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Assessing the effectiveness of India's solar Production Linked Incentive scheme

How policy coherence, capital, and upstream integration can power India's path to solar self-reliance

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Key findings

Launched in 2021, the Production Linked Incentive (PLI) scheme for high-efficiency solar modules has attracted strong industry interest and revived investor confidence in domestic solar manufacturing. However, capacity additions remain below targets, with only 56% of module and 14% of polysilicon capacity achieved as of June 2025.

In June 2025, India's PV capacity reached 3.3 gigawatts (GW) polysilicon, 5.3GW wafer, 29GW cell, and 120GW module, with the PLI scheme driving all upstream capacity.

Future iterations of PLI must adopt a comprehensive manufacturing-linked framework that integrates fiscal support, upfront capital subsidies, ancillary development and longer policy tenures.

The PLI scheme has reinforced the government's push for self-sufficiency, spurring an upsurge in domestic module capacity and investment inflow into the sector. At the same time, its full potential is yet to be realised due to delays in upstream integration, policy uncertainties, technical constraints, and volatility in global raw material prices.

Executive summary

India's Production Linked Incentive (PLI) scheme for high-efficiency solar photovoltaic (PV) modules is one of the most significant policy interventions to build domestic manufacturing capability in clean energy technologies. Implemented by the Ministry of New and Renewable Energy, the scheme aims to reduce import dependence, encourage upstream integration, and create a globally competitive ecosystem for solar manufacturing. Launched in March 2021 with an outlay of Rs4,500 crore (~US$517.24 million), the scheme's strong industry response led to an additional budget allocation of Rs19,500 crore (~US$2.24 billion) in 2022, bringing the total to Rs24,000 crore (~US$2.76 billion) across two tranches.[1]

Tranche-I of the solar PLI, awarded in December 2021, focused on a smaller number of fully integrated manufacturing facilities (polysilicon-to-module). Its selection mechanism prioritised higher integration levels, higher capacity and local value addition (LVA). In contrast, Tranche-II (April 2023) adopted a broader, basket-based structure that distributed capacity across three integration categories: polysilicon-to-module, wafer-to-module, and cell-to-module. It emphasised more efficient technologies by prioritising allocation to bids offering superior module efficiencies, followed by higher integration levels and LVA trajectories, showing a more structured and performance-linked allocation framework than Tranche-I.

As of June 2025, India's installed PV manufacturing capacity stood at 3.3 gigawatts (GW) of polysilicon (equivalent capacity from First Solar), 5.3GW of wafers, 29GW of cells, and 120GW of modules.[2] Whatever limited polysilicon and wafer capacities exist in India have come solely through the PLI scheme, underscoring India's continued upstream dependence on imports, while about 36% of total cell and 24% of module capacity have come from capacities allocated under PLI. Despite the government's recent announcement on the extension of commissioning timelines by two years, the scheme is yet to reach operational maturity, with several facilities still in the advanced construction or partial commissioning stages, reflecting structural and operational constraints.

One of the key policy hurdles has been the frequent changes to the Approved List of Models and Manufacturers (ALMM), which has created uncertainty for investors. ALMM's deferment in April 2023 coincided with the Tranche-II allocation, allowing unrestricted imports during a period of global oversupply. Even after its reinstatement in April 2024, imported cells remained exempt, and cell import prices fell, eroding the financial viability of integrated domestic manufacturing facilities.

Capital intensity has further slowed progress, especially in upstream segments like ingot and wafer production, which require three to five times the investment of module lines. These financial constraints, compounded by import dependence on PV machinery and materials, have limited manufacturers' ability to meet ambitious LVA targets.

[1] PIB. Cabinet approves Production Linked Incentive Scheme. September 2022

[2] Note: The commissioned capacities correspond to facilities that have achieved the respective level of integration as defined under the PLI scheme, ranging from polysilicon (Stage-1) to module manufacturing (Stage-4). In certain cases, equivalent integration has been achieved through thin-film or alternative technologies.

Technical implementation challenges have also emerged, with visa restrictions limiting the entry of Chinese technicians, who are critical for equipment installation and commissioning. Although expedited visa approvals introduced in 2024 helped ease manpower constraints, financial stress in the Chinese PV industry further restricted the availability of experts. Volatility in global polysilicon and wafer prices, alongside emerging geopolitical friction and export control measures, has also complicated project economics.

Despite these barriers, the PLI scheme has catalysed substantial domestic investment. India's module and cell capacities grew 216% and 344%, respectively, since 2022, with PLI-linked facilities accounting for 39% of total module and 62% of total cell additions. However, economic gains have been only partial. Against the target of Rs94,000 crore (~US$10.80 billion) in investment and 65GW of capacity, progress reached Rs48,120 crore (~US$5.53 billion) and 31GW by June 2025, roughly half the intended outcome.[3]

Financial risks for awardees remain considerable, with potential losses of up to Rs41,834 crore (~US$4.81 billion)[4,5] through encashed bank guarantees, forgone incentives, and unrealised revenue. The two-year extension granted in 2025 mitigates immediate penalties but does not extend the incentive period, meaning beneficiaries availing this relief will receive incentives only for the remaining three years of the original five-year term.

At the market level, solar tariff stagnation reflects the lack of a resilient integrated domestic PV module manufacturing industry. While solar tariffs fell to Rs2.0–2.2 (US¢2.3-2.5) per kWh during FY2020–21, they have since plateaued at Rs2.5–2.7 (US¢2.9-3.1) per kWh (as of FY2024-25). Global module price declines, largely driven by dumping and oversupply from China, have been offset domestically by higher Domestic Content Requirement-compliant module costs and rising balance-of-system and financing expenses. The correction in Chinese pricing under its "involution" policy is likely to moderate price fluctuations but will keep cost competitiveness a challenge for Indian manufacturers in the short term.

India's solar PLI scheme has established a foundation for domestic manufacturing, but its long-term success depends on sustained policy coherence, upstream integration, and ecosystem development. The government's decision to extend commissioning deadlines and expand ALMM coverage to cells and wafers demonstrates its intent to reinforce backward linkages. However, the US's recent imposition of a 50% tariff on Indian solar exports poses a significant trade risk, underscoring the need to diversify export markets and strengthen domestic demand absorption.

