



State-Level Disparities in Renewable Energy Potential and Installed Capacity in India

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Abstract

The expansion of renewable energy is central to India's long-term energy transition strategy. However, the distribution of renewable resources and their actual development differ significantly across states. This study examines state-level variations in renewable energy potential and installed capacity in India using secondary data from the Ministry of New and Renewable Energy (MNRE), Central Electricity Authority (CEA), MoSPI Energy Statistics and India Climate and Energy Dashboard (ICED), NITI Aayog. The analysis focuses on major renewable sources, including solar, wind, and hydro power, to evaluate how effectively natural resource availability is being translated into installed infrastructure. A descriptive comparative approach is adopted to assess the extent to which resource potential is reflected in installed capacity. The study calculates the ratio of installed capacity to estimated potential to identify differences in renewable energy utilization across states. This helps highlight states that have effectively utilized their

resource base and those where substantial underutilized capacity potential persists. The study will help inform state-level policy formulation, strengthen renewable energy planning strategies, and support the effective utilization of renewable resources across India.

Keywords: Energy Transition, Renewable Resources, Solar Energy, Wind Energy, Hydro Energy.

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1. Introduction

Energy security and environmental sustainability represent the twin imperatives driving India's energy transition in the twenty-first century. As the world's third-largest energy consumer (IEA, 2023), India faces the dual challenge of meeting rapidly growing energy demand while reducing its dependence on fossil fuels and curbing greenhouse gas emissions. Renewable energy has emerged as the cornerstone of India's strategy to address these challenges (MoSPI, 2024).

India has set an ambitious target of achieving 500 GW of non-fossil fuel-based energy capacity by 2030, in alignment with its Nationally Determined Contributions (NDCs) under the Paris Agreement (Ministry of Power, 2023). As of March 2024, the country's total installed renewable energy capacity stood at approximately 190 GW, reflecting substantial progress but also underscoring the magnitude of the remaining challenge (MNRE, 2024). Solar and wind energy have been the primary drivers of this expansion, while hydro, bio-power, and small hydro continue to contribute to the diversified energy mix.

However, India's renewable energy landscape is far from uniform. The country's vast geographical expanse, varied topography, and climatic diversity result in significant spatial heterogeneity in renewable resource endowment (Pillai & Banerjee, 2009). States such as Rajasthan and Gujarat command enormous solar irradiance, while the coastal states of Tamil Nadu and Andhra Pradesh, along with Gujarat, enjoy high wind energy potential. The north-eastern states and Himalayan region hold substantial hydro and small hydro potential. This uneven distribution of natural resources creates inherent disparities in renewable energy potential across states.

Beyond the differential in natural endowment, there exists a further layer of disparity: the degree to which states have been able to convert their resource potential into installed energy infrastructure. Institutional capacity, financial resources, grid infrastructure, regulatory environment, land availability, and political will all mediate the relationship between potential and actual development (Tongia & Gross, 2019; Srivastava et al., 2022). As a result, some states have achieved high levels of capacity utilization relative to their potential, while others, despite possessing vast resources, have barely scratched the surface.

This study investigates these state-level disparities systematically using data from the Ministry of New and Renewable Energy (MNRE), Central Electricity Authority (CEA), MoSPI Energy Statistics and India Climate and Energy Dashboard (ICED), NITI Aayog. By computing a Capacity Utilization Ratio (CUR) for each state and energy source, the study provides a comparative snapshot of renewable energy development trajectories across India. This analysis is particularly timely given India's accelerating energy transition and the critical role that state-level action plays in achieving national targets.

The remainder of this paper is organized as follows: Section 2 reviews the relevant literature; Section 3 describes the data and methodology; Section 4 presents the descriptive analysis and data tables; Section 5 offers policy recommendations; and Section 6 concludes.



2. Literature Review

The literature on renewable energy deployment in India spans macro-level assessments of policy frameworks, sector-specific studies, and increasingly, spatially disaggregated analyses of state-level performance.

2.1 National Renewable Energy Policy Frameworks

India's renewable energy policy has evolved through successive phases, from early incentive-based regimes to the current large-scale competitive bidding system (Bridge to India, 2022). Chaurey et al. (2004) provided one of the early assessments of India's renewable energy status, emphasizing the gap between resource potential and actual deployment. Subsequent work by Tongia and Gross (2019) argued that despite significant policy attention, structural barriers—particularly grid infrastructure limitations and financial stress in electricity distribution companies (DISCOMs)—continue to constrain the pace of renewable energy deployment.

The National Solar Mission, launched in 2010, marked a turning point in India's solar energy ambitions (Schmid, 2012). Pillai and Banerjee (2009) assessed India's wind and solar potential using geographic information system (GIS) techniques, establishing a scientific basis for estimating state-level resource availability. Their estimates, subsequently refined by the National Renewable Energy Laboratory (NREL) and the Ministry of New and Renewable Energy (MNRE), form the basis for the potential capacity figures used in this study.

2.2 State-Level Disparities in Renewable Energy

A growing body of literature has examined the uneven development of renewable energy across Indian states. Srivastava et al. (2022) analyzed state-level renewable energy deployment and found significant variation linked to differences in regulatory quality, state-level renewable purchase obligations (RPOs), and fiscal capacity. States with proactive renewable energy policies and supportive regulatory commissions, such as Gujarat and Tamil Nadu, consistently outperformed others in attracting investment and commissioning capacity.

