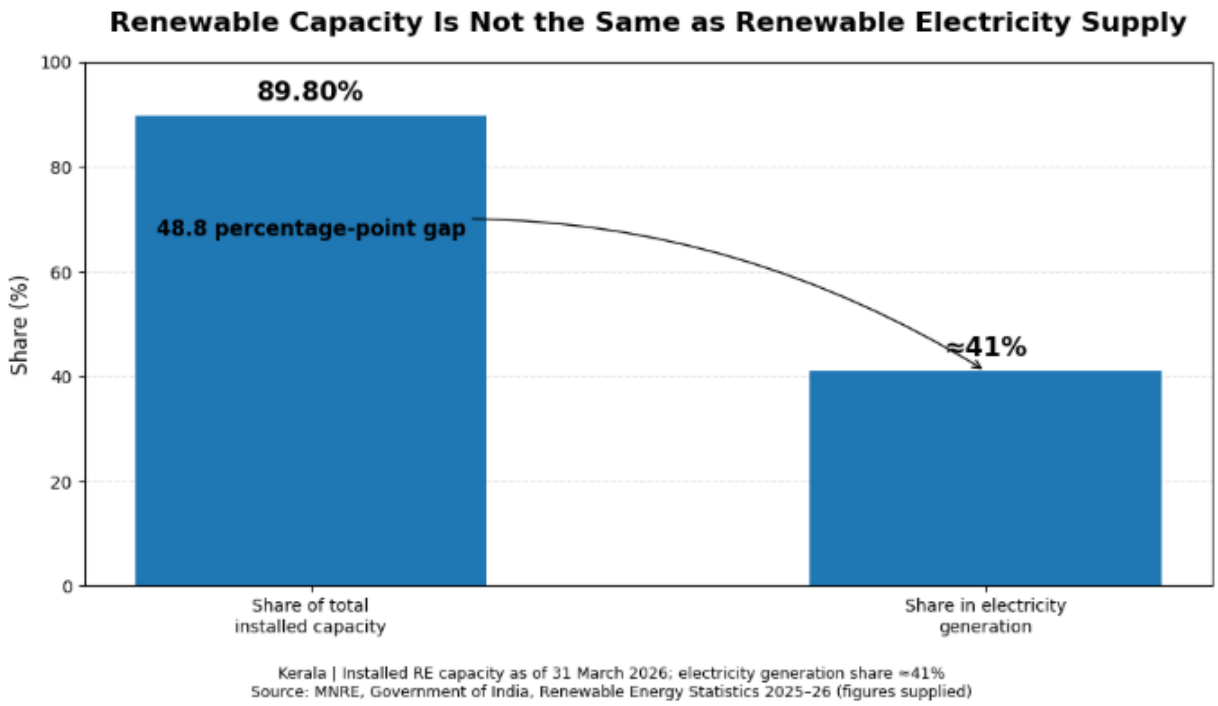
The levers available to Kerala extend beyond adding power generation capacity to include investment in energy storage, transmission infrastructure, power procurement and demand-side management. Within the generation mix, particular attention needs to be given to Kerala's ambition of achieving 100% renewable energy by 2040.

The RE Assessment

Kerala has an ambition to go 100% renewable by 2040, practically implying meeting its electricity requirements through renewable energy sources[1] by 2040, supported by large-scale renewable generation, energy storage, grid modernisation, demand-side flexibility and procurement of renewable electricity from other states and a concerted push towards increased electrification across sectors.