Future iterations of PLI must evolve from a narrow production-linked design to a comprehensive manufacturing-linked framework, integrating fiscal support, upfront capital subsidies, and longer policy tenures. Incorporating ancillary component support (for solar glass, encapsulants, and aluminium frames) and mechanisms for price stabilisation will be essential to achieving full value-

[3] Economic Times. Over Rs48,000 cr investment, 38,500 jobs generated under solar PLI scheme till June 2025. July 2025
[4] IREDA. Invitation for Application For Selection of Manufacturers for Setting up Manufacturing Capacities for High Efficiency Solar PV Modules under the Production Linked Incentive (PLI) scheme. May 2021
[5] SECI. Request for Selection (RfS) for Selection of Solar PV Module Manufacturers for Setting up Manufacturing Capacities for High Efficiency Solar PV Modules in India under the Production Linked Incentive Scheme (Tranche-II). November 2022

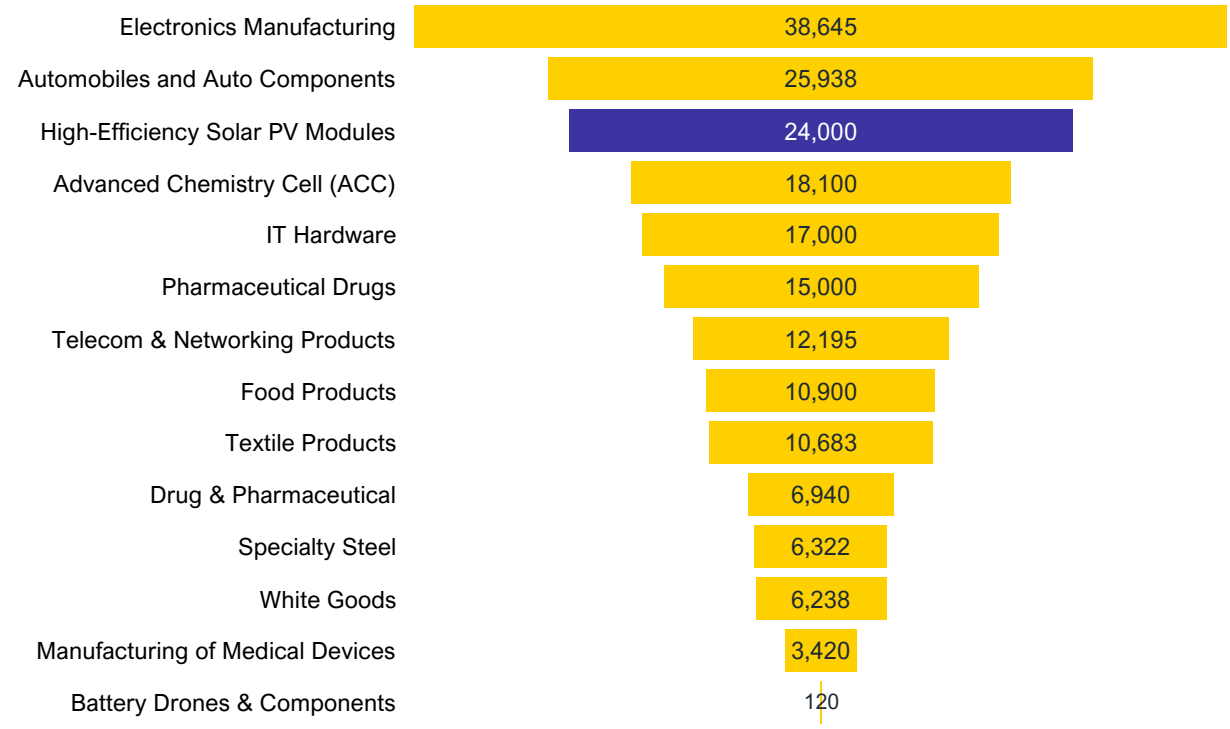
chain resilience. In essence, while the PLI scheme has catalysed India's transition from policy intent to tangible capacity creation, the journey towards self-reliance in solar manufacturing is still far from complete.

Introduction to the PLI scheme

The national PLI framework was launched in 2020, under the Department for Promotion of Industry and Internal Trade, with sector-specific PLI schemes rolled out subsequently. The framework is part of the government's broader perspective of self-reliance with a total approved outlay of Rs1,97,2916 crore (~US$22.67 billion) across 14 sectors. Large-scale electronics manufacturing was allocated the highest PLI quantum of Rs38,645 crore (US$4.35 billion), followed by automobiles, high-efficiency solar PV and Advanced Chemistry Cell.

The scheme is designed to reward actual production rather than provide upfront capital subsidies, ensuring that fiscal resources translate directly into manufacturing outcomes. This approach aligns government support with measurable industrial output, creating sustainable manufacturing capabilities.

Figure 1: PLI scheme sectoral outlay distribution (Rs crore)



Source: PIB, JMK Research

[6] PIB. PLI Schemes: Shaping India's Industrial Growth. Nov. 2024

Initially, the solar PLI scheme (high-efficiency solar PV modules) was allocated Rs4,500 crore[7] (~US$517.24 million). Given the strong industry response in the first auction (Tranche-I), the Ministry of New and Renewable Energy (MNRE) increased the budget by Rs19,500 crore[8] (~US$ 2.24 billion) in September 2022, and conducted a second auction.[9,10] The central cabinet outlined the following objectives for the solar PLI scheme:

- Install 65 gigawatts (GW) per annum of fully and partially integrated solar PV module manufacturing capacity.
- Attract direct investment of around Rs94,000 crore (~US$10.80 billion).
- Create domestic manufacturing capacity for balance-of-materials components like Ethylene Vinyl Acetate (EVA), solar glass, backsheet, etc.
- Generate about 1.95 lakh direct and around 7.8 lakh indirect jobs.
- Achieve import substitution of ~Rs1.37 lakh crore (~US$15.75 billion).
- Provide impetus to research and development to achieve higher-efficiency solar PV modules.

As of June 2025, India's PV manufacturing capacity had reached 3.3GW polysilicon, 5.3GW wafer, 29GW cell, and 120GW module. The PLI scheme contributed entirely to the installed polysilicon or equivalent, and accounted for about 75% of wafer capacity, 36% of cell and 24% of module capacities, respectively, signalling strong progress in upstream integration, though downstream expansion remains largely outside the PLI framework.

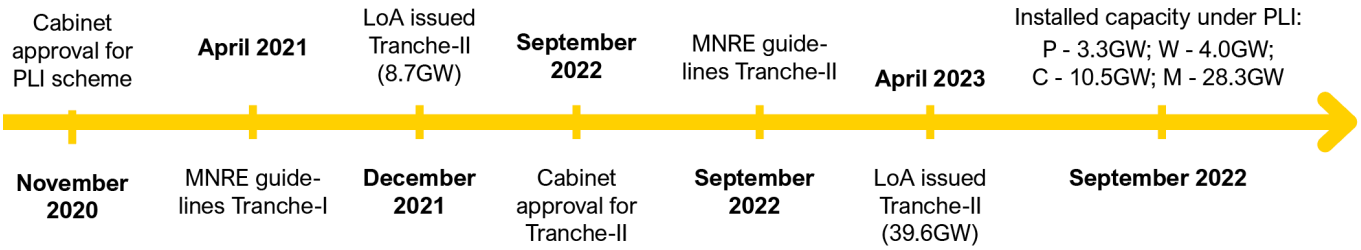
PLI auction analysis

The Indian Renewable Energy Development Agency (IREDA) was the implementing agency for Tranche-I of the solar PLI. The Tranche-I tender (issued in May 2021) garnered strong interest, receiving proposals for 54.8GW of integrated PV manufacturing capacity from 18 bidders — over five times the targeted 10GW. The tranche allocated Rs4,455 crore (~US$517 million) in PLI for 8.7GW of fully integrated capacity to three manufacturers — Shirdi Sai Electricals, Reliance New Energy and Adani Infrastructure.[11]

The Solar Energy Corporation of India (SECI) implemented Tranche-II of the "High-efficiency Solar PV Modules" scheme. SECI issued the tender for Tranche-II in November 2022, and the letter of award (LoA) post-bidding was issued in February 2023. Tranche-II marked a decisive scale-up from Tranche-I, with approximately fourfold higher outlay, multi-basket bidding, and bidding capacity caps that prevented concentration and enabled wider industry participation.