Mathur and Dholakia (2016) examined the role of state electricity regulatory commissions (SERCs) in shaping renewable energy outcomes, highlighting that regulatory uncertainty and delayed approvals significantly deter investment. Luthra et al. (2015) employed an analytical hierarchy process to rank barriers to renewable energy adoption in India, identifying high upfront costs, lack of awareness, and institutional inertia as critical obstacles—factors that are differentially present across states.

Sharma and Bhatt (2018) studied solar energy deployment across major Indian states and found that while Rajasthan possesses the highest solar potential, its CUR remained relatively modest compared to smaller states with more developed grid infrastructure and policy support. This paradox of high potential but relatively low utilization is a recurring theme in the literature and motivates the present analysis.

2.3 Hydro and Small Hydro Power

India's large hydro potential, particularly in the Himalayan states and the Northeast, has been extensively documented (CEA, 2022). Arunachal Pradesh alone accounts for approximately 51,000 MW of assessed large hydro potential, yet its installed capacity remains a fraction of this figure due to environmental concerns,



limited transmission infrastructure, and administrative challenges (Vagholikar & Das, 2010). Bhatt and Bhatt (2018) analyzed small hydro development and noted that while states like Himachal Pradesh and Karnataka have made progress, many north-eastern states remain underserved due to remoteness and lack of grid connectivity.

2.4 Bio-Power and Diversified Renewable Portfolios

Bio-power, including biomass and biogas, represents an important but often underappreciated component of India's renewable energy mix (MNRE, 2023). Hiloidhari et al. (2014) assessed the spatial distribution of biomass potential in India and found substantial untapped resources in states such as Uttar Pradesh, Maharashtra, and Karnataka—a finding corroborated by the present study's data. Bio-power offers additional co-benefits, including agricultural waste management and rural employment generation, making its development particularly valuable in agrarian states.

2.5 Research Gap

While the above mentioned studies provide valuable insights into specific renewable energy sectors or aspects of state-level performance, there is limited research that systematically compares state-level potential and installed capacity across all major renewable energy sources simultaneously, using a unified analytical framework. This study addresses this gap by employing the Capacity Utilization Ratio (CUR) as a consistent metric across solar, wind, hydro, bio-power, and small hydro energy, enabling a comprehensive cross-state and cross-sector comparison based on the most current available data from ICED, NITI Aayog.

3. Data Source and Methodology

3.1 Data Source

This study uses secondary data exclusively sourced from Ministry of New and Renewable Energy (MNRE), Central Electricity Authority (CEA), MoSPI Energy Statistics and India Climate and Energy Dashboard (ICED), NITI Aayog. (as on March, 2026). ICED compiles state-wise data on renewable energy potential and installed capacity across major energy categories, drawing from the Central Electricity Authority (CEA), the Ministry of New and Renewable Energy (MNRE), and other official sources. The dataset encompasses all 36 Indian states and Union Territories and covers five renewable energy categories: large hydro power, wind energy, solar energy, bio-power, and small hydro power.

3.2 Analytical Framework

The study adopts a descriptive comparative approach. The primary analytical tool is the Capacity Utilization Ratio (CUR), defined as:

$$\text{Capacity Utilization Ratio} = \frac{\text{Installed Capacity} * 100}{\text{Potential Capacity}}$$

The CUR provides a standardized measure of the extent to which a state has mobilized its renewable energy endowment. A higher CUR indicates more effective utilization of available potential, while a lower CUR



signals underutilized resources. The ratio is computed separately for each renewable energy source at the state level, enabling both cross-state and cross-sector comparisons.

States or territories with zero potential capacity for a given energy source are excluded from the CUR calculation for that category, as division by zero is not meaningful. Certain anomalous CUR values exceeding 100% arise due to definitional differences between the potential estimates and actual installed capacity—for instance, where installed capacity includes systems not captured in the potential estimate (e.g., rooftop solar in Chandigarh) or where potential estimates have been revised downward. These cases are flagged in the data tables.

The analysis is descriptive and does not attempt to model the causal determinants of interstate variation in CUR. Potential capacity estimates are subject to methodological differences across sources and may not fully capture all technically exploitable resources.

4. Descriptive Analysis

4.1 Overall Renewable Energy Potential and Installed Capacity in India

Table 1 presents the aggregate potential capacity, installed capacity, and CUR for each renewable energy source at the national level. India's total assessed renewable energy potential stands at approximately 4,880 GW, while total installed renewable energy capacity is 2,63,189 MW (263 GW), yielding an aggregate CUR of approximately 5.39%. This figure underscores the enormous gap between India's resource endowment and current deployment levels, representing a substantial opportunity for further expansion.

Solar energy dominates the potential landscape with an estimated 3,343 GW, followed by wind at 11,63,856 MW (1,164 GW) and large hydro at 3,09,690 MW (310 GW). Bio-power and small hydro account for smaller but significant shares. Among installed categories, solar leads with 141 GW, followed by wind at 55 GW and large hydro at 51 GW. The CUR for bio-power (27.48%) is notably higher than for solar (4.21%) and wind (4.70%), reflecting the comparatively mature development of bio-power relative to its assessed potential.

