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ABOUT US

CENJOWS was raised in 2007 as an independent think tank, registered under the Societies Registration Act, 1860. This aims to promote Jointness as a synergistic enabler for the growth of Comprehensive National Power and provide alternatives in all dimensions of its applications through focused research and debate.

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India's Solar Ambition: Solving the China Problem Through Energy Federalism

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India’s Solar Ambition: Solving the China Problem through Energy Federalism

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Introduction

India's solar energy programme has, over the past decade, undergone a transformation in both scale and ambition. Installed solar capacity crossed 132 gigawatts in November 2025, up from 2.82 gigawatts in 2014, representing a fifty-three-fold increase within a single decade.[1] The government crossed its target of 50 per cent non-fossil fuel installed capacity five years ahead of schedule, and on 29 July 2025, renewable energy sources collectively met 51.5 per cent of India's total electricity demand in a single day.[2] Research by the climate analytics organisation Ember has further found that, measured against comparable income levels, India is deploying solar electricity at a faster pace than China did during the equivalent period of its own development.[3] China subsequently went on to capture over 63 per cent of global solar panel production and to drive solar module costs down by over 90 per cent, making it the dominant force in global solar manufacturing.[4] This comparison is relevant not merely as a benchmark of ambition but as an entry point into a structural question: whether India's current solar trajectory is building durable industrial and supply chain foundations, or whether it rests on a dependency that could constrain the transition itself.

Over the past few years, the central government's response to solar supply chain exposure has been evolving at pace. The Production Linked Incentive (PLI) scheme for solar manufacturing, the Approved List of Models and Manufacturers (ALMM), and successive rounds of import duties have together expanded module assembly capacity to over 120 gigawatts. Legal and regulatory frameworks governing domestic content requirements have been tightened, and the scope of ALMM has been extended from modules to solar cells from June 2026. Yet the upstream materials that feed India's expanding module assembly base, chiefly polysilicon, ingots, and wafers, continue to flow from one country. China produces approximately 91 per cent of the world's polysilicon and over 97 per cent of its ingots and wafers.[5] In the first half of 2025, India's solar cell imports from China nearly doubled year-on-year, and India absorbed 52 per cent of the entire growth in Chinese solar cell exports globally during that period.[6] Dependency has not been resolved; it has migrated from finished modules to raw upstream inputs.

A dimension of this challenge that has received less policy attention than it warrants concerns the role of state governments. Electricity in India is a concurrent subject under the Seventh Schedule of the Constitution, which means that state governments hold real authority over land allocation, grid transmission, distribution company procurement behaviour, and local manufacturing incentives. The financial condition of state distribution companies, the rigour with which procurement standards are enforced, and the quality of state-level industrial facilitation all directly shape whether national manufacturing targets generate ground-level industrial capacity. Drawing on recent empirical work by Banares-Sanchez, Burgess, Laszlo, Simpson, Van Reenen, and Wang on how China's provincial solar industrial policy generated the learning spillovers that drove down global solar costs, this article examines what a more coherent subnational execution framework might look like for India.

The Supply Chain Picture: Where India Stands

The solar photovoltaic value chain runs from polysilicon through ingots, wafers, and cells to finished modules. India has, in recent years, concentrated its manufacturing build-out at the downstream end of this chain, with module assembly capacity crossing 120 gigawatts by mid-2025 and cell capacity tripling between March 2024 and March 2025 to reach 25 gigawatts.[7] Progress at the upstream end has been considerably more constrained: as of June 2025, India's domestic polysilicon capacity stood at 3.3 gigawatts, its wafer capacity at 5.3 gigawatts, and its cell capacity at 29 gigawatts.[8] The consequence of this imbalance is that India can currently assemble far more modules than it can produce cells to fill them, and its cell production base rests on a wafer foundation that is itself dependent on imported feedstock. The gap between assembly capacity and upstream self-sufficiency is structural in character and cannot be addressed through module-level policy instruments alone.