[7] MNRE. List of successful bidders under Tranche-I. 2021
[8] SECI. List of successful bidders under Tranche-II. 2023
[9] PIB. Cabinet approves Production Linked Incentive Scheme. September 2022
[10] IEEFA-JMK Research. India's Photovoltaic Manufacturing Capacity Set to Surge. April 2023
[11] MNRE. List of successful bidders under Tranche-I. 2021

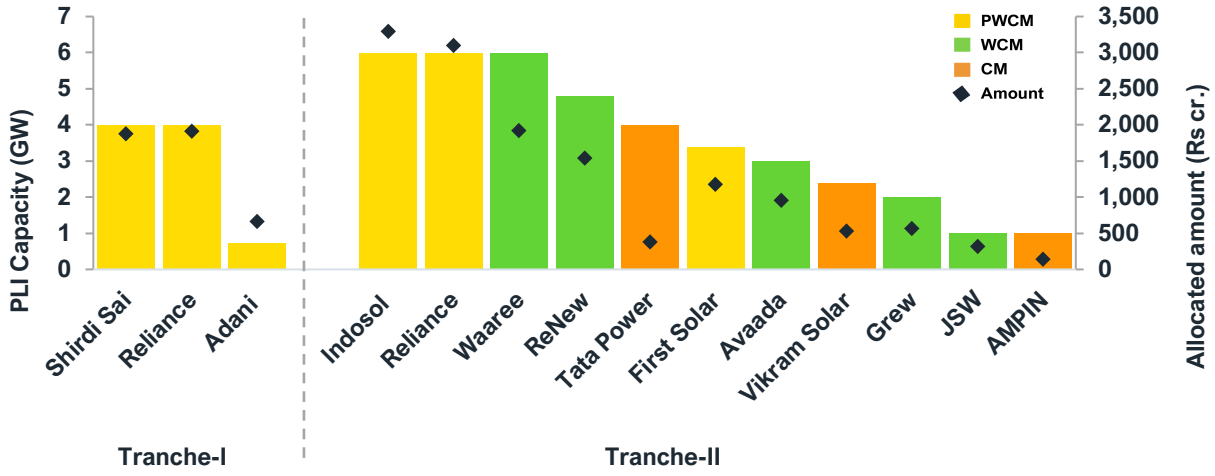
Figure 2: PLI scheme: Timeline



Note: P: Polysilicon, W: Wafer-ingot, C: Cells, and M: Module
Source: SECI, MNRE and JMK Research

Under the Tranche-II auction, SECI allocated Rs13,937 crore (US$1.60 billion) to 11 manufacturers across technology-differentiated baskets with varying levels of integration.[12] The majority of this allocation (approximately 54%) was for the complete end-to-end PV manufacturing integration basket, i.e. polysilicon to module, for a cumulative capacity of 15.4GW. Overall, both the auctions of solar PLI augmented India's domestic solar PV manufacturing pipeline across the segments as follows: polysilicon – 24.1GW, wafer – 40.9GW, cell – 48.3GW, module – 48.3GW.[13,14]

Figure 3: PLI allocation across solar manufacturers: Capacity and financial support



Source: MNRE, SECI, JMK Research; note: P: Polysilicon, W: Wafer, C: Cell, M: Module

Solar PLI winners ranged from established PV manufacturers (Waaree, Vikram Solar) to solar developers (Avaada, JSW) and large conglomerates (Reliance, Adani). Solar PLI auctions marked the entry of several players in the PV manufacturing sector, including Reliance, Shirdi Sai Electricals, JSW Renewables, Avaada and AMPIN Energy.

[12] SECI. List of successful bidders under Tranche-II. 2023
[13] MNRE. List of successful bidders under Tranche-I. 2021
[14] SECI. List of successful bidders under Tranche-II. 2023

Notably, US-based solar manufacturer First Solar became the first and only international entity to secure PLI under the scheme. The company established an integrated thin-film PV module manufacturing facility in Tamil Nadu, which commenced operations in July 2023. The plant was primarily set up to cater to India's domestic demand, aligning with the country's broader localisation goals. As of mid-2025, the facility was operational but is yet to meet performance and integration benchmarks required under Tranche-II. According to industry sources, several PLI winners, such as Avaada, ReNew and Tata Power, plan to use a significant share of their output in their own solar projects, given their strong presence in renewable-energy project development.

Table 1: Salient features of PLI Tranche-I and Tranche-II for solar PV manufacturing

Parameter	Tranche-I	Tranche-II
Implementing agency	IREDA (under MNRE)	SECI (under MNRE)
Outlay	Outlay: Rs4,500 crore (~US$517.24 million); Allocated: Rs4,455 crore (~US$512.07 million);	Outlay: Rs19,500 crore (~US$2.24 billion); Allocated: Rs13,937 crore (~US$1.60 billion)
Integration baskets	Baskets Basket I. Polysilicon, Wafer, Cell, and Module (P+W+C+M) Basket II. Wafer, Cell, and Module (W+C+M) Basket III. Cell and Module (C+M)	
Selection mechanism	Bids are evaluated on technical and financial parameters and ranked by first higher integration, capacity, and then % of local value addition (LVA) that aligns with scheme goals.	Bucket-filling within baskets, ranked by efficiency (year 1–5), level of integration, LVA[15] trajectory, and bid capacity.
Module performance	PLI linked to efficiency & LVA	Detailed performance matrix (≥20.5% efficiency) & LVA multiplier
Financial threshold	Lower net-worth requirement (e.g., Rs220 crore/GW or ~US$25.29 million/GW for full integration)	Higher net-worth requirement (Rs380 crore/GW or ~US$43.68 million for full integration)
Performance Bank Guarantee (PBG)	Rs4.5 - Rs11 crore/GW (~US$0.52 - US$1.26 million/GW)	Rs6–Rs13 crore/GW (~US$0.69 - US$1.49 million/GW)
Allocated Capacity	P+W+C+M: 8,737MW	P+W+C+M: 15,400MW W+C+M: 16,800MW C+M: 7,400MW
LoA date	December 2021	April 2023
Commissioning deadlines	Timelines: Basket-I: 3 years, Basket-II: 2 years, and Basket-III: 1.5 years from the LoA date [16]	
PLI disbursement	Year-on-year till five years from scheduled commissioning, will be reduced if delayed & no part-commissioning benefits	

Note: P: Polysilicon, W: Wafer-ingot, M: Module, and C: Cells
Source: IREDA, SECI, MNRE, and JMK Research

[15] *Note: LVA refers to the proportion of domestic inputs and processes used in manufacturing, indicating the percentage share of value created within India's supply chain.*