Table 1: Aggregate Renewable Energy Potential, Installed Capacity, Gap, and Capacity Utilization Ratio of India

Category	Capacity (MW)				CUR (%)
	Potential	Installed	Total	Gap (MW)	
Large Hydro	3,09,690	51,165	3,60,855	2,58,525	16.52
Wind	11,63,856	54,650	12,18,506	11,09,206	4.70
Solar	33,43,350	1,40,602	34,83,952	32,02,748	4.21
Bio-Power	42,263	11,614	53,877	30,649	27.48
Small Hydro	21,134	5,159	26,293	15,975	24.41



Category	Capacity (MW)				CUR (%)
	Potential	Installed	Total	Gap (MW)	
TOTAL	48,80,293	2,63,190	51,43,483	46,17,103	5.39

Source: Ministry of New and Renewable Energy (MNRE), Central Electricity Authority (CEA), MoSPI Energy Statistics and India Climate and Energy Dashboard (ICED), NITI Aayog (as on March, 2026).

4.2 State-Level Analysis: Large Hydro Power

Table 2 presents state-level data on large hydro potential, installed capacity, and CUR. Large hydro power has a total assessed potential of 3,09,690 MW across India, with an installed capacity of 51,165 MW, yielding a national CUR of 16.52%. The analysis reveals a bimodal distribution: a small number of states have achieved relatively high utilization rates, while the majority—particularly those with the largest potential—exhibit very low CURs.

Assam records the highest CUR at 87.85%, indicating that its hydro development is nearly at the level of its assessed potential, though this also reflects a modest absolute potential of only 963 MW. Punjab follows with 84.27%, while Kerala records 54.67%. These states benefit from smaller, more manageable river systems and better grid connectivity. Himachal Pradesh, despite its large potential of 25,565 MW, has achieved a commendable CUR of 44.67%, driven by sustained investment and a well-established hydro sector.

In contrast, Arunachal Pradesh—which holds India's largest hydro potential at 51,054 MW—has a CUR of merely 2.18%, representing one of the starkest examples of potential-deployment divergence in the dataset. Maharashtra, despite a potential of 46,099 MW, records a CUR of only 6.61%. Mizoram and Chhattisgarh also exhibit very low CURs (0.80% and 1.17%, respectively), suggesting that environmental, infrastructural, and financial barriers have significantly constrained hydro development in these states (Vaghlikar & Das, 2010; CEA, 2022).

Table 2: State-wise Large Hydro Energy — Potential Capacity, Installed Capacity, and CUR.

State / UT	Potential (MW)	Installed (MW)	CUR (%)	State / UT	Potential (MW)	Installed (MW)	CUR (%)
Andaman & Nicobar Islands	0	0	—	Lakshadweep	0	0	—
Andhra Pradesh	29,016	3,290	11.34	Madhya Pradesh	11,379	2,235	19.64
Arunachal Pradesh	51,054	1,115	2.18	Maharashtra	46,099	3,047	6.61
Assam	963	846	87.85	Manipur	615	105	17.07



State / UT	Potential (MW)	Installed (MW)	CUR (%)	State / UT	Potential (MW)	Installed (MW)	CUR (%)
Bihar	130	0	0	Meghalaya	2,026	322	15.89
Chandigarh	0	0	—	Mizoram	7,477	60	0.80
Chhattisgarh	10,236	120	1.17	Nagaland	325	75	23.08
Dadra & NH and D&D	0	0	—	Odisha	7,620	2,155	28.27
Delhi	0	0	—	Puducherry	0	0	—
Goa	0	0	—	Punjab	1,301	1,096	84.27
Gujarat	6,690	1,990	29.75	Rajasthan	9,611	413	4.29
Haryana	0	0	—	Sikkim	6,051	2,282	37.71
Himachal Pradesh	25,565	11,421	44.67	Tamil Nadu	18,285	2,203	12.05
Jammu & Kashmir	12,264	3,360	27.40	Telangana	10,057	2,406	23.92
Jharkhand	1,800	210	11.67	Tripura	0	0	—
Karnataka	12,014	3,689	30.71	Uttar Pradesh	13,942	502	3.60
Kerala	3,673	2,008	54.67	Uttarakhand	14,481	4,785	33.05
Ladakh	707	89	12.59	West Bengal	6,309	1,341	21.26

Source: Ministry of New and Renewable Energy (MNRE), Central Electricity Authority (CEA), MoSPI Energy Statistics and India Climate and Energy Dashboard (ICED), NITI Aayog (as on March, 2026).

4.3 State-Level Analysis: Wind Energy

Wind energy presents perhaps the sharpest contrast between potential and deployment among all renewable categories. India's assessed wind potential stands at approximately 11,63,856 MW (1,164 GW), yet total installed wind capacity is only 54,650 MW—a CUR of 4.70%. This gap underscores the significant untapped wind resources across the country (MNRE, 2024).

Rajasthan possesses the highest wind potential in India at 2,84,250 MW, followed by Maharashtra (1,73,868 MW), Karnataka (1,69,251 MW), Andhra Pradesh (1,23,336 MW), and Tamil Nadu (95,107 MW). Among these, Tamil Nadu records the highest CUR at 12.71%, reflecting its long history of wind energy development



and strong regulatory support. Gujarat (8.22%), Madhya Pradesh (6.48%), and Karnataka (4.98%) follow. Rajasthan's CUR of only 1.84% is particularly striking given its enormous potential, indicating that factors beyond resource availability—such as grid infrastructure, land acquisition challenges, and transmission constraints—are limiting deployment (Srivastava et al., 2022).

