



Farhan Khan,  
2. DR. Deepa Rawat

## Why Solar Deployment Diverges across Indian States: The Role of Utility Collection Delay

Research Scholar, 2. Professor and Head, Department of Economics, Agra  
College, (Dr. B.R. Ambedkar University), Agra (U.P.) India

Received-10.07.2026,

Revised-18.07.2026,

Accepted-24.07.2026,

E-mail:farhan.mews@gmail.com

**Abstract:** *India's solar capacity has grown rapidly under a common national policy framework, yet its distribution across states remains strikingly uneven. This paper asks why states operating under broadly similar solar-policy incentives have achieved sharply different deployment outcomes. It pairs state-wise installed capacity from the Ministry of New and Renewable Energy, at 31 March 2026, with distribution-utility indicators for 2024-25 published in the Fourteenth Annual Integrated Rating and Ranking of Power Distribution Utilities.*

*Across the twenty-two states for which utility data are available, deployment per crore of population is negatively associated with the time a state's utilities take to be paid, at a correlation of about  $-0.41$ , and is essentially unrelated to the gap between their average cost of supply and average revenue realised, at about  $-0.21$  and statistically indistinguishable from zero. The contrast is stable across both years examined. It points to utility liquidity rather than tariff economics as the operative channel.*

*A controlled five-state comparison, taking Uttar Pradesh against Rajasthan, Gujarat, Karnataka and Tamil Nadu, shows that state policy levers do not order the states as deployment does, the laggard being the most supported of the five, so policy design cannot account for the divergence. Uttar Pradesh is a simultaneous outlier: its utilities were owed for 295 days in 2024-25 against 6 to 76 days for its comparators, and held 206 MW of solar per crore of population against 1,817 to 5,983 MW.*

*The findings imply that solar deployment in lagging states must be addressed through the liquidity of the distribution sector rather than through further incentives on the generation side.*

### Highlights-

- *Five States share solar policy levers but differ sharply in deployment.*
- *Across 22 States deployment tracks utility liquidity, not the cost-revenue gap.*
- *Days receivable correlate with solar per crore at  $-0.41$ ; the gap at  $-0.21$ .*
- *Uttar Pradesh was owed for 295 days against 6 to 76 days for its comparators.*
- *Lagging States need distribution-sector liquidity, not generation-side incentives.*

**Key words:** *solar energy, Uttar Pradesh, distribution-utility finance, offtaker risk, renewable energy policy, SDG 7.*

**1. Introduction-** India's installed solar capacity reached 150,261 MW at 31 March 2026, having crossed 100 GW in early 2025. The expansion took place under a single national architecture, comprising the National Solar Mission, a common renewable purchase obligation, and centrally administered support schemes. Beneath the national total, the geography of solar is highly concentrated. A small group of states accounts for the majority of capacity. Several large states remain far behind relative to their size and their electricity demand. Resource endowment accounts for part of this, since the leading states include the highest-irradiation regions of the country, but it does not account for all of it: states of comparable resource and comparable policy have nonetheless diverged markedly in what they have built.

This paper examines that divergence directly. It asks a specific question. When the headline policy incentives facing solar developers are broadly similar across states, what accounts for the large differences in deployment outcomes? Uttar Pradesh, India's most populous state and a persistent laggard, is contrasted with four high-deployment states: Rajasthan, Gujarat, Karnataka and Tamil Nadu, in a comparison of the most-similar-systems type. These states share the same national mission and the same obligation trajectory, and differ in state incentives in a direction that runs against the deployment record, which allows the analysis to isolate the factor on which they differ. That controlled comparison is then set against the full national sample of twenty-two states, which is where two competing explanations of utility distress can be tested against each other with enough observations to separate them.