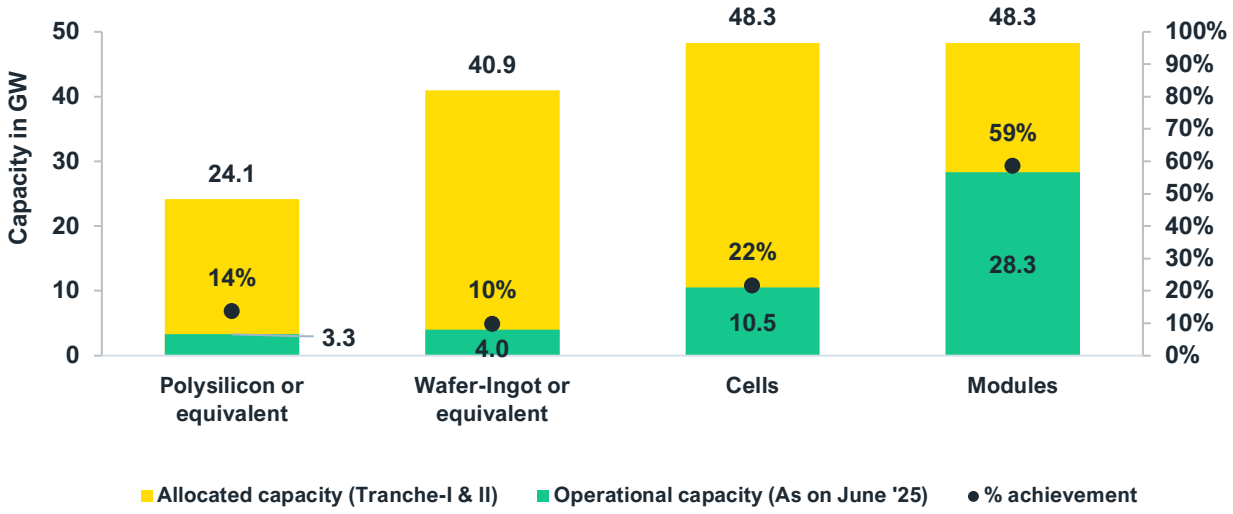
[16] Note: Basket-1 (polysilicon-to-module integration), Basket-2 (wafer-to-module), and Basket-3 (cell-to-module)

Status and progress of PLI facilities

The operationalisation of PLI-awarded facilities demonstrates partial capacity realisation with significant implementation and project execution gaps. Module and cell manufacturing show partial implementation, while wafer and polysilicon capacities remain largely non-operational. As of June 2025, the overall achievement (operational capacity) rate of the solar PLI scheme stood at approximately 29% of the total awarded capacity.

Module assembly demonstrates the highest capacity-achievement rate at 59%. However, the achievement rates for cell, wafer-ingot manufacturing, and polysilicon manufacturing are significantly lower, indicating substantial deployment challenges that intensify with increasing upstream complexity.[17] These gaps are particularly concerning when viewed against the scheduled commissioning deadlines, with Tranche-I (December 2024) and Baskets II and III of Tranche-II (April 2025 and September 2024) already overdue.

Figure 4: Progress of solar manufacturing under PLI: Allocated & operational capacity



Source: SECI, Lok Sabha, industry insights, JMK Research
Note: The commissioned capacities correspond to facilities that have achieved the respective level of integration as defined under the PLI scheme, ranging from polysilicon (Stage-1) to module manufacturing (Stage-4). In certain cases, equivalent integration has been achieved through thin-film or alternative technologies.

Execution outcomes vary, with both established manufacturers and new entrants encountering implementation challenges. So far, Tata Power and First Solar are the only players to have commissioned their awarded PLI capacities. Among all PLI recipients, only Adani and First Solar have commissioned wafer- or equivalent-stage production facilities, with capacities of 0.737GW and 3.3GW, under Tranche-I & Tranche-II of the scheme, respectively.[18]

[17] Lok Sabha. Manufacturing capacity of solar modules under PLI scheme. August 2025
[18] Reuters. Adani begins commercial output of wafers, ingots for solar power. April 2024

Table 2: Operational status of PLI-awarded manufacturing capacities (as of June 2025)

Baskets with different integration levels	Player	Location: PLI facility	Capacity allocated under stage for respective integration level (GW)	Status (operational capacity)			
				Stage I: Polysilicon or equivalent	Stage II: Wafer-ingot or equivalent	Stage III: Cells	Stage IV: Modules
Basket-I PWCM	Shirdi Sai	Andhra Pradesh	10	0%	0%	0%	5%
	Reliance	Gujarat	10	0%	0%	0%	100%
	Adani	Gujarat	0.7	0%	100%	100%	100%
	First Solar	Tamil Nadu	3.4	97%	97%	97%	97%
Basket-II WCM	Waaree	Gujarat, Maharashtra	6	-	0%	0%	0%
	Avaada	Uttar Pradesh, Maharashtra	3		0%	0%	100%
	ReNew	Rajasthan, Gujarat	4.8		0%	52%	100%
	JSW	Rajasthan	1		0%	0%	0%
	Grew	Jammu & Kashmir	2		0%	0%	100%
Basket-III CM	Vikram Solar	Tamil Nadu	2.4	-	-	0%	0%
	AMPIN	Odisha	1			0%	0%
	Tata Power	Tamil Nadu	4			100%	100%
Total % PLI capacity operational for each level of integration				**14%**	**10%**	**22%**	**59%**

Source: Industry reports, JMK Research
Note: First Solar's manufacturing is based on Cd-Te thin-film technology, which obviates the need for the sequential polysilicon-to-module fabrication process. Hence, its progress is shown in terms of percentage completion of a fully integrated facility.

A review of the player-specific PLI manufacturing facility status shows that even established manufacturers undertaking parallel commercial expansions, like Waaree and Vikram Solar, have struggled to execute their PLI projects. Notably, Waaree Energies Limited's 0% operational status reflects documented project location changes driven by execution delays at originally specified sites, prompting relocations across Gujarat, Tamil Nadu, and Maharashtra with revised project plans.[19, 20]

Even for operational facilities, manufacturers report difficulties in meeting the LVA requirements specified in the bidding documents required to process their PLI entitlement. Among awarded players, there is a clear technological trend; most manufacturers, including Adani, Avaada, and ReNew, are deploying Tunnel Oxide Passivated Contact (TopCon) technology, while Reliance has adopted Heterojunction Technology (HJT) across its 10GW facility, and First Solar operates on thin-

[19] Waaree, Outcome of Board Meeting, June 2025
[20] Waaree, Integrated Annual Report 2024-25, September 2025

film Cadmium telluride (Cd-Te) technology. The next section analyses the key reasons behind the delays hindering solar PLI actualisation.[21]

Reasons for delays and key challenges

The PLI scheme for solar PV manufacturing faces multiple implementation challenges. These include the high capital intensity of upstream integration, inadequate incentives, policy asymmetries, import dependency, and global raw material price volatility.

Policy asymmetry and ALMM flip-flops

The current policy structure creates an uneven playing field with imports remaining unrestricted for polysilicon and wafers, while modules face import restrictions under the Approved List of Models and Manufacturers (ALMM). This asymmetry in protection measures discourages long-term capacity investments by domestic players, especially in polysilicon and wafer manufacturing.

