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Assessing overcapacity risk in India's solar PV manufacturing market

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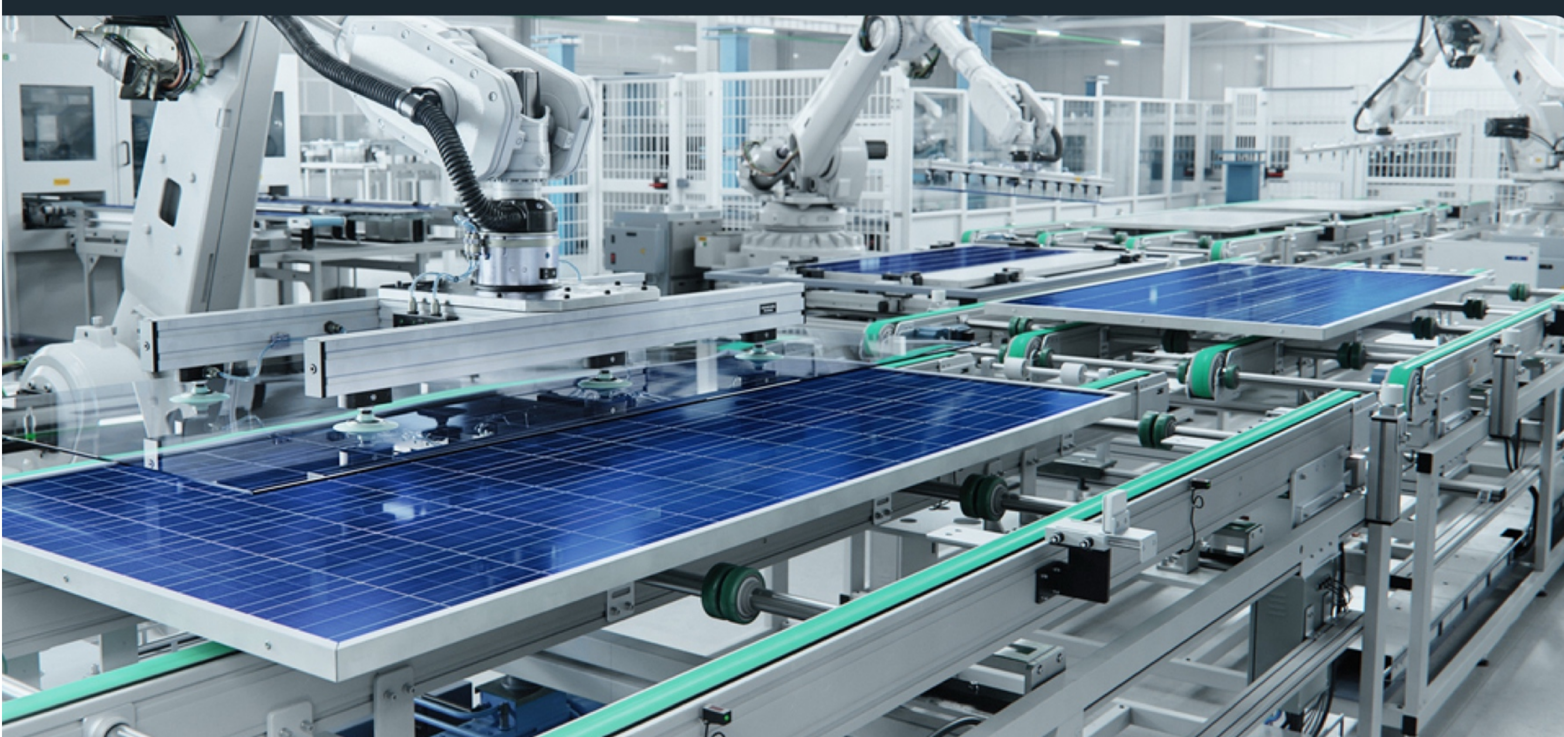

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List of abbreviations

ALMM: Approved List of Models and Manufacturers

BCD: Basic Customs Duty

CM: Cell and Module

CPSU: Central Public Sector Undertaking

DCR: Domestic Content Requirement

EPC: Engineering, Procurement, and Construction

HJT: Heterojunction

IPP: Independent Power Producer

ISTS: Interstate Transmission System

MMTPA: Million Metric Tonnes Per Annum

MNRE: Ministry of New and Renewable Energy

MoU: Memorandum of Understanding

PERC: Passivated Emitter and Rear Cell photovoltaic technology

PLI: Production-Linked Incentive

PM-KUSUM: Pradhan Mantri-Kisan Urja Suraksha evam Utthan Mahabhiyan

PM-SGMBY: Pradhan Mantri-Surya Ghar Muft Bijli Yojana

PSA: Power Supply Agreement

PWCM: Polysilicon, Wafer-Ingot, Cell & Module

R&D: Research and Development

RoW: Right-of-Way

TOPCon: Tunnel Oxide Passivated Contact

WCM: Wafer-Ingot, Cell & Module

Key findings

India's solar PV module manufacturing capacity reached approximately 233 gigawatts (GW) by June 2026, placing it among the world's largest module manufacturing bases. However, this capacity is heavily concentrated in modules, at nearly 7x cell capacity and 116x ingot-wafer capacity, signalling a structural gap in upstream manufacturing.

India's module manufacturing base is operating at 35–40% utilisation, well below the 50–65% level required for sustainable operations. With manufacturing capacity already exceeding domestic demand, further capacity additions risk widening the supply-demand gap in modules.

Data centres, green hydrogen, and export markets could be the largest sources of incremental module demand by 2030, offering 17–22GW of annual additional opportunity beyond conventional solar deployment. Their ability to scale up will depend on supportive policy, project execution, and evolving procurement dynamics.

Vertically integrated manufacturers with scale and technology depth are positioned to define the industry's next growth phase. Small-scale assemblers, legacy Passive Emitter and Rear Cell (PERC)-based lines, and manufacturers without an upstream integration roadmap will be at risk of consolidation, acquisitions, or exit.

Executive summary

India has moved from near-total import dependence in solar photovoltaics (PVs) to becoming one of the world's largest manufacturers of solar PVs. This rapid expansion has strengthened domestic manufacturing capabilities, but most new capacity has been added at the module stage, with domestic nameplate capacity (maximum annual production capacity) reaching approximately 233 gigawatts (GW) by June 2026. This concentration has established India as a major manufacturing destination[1] while leaving upstream segments such as cells, wafers, and polysilicon underdeveloped, creating an imbalance that now shapes the central challenge in the PV manufacturing sector.