1. As of March 2025, around 88% of its installed capacity was already based on renewable energy. (KSEB, 2025, pp. 323–326) However, a large portion of its electricity is sourced from other states (around 70% in 2024-25) - coal accounted for around 45% of the total power purchased. (GoI, 2024)
2. Assessing the last year situation (2025-26), out of the 12.88 GU energy generation for Kerala, 9.2 GU was Large Hydro that comprised around 70% of the total energy generated, thermal was nil and remaining was RES comprising mainly solar (18%) followed by Small Hydro, Wind and Bio power. (GoI, 2026, p. 50) The actual demand was 31.16 GU. (CEA, 2025, p. 75) Hence, **last year, domestic renewable energy could meet around 40% of its actual electricity requirement.** This also points towards the **inherent variability and lower capacity utilization of solar and wind energy as compared to other energy sources.**

[1] Renewable energy comprises Large Hydro, Small Hydro, Solar, Wind, Biomass and Waste to Energy as per latest MNRE classification



3. Kerala's **estimated in-state renewable energy potential is approximately 18.92 GW**, comprising 12.40 GW of solar, 2.62 GW of onshore wind, 2.47 GW of conventional hydropower, and additional potential from small hydro and biomass. (GoI, n.d.)
4. On the ground, the capacity additions envisaged under the State's Resource Adequacy Plan for the coming decade are substantially lower than the estimated potential - around 4.4 GW of solar including Rooftop DRE, 514 MW of wind and 112 MW of Hydro. So that solar energy can contribute to firm capacity, battery energy storage system is also planned of around 250 MW and 300 MW for 4 hours and two hours, respectively. Further, it may be noted that the planned capacity is NOT guaranteed available capacity - These are all at various stages of processing like signing of PPA or PSA, floating tenders etc. and there is no guarantee that proposed projects will be commissioned on schedule or the said capacity will be available at desired hours. (KSERC, 2025, p. 7)
5. The projected demand is 41.59 TWh in 2030 increasing to 65.98 TWh in "Business-As-Usual" simulation that increases even further in the CN50 scenario (BAU: Assumes growth aligned with current trajectories, consistent efficiency levels, and continued reliance on LPG/biomass for thermal needs; CN50: Mandates deep electrification, rapid adoption of Green Hydrogen and aggressive deployment of storage technologies to eliminate fossil fuel reliance.) (Carbon Neutral Kerala 2050, 2026, p. 104)
6. Another report on Kerala's clean energy transition concurs that to remove thermal dependence completely, substantial investment will be required and a substantial additional renewable capacity would be needed by 2040. (Ijas M. & Vaisakh Suresh, 2026)

A cursory look at the current and projected RE capability to meet the demand establishes the **renewable energy sources in the state are inadequate to meet the current and projected demand.**

7. Hence there is a need of not only expansion of local renewable energy infrastructure including better grid integration of renewable generation, but also for embracing inter-state renewable energy trade, energy storage installation, grid strengthening as improved resource-adequacy planning.

Key Findings & Conclusion

1. **Annual supply adequacy does not guarantee peak-hour security**
   - Kerala's annual electricity requirement was almost fully met in FY2025–26, but this does not establish that supply was reliable during every hour or that future peak demand will be met.
2. **The contracted portfolio requires further strengthening**
   - CEA's initial assessment indicates a substantial adequacy gap under existing and planned contracts, before additional procurement and capacity options are considered.
3. **High renewable capacity does not translate into equivalent electricity supply**
   - Kerala's renewable capacity is dominated by hydro and solar, while its total electricity requirement is much larger than its in-state generation.
4. **The 2040 ambition requires a system-wide transition**
   - Renewable generation needs to be supported by storage, grid infrastructure, renewable power procurement, demand-side flexibility and resource adequacy planning.
   - Kerala also needs to assess its optimal electricity mix without treating any technology pathway as a foregone conclusion.

Kerala's readiness for a reliable and affordable transition to 100% renewable electricity by 2040 is not yet demonstrated by the available evidence. The state has made progress in renewable energy deployment, but its dependence on external electricity procurement, the projected adequacy gap in its contracted portfolio, and the need to manage peak demand indicate that generation capacity additions alone will not be sufficient. The transition will require a coordinated strategy. The feasibility and affordability of alternative pathways to 2040 remain important areas for further assessment. The overarching objective must remain the provision of reliable and affordable electricity to consumers over the next two to three decades.

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