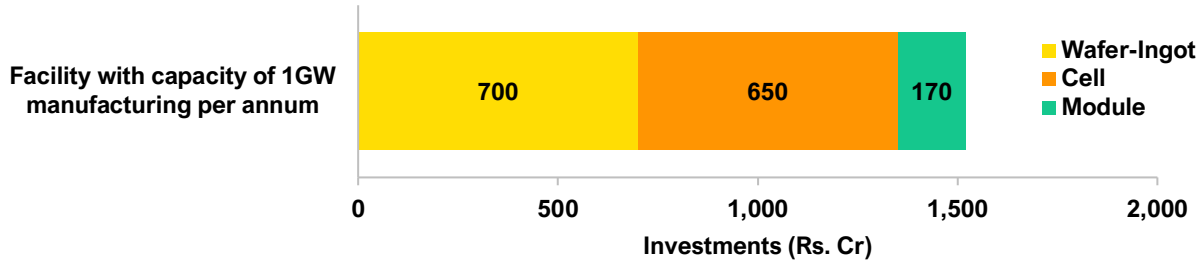
The ALMM policy itself has faced implementation inconsistencies, creating uncertainty for manufacturers. ALMM was deferred in April 2023, coinciding with the month in which Tranche-II was awarded, allowing unrestricted imports amid global oversupply, which slowed tangible PLI progress as the minimum threshold covered cells and modules. Although reinstated on 1 April 2024, imported cells remained exempt, and cell prices fell sharply from about US$0.12/Wp (March 2023) to US$0.03/Wp (FY2024–25), undermining the investment viability of integrated cell + module facilities under PLI. The industry remains cautious about future policy changes, particularly regarding the Approved List of Cell Manufacturers (ALMM List-II) coming into force in June 2026[22] and the recently drafted ALMM (List-III) for wafer manufacturing that will come into effect in June 2028.[23]

Capital intensity of upstream integration

The PLI scheme's emphasis on fully integrated manufacturing presents significant capital challenges due to the upstream segments' exponentially higher investment requirements. While setting up an integrated wafer-to-module manufacturing plant, ingot-wafers and cells require approximately 3x to 5x the capital investment needed to set up the concurrent module facility. Overall, for this wafer-to-module plant, the total capital requirement reaches approximately Rs1,500 crore (~US$172.41 million) per GW, with upstream processes (ingot-wafer + cell) accounting for ~90% of the total investment.[24]

[21] TopCon: It uses a thin tunnel oxide layer and polysilicon layer on the rear side of the cell to reduce energy loss and improve efficiency.
HJT: It combines crystalline silicon with thin amorphous silicon layers to create a highly efficient solar cell.
Thin-film: These solar cells use very thin semiconductor layers (like CdTe or CIGS) instead of crystalline silicon wafers.
[22] MNRE. Amendment to ALMM Order for Implementation of ALMM for Solar PV cells. December 2024
[23] MNRE. Draft Order for Implementation of ALMM for Wafers. September 2025
[24] Waaree. Solar Industry Reacts: PLI Program Good for Large Manufacturers; MSMEs Left Out. 2021

Figure 5: Capital investment requirements across the PV manufacturing value chain



Source: Industry insights, JMK Research

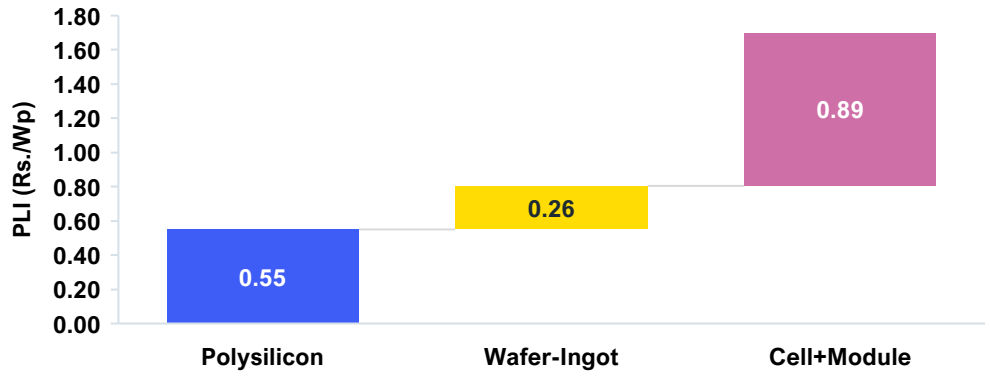
The high capital intensity of upstream segments has slowed progress towards the scheme's integrated manufacturing goals, as manufacturers face steep upfront investment requirements, resulting in extended and uncertain payback periods.

Inadequate incentive structure

PLI incentives — ranging from Rs1.5–2 (US¢1.7-2.3) per Watt peak (Wp) for a fully integrated setup — constitute merely 5–10% of production costs. This limited support is modest relative to international benchmarks and does little to offset the cost disadvantages domestic manufacturers face.

For example, the US provides substantially more comprehensive manufacturing support through its Inflation Reduction Act (IRA). The production and investment tax credit mechanisms under IRA can deliver total support exceeding US¢15–20 per Wp, representing three to five times the financial support offered under the PLI scheme.[25]

Figure 6: Effective incentive distribution (Rs/Wp) by integration stage under PLI



Source: IREDA, SECI, JMK Research
Note: Incentives for each integration level are calculated using the module parameters shown in Annex 1 (efficiency, temp. coefficient, LVA) with 1GW annual sales. Values for polysilicon, wafer-ingot, and cell+module are the five-year average disbursement in Rs/Wp.

[25] US Department of Energy. Federal Tax Credits for Solar Manufacturers. 2024

The US system also includes direct-pay options, allowing manufacturers to receive immediate cash refunds instead of tax credits, and transferability provisions that enable credit monetisation, providing operational flexibility that India's retrospective incentive structure cannot match.

Supply chain ecosystem deficiencies and import dependence

India's solar manufacturing remains heavily import-dependent for ancillaries and industrial machinery. Critical component gaps persist in encapsulants, backsheets, junction boxes, and specialised glass, necessitating continued reliance on international suppliers.[26] Additionally, industrial machinery and equipment for solar manufacturing are still almost entirely imported, mainly from China.[27]

This import dependency creates challenges for manufacturers attempting to meet progressive and stringent localisation targets, escalating from 68% in year one to approximately 90% by year five.[28] Additionally, in the event of breakdowns or process fine-tuning, etc, there is an understated overreliance on spare parts/assistance from the overseas PV machinery supplier.

Polysilicon and wafer gaps remain the weakest link in India's PV value chain

Globally, China's dominance in polysilicon, wafer, and cell production gives it significant pricing power, with domestic policy changes, regulatory shifts, and strategic production cycles creating ripple effects worldwide.[29] By adjusting export rebates, subsidies, and production levels, China can either raise costs or dump products to undercut competitors, while overcapacity and consolidation cycles generate artificial price volatility,[30] exposing India to cost spikes, supply shortages, and financing risks.

Despite rapid growth in module capacity, India's solar manufacturing sector continues to lag in upstream sectors, with several projects delayed beyond 2026. As a result, even new cell and module facilities will remain dependent on imported wafers for the next two years at least, while projects requiring ALMM-compliant modules still rely on imports, leaving upstream stages as the sector's weakest link.