Trade data from financial year 2024 gives a precise measure of this exposure. India's total solar sector imports reached USD 7 billion, with USD 3.89 billion sourced directly from China.[9]

Over the period between 2022 and 2025, the composition of India's solar imports shifted markedly: where finished modules once constituted the dominant category, cells and wafers have since overtaken them, reflecting the migration of dependency from the visible finished-product layer to the less visible upstream materials layer.[10] Countries in Southeast Asia that serve as nominally alternative module suppliers to India, including Vietnam, Malaysia, and Thailand, are themselves reliant on Chinese polysilicon and wafer inputs, which means that sourcing from these intermediaries does not reduce the underlying exposure to Chinese upstream production.[11]

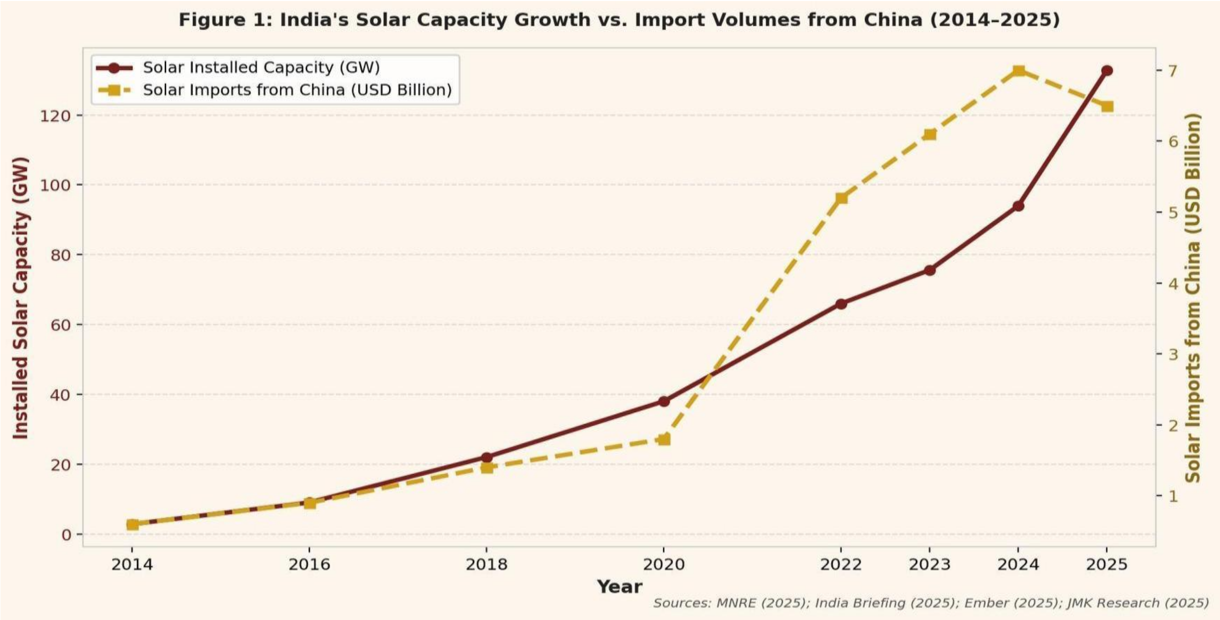

Figure 1: India's Solar Capacity Growth vs. Import Volumes from China (2014-2025).

Source: Ministry of New and Renewable Energy (MNRE), Government of India (2025); Ember (2025); Institute for Energy Economics and Financial Analysis (IEEFA) (2025); JMK Research (2025).

Against this backdrop, the PLI scheme's implementation record warrants attention. As of June 2025, only 56 per cent of targeted module capacity and 14 percent cent of targeted polysilicon capacity had been commissioned.[12]

Against the 65 gigawatts of module capacity originally targeted under PLI, only 31 gigawatts was operational by mid-2025, attracting approximately USD 5.5 billion in investment against a target of USD 10.45 billion.[13]

Polysilicon and wafer manufacturing are energy-intensive and capital-intensive processes in which India's relatively high industrial electricity tariffs create a cost structure that is difficult to reconcile with Chinese-subsidised upstream pricing. Furthermore, three-year PLI cycles have not provided the investment horizon that upstream capital commitments, which often run to a decade or more, require.