The central argument is that the binding constraint lies not on the generation side but in the financial condition of the distribution utilities that purchase the power. A developer's decision to build depends on the creditworthiness of the buyer. The literature reviewed in the next section establishes counterparty risk as the dominant financing constraint on renewable investment in India and documents wide divergence between states, but it has not related published utility indicators to observed deployment across states. That is what this paper does. Deployment is found to be negatively related to how long a state's utilities wait to be paid by their own consumers, an indicator of liquidity stress that transmits directly to the generators they in turn owe. It is not related to their underlying gap between cost and revenue. The distinction matters, because it points to liquidity and payment discipline rather than tariff economics as the mechanism.

**2. Review of literature-** Four strands of work bear on the question addressed here. The first establishes counterparty risk as the dominant financing constraint on renewable energy in India. Surveys of domestic and foreign investors rank off-taker risk second only to currency risk overall, and first among domestic investors, well ahead of regulatory risk, transmission constraints and land acquisition.<sup>1,2</sup> The mechanism is that the distribution utility, as contractual buyer, delays payment; lenders price that delay into the cost of debt. One estimate places the resulting premium at about 1.07 percentage points on the cost of debt.<sup>3</sup> Work on financing costs finds that debt terms alone raise the cost of renewable energy in India by roughly a quarter to a third relative to comparable projects elsewhere.<sup>4</sup>

The second strand traces the effect through to procurement prices. Where a creditworthy central intermediary substitutes for a state utility as the buyer, discovered tariffs fall. In a paired comparison of auctions held in Karnataka in 2015-16, a state auction cleared at ₹ 5.07 per kWh against ₹ 4.78 for an auction with a centrally owned off-taker, a difference of ₹ 0.29 per kWh attributable to the credit of the buyer rather than to the cost of the plant.<sup>1</sup> The same literature proposes payment security mechanisms sized at 10 to 20 per cent of project capital cost as a remedy, and finds the support required varies sharply between utilities: one month of cover for a highly rated Gujarat utility, against amounts no facility of any size could deliver for the weakest.<sup>1</sup> That finding is important here, because it implies the constraint is utility-specific rather than uniformly national.

The third strand concerns sub-national divergence. Assessments of federal renewable policy find its effectiveness varying considerably across states.<sup>5</sup> Modelling of India's power-sector transition likewise finds that state trajectories differ markedly even under common national targets, so the national aggregate conceals wide variation.<sup>6</sup> Case-study work on Uttar Pradesh and Gujarat links that divergence to the financial sustainability of the distribution utilities.<sup>7</sup>

The fourth strand is sceptical of the framing itself. It holds that describing distribution utilities as inefficient misplaces the problem, which is political: tariffs are held below the cost of supply because subsidised electricity has long been an instrument of electoral competition, and the resulting shortfall then appears in the utility's accounts and is read as inefficiency.<sup>8</sup>

Two gaps remain. First, the evidence connecting utility distress to deployment is largely either project-level, showing how payment risk enters the cost of capital, or case-study, showing why two particular states differ. A systematic cross-state test relating published utility indicators to observed deployment is missing. Second, the literature treats financial distress as a single condition, when the published indicators separate at least two: how long a utility waits to be paid, and whether its tariffs cover its costs. These are distinct, and if they behave differently the appropriate remedies differ. This paper addresses both gaps.

**3. Data and method- 3.1 Comparative design:** The analysis proceeds on two samples. The first is a most-similar-systems comparison across five states, in which policy design is examined rather than assumed comparable and resource endowment is broadly, though not exactly, comparable; the qualification is taken up in Section 5. The second is the full set of twenty-two states for which distribution-utility indicators are published. The dependent variable in both is the deployment outcome, measured as installed solar capacity and as capacity per crore of population. Two candidate explanatory variables are tested against each other: days receivable, being the time a utility waits to be paid by its own consumers, which is an indicator of liquidity; and the gap between its average cost of supply and its average revenue realised, which is an indicator of tariff adequacy. Days payable to generators is tested alongside these as a third candidate, and aggregate technical and commercial losses are reported as descriptive context. Associations are reported as Pearson product-moment correlations, with Spearman rank correlations given alongside as a check against the influence of extreme values, and two-tailed significance levels where the sample supports them. The states' policy provisions are examined separately as a control condition.