Visa restrictions and technical expertise constraints

Visa restrictions for Chinese nationals have significantly affected PLI manufacturing timelines, with India issuing only 2,000 visas in 2024 compared to 200,000 pre-pandemic in 2019, a 99% reduction.[31] The dependency on Chinese technical expertise arises because nearly all critical PV manufacturing equipment — particularly for ingot, wafer, and advanced cell production — is

[26] SAEL. India Renewable Energy Market Assessment. October 2025
[27] GTRI. Global Solar Industry in China's Iron Grip. October 2024
[28] MNRE. Production Linked Incentive Scheme (Tranche-II) under 'National Programme on High Efficiency Solar PV Modules. 2023
[29] Bloomberg. China Dominates Clean Technology Manufacturing Investment as Tariffs Begin to Reshape Trade Flows. April 2025
[30] Reuters. China's solar industry losses balloon on falling prices. August 2025
[31] TOI. India to fast-track China visas after businesses hit by delays. July 2024

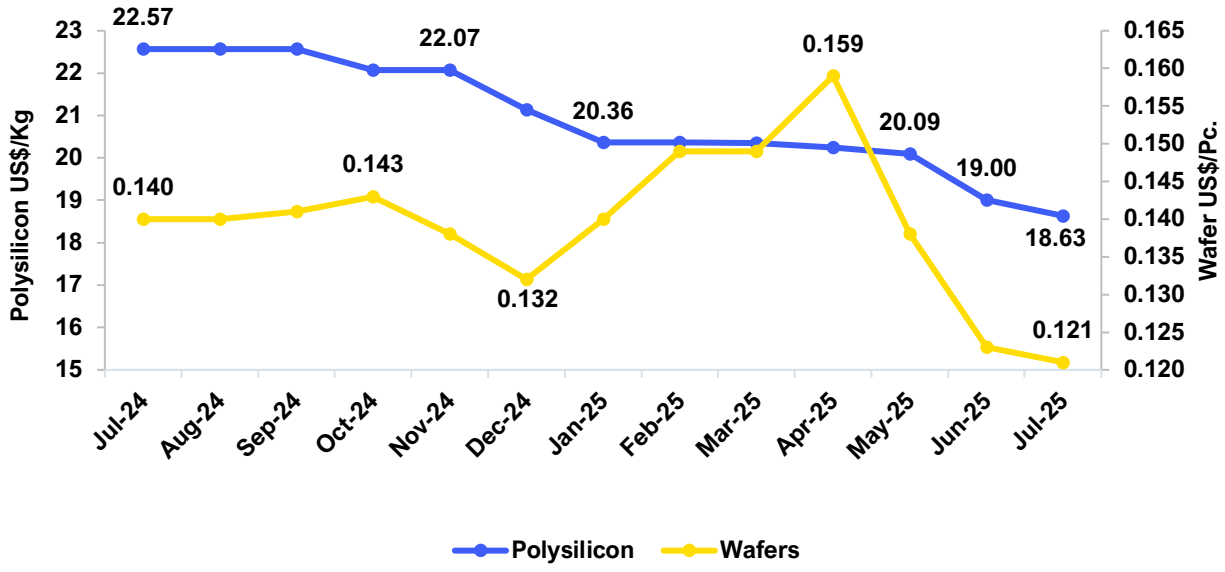
imported from Chinese suppliers, whose engineers possess the proprietary know-how for installation, commissioning, and training. This has created cascading project delays across manufacturing units. Manufacturing firms consistently reported visa processing bottlenecks for essential activities, including machinery setup, technology transfer, and operational training programmes.

Recognising the impact on investments worth billions of dollars, the Ministry of Commerce introduced expedited visa approvals for PLI beneficiaries in August 2024, which eased manpower constraints. However, progress continued to be slow as the Chinese PV industry faced financial stress, limiting its ability to deploy technical experts abroad. Recent interventions, including a standardised approval procedure and a dedicated visa portal launched in August 2024, have improved processing times. However, initial delays led to slower-than-expected capacity ramp-up across the solar manufacturing ecosystem.

Global raw material price volatility

The Global Polysilicon Marker has demonstrated extreme volatility in the past couple of years, declining from US$22.567/kg in July 2024 to US$18.633/kg in July 2025. Also, the N-type M10 wafer prices experienced volatile fluctuations between US$0.132 and US$0.159/pc in late 2024 and early 2025,[32] when China reduced export tax rebates on PV products from 13% to 9%.[33]

Figure 7: Price trends for polysilicon & wafers in global markets



Source: OPIS - Dow Jones, JMK Research
Note: Prices shown are for the Global Polysilicon Marker and N-type M10 wafer

[32] OPIS - Dow Jones Company. Solar Weekly Issue 755. July 2025
[33] Taiyang News. China To Lower Solar Export Tax Rebates From 13% To 9%. November 2024

This price instability undermines investment planning for PLI manufacturers, who require predictable input costs for their factory feasibility assessments, particularly given the substantial capital-intensive requirements for polysilicon and wafer production.

In addition to the evident price volatility of raw materials (such as polysilicon and wafers), the availability of critical minerals and equipment adds a significant geopolitical dimension to the domestic manufacturing challenge. China's recent policy changes, including the lowering of export rebates for PV products and the tightening of export licences on key components and assemblies, have heightened India's exposure to possible disruptions in its upstream supply chain. These risks increase implementation uncertainty for domestic manufacturers under the PLI scheme, who rely not only on stable input costs but also on assured access to imported polysilicon, wafers, and manufacturing equipment.[34]

Lack of cost and scale competitiveness

A critical challenge in developing domestic polysilicon manufacturing is achieving cost and scale competitiveness vis-à-vis China. According to market stakeholders, polysilicon production becomes economically viable only beyond 40,000 tonnes per year, while leading Chinese manufacturers operate at scales exceeding 100,000 tonnes annually. These large-scale operations enable significant economies of scale, lowering per-unit costs and enhancing global price competitiveness.

In India, the maximum PLI allocation of 10GW, equivalent to roughly 25,000 tonnes[35] per year of polysilicon output, falls short of this economic threshold. As a result, Indian manufacturers are unable to compete with global manufacturers on cost as well as scale in the absence of stringent tariff and non-tariff barriers.

Recognising this limitation, Reliance has planned to double its manufacturing capacity from 10GW to 20GW — approximately 50,000 tonnes per year — to achieve comparable economies of scale. This move underscores the structural importance of scale in making upstream polysilicon production viable and globally competitive within India's solar manufacturing ecosystem.