This challenge is most acute at the module level, where capacity has expanded well ahead of demand. With approximately 135GW of such future capacity additions underpinned by firm investment commitments and near-certain commissioning schedules, the sector faces a clear risk of overcapacity at this stage. This is already evident in utilisation, with Indian manufacturers operating at an estimated 35–40% utilisation, below the 50–65% range that industry stakeholders identify as generally required for sustainable operations. As demand grows gradually, manufacturers are likely to face increasing pressure on utilisation, margins, and investment returns, raising stranded asset-risk for standalone manufacturers.

This pressure is unlikely to ease by 2030, according to JMK Research's analysis. India's solar deployment is expected to grow strongly on utility scale, commercial and industrial, rooftop, and hybrid demand, but that growth alone is unlikely to absorb the capacity already commissioned or announced. JMK Research models two pathways to 2030. One is based on capacity backed by confirmed investment, and the other on all capacity announced by manufacturers. Module capacity remains ahead of demand under both, with polysilicon the hardest upstream gap to close. The supply-demand gap therefore persists through the decade at the module stage, and partly at the cell stage.

The imbalance stems from two key factors. Module assembly is the easiest segment to enter, requiring modest capital, short commissioning timelines, and limited process complexity. On the other hand, cell and wafer manufacturing demand larger capital, longer build-outs, and specialised expertise. Compounding this, the Approved List of Models and Manufacturers (ALMM) sequencing concentrated the early demand pull at the module stage, with List I for modules binding for nearly five years before cell and wafer requirements followed. Investment therefore flowed to the one segment offering assured offtake and the lowest entry barrier.

Narrowing this gap will increasingly depend on demand emerging beyond conventional solar deployment. Data centres, green hydrogen/ammonia, and exports are segments that offer the most credible upside by 2030. Green hydrogen is the largest single avenue, given the dedicated renewable capacity needed for its production. While meaningful, this incremental demand is unlikely

[1] PRS Legislative Research. Standing Committee Report Summary. December 2025

to fully offset the planned scale of expansion, keeping competitiveness and market access central to absorbing the surplus.

Exports will be pivotal to utilising India's expanding base. High dependence on US, which absorbs the bulk of current shipments, has exposed manufacturers to rising trade-policy risk and emphasised the urgent need for diversification. Europe offers the most structured medium-term opportunity, as its policy frameworks increasingly reward supply-chain resilience and sourcing diversification. Market access alone, however, will be insufficient. Sustained export growth will depend on India's ability to narrow its cost and technology gap with China through scale, integration, and operational efficiency. The timing favours such investment, as leading Chinese producers are absorbing losses from oversupply while Indian manufacturers have stayed profitable,[2] creating room to invest in upstream integration, efficiency, and research and development (R&D).

On the supply side, a gap between demand and available manufacturing capacity could change the industry structure. Smaller, non-integrated manufacturers may face greater pressure, while larger, vertically integrated companies could gain an advantage. Domestic manufacturing is also likely to expand beyond modules to cells, wafers, and eventually polysilicon, reducing dependence on imported inputs. India's membership of the Pax Silica coalition supports this shift, creating opportunities to diversify silicon-based solar manufacturing inputs and reduce reliance on China.

The sector's challenge is, therefore, no longer one of capacity creation, but of utilisation, competitiveness, and value-chain depth. Policy support remains critical, with a growing focus toward strengthening competitiveness and addressing the gaps that constrain it, alongside continued capacity expansion. This will require incentives that promote upstream specialisation, stronger industry-research collaboration, targeted export support, and faster power transmission and right-of-way (RoW) clearances to accelerate the installation of power generation capacity.

In the near term, however, the lack of availability of ALMM List II-compliant domestic cells has emerged as a key constraint for module manufacturers without in-house cell production. The subsequent introduction of an exemption for net-metering and open-access renewable energy projects[3] until the end of 2026 provides additional time for domestic cell-manufacturing capacity to scale while mitigating immediate utilisation pressure on standalone module manufacturers. Ultimately, the pace of upstream integration, export diversification, and technology advancement could determine whether India can translate its manufacturing scale into lasting global competitiveness.

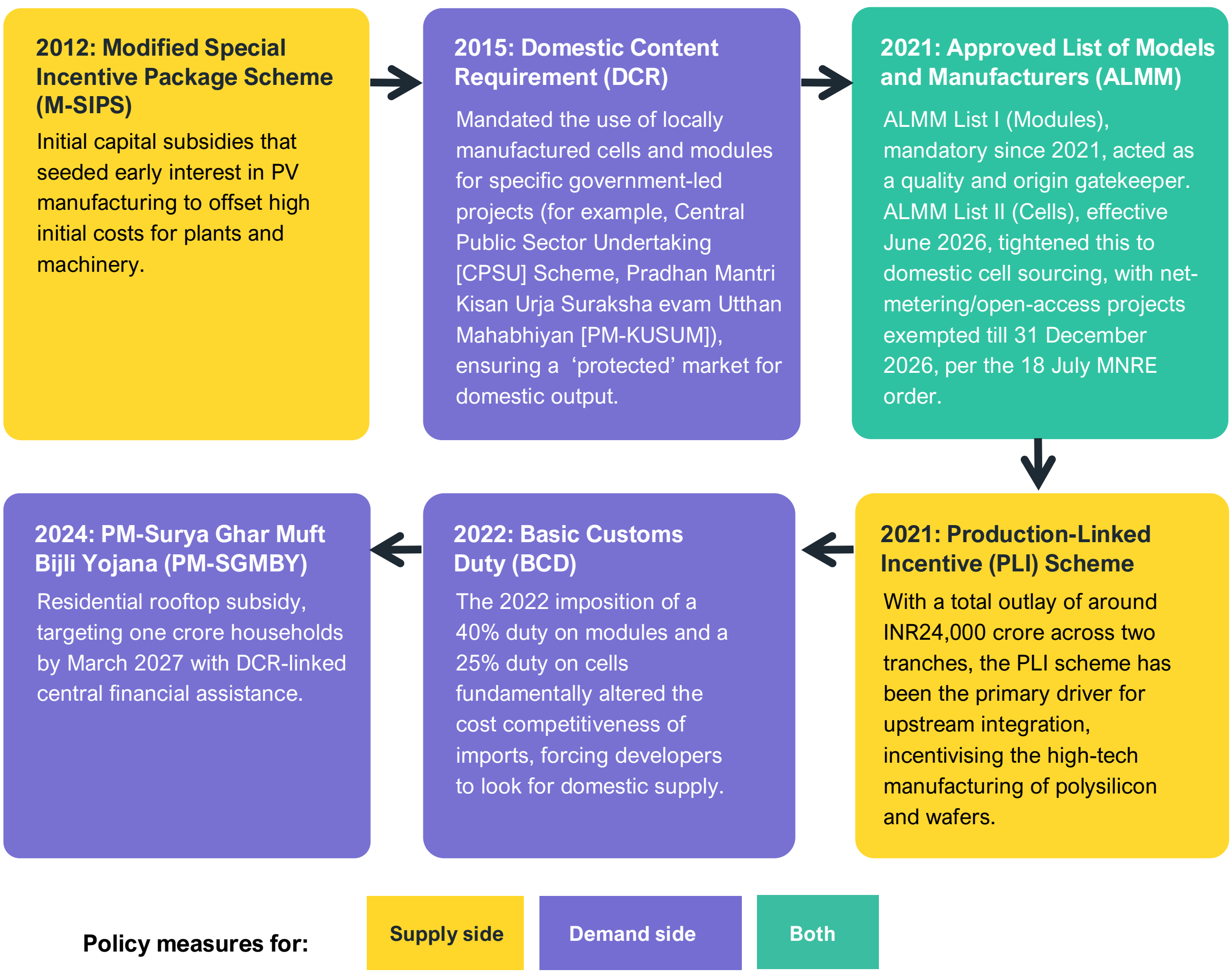
[2] PV Tech. Five Chinese PV giants anticipate combined 2025 losses of USD4.1–4.7 billion. January 2026