**3.2 Data sources:** Deployment data are taken from the Ministry of New and Renewable Energy's state-wise installed-capacity statement as on 31 March 2026, using the solar-power total for each state<sup>9</sup> to <sup>12</sup>. Distribution-utility indicators are taken from the Fourteenth Annual Integrated Rating and Ranking of Power Distribution Utilities, published by the Power Finance Corporation for the Ministry of Power in January 2026.<sup>13</sup> Days receivable and days payable are drawn from its Appendix 5, aggregate technical and commercial losses from Appendix 1, and the gap between average cost of supply and average revenue realised, on the tariff-subsidy-received basis excluding regulatory income and UDAY grant, from Appendix 3. Using a single source for all financial indicators keeps the basis consistent across states and years. Policy provisions are drawn from each state's solar or renewable-energy policy and the associated regulatory orders<sup>14</sup> to <sup>20</sup>. Population is taken from the Census of India 2011.<sup>21</sup>

Financial indicators are reported for 2024-25, the latest year published, and paired with capacity at 31 March 2026. Because utility accounts are finalised with a lag, the two series are not contemporaneous; the analysis is repeated on 2023-24 indicators, and the results reported below hold in both years unless stated.

**3.3 Analysis:** The deployment trajectory is documented first, to establish the pattern of divergence. The five states' policy provisions are then placed side by side to test whether their incentives are comparable. Deployment is finally related to utility financial indicators in two steps: a controlled five-state comparison, in which resource endowment and policy are held broadly constant, and a national test across all states for which the indicators are published.

The national test is the primary analysis. With twenty-two observations it can distinguish between the two candidate indicators and attach significance levels to the result. The five-state comparison is complementary: it holds resource and policy roughly constant, establishes that policy design is not the explanation, and locates Uttar Pradesh as a joint outlier. Its correlations rest on five observations and are reported as descriptive.

**4. Results- 4.1 A widening deployment gap:** Table 1 reports installed solar capacity for the five states at four points between 2017 and 2026, with each state's share of the national solar total and its capacity per crore of population at the latest date. The pattern is one of divergence rather than catch-up, as Figure 1 shows. Between 2017 and 2026 Rajasthan added roughly 39,100 MW and Gujarat roughly 28,000 MW. Uttar Pradesh added about 3,700 MW over the same period. By 31 March 2026 Uttar Pradesh held 2.74 per cent of national solar capacity while accounting for around one-sixth of the country's population, down from 3.57 per cent two years earlier. On a per-capita basis it had 206 MW per crore, against 1,817 to 5,983 MW for the four comparators.

| State         | 2017  | 2020  | 2022   | 2026   | Share 2026 | MW per crore |
|---------------|-------|-------|--------|--------|------------|--------------|
| Rajasthan     | 1,908 | 5,275 | 12,565 | 41,013 | 27.29%     | 5,983        |
| Gujarat       | 1,278 | 2,987 | 7,180  | 29,303 | 19.50%     | 4,848        |
| Karnataka     | 1,045 | 7,306 | 7,591  | 11,102 | 7.39%      | 1,817        |
| Tamil Nadu    | 1,729 | 3,962 | 5,067  | 13,580 | 9.04%      | 1,883        |
| Uttar Pradesh | 389   | 1,209 | 2,244  | 4,123  | 2.74%      | 206          |

Table 1. Installed solar capacity (MW) by state, 2017 to 2026, with share of the national solar total and capacity per crore of population at 31 March 2026. Source: MNRE state-wise capacity statements<sup>9</sup> to <sup>12</sup>; population from Census of India 2011.