Impact on the sector

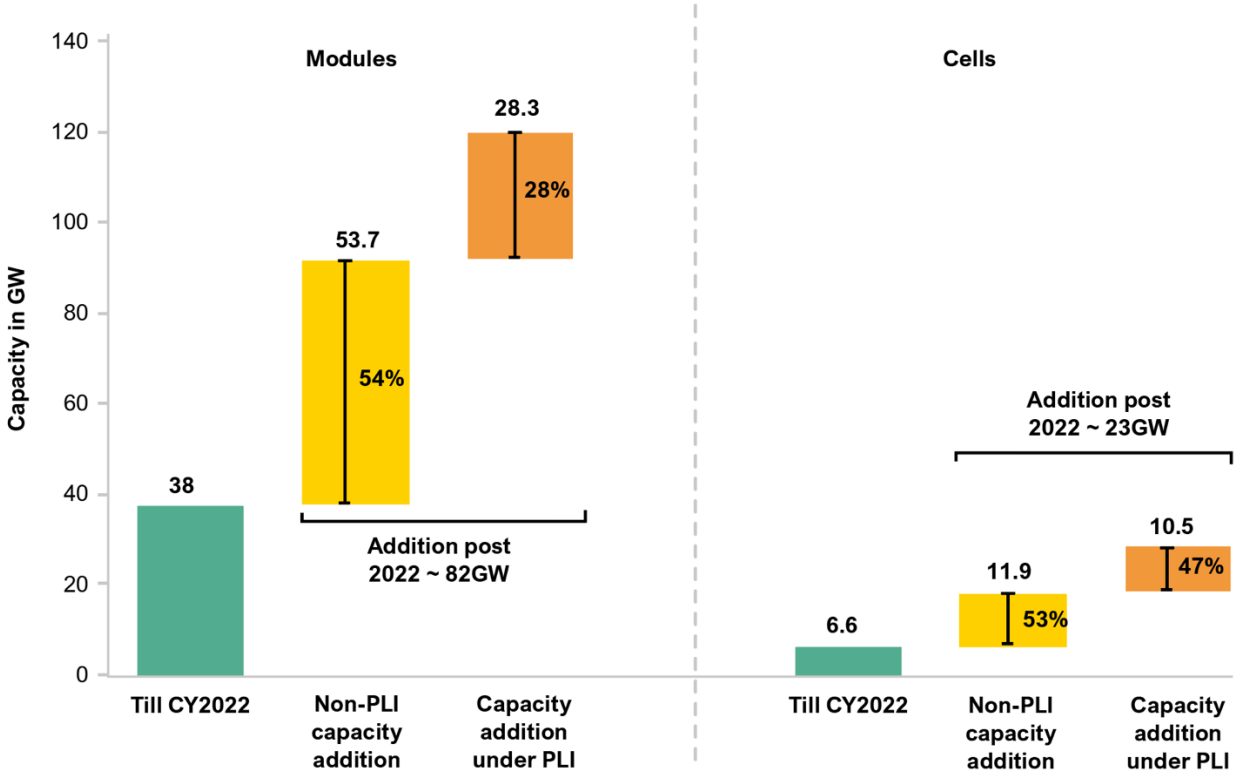
The PLI scheme has had a multifaceted impact on India's PV manufacturing sector. On the positive side, it has reinforced the government's push for self-sufficiency, spurring an upsurge in domestic module capacity and investment inflow into the sector. At the same time, as highlighted in the previous sections, its full potential is yet to be realised due to delays in upstream integration, policy uncertainties, technical constraints, and volatility in global raw material prices.

Manufacturing capacity additions post-PLI implementation

India's solar manufacturing capacity has expanded significantly since 2022, with current operational capacity reaching 120GW for modules and 29.3GW for cells (as of June 2025). Post-2022 capacity additions totalled 82GW in modules and 22.7GW in cells, representing a 216% and 344% increase, respectively, from 2022 levels.[36]

[34] IEA. Global Critical Minerals Outlook 2025. May 2025
[35] Australian PV Institute. Silicon to Solar. December 2023
[36] JMK Research. Solar PV Manufacturing in India: Trends and Opportunities. August 2025

Figure 8: Solar PV manufacturing in India: Pre-PLI & post-PLI additions (till June 2025)



Source: JMK Research

PLI facilities account for 39% of total module capacity additions and 62% of cell capacity additions since 2022, while non-PLI investments contributed the remaining 61% and 38% respectively. This distribution indicates that while PLI has driven cell manufacturing investments, the broader module capacity expansion has been primarily market-driven.

Consequences of delays in PLI facility implementation

Economic impact

Delays in reaching the targeted 65GW per annum of fully and partially integrated solar PV module capacity have limited the PLI scheme's potential. The scheme aimed to attract an estimated Rs94,000 crore (~US$10.80 billion) in investments and generate 1.95 lakh direct and 7.8 lakh indirect jobs. As of June 2025, the scheme had attracted approximately Rs48,120 crore (~US$5.53 billion) in investments and created around 38,500 direct jobs, reflecting only a fraction of the expected impact.[37]

[37] Economic Times. Over Rs48,000 cr investment, 38,500 jobs generated under solar PLI scheme till June 2025. July 2025

Table 3: PLI for high-efficiency solar PV modules: Targets vs achievements (as of June 2025)

Parameters	Target	Progress	% achieved
Module manufacturing capacity (annual)	65GW	31GW*	47.7%*
Employment generation	Direct jobs - 1.95 lakh Indirect jobs - 7.8 lakh	Direct jobs - 38,500	3.95%
Investment mobilisation	Rs94,000 crore (~US$10.80 billion)	Rs48,120 crore (~US$5.53 billion)**	53.4%**

** It addresses only partially integrated PV module manufacturing capacity commissioned under the scheme, while the target is for both fully and partially integrated PV manufacturing capacity.*

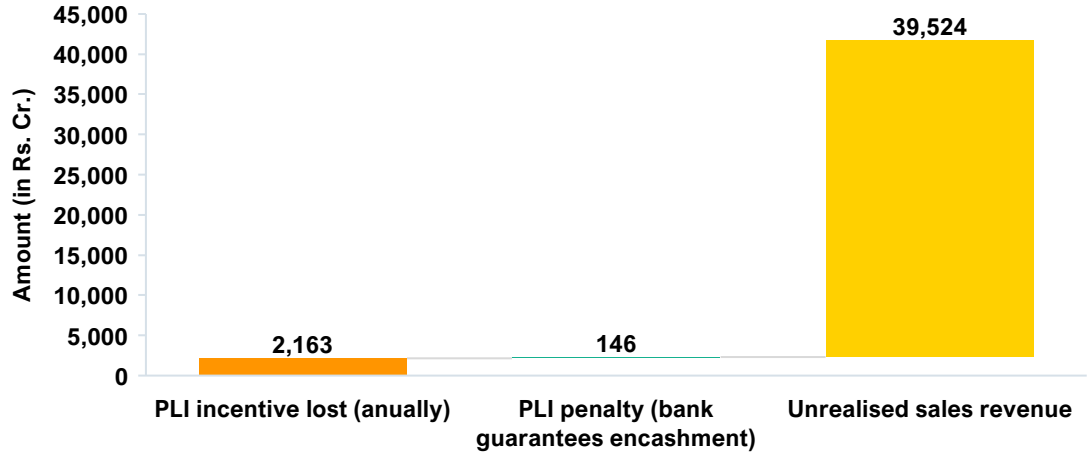
*** Committed investments*

Source: MNRE, PIB and JMK Research

Financial implications for PLI winners

PLI non-compliance can lead to a substantial financial loss for solar PLI awardees. According to JMK Research, across both tranches, solar PLI awardees can incur a monetary risk of up to Rs41,834 crore (~US$4.81 billion) cumulatively, combining direct penalties (bank guarantees encashment), lost incentives, and unrealised revenue from sales.[38,39] However, the recent two-year extension in commissioning timelines primarily defers bank guarantee encashment; since the overall incentive period remains unchanged, beneficiaries availing the extension will receive incentives only for the remaining three years of the original five-year window.[40]

Figure 9: Financial implications for PLI winners



Source: MNRE, PIB and JMK Research

[38] IREDA. Invitation for Application For Selection of Manufacturers for Setting up Manufacturing Capacities for High Efficiency Solar PV Modules under the Production Linked Incentive (PLI) scheme. May 2021
[39] SECI. Request for Selection (RfS) for Selection of Solar PV Module Manufacturers for Setting up Manufacturing Capacities for High Efficiency Solar PV Modules in India under the Production Linked Incentive Scheme (Tranche-II). November 2022
[40] Economic Times. Two-year extension for commissioning projects under solar PLI scheme. September 2025

Impact on solar tariffs

Before the introduction of the PLI scheme, India's solar tariffs had reached record lows of around Rs2.0–Rs2.2 (US¢2.3-2.5) per kWh (FY2020–21),[41] closely tracking global declines in module prices. However, delays in achieving PLI targets have restricted the domestic supply of high-efficiency modules, particularly under Domestic Content Requirements (DCRs), keeping tariffs elevated at around Rs2.5–2.7 (US¢2.9-3.1) per kWh[42] through FY2024–25 despite falling international module prices.