[3] Ministry of New and Renewable Energy (MNRE) | ALMM List II (for solar PV cells) – No blanket extension subject to limited window till 31.12.2026 for commissioning Net-Metering and Open Access RE power projects. July 2026

1. Background

The trajectory of India's solar photovoltaic (PV) manufacturing sector has undergone a major transformation. For much of the first decade of the National Solar Mission (2010), the sector remained nascent. However, there has been large-scale capacity building in 2019–2026. Ultimately, India has moved from near-complete PV import dependence, with imports meeting over 90% of domestic module demand as of FY2022,[4] to one of the major manufacturing countries[5] in the world.

Figure 1: Key policy developments in the Indian PV manufacturing landscape



Source: Ministry of New and Renewable Energy (MNRE), JMK Research

[4] Science Direct. Strategies for solar PV manufacturing in India: Harnessing stakeholder inputs. December 2025
[5] PRS Legislative Research. Standing Committee Report Summary. December 2025

The structural pivot occurred as India's policy focus shifted toward building a resilient domestic supply chain for energy security. A series of policy interventions redefined the market, introducing a multi-layered policy framework designed to strengthen the supply and demand of domestically manufactured PV modules.

Among the policy measures shown in Figure 1, the ALMM strengthens both the supply and demand for domestically manufactured PV modules. Following the operationalisation of ALMM List II from June 2026, the MNRE has introduced the exemption for net-metering and open-access renewable energy projects until 31 December 2026.[6] Meanwhile, List III for ingot-wafers remains proposed from June 2028, reinforcing the framework's role in driving progressive localisation across the PV manufacturing value chain.

Despite the rise in capacity additions, India's PV manufacturing ecosystem remains significantly concentrated downstream. Module manufacturing capacity has grown since 2024, surpassing domestic demand growth, but upstream capacities for cells, ingot-wafers, and polysilicon have not. As of June 2026, India's solar module nameplate manufacturing capacity stood at 233GW, as per JMK Research, which is approximately 7x and 116x of the corresponding capacities for cells and ingot-wafers, respectively.[7]

2. Domestic PV manufacturing evolution by 2030

Substantial manufacturing capacity has already been commissioned or is under development in India's solar PV sector. The industry's evolution till 2030 will depend on the scale of future capacity expansion relative to the demand growth in domestic and international markets.

As of financial year (FY) 2026, domestic PV manufacturing capacity reveals a structural imbalance across the value chain. Module assembly capacity significantly exceeds addressable demand, which remains overwhelmingly driven by conventional utility-scale deployment, with a modest share of exports.[8] Upstream segments like cell capacity fall short of demand, while wafer-ingot and polysilicon manufacturing remain nascent. This leaves the domestic supply chain heavily dependent on imported inputs, predominantly from China.

As seen in Figure 2, Scenario I for FY2030 domestic PV manufacturing landscape demonstrates capacity additions backed by confirmed investments and credible commissioning timelines. Module capacity remains broadly unchanged, and with demand growing, the surplus narrows marginally vis-à-vis FY2026. Within that same period under Scenario I, cells are likely to scale up to marginal overcapacity and wafer-ingot capacity would almost reach the demand threshold. However, a slight

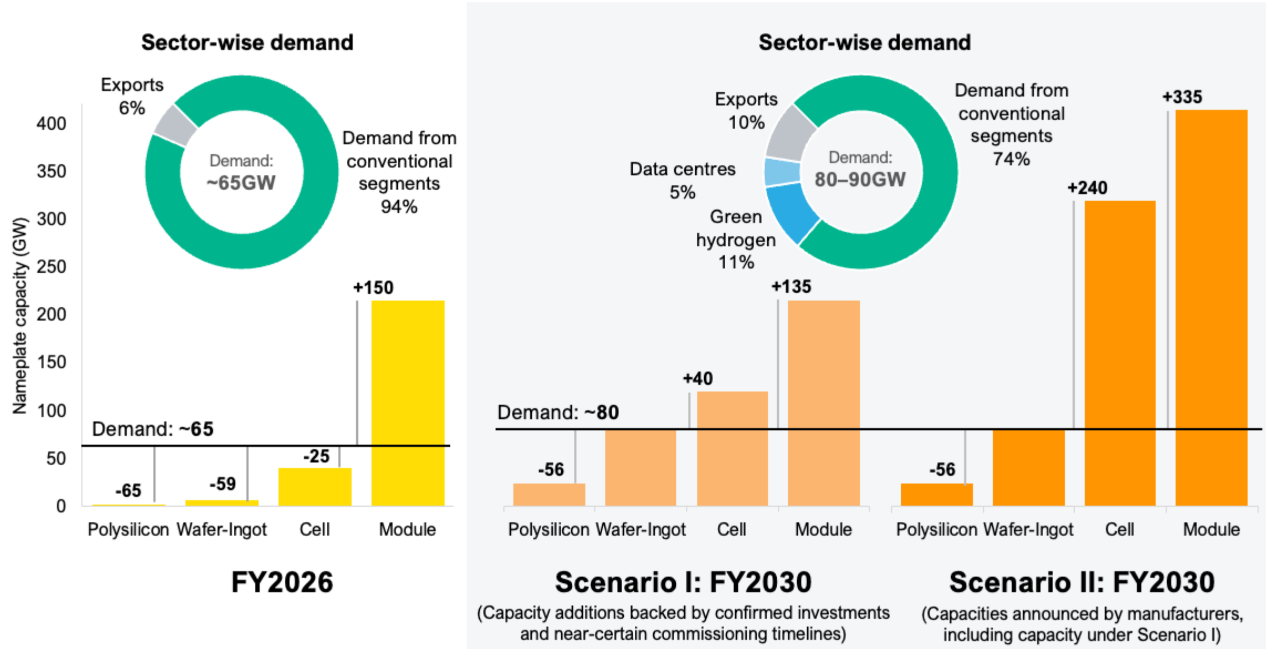
[6] MNRE | ALMM List II (for solar PV cells) – No blanket extension subject to limited window till 31.12.2026 for commissioning Net-Metering and Open Access RE power projects. July 2026

[7] Unless otherwise specified, all solar PV capacities expressed in GW refer to Direct Current (DC). Capacities explicitly denoted as GWac or MWac refer to Alternating Current (AC) capacity.