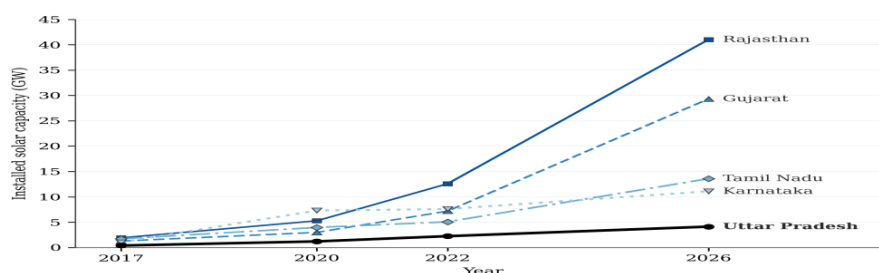


Figure 1. Solar deployment trajectory, 2017 to 2026, in GW. Uttar Pradesh, shown in bold, diverges progressively from the comparator states.

**4.2 Comparable policy incentives:** The divergence is not explained by policy design. The headline incentives of the five states are set out in Table 2, drawn in each case from the policy currently in force, and they do not order the states as deployment does. Uttar Pradesh is the only one of the five to offer a state-level capital subsidy for utility-scale solar, at ₹ 2.50 crore per megawatt for storage-linked projects of 5 MW and above; the other four rely on central schemes for that segment. On residential rooftop, Uttar Pradesh offers ₹ 15,000 per kilowatt to a ceiling of ₹ 30,000 and Tamil Nadu a flat ₹ 20,000 on the first kilowatt, while Karnataka, Rajasthan and Gujarat add nothing to the central subsidy and direct consumers to it. The same asymmetry appears on banking and wheeling. Rajasthan, Gujarat, Karnataka and Tamil Nadu each leave both to their regulator, and Gujarat levies wheeling on renewable projects as it does on any open-access consumer. Uttar Pradesh alone grants concessions in the policy itself: banking of up to 100 per cent within the financial year, full exemption from wheeling and transmission charges on sale to the utility, and half exemption on captive and third-party sale. On every column of Table 2 the state that has built least offers the

most. Policy design therefore cannot account for the divergence, and the direction in which it fails to account for it is the opposite of the one usually assumed.

The renewable purchase obligation was historically set on a uniform national trajectory. The separate solar sub-target was withdrawn from 2022-23, and from 2024-25 the obligation has been set as a single national renewable consumption obligation.<sup>20</sup> It is therefore determined nationally rather than by each state, and cannot serve as a differentiator. The states do differ in banking charges, in wheeling and cross-subsidy concessions, and in how firmly the obligation is enforced. Those differences are second-order, and they do not align with the deployment ranking. In short, policy design does not distinguish the five states in the direction deployment does.

| State         | State VGF, utility-scale                    | Rooftop top-up beyond central subsidy | Energy banking                                      | Wheeling / transmission concession                       |
|---------------|---------------------------------------------|---------------------------------------|-----------------------------------------------------|----------------------------------------------------------|
| Rajasthan     | None                                        | None                                  | Per RERC regulation                                 | Per RERC regulation; benefit via RIPS                    |
| Gujarat       | None                                        | None                                  | Billing cycle; charges per GERC, residential exempt | Per GERC, as for normal open access                      |
| Karnataka     | None                                        | None                                  | Per KERC regulation                                 | Per KERC regulation                                      |
| Tamil Nadu    | None                                        | □ 20,000 flat, first kW, residential  | Per TNERC orders                                    | Per TNERC orders                                         |
| Uttar Pradesh | □ 2.50 crore/MW, storage linked, above 5 MW | □ 15,000/kW, capped at □ 30,000       | Annual, up to 100%                                  | 100% on sale to the utility; 50% captive and third-party |

Table 2. Headline solar-policy provisions of the five comparison states. Compiled from each state's solar or renewable-energy policy and the associated regulatory orders<sup>14</sup> to <sup>20</sup>; provisions current to July 2026. State regulatory commissions revise banking, wheeling and cross-subsidy charges periodically.