A large number of states with non-negligible wind potential, including Odisha, Bihar, Chhattisgarh, Haryana, and West Bengal, have a CUR of zero, indicating no commercial wind energy installations as yet. This suggests that wind energy development is highly geographically concentrated in a handful of states, creating structural imbalances in the energy transition (Luthra et al., 2015).

Table 3: State-wise Wind Energy — Potential Capacity, Installed Capacity, and CUR.

State / UT	Potential (MW)	Installed (MW)	CUR (%)	State / UT	Potential (MW)	Installed (MW)	CUR (%)
Andaman & Nicobar Islands	1,245	0	0	Lakshadweep	31	0	0
Andhra Pradesh	1,23,336	4,416	3.58	Madhya Pradesh	55,423	3,591	6.48
Arunachal Pradesh	246	0	0	Maharashtra	1,73,868	5,847	3.36
Assam	459	0	0	Manipur	0	0	—
Bihar	4,023	0	0	Meghalaya	55	0	0
Chandigarh	0	0	—	Mizoram	0	0	—
Chhattisgarh	2,749	0	0	Nagaland	0	0	—
Dadra & NH and D&D	17	0	0	Odisha	12,129	0	0
Delhi	0	0	—	Puducherry	408	0	0
Goa	14	0	0	Punjab	428	0	0
Gujarat	1,80,790	14,855	8.22	Rajasthan	2,84,250	5,229	1.84
Haryana	593	0	0	Sikkim	0	0	—
Himachal Pradesh	239	0	0	Tamil Nadu	95,107	12,085	12.71



State / UT	Potential (MW)	Installed (MW)	CUR (%)	State / UT	Potential (MW)	Installed (MW)	CUR (%)
Jammu & Kashmir	0	0	—	Telangana	54,717	128	0.23
Jharkhand	16	0	0	Tripura	0	0	—
Karnataka	1,69,251	8,424	4.98	Uttar Pradesh	510	0	0
Kerala	2,621	72	2.73	Uttarakhand	49	0	0
Ladakh	1	0	0	West Bengal	1,281	0	0

Source: Ministry of New and Renewable Energy (MNRE), Central Electricity Authority (CEA), MoSPI Energy Statistics and India Climate and Energy Dashboard (ICED), NITI Aayog (as on March, 2026).

4.4 State-Level Analysis: Solar Energy

Solar energy commands the largest share of India's renewable potential (33,43,350 MW or 3,343 GW) and has been the fastest-growing renewable sector in the country, driven by rapidly falling costs and strong policy support under the National Solar Mission and PM-KUSUM scheme (Schmid, 2012; MNRE, 2024). Despite this progress, the aggregate CUR for solar energy stands at only 4.21%, reflecting the enormity of unrealized potential.

Rajasthan leads in both solar potential (8,28,780 MW) and installed capacity (37,925 MW), recording a CUR of 4.58%. Gujarat follows with an installed capacity of 26,909 MW against a potential of 2,43,220 MW (CUR: 11.06%). Maharashtra, despite having the highest solar potential at 4,86,680 MW, records an installed capacity of 19,105 MW (CUR: 3.93%). Karnataka and Tamil Nadu also feature large installed capacities, with CURs of 3.62% and 5.73%, respectively.

Certain small states and Union Territories exhibit anomalously high CURs. Chandigarh records a CUR of 394.25%, and Delhi records 73.33%. These figures arise because potential estimates for densely urbanized territories are based on limited land availability, while rooftop solar installations have significantly expanded the installed base beyond these estimates. These are data interpretation artifacts and should not be taken as indicators of over-performance (ICED, NITI Aayog). States with high solar potential but very low CURs include Madhya Pradesh (1.84%), Odisha (0.55%), Jharkhand (0.45%), Meghalaya (0.03%), and Ladakh (0.14%). These states represent significant opportunities for accelerated solar deployment (Sharma & Bhatt, 2018).



Table 4: State-wise Solar Energy — Potential Capacity, Installed Capacity, and CUR.

State / UT	Potential (MW)	Installed (MW)	CUR (%)	State / UT	Potential (MW)	Installed (MW)	CUR (%)
Andaman & Nicobar Islands	590	32	5.44	Lakshadweep	0	7	—
Andhra Pradesh	2,23,280	6,935	3.11	Madhya Pradesh	3,18,970	5,856	1.84
Arunachal Pradesh	470	15	3.29	Maharashtra	4,86,680	19,105	3.93
Assam	19,170	474	2.47	Manipur	2,290	18	0.77
Bihar	32,990	435	1.32	Meghalaya	14,670	4	0.03
Chandigarh	20	79	394.25*	Mizoram	610	34	5.52
Chhattisgarh	1,26,480	1,755	1.39	Nagaland	190	3	1.76
Dadra & NH and D&D	500	135	26.98	Odisha	1,39,470	773	0.55
Delhi	550	403	73.33	Puducherry	200	78	38.81
Goa	6,750	74	1.09	Punjab	9,210	1,561	16.95
Gujarat	2,43,220	26,909	11.06	Rajasthan	8,28,780	37,925	4.58
Haryana	6,470	2,540	39.26	Sikkim	250	8	3.02
Himachal Pradesh	21,500	346	1.61	Tamil Nadu	2,04,770	11,732	5.73
Jammu & Kashmir	8,590	79	0.93	Telangana	1,40,450	5,065	3.61
Jharkhand	51,830	236	0.45	Tripura	9,110	35	0.39
Karnataka	2,99,310	10,824	3.62	Uttar Pradesh	97,840	3,830	3.91
Kerala	12,400	2,080	16.78	Uttarakhand	4,440	838	18.87
Ladakh	8,560	12	0.14	West Bengal	22,740	321	1.41



