India Solar Manufacturing

Demand Update, Supply Reality and Policy Landscape

- Demand Underestimated
- Supply Overstated
- Policy Misread

VALUEQUEST

A Note from our Research Team

India's energy transition is one of the most documented stories in domestic capital markets. And yet, the more deeply we researched it, the more we found that the conventional framing, the one that shapes most of the analysis we read was leaving the most important parts of the story untold.

This report is the product of eighteen months of sustained research into India's solar manufacturing sector. It is the most comprehensive work we have produced on this theme built from the ground up, from installation data, player-level production figures, policy documents, power generation statistics and our own modelling across the full value chain.

What drew us in was a question that seemed simple on the surface: how much module capacity does India actually need? The further we pursued it, the more the answer diverged from what the market assumes. Demand, it turns out, is not one number, it is several, each driven by a different mechanism, each with its own trajectory. And when you account for how the nature of tenders is changing, the true module requirement looks very different from what the gigawatt headlines imply.

The supply picture surprised us too, not in the direction most expect. And the further upstream you go in the value chain, the more interesting and the more consequential the picture becomes.

Underlying all of it is a policy architecture of unusual deliberateness. India has not left its solar manufacturing ambition to market forces. The government has engineered a system in which the domestic value chain is protected, incentivised and progressively deepened, layer by layer, in a sequence that has a clear and knowable logic. Understanding that sequence, we believe, is what separates a structural view of this sector from a thematic one.

And then there is the power generation story, which is where the real long-term conviction comes from. The economics of how India will power itself over the next two decades have shifted in ways that are still not fully reflected in how investors think about this sector. We have tried to document that shift rigorously.

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Agenda

What this report covers across demand, supply, policy and the structural outlook

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India Installation Market

Utility, C&I Open Access, KUSUM and Rooftop — each segment, trajectory and data

02
Total Cell & Module Requirements

How demand aggregates; the oversizing multiplier in FDRE/RTC/Solar+BESS tenders

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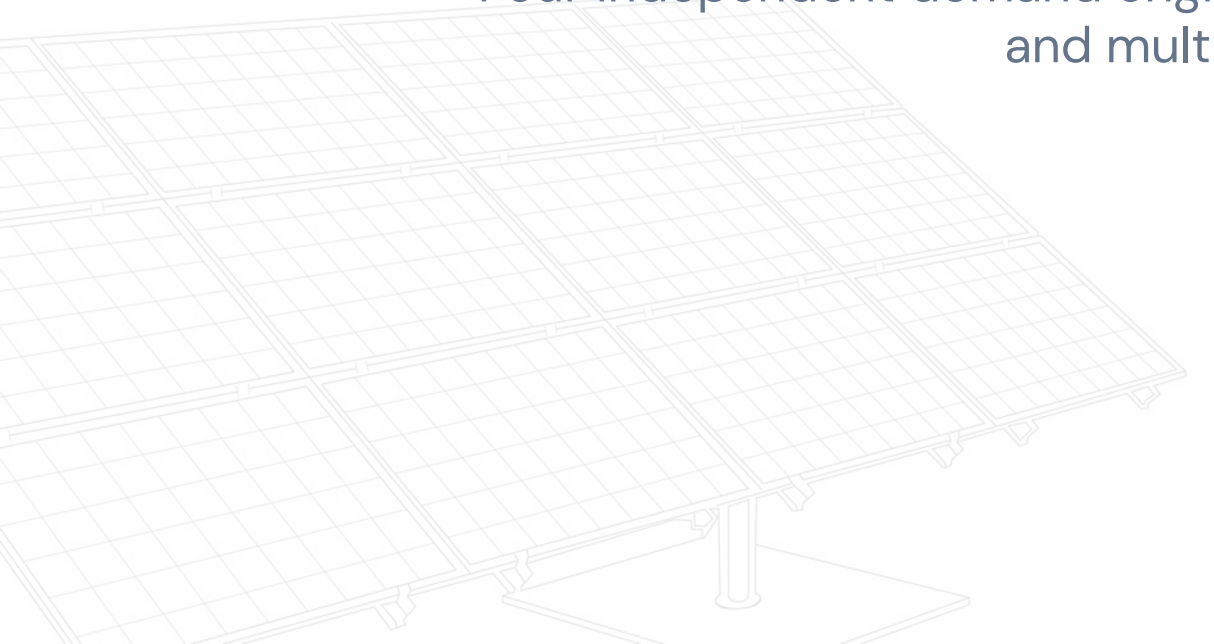
India's Solar Market is not Slowing. It is Accelerating in Ways the Market is not Modelling.