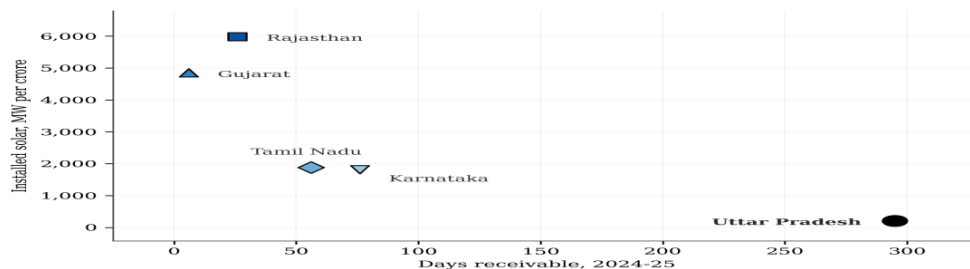
**4.3 The controlled comparison: policy is common, liquidity is not:** Table 3 reports the utility indicators for the five states for 2024-25. The states separate sharply on liquidity. Uttar Pradesh's utilities were owed for 295 days and took 159 days to settle with their own generators. The comparable receivable figures were 26 days for Rajasthan, 6 for Gujarat, 76 for Karnataka and 56 for Tamil Nadu. Uttar Pradesh also carried the highest aggregate technical and commercial losses of the five, at 19.54 per cent, and the widest cost-revenue gap, at □ 0.73 per kWh.

Within this controlled set Uttar Pradesh is a simultaneous outlier on every indicator and on deployment, as Figure 2 shows, which is the observation the comparison is designed to produce. The five-state correlations are reported for completeness (−0.78 for receivable days against capacity per crore, −0.85 for payable days and −0.70 for the cost-revenue gap), but with five observations they cannot discriminate between the indicators, and no weight is placed on their relative magnitudes. That discrimination is the work of the national test in Section 4.4.

| State         | Days receivable | Days payable | AT&C loss (%) | ACS-ARR gap (□ /kWh) |
|---------------|-----------------|--------------|---------------|----------------------|
| Rajasthan     | 26              | 51           | 15.18         | −0.04                |
| Gujarat       | 6               | 4            | 8.25          | −0.40                |
| Karnataka     | 76              | 137          | 11.92         | +0.69                |
| Tamil Nadu    | 56              | 78           | 10.96         | −0.19                |
| Uttar Pradesh | 295             | 159          | 19.54         | +0.73                |

Table 3. Distribution-utility indicators for the five comparison states, 2024-25. Days receivable and payable from Appendix 5, AT&C losses from Appendix 1, and the cost-revenue gap on the tariff-subsidy-received basis excluding regulatory income and UDAY grant from Appendix 3, all of the Fourteenth Integrated Rating.<sup>13</sup> A negative gap denotes a surplus.

Figure 2. Five-state comparison: days receivable against installed solar per crore of population, 2024-25. Uttar Pradesh is a simultaneous outlier on both axes.



**4.4 The national test: liquidity, not the cost-revenue gap:** The analysis is extended to all twenty-two states for which utility indicators are published, and the result is plotted in Figure 3. Across that sample, days receivable are negatively associated with installed solar per crore of population, at  $-0.41$  for 2024-25 and  $-0.45$  for 2023-24, with Spearman rank correlations of  $-0.45$  and  $-0.50$ . The association is significant at conventional levels on 2023-24 indicators and marginally short of it on 2024-25.

The cost-revenue gap behaves quite differently. Across the same twenty-two states it is essentially unrelated to deployment, at  $-0.21$  for 2024-25 and  $-0.20$  for 2023-24, with rank correlations of  $-0.05$  and  $-0.09$  and significance levels far from any conventional threshold. Two indicators of financial stress, drawn from the same document and the same states, therefore behave in opposite ways. The one that tracks deployment is the time a utility waits to be paid; the one that does not is the margin between what it spends and what it earns.