[8] MNRE. Achievements year-wise. April 2026

overcapacity will be operationally necessary given inherent manufacturing process losses and yield considerations.

Figure 2: PV manufacturing capacity vs demand (FY2026 and FY2030)



Source: Industry insights, MNRE, JMK Research

Note: Conventional segments include utility-scale solar, rooftop solar, off-grid, and hybrid solar component. FY2030 demand reflects ALMM List II- and DCR-compliant sourcing requirements for cells and modules. All capacity figures are rated nameplate manufacturing capacity. The factory utilisation is likely to vary from 35–40% in FY2026 to around 50% in FY2030 for Tier 1 manufacturers.

Scenario II captures the full extent of nameplate capacities announced by Indian manufacturers. Under this scenario, module surplus expands sharply and the nameplate module capacity is more than five times the annual solar PV demand. Under both the scenarios, polysilicon represents the toughest upstream integration challenge, with domestic capacity unlikely to meaningfully develop beyond production-linked incentive (PLI) commitments by FY2030.

These scenarios point to sustained utilisation pressure across the PV manufacturing value chain, particularly in modules, where Tier I manufacturers already operated at 50–85% utilisation in FY2026. As surplus capacity expands, the sector is likely to face increasing margin pressure and a higher risk of stranded manufacturing assets.

2.1. Capacity-demand mismatch

Several structural and policy-linked factors have converged to result in the overcapacity build-up:

- **Strong module-level capacity growth momentum:** Between FY2022 and FY2025, annual solar installations rose from around 13GW to over 30GW in capacity, while domestic module manufacturing capacity expanded from around 38GW to over 90GW.[9] This sustained growth, supported by PLI allocations, ALMM enforcement on modules, and a clear policy towards domestic manufacturing created a constructive investment environment. Payback periods at the module stage during this time were at an estimated 1.5–2 years. Lenders, including major commercial banks, viewed the segment as commercially attractive. These conditions encouraged a wide set of manufacturers, including new entrants without prior manufacturing experience, to announce sizeable capacity plans.

- **Lower entry barriers:** The economics of solar manufacturing strongly favour downstream assembly. Module facilities require approximately INR150–170crore/GW (USD16–18million/GW)[10] and can be commissioned in 8–15 months. Cell manufacturing, by contrast, demands INR500–700crore/GW (USD53–74million/GW), while integrated ingot-wafer facilities require upwards of INR700–1,000crore/GW (USD74–106million/GW), along with commissioning timelines of 18–24 months, large contiguous land parcels, and reliable low-cost power supply.[11]

  Beyond capital requirements, cell and ingot-wafer manufacturing involve significantly more complex processes. Module assembly is a largely standardised activity with limited intellectual property rights or patented technology, and equipment is available from a broad vendor base. Cell manufacturing demands precise control where yield and efficiency depend on process engineering capability accumulated over years of operational learning. Similarly, ingot and wafering require deeper mastery, with critical equipment concentrated among a small set of global suppliers.

  Together, the capital and technology asymmetry have directly shaped India's capacity build-out. The low capital-threshold and simple execution of module assembly enabled rapid capacity creation, but at the cost of vertical integration, leaving upstream segments critically underdeveloped.

- **Asymmetric ALMM sequencing across the value chain:** ALMM List I for modules, operationalised in March 2021, remained the only binding domestic content requirement for nearly five years. ALMM List II for cells was notified in July 2025, and became operational from June 2026,[12] while List III for wafers is proposed for June 2028.[13] This staggered rollout created a one-sided demand pull for modules, while cells continued to compete against lower-cost imports, directing investment toward the only segment with assured offtake.

[9] MNRE. Approved list of models and manufacturers
[10] All USD to INR conversions in this report are at an exchange rate of USD1=INR94.5, reflecting the prevailing exchange rate at the time of analysis (May–June 2026).
[11] Institute for Energy Economics and Financial Analysis (IEEFA)-JMK. Assessing the effectiveness of India's solar Production Linked Incentive scheme. December 2025
[12] MNRE. ALMM Order for Implementation of ALMM for Solar PV cells. December 2024
[13] MNRE. ALMM Order for Implementation of ALMM for Wafers. March 2026

- **Integrated manufacturers’ in-house demand leaving more excess module capacity in the open market:** A significant share of module capacity is held by integrated developers with downstream Independent Power Producer (IPP) or Engineering, Procurement, and Construction (EPC) operations, enabling internal absorption of output. Merchant demand does not fully reflect this captive offtake, reducing the effectively addressable market for standalone manufacturers.

- **Domestic demand shortfalls:** Despite India’s annual renewable energy bidding target of 50GW, tenders were issued for approximately 24GW of renewable energy capacity in FY2026. This represents a sharp decline of around 47% compared with FY2025, when nearly 45GW of capacity was tendered. The slowdown can be attributed to a combination of persistent project realisation challenges, including delays in land acquisition, grid connectivity constraints, and delays in power supply agreement (PSA) execution. While demand from the open access and residential solar segments has continued to grow steadily, the significant contraction in utility-scale tenders that have traditionally been the largest share of the market, indicates sustained near-term demand-side challenges.

- **Financing flows reinforcing downstream concentration:** Lending has historically favoured module assembly due to shorter payback periods and lower technology risk. Upstream segments have faced tighter financing conditions due to higher capital intensity and longer gestation periods. This difference in capital allocation reinforced investment at the module stage. Recent policy signals, including MNRE advisories to conduct a prudence check before lending, indicate a shift in financing direction.[14] However, given longer execution timelines for upstream capacity, this is unlikely to resolve the module supply-demand mismatch in the near term.

- **Contraction in international demand:** India’s previous high-margin export channel to the US has been disrupted by the sharp escalation in US tariffs, resulting in abrupt loss of a premium export market. This development is explored in detail in the following chapter.

2.2. Key trends expected by 2030

The overcapacity position projected for 2030 in Figure 2 represents a continuation of current demand patterns and announced manufacturing expansion plans. Two parallel developments will shape how the surplus gap evolves. On the demand side, new sources of module demand are likely to emerge beyond traditional utility-scale, open-access rooftop solar, and off-grid markets. On the supply side, the industry is likely to undergo a transition as policy, competitive pressure, and capital discipline reshape the manufacturing landscape. The following sections examine how these demand-side and supply-side developments could influence the sector’s trajectory through 2030.