SECTION 01

India Installation Market

Four independent demand engines, each with its own driver, pipeline and multi-year visibility



01

India Installation Market

India's solar market is frequently described as a single number. The reality is more interesting, it is four separate, independently growing demand engines operating in parallel, none of which depends on the others to keep compounding. In FY26, total installations reached ~45 GW across all segments - a number that would have seemed absurd five years ago. The pace of that build-out is without precedent: the **first 50 GW took 11 years, the next 50 GW took 3 years, and the most recent 50 GW took just 14 months.**

The four engines

- Utility scale (47%): Auction-based, ground-mounted projects supplying DISCOMs. ~21 GW in FY26, highest ever, driven by signed PPAs and RPO obligations.
- C&I Open Access (17%): 7.5 GW in FY26. Businesses buying directly from generators. No tenders, no subsidies, grid parity has been crossed and this segment is now self-sustaining.
- KUSUM — Agriculture (16%): PM KUSUM solarises agricultural feeders and pumps. The original 35 GW scheme has grown to ~50–55 GW with state participation, with ~18 GW of PPAs already signed and awaiting execution.
- Rooftop (20%): PM Surya Ghar Yojana drives adoption, ~30 lakh installations so far against a 1 crore target, with 40 lakh applications pending and ₹22,000 Cr allocated for FY27.

The hidden demand multiplier

As DISCOMs shift from plain solar tenders toward storage-backed formats - FDRE, RTC, Solar+BESS, each megawatt of contracted capacity requires substantially more physical modules. A 100 MW plain solar tender requires ~140 MW DC of modules. The same 100 MW in a complex format requires ~200 MW DC of modules. This means module demand is growing structurally faster than the GW installation headline suggests. Compounding this, out of ~58 GW of unsigned PPAs, 73% are plain-vanilla solar PPA's. With DISCOM's preference inclined towards FDRE/RTC, these tenders run a reasonable probability of getting re-tendered in the new complex formats, each re-tender effectively converts a 1.4× module demand event into a 2× event.

Three engines not yet in any model

Data centres, green hydrogen and night-time connectivity are expected to add 15–20 GW of additional annual solar demand from FY29 none of which appears in forecasts or mainstream analyst models. Total demand is conservatively expected to reach ~85 GW annually by FY30.

FDRE – Firm and Dispatchable Renewable Energy, **RTC** – Round-The-Clock (power supply), **BESS** – Battery Energy Storage System

Annual Solar Installations

India's solar market has four distinct, independently growing demand engines

Utility Scale

Large solar projects (50 MW to GW scale) supplying power to DISCOMs or central agencies.

Tender-based (REIA/state auctions) and typically ground-mounted due to large land requirements.

47% share of total installations in FY26

Open Access (C&I)

Projects supply power directly to C&I consumers through bilateral PPAs, bypassing DISCOMs.

Non-tendered, largely ground-mounted, driven by customer acquisition and relationship-led wins rather than auctions.

~17% share | Grid parity crossed — no subsidies needed

Agriculture (KUSUM)

Agriculture-focused solar schemes under PM KUSUM. Tender-driven with state governments awarding projects via competitive bidding.

Component A: small grid-connected plants. Component B: standalone solar pumps. Component C: solarising agricultural feeders.

16% share | ~18 GW unexecuted PPA signed

Rooftop Solar

Small-scale installations on residential, commercial, or industrial rooftops for captive use.

Not tender-based and entirely rooftop-mounted. PM Surya Ghar Yojana is the flagship scheme driving strong adoption and accelerating growth.

~20% share | 11.5 GW application pipeline

Annual Solar Installations

India's solar market has four distinct, independently growing demand engines

Total Solar installed is ~150 GW – First 50 GW took 11 years, next 50 GW took 3 years, while last 50 GW took just 14 months !