How China Built Its Dominance: The Provincial Policy Engine

The attribution of China's solar dominance to central government planning and state-directed capital, while not inaccurate, captures only part of the picture. Research published through VoxEU and the Centre for Economic Policy Research in March 2026, drawing on comprehensive data tracking all solar-related law and regulations, patents, output, inputs, and exports of every solar firm in China over twenty-five years, demonstrates that local government industrial policy was a primary driver of the industry's growth.[15] Between 2004 and 2013, the output of Chinese solar manufacturers grew at 76 per cent annually; by 2019, Chinese firms accounted for 63 per cent of all solar panels produced worldwide. The cost of solar fell by over 90 per cent since 2004, and local industrial policies at the provincial and municipal level account for approximately half of that global price decline.[16]

In China, municipal and provincial governments introduced production subsidies, installation incentives, and research and development support at different times and to varying degrees of generosity.[17] As firms in subsidised cities produced more solar panels, they accumulated manufacturing knowledge and improved their processes, driving down unit costs and improving product quality. This learning spilled across ~~company boundaries~~ and then across city boundaries, kickstarting competitive industrial dynamics in areas that had not themselves introduced subsidies. Over time, what began as incremental process improvement evolved into frontier innovation: China now wins almost half of all world records for solar cell efficiency, a position it did not hold in any year before 2005.[18] Cities that adopted solar industrial policies recorded a 64 per cent increase in patenting alongside rises in revenues, production capacity, and firm numbers, and these effects grew over time and persisted long after subsidies were introduced.[19] Across the national economy, Chinese green industrial policy accounted for 40 to 50 per cent of all changes in solar innovation, revenues, and prices from 2004 to 2020, and each dollar of solar subsidy generated approximately USD 1.65 in welfare benefits for Chinese citizens through lower energy prices and export growth, before environmental gains are included.[20]

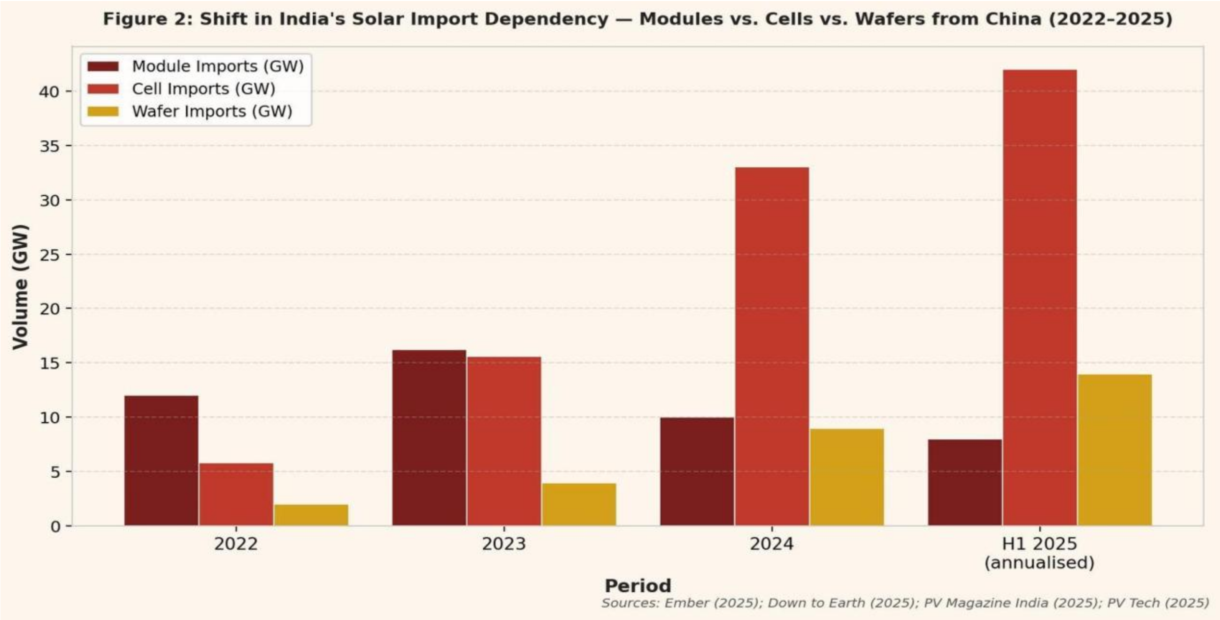

Figure 2: Shift in India's Solar Import Dependency from China: Modules vs. Cells vs. Wafers (2022-2025).