Source: Ministry of New and Renewable Energy (MNRE), Central Electricity Authority (CEA), MoSPI Energy Statistics and India Climate and Energy Dashboard (ICED), NITI Aayog (as on March, 2026).

4.5 State-Level Analysis: Bio-Power

Bio-power—derived from biomass, biogas, and waste-to-energy—has India's total assessed potential of 42,263 MW, with an installed capacity of 11,614 MW, yielding the highest national CUR of 27.48% among all renewable energy categories. This reflects the relatively mature development of the bio-power sector and its roots in agricultural and agro-industrial waste streams (MNRE, 2023; Hiloidhari et al., 2014).

Chhattisgarh records a remarkably high CUR of 80.63%, and Karnataka achieves 53.91%, indicating efficient utilization of biomass resources. Maharashtra (45.80%), Tamil Nadu (47.60%), and Uttarakhand (48.56%) also demonstrate strong performance. Uttar Pradesh, which has India's largest bio-power potential at 7,726 MW, records a CUR of 29.90%, reflecting substantial but incomplete development of its vast agricultural waste base (Hiloidhari et al., 2014).

An anomalous CUR of 187.5% is observed for Dadra & Nagar Haveli and Daman & Diu, where installed capacity (3.75 MW) exceeds the assessed potential (2 MW)—likely reflecting waste-to-energy and industrial biomass projects not fully captured in potential estimates. Several north-eastern and island states record zero installed capacity against positive potential, pointing to the need for targeted bio-power development programs in these regions.

Table 5: State-wise Bio-Power Energy — Potential Capacity, Installed Capacity, and CUR.

State / UT	Potential (MW)	Installed (MW)	CUR (%)	State / UT	Potential (MW)	Installed (MW)	CUR (%)
Andaman & Nicobar Islands	18	0	0	Lakshadweep	1	0	0
Andhra Pradesh	2,279	594	26.06	Madhya Pradesh	2,516	155	6.18
Arunachal Pradesh	18	0	0	Maharashtra	6,547	2,998	45.80
Assam	322	2	0.62	Manipur	62	0	0
Bihar	1,311	140	10.70	Meghalaya	69	14	20.00
Chandigarh	0	0	—	Mizoram	3	0	0
Chhattisgarh	354	285	80.63	Nagaland	54	0	0



State / UT	Potential (MW)	Installed (MW)	CUR (%)	State / UT	Potential (MW)	Installed (MW)	CUR (%)
Dadra & NH and D&D	2	4	187.5*	Odisha	299	64	21.48
Delhi	0	85	—	Puducherry	5	0	0
Goa	33	2	5.88	Punjab	3,436	577	16.78
Gujarat	3,193	130	4.07	Rajasthan	1,300	208	15.96
Haryana	1,715	326	18.99	Sikkim	5	0	0
Himachal Pradesh	70	10	14.57	Tamil Nadu	2,199	1,047	47.60
Jammu & Kashmir	83	0	0	Telangana	1,795	222	12.35
Jharkhand	146	20	13.79	Tripura	34	0	0
Karnataka	3,556	1,917	53.91	Uttar Pradesh	7,726	2,310	29.90
Kerala	778	3	0.32	Uttarakhand	308	150	48.56
Ladakh	0	0	—	West Bengal	1,742	352	20.20

Source: Ministry of New and Renewable Energy (MNRE), Central Electricity Authority (CEA), MoSPI Energy Statistics and India Climate and Energy Dashboard (ICED), NITI Aayog (as on March, 2026).

4.6 State-Level Analysis: Small Hydro Power

Small hydro power (up to 25 MW capacity) plays a niche but strategically important role in India's renewable energy mix, particularly for electrifying remote and hilly areas not connected to the main grid (Bhatt & Bhatt, 2018). India's total small hydro potential is 21,134 MW, against an installed capacity of 5,159 MW, yielding a CUR of 24.41%—the second highest among all renewable categories.

Telangana records the highest CUR at 87.70%, despite its modest potential of 102.25 MW, indicating near-complete utilization of available sites. The Andaman & Nicobar Islands achieve a CUR of 72.21%, reflecting the strategic importance of small hydro for island electrification. Haryana (68.44%) and Gujarat (56.10%) also demonstrate high utilization.

Karnataka (34.48%), Himachal Pradesh (28.92%), and Punjab (30.45%) have made significant investments in small hydro, consistent with their broader hydro development strategies. Arunachal Pradesh, despite possessing India's second-largest small hydro potential (2,064.92 MW), records a CUR of only 6.81%, echoing



its underperformance in large hydro as well. Jharkhand (1.78%) and Goa (1.06%) also exhibit very low CURs, suggesting that administrative and topographic challenges are limiting development in these states.