[14] MNRE. Prudence in Lending for Solar PV Modules. November 2025

2.2.1. Emerging demand avenues

Data centres, green hydrogen, and export markets could offer the most significant upside towards module demand by 2030. While they differ in maturity, scale, and procurement dynamics, each represents a potential source of incremental demand beyond conventional solar deployment.

Under favourable policy support and timely execution, these segments could scale significantly, making them the drivers of demand upside beyond the base trajectory. Together, they represent an incremental solar demand opportunity of approximately 17–22GW by 2030, as estimated by JMK Research.

2.2.1.1. Data centres

India's data centre sector could emerge as a meaningful source of incremental solar PV demand by 2030. Driven by hyperscaler expansion, increasing digitisation, data localisation requirements under the Digital Personal Data Protection Act, and rapidly growing artificial intelligence-based compute needs, information technology-sector load is projected to increase from approximately 1.5GWac in 2025 to 7–8GWac by 2030.[15] This expansion can raise annual electricity consumption from around 13 terawatt hours (TWh) currently to 40–57TWh by the end of the decade. Given the sector's preference for open access and captive procurement structures, this could create a potential annual solar demand upside opportunity of around 2–3GW by 2030.

Table 1: Renewable energy and net-zero commitments of major data centre operators in India

Data centre operator	Decarbonisation target	Renewable energy target	Other details
STT global data centres India	Carbon-neutral by 2030	100% renewable energy by 2030 (48% achieved in FY2024)	Bengaluru facility holds first net-zero energy certification for a data centre
NTT global data centres India	Carbon-neutral by 2040	100% renewable energy across India operations by 2030	Approximately 100 MWac of operational solar and wind capacity supplying Mumbai and Bengaluru facilities

[15] Deloitte. Powering Asia Pacific's data centre boom. 2026

CtrlS data centres	Net-zero by 2040	100% renewable energy by 2030 (1GWac of renewable energy capacity)	Signed a memorandum of understanding (MoU) with NTPC Green Energy Limited for 2GWac renewable energy
Nxtra	Net-zero by 2031	100% renewable electricity under RE100 commitment	Partnered with AMPIN Energy Transition to source renewable power from Interstate Transmission System (ISTS)-connected solar-wind hybrid project of 125 MW capacity

Source: Company disclosures, press releases, JMK Research

The renewable energy commitments of India's leading data centre operators further reinforce the demand outlook. As seen in the table above, major data centre operators have ambitious decarbonisation and renewable electricity targets, with most aiming to source 100% renewable power by 2030 or shortly thereafter.

The broader investment pipeline also supports continued growth in renewable electricity demand from the sector. Hyperscalers like Microsoft, Amazon Web Services (AWS), and Google have collectively committed more than USD50billion (around INR4.73lakh crore) toward Indian data centres.[16] Combined with RE100 and similar corporate sustainability commitments, these investments are likely to increase demand for long-term renewable power procurement as new facilities become operational.

2.2.1.2. Green hydrogen and ammonia

Green hydrogen and ammonia together constitute one of the largest demand segments. Unlike conventional industrial end-use sectors served from the grid, green hydrogen production requires dedicated renewable power at scale, creating a direct linkage between hydrogen deployment and incremental solar capacity additions.

While the National Green Hydrogen Mission has set a production target of 5 million metric tonnes per annum (MMTPA) by 2030, most projects awarded are still at financial closure or early construction stages, with commissioned electrolyser capacity still negligible.[17] Given the early stage of market development, a more realistic deployment trajectory is likely to be closer to 3MMTPA, which could

[16] The Economic Times. Data nation: 9GW capacity seen by 2032 on $50 billion flows. October 2025
[17] Press Information Bureau (PIB). Cabinet approves National Green Hydrogen Mission. January 2023

create an incremental solar PV demand opportunity of 8–10GW by 2030.[18] Material scale-up is expected after 2030.

Realising this opportunity through 2030 will depend on the pace at which the current project pipeline converts from announcements and awards to commissioned electrolyser capacity. Several parallel drivers will shape this trajectory:

- **Cost reductions:** India's current levelised cost of green hydrogen is estimated at USD3.5–5/kilogram (kg),[19] against the approximately USD2/kg[20] threshold required to approach parity with grey hydrogen across industrial end-uses.

- **Development of offtake markets:** Demand growth from ammonia, refining, steel, and heavy transport sectors needs to be underpinned by bankable procurement frameworks and long-term purchase agreements.

- **Project execution:** As per JMK Research, a cumulative 872,000 tonnes per annum of green hydrogen and 724,000 tonnes per annum of green ammonia capacity were awarded by June 2026. These projects must progress from financial closure to construction and commercial operation on planned timelines, given the multi-year development cycles associated with large-scale green hydrogen facilities.

- **Parallel build-out of dedicated renewables and transmission infrastructure:** Each MMTPA of green hydrogen production is estimated to require 25GWac of dedicated renewable energy capacity, underscoring the corresponding need for investments in generation and grid networks.