The recent decline in global module prices has largely been driven by aggressive price undercutting and oversupply from China, rather than a structural reduction in production costs. With China now moving to correct this through its "involution" policy, international prices are expected to normalise.[43] Meanwhile, the mandatory DCRs for projects have nearly doubled domestic module costs, offsetting the benefits of international price reductions.[44]

Consequently, overall project costs have fallen only marginally, and the expected decline in tariffs has not yet materialised. The potential inclusion of wafers and polysilicon under ALMM could keep procurement costs elevated until the domestic value chain achieves full integration.

Way forward

Despite these challenges, industry sentiment remains optimistic about building a fully integrated domestic PV supply chain. Yet, the realisation of these ambitions may extend beyond FY2027, making regulatory and financial support mechanisms critical for India's transition to a fully integrated solar manufacturing hub. Despite discussions about scrapping the scheme, the central government has extended the commissioning deadlines for PLI facilities by two years.[45]

Strengthening India's upstream solar manufacturing ecosystem

To address upstream solar integration, India is advancing a multipronged strategy combining policy intervention, industrial investment, and strategic sourcing. The National Critical Mineral Mission[46] was launched in early 2025 to strengthen domestic supply chains for critical minerals such as silicon, tellurium, indium, and gallium, which are essential for PV cell manufacturing. Simultaneously, the government's ALMM framework is being expanded beyond modules to cover cells, ingots, and eventually polysilicon,[47] reinforcing the goal of full domestic backward integration.

Several industry stakeholders are assessing opportunities abroad to secure silica/ quartz (SiO_2) reserves, the key raw material for polysilicon production. Leading Original Equipment Manufacturers, including Adani Solar, Avaada, Premier Energies and Waaree, have already announced upstream investments in polysilicon and wafer facilities, signalling progress towards domestic value-chain expansion. In the near term, however, bridging imports through long-term offtake contracts, strategic

[41] IEEFA-JMK. Why India's Solar Power Tariffs Reached an Historic Low. December 2020
[42] JMK Research. RE Updates Report. February 2024
[43] Reuters. What is "involution", China's race-to-the-bottom competition trend? September 2025
[44] TOI. Domestically made solar panel costs doubles, raises project cost. June 2025
[45] Economic Times. Two-year extension for commissioning projects under solar PLI scheme. September 2025
[46] PIB. National Critical Mineral Mission. April 2025
[47] MNRE. Draft Amendment to ALMM Order for Implementation of ALMM for Wafers. September 2025

partnerships with global suppliers, and targeted fiscal incentives will remain essential to maintain supply stability and safeguard against global dumping or tariff shocks.

US tariffs to reshape India's solar export outlook

The recent move by the US to impose a 25% reciprocal tariff on Indian exports in July 2025,[48] followed by an additional 25% ad-valorem duties in August 2025,[49] poses new challenges for India's trade outlook. The net 50% duty on Indian solar panel shipments will curtail sales to India's largest export destination, which accounts for nearly 90% of module exports.

This could leave India with an oversupply of solar panels in 2026, especially as exports shrink while project bidding slows[50] due to transmission congestion from early-commissioned plants and delayed grid projects.[51] To navigate this, strengthening domestic demand and building resilience through export diversification will be crucial to sustaining momentum in solar manufacturing.

Enhancing India's PLI design

PLI schemes need to be recalibrated to address cost competitiveness and upstream integration.

- Scheme adjustments should include tax credits, low-cost financing, and risk mitigation tools such as stabilisation funds or minimum support price frameworks to shield domestic producers from global price volatility.
- Future iterations of the PLI can incorporate layered incentives tied to the level of integration from polysilicon to ingots/wafers to cells and modules, longer policy impact periods (extending the current five-year timeline to 8–10 years), and more flexible eligibility criteria, drawing lessons from international frameworks such as the IRA. Upfront cost subsidies for smaller players, extended policy horizons, and relaxed qualifying criteria could encourage participation.
- To strengthen the ancillary market, the scheme can support critical components such as EVA, solar glass, and backsheets, enabling import substitution and fostering a more integrated, resilient solar PV supply chain.

Conclusion

India's PLI scheme for solar photovoltaic manufacturing represents a strategic pivot towards self-reliance in critical clean energy technologies. However, with only 24% of awarded capacity operational as of June 2025, the scheme's ambitious vision of end-to-end domestic manufacturing still faces structural and execution delays.

The slow augmentation of upstream integration and subsequent import dependency will continue to be the biggest roadblock to India attaining its PV manufacturing goals in the near term. This reliance

[48] The White House. Executive Orders. July 2025
[49] The White House. Executive Orders. August 2025
[50] Economic Times. US tariffs to worsen India solar panel glut as domestic bidding slows. August 2025
[51] Reuters. India curbs solar power output to keep grid stable amid low demand. August 2025

on overseas firms exposes manufacturers to global price volatility and strategic market manipulation by dominant suppliers, undermining domestic manufacturing economics and strategic objectives.

According to industry stakeholders, the government might waive encashment of the performance bank guarantee in lieu of shortening the eligibility period for the PLI scheme for high-efficiency solar PV module manufacturing. The two-year extension granted by the central government in 2025 — offered in exchange for waiving the encashment of the performance bank guarantee — provides a much-needed stopgap for manufacturers facing delays in setting up their factories. However, it must be complemented by measures addressing the underlying causes of these delays, including bottlenecks in visa approvals and policy uncertainty.

The scheme's trajectory hinges on comprehensive recalibration rather than mere timeline extensions. The emerging 50% US tariff burden on Indian solar exports creates a complex environment that requires strategic adaptation. Future iterations must incorporate layered incentives tied to integration levels, extended policy horizons of 8–10 years, and stability mechanisms to protect manufacturers from global price volatility.

The path to self-reliance in manufacturing demands recognition that upstream integration cannot be achieved through production incentives alone. Success requires a holistic approach combining upfront capital subsidies, risk mitigation frameworks, and ancillary component support for EVA, solar glass, and backsheets. Without government intervention through offtake underwriting at viable margins or co-lending capital, large-scale polysilicon investments will remain financially unfeasible. Most importantly, India must develop institutional mechanisms for coordinated policy implementation, and better align incentives with manufacturing timelines and market protection measures, while providing long-term policy certainty.

Despite these shortfalls, the PLI scheme has catalysed significant capacity additions and shown India's manufacturing potential. Achieving the broader objective of supply chain independence will require sustained commitment, adaptive policy design, and recognition that building globally competitive manufacturing capabilities is a multi-decade endeavour that demands patient capital and consistent support frameworks.

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