Table 6: State-wise Small Hydro Energy — Potential Capacity, Installed Capacity, and CUR

State / UT	Potential (MW)	Installed (MW)	CUR (%)	State / UT	Potential (MW)	Installed (MW)	CUR (%)
Andaman & Nicobar Islands	7.27	5.25	72.21	Lakshadweep	0	0	—
Andhra Pradesh	409.32	164.51	40.19	Madhya Pradesh	820.44	123.71	15.08
Arunachal Pradesh	2,064.92	140.61	6.81	Maharashtra	786.46	384.28	48.86
Assam	201.99	34.11	16.89	Manipur	99.95	5.45	5.45
Bihar	526.98	70.70	13.42	Meghalaya	230.05	55.03	23.92
Chandigarh	0	0	—	Mizoram	168.90	45.47	26.92
Chhattisgarh	1,098.20	100.90	9.19	Nagaland	182.18	32.67	17.93
Dadra & NH and D&D	0	0	—	Odisha	286.22	140.63	49.13
Delhi	0	0	—	Puducherry	0	0	—
Goa	4.70	0.05	1.06	Punjab	578.28	176.10	30.45
Gujarat	201.97	113.30	56.10	Rajasthan	51.67	23.85	46.16
Haryana	107.40	73.50	68.44	Sikkim	266.64	55.11	20.67
Himachal Pradesh	3,460.34	1,000.71	28.92	Tamil Nadu	604.46	123.05	20.36
Jammu & Kashmir	1,311.79	189.93	14.48	Telangana	102.25	89.67	87.70
Jharkhand	227.96	4.05	1.78	Tripura	46.86	16.01	34.17
Karnataka	3,726.49	1,284.73	34.48	Uttar Pradesh	460.75	50.60	10.98



State / UT	Potential (MW)	Installed (MW)	CUR (%)	State / UT	Potential (MW)	Installed (MW)	CUR (%)
Kerala	647.15	276.52	42.73	Uttarakhand	1,664.31	233.82	14.05
Ladakh	395.65	45.79	11.57	West Bengal	392.06	98.50	25.12

Source: Ministry of New and Renewable Energy (MNRE), Central Electricity Authority (CEA), MoSPI Energy Statistics and India Climate and Energy Dashboard (ICED), NITI Aayog (as on March, 2026).

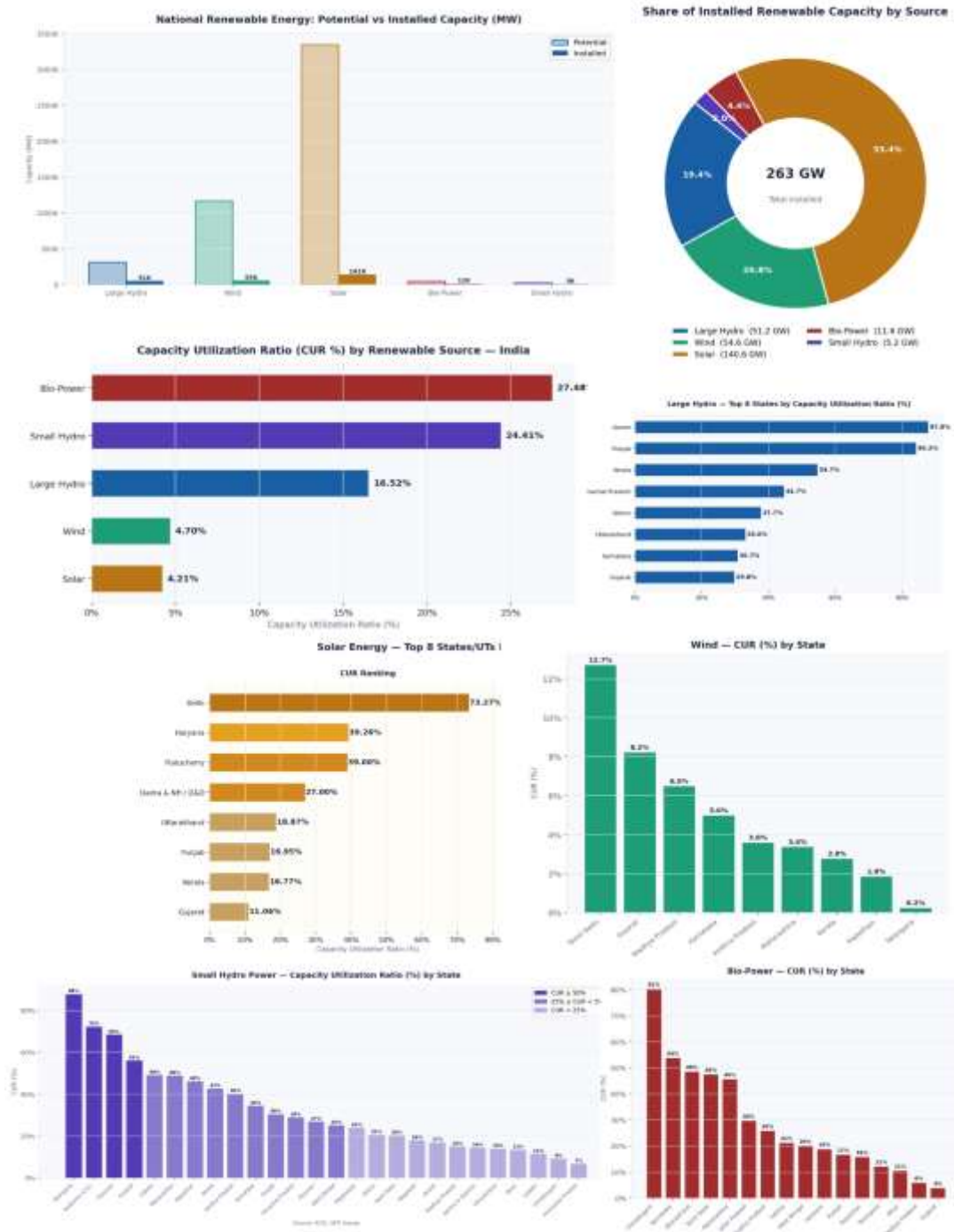
4.7 Cross-Sectoral Summary and Key Observations