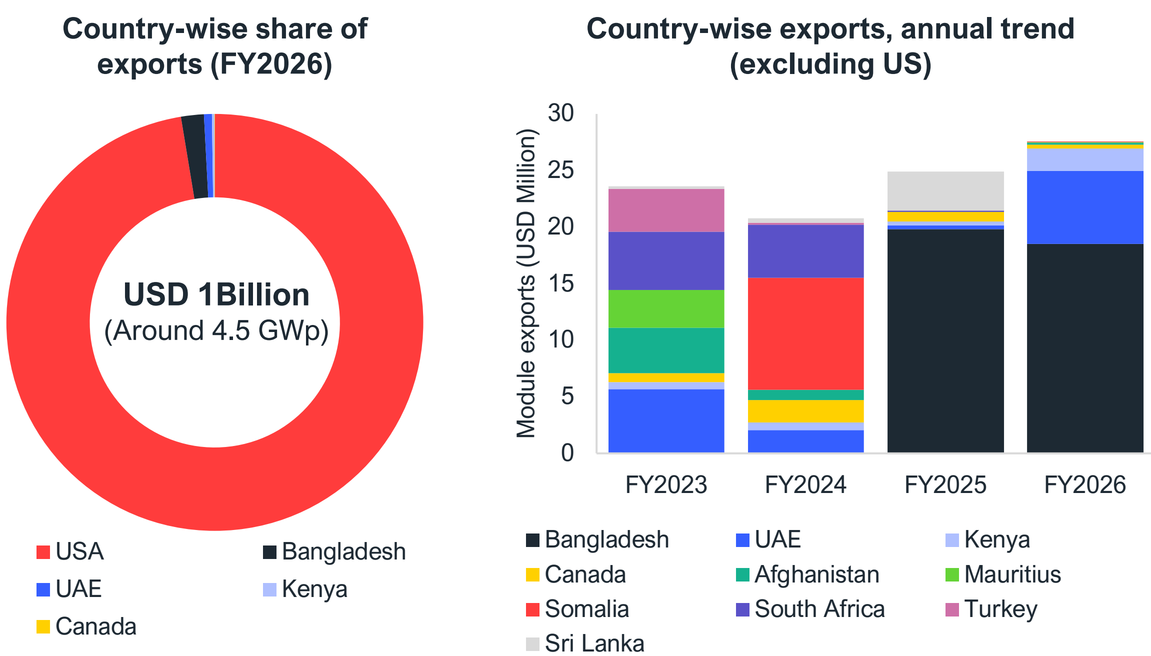
2.2.1.3. Exports

Exports are likely to play an increasingly important role in supporting the utilisation of India's expanding solar manufacturing base. With announced manufacturing capacity additions through 2030 outpacing what domestic demand alone can absorb, the ability to access and diversify international markets becomes essential to sustaining utilisation. Figure 3 below provides an overview of India's current export market structure and recent trends across key export destinations.

India's total solar module exports stood at approximately 4.5GW in FY2026, with the US accounting for around 97% of total export volume. Outside the US, the export base is around 128MW, narrowing in recent years. Current volumes are concentrated in Bangladesh, UAE, and Kenya, which continue to serve as smaller secondary markets. As a result, India's export performance remains heavily dependent on the US market.

[18] Reuters. India could miss 2030 green hydrogen production goals, top official says. November 2025
[19] ET Energy. India hits lowest green hydrogen price, moves closer to $2/kg goal: Amitabh Kant. March 2026
[20] ET Energy. India aims to cut green hydrogen price to $2/kg by 2030: Joshi. September 2025

Figure 3: India's PV module exports: Country-wise share by FY2026 and annual trends across non-US destinations in FY2023–FY2026



Note: Export volume estimates are derived from export value (USD) reported by the Ministry of Commerce and Industry using domestically manufactured non-DCR module selling prices (USD/Wp) and assumed industry margin levels.

Source: Ministry of Commerce and Industry, JMK Research

This dependence emerged as US trade restrictions on Chinese and Southeast Asian solar imports (UFLP Act 2022[21] and Anti-circumvention determination 2023[22]) created a supply gap that Indian manufacturers were positioned to fill. However, the conditions are now weakening. After peaking at approximately USD1.94billion (INR18,330crore) in trade in FY2024, Indian solar module exports to the US contracted 44–47% over the following two years.[23] The decline reflects a marked tightening of US trade policy toward Indian module imports, anchored in two recent regulatory developments:

- Preliminary determinations announced by the US Department of Commerce in February and April 2026 resulted in combined duty exposure exceeding 200% for most Indian manufacturers, materially affecting shipment viability into the US market.[24]

[21] US Customs and Border Protection. Uyghur Forced Labor Prevention Act. June 2022.
[22] International Trade Administration. Reminder on Utilization Requirements for Solar Cells and Modules Imported from Cambodia, Malaysia, Thailand, and Vietnam. August 2023
[23] Ministry of Commerce and Industry. Imports-Exports Tradestat. May 2026
[24] PV Magazine. U.S government sets preliminary countervailing duties on solar imports from India, Indonesia and Laos. February 2026

- While final determinations are scheduled for July 2026 (now deferred to October 2026) and final anti-dumping/countervailing duties (AD/CVD) orders are scheduled by late October 2026, the eventual duty position remains uncertain and will depend in part on the outcome of the ongoing India-US trade negotiations.

Against this constrained US outlook, the European Union (EU) emerges as one of the most structured diversification opportunities for Indian solar manufacturers. Over the past two years, the EU has introduced a series of policy measures, including the Net-Zero Industry Act (NZIA),[25] Foreign Subsidies Regulation (FSR),[26] and Forced Labour Regulation (FLR),[27] which place greater emphasis on supply-chain resilience, sourcing transparency, and sustainability in procurement and market access. Together, these measures could gradually shift a portion of solar procurement away from a purely price-driven market, creating opportunities for manufacturers who can demonstrate compliance, traceability, and supply-chain diversification.

Beyond Europe, opportunities are also emerging across the Middle East and Africa, where some projects, often developed by international and Indian EPC contractors, could provide additional avenues for Indian module exports.

2.2.2. Export competitiveness

While the above developments improve market access opportunities, Indian manufacturers' ability to convert these diversification opportunities into sustained export volumes depends on their competitive position relative to China, the dominant global supplier. That position is shaped by a cost premium and a technology gap. However, the competitive landscape is currently being shaped by financial conditions that favour Indian manufacturers.

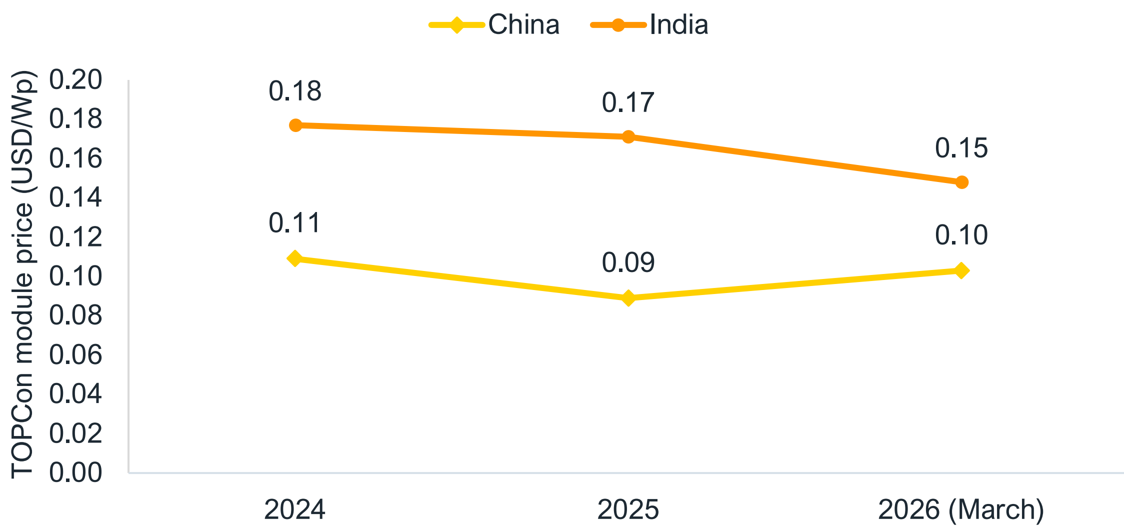
Leading Chinese module producers have been operating under sustained financial stress, with the top five producers reporting combined net losses exceeding USD4–4.7billion (approximately INR37,800–44,415crore) in 2025,[28] driven by persistent oversupply. Indian manufacturers, in contrast, remained profitable through 2025 and first quarter of (Q1) 2026[29], supported by domestic policy protection and higher export margins.