~45 GW

FY26 Total — all segments combined

47%

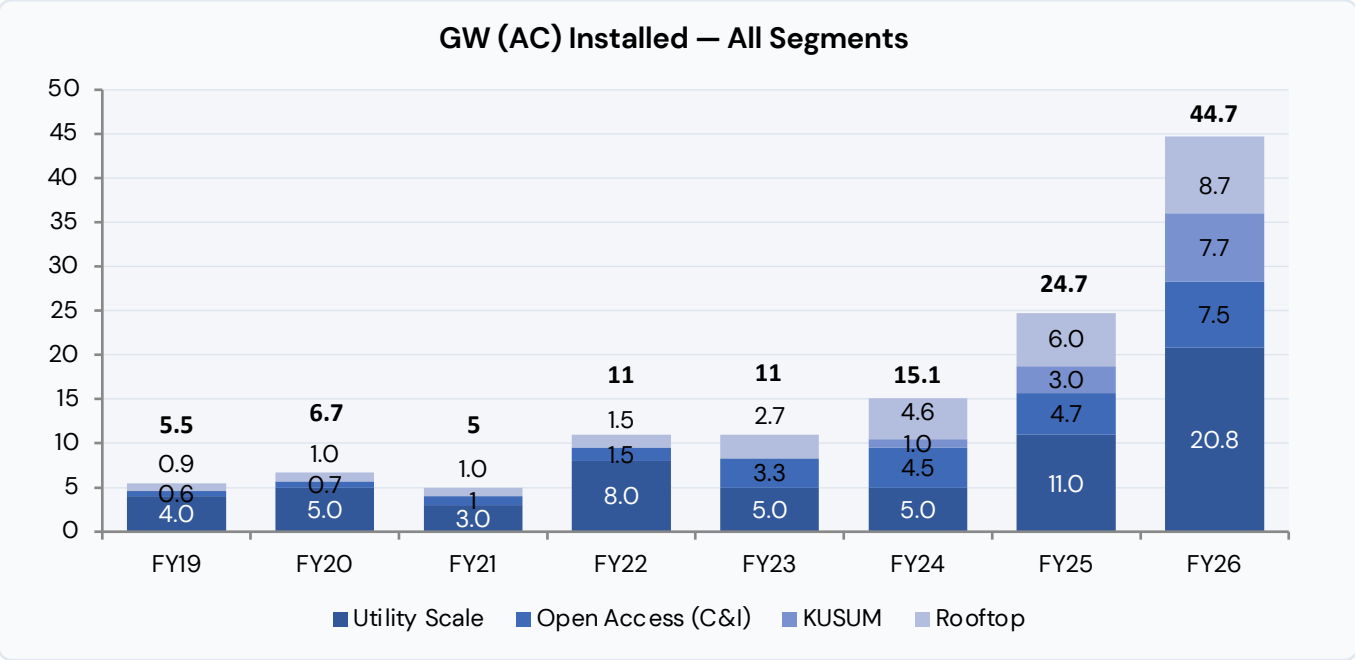
Utility Scale's share of total market

~17% each

Open Access / C&I & KUSUM's share

~20%

Rooftop's share (PM Surya Ghar driven)



Source: JMK Research

How Installation Market is Evolving

Complex tenders create structural module oversizing

Module Oversizing by Tender Type

Tender Type	Installations (MW in AC)	Oversizing for storage (A)	AC/DC Ratio (B)	Modules Required (A * B)
Plain Solar	100	1x	1.4x	1.4x
Solar + BESS (4hr)	100	1.3x	1.4x	1.8x
FDRE	100	1.6x	1.4x	2.3x
RTC	100	1.5x	1.4x	2.1x

DISCOMs increasingly prefer RTC / FDRE / Solar + BESS over standalone solar due to intermittency concerns.

Earlier, a 100 MW plain tender translated to about 140 MW of installed capacity; now, a 100 MW firm power tender corresponds to roughly 200 MW of installation.