Days payable to generators, the indicator that bears most directly on a developer's exposure to the buyer, behaves like the cost-revenue gap rather than like days receivable. Tested on the same twenty-two states it correlates with deployment at  $-0.33$  for 2024-25 and  $-0.27$  for 2023-24, with rank correlations of  $-0.34$  and  $-0.23$ , and reaches conventional significance in neither year. The liquidity indicator that tracks deployment is therefore the time a utility waits to be paid, not the time it takes to pay. Within the five-state set the ordering reverses, at  $-0.85$ , which is a further reason to place no weight on correlations drawn from five observations.

That contrast is the paper's central result, and it is stable. It holds in both years examined, on both Pearson and Spearman measures, and it does not depend on the five-state selection. Uttar Pradesh sits where the argument predicts: the third-slowest state in the country on days receivable in 2024-25, behind only Manipur and Jharkhand, and the second-slowest in 2023-24 behind only Manipur, while ranking eighth from the bottom of the twenty-two on capacity per crore of population and lowest among the five states compared here.

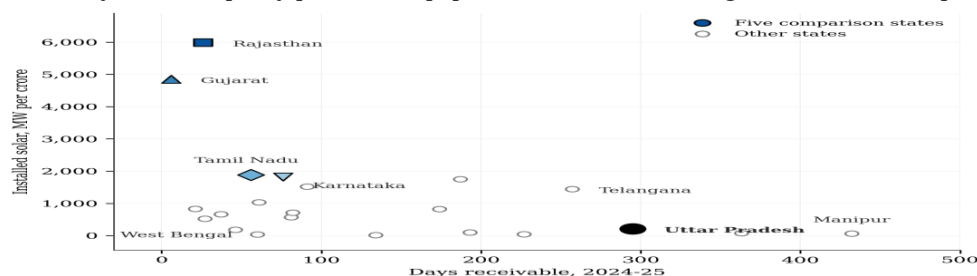


Figure 3. National test across 22 states: days receivable against installed solar per crore of population. The five comparison states are highlighted.

**5. Discussion-** Read together, the results support a single interpretation. The five states diverged in deployment, as Section 4.1 shows, despite policy incentives that favour Uttar Pradesh, as Section 4.2 establishes. Uttar Pradesh is a simultaneous outlier on utility liquidity and on deployment, as Section 4.3 documents. And across the wider national sample, deployment tracks utility liquidity while showing no relationship with the cost-revenue gap, as Section 4.4 demonstrates.

The mechanism is counterparty risk. Solar projects are financed on the strength of a long-term power-purchase agreement, and the value of that agreement depends on the buyer paying reliably. A utility that is itself owed for the better part of a year is short of working capital, and that shortage is passed down the chain to the generators it in turn owes. Across the twenty-two states the two measures are moderately related, at a correlation of  $0.57$  and a rank correlation of  $0.64$ , so slow collection and slow payment do broadly travel together, though not tightly: Manipur waits 432 days to be paid yet settles in 74, while West Bengal waits 60 and takes 172. Uttar Pradesh waits 295 days and takes 159, against Gujarat's 6 and 4. The

effect on a developer is to raise both the cost of capital and the working-capital burden of any project selling into that state, which deters deployment even where headline tariffs and incentives are attractive.

The finding that deployment tracks days receivable rather than the cost-revenue gap is analytically important, and the labelling matters. Days receivable measure how long a utility waits to be paid by its own consumers, not how promptly it pays others. They are an indicator of liquidity rather than of tariff adequacy. That the liquidity indicator predicts deployment while the tariff-adequacy indicator does not suggests the constraint is not primarily that power is sold below cost. It is that revenue, once billed, is not collected on time, and the resulting shortage propagates to generators. The two require different remedies. A tariff problem points to tariff and subsidy reform. A liquidity problem points to collection efficiency, payment security mechanisms, liquidation of dues and enforcement of settlement timelines. For a laggard state such as Uttar Pradesh, the implication is that further incentives on the generation side are unlikely to move deployment materially while the buyer remains illiquid.