On cost, Indian modules remain more expensive than Chinese modules. The price gap has nonetheless narrowed by roughly 28.6% from its earlier 2024 level (Figure 4), driven primarily by domestic policy support and market protection. Continued additions in cell and wafer manufacturing are expected to reduce import dependence further and improve cost competitiveness over time,

[25] European Commission. Net Zero Industry Act
[26] European Commission. Foreign Subsidies Regulation
[27] European Commission. The Forced Labour Regulation
[28] PV Tech. Five Chinese PV giants anticipate combined 2025 losses of USD4.1–4.7 billion. January 2026
[29] Vikram Solar. Investor Presentation Q4 FY2026

although Chinese manufacturers are likely to retain a scale and integration advantage in the near to medium term.

Figure 4: Narrowing price gap between Indian and Chinese solar modules



Source: Infolink, JMK Research

On technology, Chinese players lead in module efficiency, manufacturing scale, and next-generation architectures. Mainstream Chinese Tunnel Oxide Passivated Contact (TOPCon) modules operate at the upper end of the 24% efficiency band, with capacity transitioning to heterojunction (HJT).[30] Indian TOPCon-based capacity, with leading manufacturers' efficiencies, currently operates in the 22–23% range.[31] The gap can be filled through technology partnerships, R&D investment, and the move toward larger and more vertically integrated Indian operations, but it will not close on policy support alone.

Taken together, supportive EU policies, time-bound investments in upstream integration and efficiency, and continued narrowing of the cost gap with Chinese supply could help Indian manufacturers compete for and capture around 8GW of additional export demand opportunity. Realising this potential, however, will depend on the industry's ability to convert current profitability into lasting cost and technology.

[30] Infolink. Supply-demand imbalance persists; the energy-efficiency standard set to break the price-competition spiral. June 16, 2026
[31] Adani Solar. Datasheet: N-type TOPCon Series

2.2.3. Supply-side landscape

A decade of policy support has helped India build one of the world's largest module manufacturing bases. However, manufacturing capacity is now growing faster than near-term demand growth, increasing pressure on manufacturers with limited technological competitiveness or weak integration across the supply chain.

2.2.3.1. Sector consolidation and mergers and acquisitions

The supply-demand imbalance is expected to accelerate the exit or acquisition of pure-play module manufacturers, while those with vertical integration are positioned to benefit from stronger supply chain control. Manufacturers most vulnerable are:

- Those operating small-scale downstream-only assembly facilities.
- Those running predominantly PERC-based lines as the market shifts toward TOPCon and HJT.
- Those without a credible upstream integration roadmap.

Based on stakeholder consultations and JMK Research's analysis, the categories above together account for 45–50GW of module capacity that is prone to consolidation and disruption in the near future. The risk is particularly acute for legacy PERC-based manufacturers, as TOPCon accounts for over 70% of India's module manufacturing capacity. For these companies, the path forward will likely narrow to strategic divestment, scaling back operations, or acquisition by Tier 1 manufacturers seeking to consolidate order books building new manufacturing capacity.

Unlike the module segment, the key challenge in the cell segment is the limited availability of merchant supply. With nearly 33GW of the 35GW cell-manufacturing capacity tied to integrated companies for captive consumption, only 2GW remains available to the merchant market. This results in a structurally constrained merchant cell market despite significant addition in domestic capacity.

2.2.3.2. Phased advancement of upstream integration

Each successive stage of backward integration requires more advanced technology and greater investment, increasing the risks involved in building and operating new facilities. In practice, upstream integration will progress in stages. Cell manufacturing capacity is already scaling under ALMM List II, and wafer capacity is expected to follow from 2028 onwards. Polysilicon capacity is likely to expand meaningfully only after 2030, with near-term progress limited to a select few PLI awardees that have the financial resources and technical capability to develop these facilities and advance upstream.

A significant recent development on the upstream front is India joining the US-led Pax Silica coalition in February 2026, which coordinates supply across the full silicon stack encompassing critical minerals, polysilicon, and rare earth elements.[32] For a manufacturing base that currently lacks meaningful polysilicon capacity, this membership offers a tangible pathway to diversify procurement away from China and provides the supply chain assurance that has, until now, been a structural barrier to upstream investment.

2.2.3.3. Factory utilisation outlook

Operating profitability for domestic solar PV manufacturers, which remained elevated at approximately 25% in FY2025, is likely to reduce as rising competition and overcapacity build-up put pressure on selling prices.[33]

As per industry experts, depending on the payback period, a module manufacturing unit requires a utilisation rate of 50–65% to operate economically. Broadly, India's module manufacturing facilities are currently operating at an estimated utilisation rate of 35–40%, indicative of the sector-level scale of idle capacity. Utilisation rates could reduce across the sector in the near term. Tier 1 manufacturers, who can shift production to meet domestic demand that is compliant with ALMM List II, are likely to efficiently manage their utilisation rates, while smaller, non-integrated assemblers face a sharper decline.

2.2.3.4. Manufacturing opportunity near overseas demand centres

Establishing manufacturing facilities closer to export markets in Europe, the Middle East, or Africa presents a viable strategic avenue, and several manufacturers are already exploring in this direction. Local manufacturing in these regions allows Indian companies to navigate import duties and local content requirements that currently limit market access, ultimately contributing to reduced exposure to Chinese pricing pressure.

The supply-demand gap will likely persist till 2030 and is expected to accelerate the emergence of a more competitive and integrated industry. Manufacturers that successfully combine scale, technological competitiveness, supply chain integration, and market diversification are best positioned to sustain utilisation and profitability in an increasingly challenging operating environment.

3. Policy recommendations

Policy support is imperative for the industry to sustain and function smoothly in the near to mid-term. The policy interventions outlined below address both the supply-side structural gaps and the demand-side bottlenecks.

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[32] Ministry of External Affairs (MEA). India Joins Pax Silica Initiative, Signs the Joint Statement on India-U.S. AI Opportunity Partnership. February 2026
[33] ICRA Limited. Overcapacity in solar module manufacturing industry. November 2025

3.1. Provide incentives evenly across the value chain

The current PLI framework primarily provides incentives to manufacturers based on integration level, rewarding those producing multiple stages of the solar PV value chain such as Polysilicon, Wafer-Ingot, Cell & Module (PWCM), Wafer-Ingot, Cell & Module (WCM), or Cell and Module (CM). However, capacity additions across these components have remained uneven, with module manufacturing expanding more rapidly than upstream segments.