The analysis across all five renewable energy categories reveals several consistent patterns:

1. **Pervasive underutilization:** Across all sectors, the aggregate CUR remains well below 30%, with solar and wind—the two largest potential sources—exhibiting CURs of only 4.21% and 4.70%, respectively. This points to a systemic and persistent gap between resource endowment and energy infrastructure development in India (MoSPI, 2024).
2. **Concentration of deployment:** Renewable energy installation is concentrated in a handful of states—primarily Gujarat, Rajasthan, Tamil Nadu, Karnataka, Maharashtra, and Andhra Pradesh—while many states, particularly in the Northeast, Central India, and island territories, remain significantly underutilized despite substantial resource potential.
3. **Potential-performance paradox:** Several states with the largest absolute potential exhibit the lowest CURs. Arunachal Pradesh (large hydro), Rajasthan (wind), Madhya Pradesh (solar), and Uttar Pradesh (bio-power) each represent cases where enormous resource endowments have not been matched by proportionate deployment.
4. **Bio-power and small hydro maturity:** These two categories record the highest national CURs, reflecting the comparatively mature development of these sectors. Their success offers transferable lessons for accelerating solar and wind deployment.
5. **Anomalous CURs:** Urban territories (Chandigarh, Delhi) and small territories (Dadra & NH) exhibit CURs exceeding 100%, reflecting definitional limitations in potential estimation for densely populated or industrially active areas.



Dashboard



Source: Ministry of New and Renewable Energy (MNRE), Central Electricity Authority (CEA), MoSPI Energy Statistics and India Climate and Energy Dashboard (ICED), NITI Aayog (as on March, 2026).

5. Policy Recommendation

Based on the analysis of state-level disparities in renewable energy potential and installed capacity, this study offers the following policy recommendations, organized across key thematic areas:

5.1 Differential State-Level Targets and Support Mechanisms: India's national renewable energy targets are presently allocated across states without fully accounting for the wide variation in their renewable resource endowments, financial capacities, and institutional readiness. A differentiated policy framework is



recommended, wherein states with high potential but low CURs receive enhanced central support—including viability gap funding, concessional financing, and technical assistance—to bridge the deployment gap (Ministry of Power, 2023). States such as Arunachal Pradesh (hydro), Rajasthan (wind), Madhya Pradesh (solar), and Uttar Pradesh (bio-power) should be prioritized in this framework.

5.2 Strengthening Grid Infrastructure in Underperforming States: Transmission and distribution infrastructure is frequently identified as the binding constraint on renewable energy deployment, particularly in remote and hilly states (Tongia & Gross, 2019). The Green Energy Corridor initiative should be expanded to cover underserved states in the Northeast, Central India, and island territories. Investment in inter-state and intra-state transmission capacity, energy storage, and smart grid technologies is essential to enable higher shares of variable renewable energy.

5.3 Regulatory Harmonization and Capacity Building: State Electricity Regulatory Commissions (SERCs) play a pivotal role in enabling renewable energy deployment through tariff determination, open access regulations, and renewable purchase obligations (RPOs). States with persistently low CURs often suffer from regulatory delays, inconsistent RPO enforcement, and limited technical capacity in their regulatory institutions (Mathur & Dholakia, 2016). A national capacity-building program for SERCs, supported by the Ministry of Power and the Forum of Regulators, should be established to harmonize regulatory frameworks and reduce uncertainty for renewable energy investors.

5.4 Harnessing Underutilized Hydro Potential: The large hydro potential of northeastern states, particularly Arunachal Pradesh, represents a strategic national asset that remains largely untapped. Given environmental sensitivities and the rights of indigenous communities, a consultative, environmentally responsible approach to hydro development is essential (Vaghlikar & Das, 2010). Run-of-river projects, which have lower environmental and social impacts than large storage dams, should be prioritized. Improved project preparation, environmental clearance processes, and community benefit-sharing mechanisms can help unlock this potential while maintaining ecological balance.

5.5 Promoting Bio-Power in Agrarian States: Uttar Pradesh, Punjab, Haryana, and Maharashtra possess large agricultural residue bases that are currently underutilized for bio-power generation. Given the twin problems of stubble burning (a major source of air pollution in north India) and low agricultural incomes, promoting biomass-based power generation through decentralized models—including bio-CNG plants, biogas digesters, and biomass co-firing in thermal plants—can generate co-benefits beyond energy (Hiloidhari et al., 2014). State governments should provide procurement guarantees and simplified licensing for small-scale bio-power projects.