Four limitations qualify the results. The first concerns the five-state correlations, which rest on a deliberately controlled sample of five observations. They are reported as descriptive and cannot discriminate between indicators; on 2024-25 data the cost-revenue gap correlates almost as strongly within that set as days receivable do. The discrimination reported here rests entirely on the twenty-two-state sample.

The second concerns the national sample, where confounders are real. Solar resource, terrain and demand vary widely across states. Small, low-irradiation states such as Manipur and Tripura have little solar for reasons unrelated to payment behaviour, and there are clear counterexamples in both directions: Telangana waits 257 days to be paid yet holds substantial capacity, while West Bengal settles its receivables in sixty days yet has among the lowest per-capita deployment of the twenty-two. The direction of the bias should be stated plainly. Measurement error and omitted confounders attenuate observed associations towards zero. The receivable-days association is therefore likely to be a lower bound rather than an overstatement. The corollary is that the null on the cost-revenue gap is the weaker of the two results, not the stronger: an attenuated true relationship would present as a null, and this test cannot exclude that. What can be said is that under identical conditions one indicator survives attenuation and the other does not.

The third concerns the five-state design itself. It holds policy constant by construction, and Section 4.2 demonstrates that. It does not hold solar resource constant: Rajasthan and Gujarat enjoy materially higher irradiation than Uttar Pradesh, and part of the deployment gap is attributable to that. The controlled comparison should therefore be read as establishing that policy design is not the explanation and that Uttar Pradesh is a joint outlier, rather than as isolating liquidity as the cause. The fourth is that these associations are not a controlled causal test. Reverse causation and common causes are conceivable, and a state that has built little solar may for unrelated reasons also run illiquid utilities. The direction of the mechanism, in which payment risk deters investment, is nonetheless well grounded in project-finance practice and in the auction evidence reviewed in Section 2. A further limitation is temporal: utility accounts are published with a lag, so the financial indicators precede the capacity measurement by up to a year. Repeating the analysis on the earlier year does not change the pattern.

**6. Conclusion and policy implications-** Under a common national solar framework, deployment across Indian states has diverged sharply. The divergence is not explained by the headline design of state policy, which favours the laggard rather than the leaders. It is associated instead with the liquidity of the distribution utilities that buy the power. Across twenty-two states, the time a utility waits to be paid by its own consumers is associated with deployment; the gap between its costs and its revenues is not. The literature has established counterparty risk as the dominant financing constraint at project level and has documented divergence between states; this paper adds a systematic cross-state test, and finds that the two components of utility distress usually treated as one behave differently.

The policy implication follows from that separation. In states whose utilities are slow to collect, accelerating solar deployment depends less on adding incentives on the generation side than on restoring the buyer's capacity to pay. The measures that follow from the finding are, in order, collection efficiency and metering, so that billed revenue is actually realised; liquidation of accumulated dues, including those owed by government departments; and enforceable payment-security mechanisms, so that a developer's exposure does not depend on the buyer's cash position in any given month. Tariff reform matters for other reasons, but on this evidence it is not what distinguishes the states that have built solar from those that have not. For Uttar Pradesh, which is a joint outlier on both counts, the implication is that its 22,000 MW target will not be met by further support to generators while its utilities remain illiquid. Two extensions would strengthen the test: a panel specification using the full run of published rating exercises rather than two years, and utility-

level rather than state-level analysis, which the same source supports and which would exploit the wide variation within states.

**Data availability-** All data analysed in this study are drawn from publicly available government sources cited in the text: the Ministry of New and Renewable Energy state-wise installed-capacity statement at 31 March 2026, the Fourteenth Annual Integrated Rating and Ranking of Power Distribution Utilities, the Census of India 2011, and the State solar and renewable-energy policies listed at references<sup>14</sup> to<sup>19</sup>.