Source: Ember (2025); Down to Earth (2025); PV Magazine India (2025); PV Tech (2025).

The number of Chinese cities implementing solar industrial policies grew from 10 in 2010 to 43 by 2022, out of 358 administrative regions.[21] This was not a programme coordinated from Beijing but rather a process of competitive subnational industrialisation, in which provincial governments raced to attract manufacturers, build supplier clusters, and create the conditions under which learning-by-doing could generate compounding cost reductions. Beijing set the macro-direction; local governments built the factories, the supplier networks, and the global cost advantage. India's constitutional framework, which places electricity as a concurrent subject, gives state governments precisely the tools that Chinese provincial governments deployed to such effect. The question of whether India's states are being actively mobilised to use them is what the following section addresses.

Energy Federalism and the Subnational Gap

India's state governments hold authority over land allocation, grid transmission within their territories, distribution company procurement behaviour, and local manufacturing incentives, the same instruments that Chinese provincial governments deployed to build their solar industrial base. In recent years, state-level engagement with the energy transition has been uneven, producing a wide distribution of outcomes that illustrates both what deliberate subnational policy can achieve and where the execution gaps remain most consequential.[22]

Karnataka's trajectory offers the clearest illustration of sustained subnational ambition translating into measurable outcomes. By February 2026, renewable energy sources accounted for approximately 70 per cent of the state's total installed capacity of 37,876 megawatts.[23] In addition to Karnataka's Renewable Energy Policy 2022-2027, which provides pre-cleared land, waives transmission and wheeling charges for ten years, and mandates solar adoption across government institutions,[24] the Pavagada Solar Park was developed through a cooperative land-lease arrangement with local farming communities, resolving the land acquisition difficulties that have stalled comparable projects in other states. Taken together, these interventions have enabled a renewable share of approximately 37 per cent in Karnataka's procurement mix, placing it ahead of all other major Indian states.[25]

The contrast with other states is instructive. Telangana recorded a renewable share of approximately 14 per cent in its power procurement mix in financial year 2024, with distribution company performance in poor condition and utilisation of renewable potential below 10 per cent as of March 2025.[26] Jharkhand records approximately 8 per cent renewable penetration, with structural challenges persisting across grid readiness and utility finances.[27] Rajasthan, which commands substantially greater solar potential than Karnataka, records lower transition metrics, pointing to governance quality and institutional capacity rather than resource endowment as the determining variables. This variation carries a direct implication for supply chain policy: the states that are furthest from realising their renewable potential are also the states least positioned to generate the reliable domestic demand that upstream manufacturing investment requires.

Table 1: Subnational Solar Transition Scorecard — Selected Indian States

State	RE Share (Procurement Mix)	DISCOM Financial Health	Grid Readiness	Overall Rating
Karnataka	~37%	Strong	Strong	A
Gujarat	~25%	Moderate	Strong	B+
Tamil Nadu	~22%	Moderate	Improving	B
Maharashtra	~20%	Weak	Strong	B
Rajasthan	~25%	Weak	Strong	B
Telangana	~14%	Weak	Weak	C
Jharkhand	~8%	Weak	Weak	C

Sources: IEEFA / SET 2026; Ember (2026); PV Tech (2026); PV Magazine India (2026)

Table 1: Subnational Solar Transition Scorecard, Selected Indian States.

Source: Institute for Energy Economics and Financial Analysis (IEEFA) / States' Electricity Transition (SET) 2026; Ember (2026); PV Tech (2026); PV Magazine India (2026).

Central to this argument is the relationship between distribution company financial health and supply chain localisation, a relationship that has not received adequate attention in Indian energy policy discussions. State distribution companies are the primary buyers of solar equipment and electricity, and when these utilities carry accumulated financial stress, reflected in high aggregate technical and commercial losses, delayed subsidy compensation from state governments, and weak billing collection, their procurement behaviour becomes highly cost-sensitive.[28] Under current global market conditions, the lowest available cost for solar equipment is delivered by Chinese-subsidised supply chains, which means that a financially constrained distribution company will, in the ordinary course of procurement, default to imported rather than domestically manufactured inputs. As of September 2025, approximately 44 gigawatts of awarded renewable capacity remained stranded with unsigned Power Sale Agreements, primarily on account of distribution company reluctance and local grid infrastructure delays.[29] Grid curtailment data from 2025 compounds this picture, with high-renewable states including Rajasthan, Gujarat, and Tamil Nadu reporting curtailment levels ranging from 10 to 30 per cent due to transmission unavailability.[30] For upstream manufacturing investments that require capital commitments over ten to fifteen year horizons, the combination of stranded capacity and high curtailment rates constitutes a demand-side risk that weighs heavily in investment decisions.