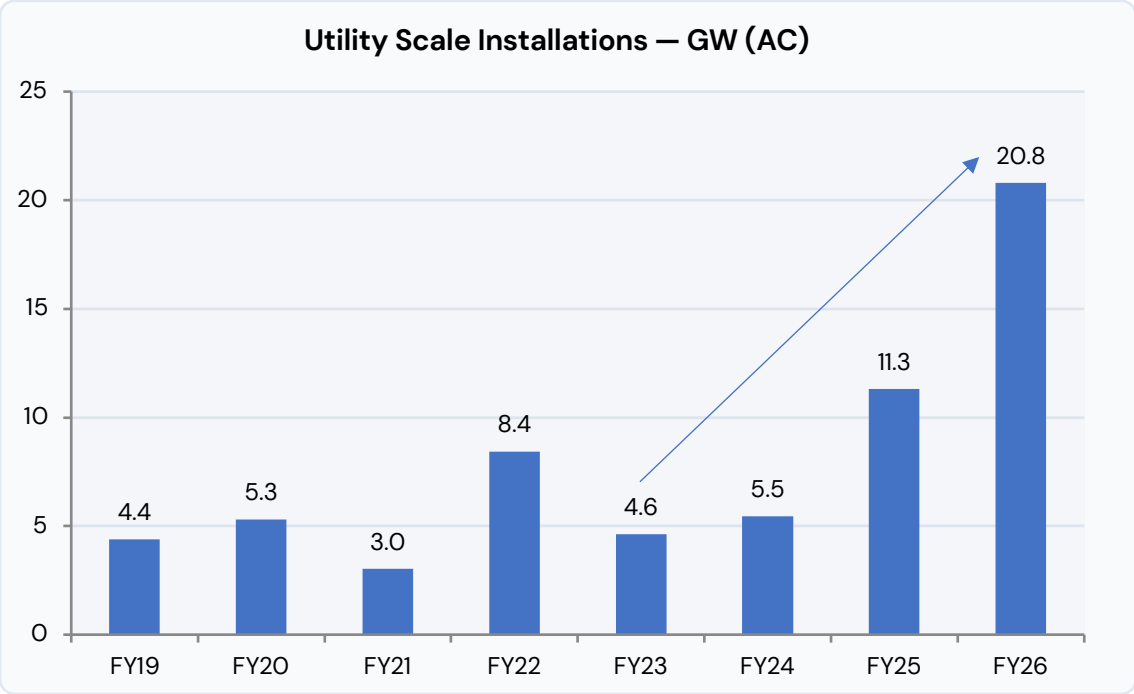
FDRE – Firm and Dispatchable Renewable Energy, **RTC** – Round-The-Clock (power supply), **BESS** – Battery Energy Storage System

Source: VQ Research

- Tender complexity increasing
- Storage-Linked Tenders Rising
- Peak demand complexity & BESS is driving module oversizing
- Module volume growth > Installation capacity growth

Utility Scale: Accelerating Sharply

FY26 achieved ~21 GW of installations — highest ever



Highest ever installations recorded

47% Share of overall Solar Installations Market

Strong visibility based on signed PPA's

Cost Advantage & RPO's driving DISCOM preference

RPO Renewable purchase obligations **PPA** Power purchase agreement

Source: VQ Research

Multi-Year Pipeline: 2.5-Year Utility Solar Visibility

215 GW LOA won; 145 GW PPA signed; 70 GW balance pipeline across solar and wind

	Total LOA Won (FY18–26)	Total PPA Signed (FY18–26)	Till Date Executed (FY20-26)	Balance Pipeline
Solar	174 GW	116 GW	60 GW	56 GW
Wind	41 GW	29 GW	17 GW	12 GW
Total	215 GW	145 GW	77 GW	68 GW

Tender type
Plain solar tenders – **43 GW**
Complex tenders – **13 GW**
(requiring oversizing)

Utility Installations ARR
~21 GW
2.5 Year Pipeline

Unsigned PPA Breakdown
70 GW – (58 GW Solar & 12 GW Wind)

Plain Solar / Hybrid
43 GW
(73%) Signing probability: Low

RTC / FDRE / Solar+BESS
15 GW
(27%) Signing probability: High

Re-tendering Wave: A Structural Tailwind for Domestic Manufacturers

58 GW of unsigned PPAs in flux — the forced reset favours integrated cell/module players

1 The supply overhang

Plain-vanilla solar PPA problem

58 GW unsigned Solar PPAs outstanding

73% plain-vanilla

DISCOMs reluctant to contract these projects. Lower tariff discovery vs. historical bids further weakens off-taker interest.

Result: projects unable to secure buyers or reach financial closure.

2 DISCOM pivot

Firm power becomes the priority

BESS + FDRE/RTC

DISCOMs want supply during both solar and non-solar hours — better aligned with grid and connectivity demands.

New tenders shifting decisively toward firm power formats, not plain solar. Focus on BESS-backed and FDRE / RTC structures.

3 Investment implication

ALMM-II compliance changes the game

2x new demand multiple

1.4x old tenders

Integrated module/cell makers are the structural winners.

Re-tendered bids must comply with **ALMM-II norms requiring domestic solar cells**.
Beneficiaries: integrated module/cell manufacturers.