**Note-** This paper draws on the first author's doctoral research.<sup>22</sup>

## REFERENCES

1. G. Shrimali, "Financial instruments to address renewable energy project risks in India," *Energies*, vol. 14, no. 19, art. 6405, 2021, doi: 10.3390/en14196405.
2. V. Sen, K. Sharma, and G. Shrimali, "Reaching India's renewable energy targets: the role of institutional investors," Climate Policy Initiative, Working Paper, 2016.
3. Climate Policy Initiative, "A framework for designing a payment security mechanism as a credit enhancement device," New Delhi, 2018.
4. G. Shrimali, D. Nelson, S. Goel, C. Konda, and R. Kumar, "Renewable deployment in India: financing costs and implications for policy," *Energy Policy*, vol. 62, pp. 28-43, 2013.
5. G. Shrimali, S. Srinivasan, S. Goel, and D. Nelson, "The effectiveness of federal renewable policies in India," *Renewable and Sustainable Energy Reviews*, vol. 70, pp. 538-550, 2017.
6. A. Gulagi, M. Ram, D. Bogdanov, S. Sarin, T. N. O. Mensah, and C. Breyer, "The role of renewables for rapid transitioning of the power sector across states in India," *Nature Communications*, vol. 13, art. 5499, 2022, doi: 10.1038/s41467-022-33048-8.
7. S. Mitra and U. Sharma, "Impact of SDG-7 policy-mix on the financial sustainability of the distribution utilities: a case study of Uttar Pradesh and Gujarat, India," SSRN Working Paper 4949758, 2024.
8. Sati, L. Powell, and V. K. Tomar, "Discom reforms in India: why the inefficiency narrative is inadequate," Observer Research Foundation, Expert Speak, New Delhi, 9 October 2021.
9. Ministry of New and Renewable Energy (MNRE), "State-wise (location based) installed capacity of renewable power as on 31.03.2026," Government of India, New Delhi, 2026.
10. Ministry of New and Renewable Energy (MNRE), "State-wise installed capacity of renewable power as on 31.03.2022," P&C Division, Government of India, New Delhi, 2022.
11. Ministry of New and Renewable Energy (MNRE), "State-wise installed capacity of grid interactive renewable power as on 31.03.2020," P&C Division, Government of India, New Delhi, 2020.
12. Ministry of New and Renewable Energy (MNRE), "State-wise installed capacity of grid interactive renewable power as on 31.03.2017," Government of India, New Delhi, 2017.
13. Power Finance Corporation (PFC) for the Ministry of Power, "Fourteenth Annual Integrated Rating and Ranking of Power Distribution Utilities," Government of India, New Delhi, January 2026.
14. Uttar Pradesh New and Renewable Energy Development Agency (UPNEDA), "Uttar Pradesh Solar Energy Policy 2022," Government of Uttar Pradesh, Lucknow, 2022.
15. Government of Rajasthan, "Rajasthan Renewable Energy Policy 2023," Energy Department, Jaipur, 2023.
16. Government of Gujarat, "Gujarat Integrated Renewable Energy Policy 2025," Energy and Petrochemicals Department, Gandhinagar, December 2025.
17. Government of Karnataka, "Karnataka Renewable Energy Policy 2022-27," Energy Department, Bengaluru, 2022.
18. Government of Tamil Nadu, "Tamil Nadu Solar Energy Policy 2019," Chennai, 2019.
19. Government of Tamil Nadu, "Chief Minister's Solar Rooftop Capital Incentive Scheme," Tamil Nadu Energy Development Agency (TEDA), Chennai, 2013.
20. Ministry of Power, "Notification specifying the minimum share of consumption of electricity from non-fossil sources by designated consumers: renewable consumption obligation trajectory, 2024-25 to 2029-30," Gazette of India, Government of India, New Delhi, 20 October 2023, effective 1 April 2024.
21. Office of the Registrar General and Census Commissioner, "Census of India 2011: primary census abstract," Government of India, New Delhi, 2011.
22. F. Khan, "An Analysis of the National Solar Mission in Achieving Sustainable Development Goal 7, with Focus on Uttar Pradesh," Doctoral thesis, Department of Economics, Agra College, Agra, 2026.

\*\*\*\*\*