A more targeted approach would restructure incentives at the component level, assigning meaningful rewards to PWCM manufacturing independently through future PLI iterations. This would ensure that upstream investment is not dependent on achieving full vertical integration, lowering the entry threshold for manufacturers willing to specialise at a single stage of the value chain. This would distribute the supply-side stimulus in a more balanced manner across the value chain, encouraging a broader and more resilient domestic manufacturing base.

3.2. Strengthen industry-research collaboration

Sustaining competitiveness as the industry shifts towards newer technologies such as HJT, perovskite-silicon tandem cells, and other next-generation architectures will require a stronger interface between manufacturers and domestic research institutions. Building innovation capabilities alongside manufacturing capacity, equipment ecosystems, and materials localisation would help shift the basis of competition from scale alone towards technology differentiation, where value addition and margins are typically higher and more durable. Sustained progress on cell efficiency will also help narrow the cost difference with Chinese manufacturers, strengthening price competitiveness in export markets.

Realising this objective will require closer collaboration between manufacturers, research institutions, and public funding agencies. The government should bring in dedicated mechanisms to support this transition, including shared pilot-line infrastructure for emerging cell technologies and industry-academia technology partnerships. These would help accelerate the innovation from laboratory research to commercial manufacturing. Early movers are already signalling this direction, with Rayzon's research partnership with Indian Institute of Technology Bombay (IIT Bombay) offering a model that broader policy support could scale across the manufacturer base.[34]

As noted earlier in the section titled Key trends expected by 2030, a meaningful share of DCR cell capacity is absorbed captively by integrated manufacturers, leaving a limited pool of compliant cells available in the merchant market. Stakeholder discussions indicated that module manufacturers lacking captive cell manufacturing capacity would find it challenging in the near future to procure compliant cells, leading to significant pressure on factory utilisation. However, the extension of the

[34] Rayzon Solar. Rayzon Solar and IIT Bombay Sign Landmark MOU to Enhance Solar Technology Research and Innovation. May 2025

exemption of net-metering and open-access renewable energy projects has provided additional time for domestic cell availability to improve while easing immediate utilisation pressure on standalone module manufacturers.

3.3. Provide well-designed export support

Export support should be designed as a targeted and time-bound subsidy. A phased incentive structure linked to predefined export milestones that is gradually tapered over time can help manufacturers establish a presence in new markets while avoiding long-term dependence on government support. Priority may be given to strategic markets where supply-chain resilience and sourcing diversification are becoming increasingly important, particularly in the EU.

In parallel, India should strengthen trade and industrial cooperation with partner countries to improve market access for domestically manufactured products. Export credit support, concessional working capital facilities, and manufacturing-linked export infrastructure near major ports could further enhance competitiveness.

3.4. Streamline transmission and RoW frameworks

Alongside support for PV manufacturing, addressing bottlenecks in power project development can help sustain domestic solar demand. Resolving the structural bottlenecks that impede project realisation, particularly transmission infrastructure delays and RoW constraints, requires targeted policy intervention. Establishing time-bound clearance mechanisms for RoW approvals, alongside stronger coordination between transmission planning and solar project commissioning timelines would meaningfully reduce project delays.

Proactive development of transmission corridors such as the green energy corridor, aligned with state-level renewable energy targets, would further reduce the gap between capacity awarded and commissioned. These measures, if implemented with clear accountability frameworks, would directly sustain utility-scale deployment, providing the demand continuity that India's expanding manufacturing base would require.

3.5. Repower ageing solar assets

India should establish a dedicated policy framework to encourage the repowering of early-generation solar projects commissioned under the National Solar Mission and other initial deployment phases. Targeted fiscal measures, including accelerated depreciation benefits, investment-linked tax incentives, and exemptions on replacement equipment, can improve the economic viability of upgrading ageing assets with higher-efficiency technologies. Concessional financing and longer-tenure loan products tailored for repowering projects would further support capital deployment.

Regulatory provisions should allow project owners to retain existing grid connectivity, land-use approvals, and other project permissions following equipment replacement, thereby reducing implementation complexity and project timelines. A structured repowering programme could therefore unlock an additional source of domestic demand while improving the productivity of India's existing solar asset base.

4. Conclusion

The expansion of India's solar manufacturing sector has outpaced the near-term domestic demand, resulting in overcapacity at the module level. Although India's solar installed capacity is expected to increase to 280–300 GW by 2030, the projected growth in deployment is unlikely to fully absorb the manufacturing capacity already established. Consequently, module overcapacity is likely to persist through 2030.

Addressing this imbalance will rest on a combination of factors, including growth in domestic deployment, export competitiveness, upstream value-chain development, and the emergence of new demand segments. The pace at which these factors materialise will hinge on the stability of the policy environment and the industry's own ability to adapt to evolving competitive dynamics.

The sector has had repeated disruptions from policy uncertainty, ALMM deferrals, shifting duty structures, and volatile demand signals. Going ahead, consistent and clear policy implementation and visibility will be important and will enable manufacturers to plan investments with confidence and deepen upstream commitments.

The industry's focus is likely to increasingly turn inward toward profitability, operational excellence, and the R&D capabilities that will determine global competitiveness. While the cost and scale gap with established producers is narrowing, it remains significant and will require sustained investment across the value chain. Closing this gap in both cost and quality aspects would open access to global export markets and transform the current surplus into a strategic asset.

On the demand side, continued growth in utility-scale and open-access solar remains the primary driver, while emerging segments such as data centres, green hydrogen, and replacement and repowering demand from India's expanding installed fleet could provide meaningful incremental volumes. The commercial and industrial segment, in particular, can unlock substantial organic demand if regulatory and offtake frameworks evolve to support faster adoption, providing a domestic absorption channel that helps the manufacturing base maintain scale.

Current module overcapacity should therefore be viewed as a transitional feature of a rapidly expanding industry, resolvable through demand absorption and consolidation. Its trajectory will be determined by the pace of market consolidation, upstream integration into cells and wafers, demand certainty, capacity utilisation, and technological advancement to stay globally competitive. Similar supply-demand dynamics are likely to emerge in cells and wafers as investment moves upstream. With these sectoral challenges still unfolding, the coming decade will be decisive in determining whether India’s solar manufacturing base evolves into a globally competitive force in the international supply chain and, in doing so, becomes integral to delivering the scale of deployment that India’s long-term energy transition demands.

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The Institute for Energy Economics and Financial Analysis (IEEFA) examines issues related to energy markets, trends and policies. The Institute's mission is to accelerate the transition to a diverse, sustainable and profitable energy economy. www.ieefa.org

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