Activating the Federal Lever

Given the foregoing, efforts to reduce India's exposure to Chinese upstream solar inputs need to engage the state level as a co-participant rather than a passive implementing agency. Three areas of state-level action carry particular weight in this regard.

1. **Distribution company financial rehabilitation** - This carries a direct bearing on the quality of demand signals available to domestic manufacturers. Maharashtra has moved in this direction by mandating its distribution companies to procure energy storage equivalent to 10 per cent of demand by 2036 alongside a 65 per cent renewable energy target, a combination that creates a long-term, legally grounded demand signal of the kind that upstream capital investment requires.[31] More broadly, financially stable utilities are in a position to sign credible long-term Power Purchase Agreements that give domestic manufacturers the demand certainty needed to justify investment in polysilicon, wafer, and cell manufacturing. Without that certainty, the investment calculus for upstream facilities remains unfavourable relative to the security and scale offered by Chinese producers.
2. **Procurement discipline at the state level** - State distribution companies issue procurement tenders and, within the national ALMM framework, determine how rigorously domestic content requirements are applied in practice. State-funded and state-facilitated projects offer additional scope for domestic content specification beyond what the central framework mandates, and states with substantial manufacturing capacity are positioned to develop premium demand channels for domestically manufactured equipment, thereby creating market segments that are partially insulated from Chinese pricing pressure.

3. **Land and infrastructure facilitation** - The Pavagada land-lease model in Karnataka, under which local farmers lease land to Karnataka Solar Power Development Corporation for 25 years in exchange for stable lease income, eliminated the adversarial land acquisition dynamics that have stalled comparable projects elsewhere in India.[32] Pre-cleared industrial zones for solar manufacturing with dedicated grid evacuation infrastructure replicate the conditions that Chinese provincial governments made available to manufacturers in the 2004 to 2013 period, namely a location where the transactional costs of industrial establishment are minimised and the conditions for learning-by-doing can take hold from the outset. India's solar module demand has, by 2025, shifted substantially to domestic sources;[33] it is the upstream supply chain, which continues to draw primarily on Chinese cells,

wafers, and polysilicon, where sustained state-level industrial facilitation would have the most direct and lasting effect on import dependency.

Conclusion

India's solar transition rests on foundations that are, in several respects, more advanced than those China had built at a comparable stage of its own economic development.[34] The PLI scheme, the ALMM framework, and the India-EU Free Trade Agreement signed in January 2026, which opens a duty-free route for Indian-manufactured solar equipment into the European market, have collectively established a national manufacturing policy architecture of considerable scope. In recent years, efforts have also been concentrated on expanding domestic cell and module capacity,

pursuing critical mineral partnerships internationally, and tightening procurement standards at the central level. What China's experience of provincial solar industrial policy between 2004 and 2020 demonstrates, with empirical precision drawn from twenty-five years of firm-level data, is that central policy creates enabling conditions whilst local governments build the actual industrial capacity. The competitive dynamic among Chinese cities and provinces generated the learning spillovers that drove down global solar costs and established Chinese dominance across the value chain. India's state governments hold exactly the institutional levers that Chinese provincial governments deployed to this end. Activating them through distribution company reform, procurement discipline, and manufacturing zone facilitation is what converts India's solar ambition into durable supply chain resilience. More recently, states such as Maharashtra have begun to move in this direction, and Karnataka's trajectory over the past decade offers a replicable template. Whether other states follow, and at what pace, will determine how deeply the upstream dependency on China is ultimately resolved.

Declaration

I declare that this manuscript is being submitted exclusively to CENJOWS for publication consideration, is original, and has not been published or submitted elsewhere. I further certify that it contains no classified, restricted, or sensitive information and is based entirely on open-source material suitable for publication in the public domain.

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