5.6 Addressing Land and Social Challenges: Land acquisition and social acceptance are critical bottlenecks for large-scale solar and wind projects (Luthra et al., 2015). The development of a transparent land bank for renewable energy projects, combined with community equity participation models, can reduce conflicts and accelerate deployment. Agri-voltaic systems, which combine solar panels with agricultural land use, offer a promising pathway to expand solar deployment without displacing agricultural activity—particularly relevant in solar-rich but agriculturally active states like Rajasthan and Madhya Pradesh.



5.7 Leveraging Small Hydro for Remote Electrification: Small hydro power offers significant potential for electrifying remote communities in hilly and forested regions not connected to the main grid. States such as Arunachal Pradesh, Jharkhand, and the northeastern states should expedite small hydro project clearances and leverage the Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY) and Pradhan Mantri Sahaj Bijli Har Ghar Yojana (Saubhagya) frameworks to channel investment into off-grid and mini-grid small hydro systems.

6. Conclusion

India's renewable energy transition is one of the most ambitious and consequential in the world. This study has examined state-level disparities in renewable energy potential and installed capacity across five major categories—large hydro, wind, solar, bio-power, and small hydro—using the Capacity Utilization Ratio (CUR) as a consistent analytical measure. Drawing on data from the India Climate and Energy Dashboard (ICED), NITI Aayog, the analysis reveals a striking and pervasive gap between resource endowment and energy infrastructure development across Indian states.

India's total assessed renewable energy potential stands at approximately 4,880 GW, against an installed capacity of roughly 263 GW—an aggregate CUR of 5.39%. While solar and wind energy command the largest shares of potential, their CURs are among the lowest at 4.21% and 4.70%, respectively. Bio-power (27.48%) and small hydro (24.41%) exhibit comparatively higher CURs, reflecting more mature development trajectories. Across all sectors, deployment is highly concentrated in a handful of states, while many regions—particularly in the Northeast, Central India, and island territories—remain significantly underserved.

The potential-performance paradox is a central finding: states with the largest absolute renewable potential often record the lowest CURs. Arunachal Pradesh's large hydro CUR of 2.18%, Rajasthan's wind CUR of 1.84%, and Madhya Pradesh's solar CUR of 1.84% are illustrative of this disconnect. These disparities are driven by a complex interplay of factors including grid infrastructure limitations, regulatory quality, financial capacity, land acquisition challenges, and environmental considerations—factors that vary substantially across states.

The policy implications are clear: achieving India's 500 GW renewable energy target by 2030 will require not only continued scale-up in the leading states but a concerted effort to unlock the vast untapped potential of lagging states. Differentiated support mechanisms, infrastructure investment, regulatory capacity building, and community engagement will all be critical. The roadmap to a renewable energy future for India is, at its core, a state-level challenge—one that demands state-specific strategies grounded in a clear understanding of where potential lies and why it remains unrealized.

This study contributes to that understanding by providing a comprehensive, data-driven snapshot of the current state of play. It is hoped that the findings and recommendations will inform policymakers, researchers, and practitioners working to accelerate India's energy transition.



7. References

1. Bhatt, M. S., & Bhatt, S. (2018). Small hydro power development in India: Status and prospects. *Renewable and Sustainable Energy Reviews*, 88, 91–103.
2. Bridge to India. (2022). *India renewable energy tracker 2022*. Bridge to India Energy Pvt. Ltd.
3. Central Electricity Authority. (2022). *Hydro power potential of India*. Ministry of Power.
4. Chaurey, A., Ranganathan, M., & Mohanty, P. (2004). Electricity access for geographically disadvantaged rural communities—Technology and policy insights. *Energy Policy*, 32(15), 1693–1705.
5. Hiloidhari, M., Das, D., & Baruah, D. C. (2014). Bioenergy potential from crop residue biomass in India. *Renewable and Sustainable Energy Reviews*, 32, 504–512.
6. India Climate and Energy Dashboard. (2024). *Renewable energy data by state*. NITI Aayog. <https://iced.niti.gov.in>
7. International Energy Agency. (2023). *India energy outlook 2023*.
8. Luthra, S., Kumar, S., Garg, D., & Haleem, A. (2015). Barriers to renewable/sustainable energy technologies adoption: Indian perspective. *Renewable and Sustainable Energy Reviews*, 41, 762–776.
9. Mathur, R., & Dholakia, R. H. (2016). *Analysis of feasibility of achieving renewable energy targets in India* (Working Paper No. 2016-03-27). Indian Institute of Management Ahmedabad.
10. Ministry of New and Renewable Energy. (2023). *Annual report 2022–23*. Government of India.
11. Ministry of New and Renewable Energy. (2024). *Renewable energy sector at a glance*. Government of India.
12. Ministry of Power. (2023). *National electricity plan 2023–2032 (Volume 1: Generation)*. Central Electricity Authority.
13. Ministry of Statistics and Programme Implementation. (2024). *Energy statistics India 2024*. Government of India.
14. Pillai, I. R., & Banerjee, R. (2009). Renewable energy in India: Status and potential. *Energy*, 34(8), 970–980.
15. Schmid, G. (2012). The development of renewable energy power in India: Which policies have been effective? *Energy Policy*, 45, 317–326.