Key IPP Pipelines: FY26–FY28

NTPC, Adani, ReNew, Tata Power, ACME — strong multi-year order books

NTPC Green

9 GW RE → 24 GW RE (including under construction)

Adani Green

17.2 GW operational → 50 GW by FY30

ReNew Power

11.5 GW RE → 17.7 GW RE

Tata Power

6.1 GW RE operational → 16 GW RE (including under construction)
FDRE/RTC 3x oversizing

JSW Energy

5.7 GW operational → 16.5 GW (including under construction)

ACME Solar

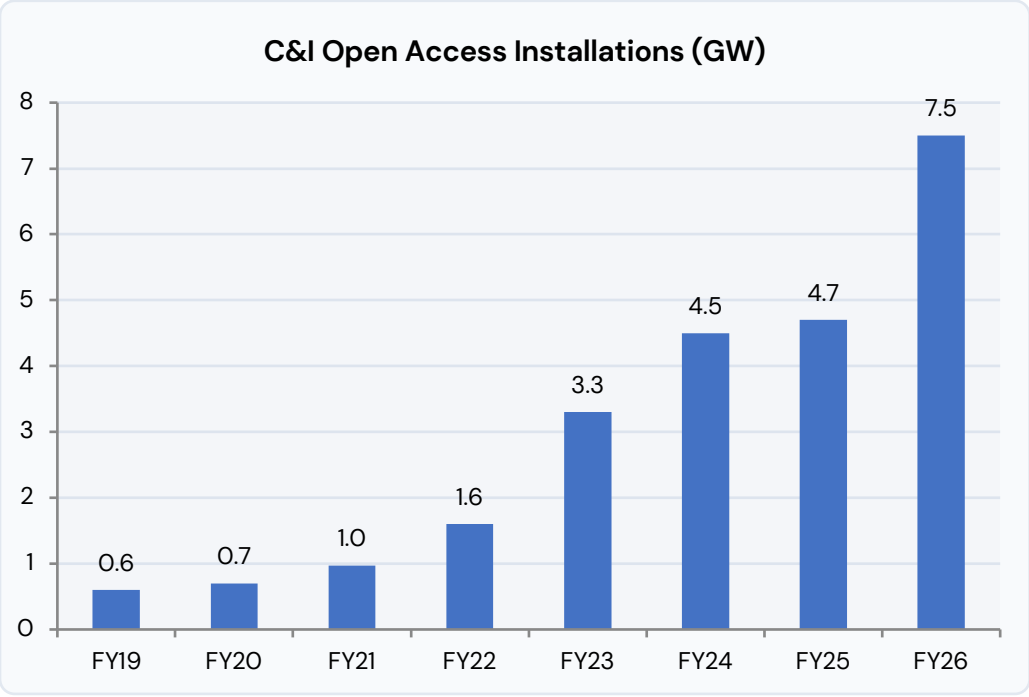
2.9 GW operational → 10 GW by FY30
- 1.5 GW AC commissioning in FY27. These require ~3.3 GW DC modules

~82 GW RE incremental capacity planned across only these players, indicating strong pipeline visibility

Source: Investor presentations, DRHP's, RE – solar + wind + hybrid

C&I Open Access (Solar) — Cost-Driven, Demand-Driven

7.5 GW FY26E; driven by economics not subsidies — most resilient demand category



7.5 GW in FY26 — highest ever

7.5 GW

FY26 — highest ever installations

>10x Growth FY19→FY26E

>10x

Growth from FY19 to FY26E

Cost-led: Grid parity crossed

Cost-led

Grid parity crossed — no subsidies needed

Structural: Long-term advantage

Structural

Long-term cost advantage, ESG commitments, and energy security

Source: Industry Analysis

KUSUM — Focused on Agriculture & Low-Income Households, Large Pipeline

35 GW scheme (40% executed with visibility for execution of remaining over next 2-3 years)

KUSUM Scheme opportunity size* **35 GW**

Total scheme opportunity including all components

Executed till date **~14 GW**

Projects already commissioned and operational

Unexecuted PPA signed **~18 GW**

Projects with signed PPAs awaiting execution

DCR modules opportunity **~11 GW**

Domestic content requirement opportunity i.e. use of domestic cells

Opportunity size breakup

~15 GW
Component A
Installation of Decentralised Grid Connected Solar Power Plant

~10 GW
Component B
Installation of Standalone Solar Powered Agricultural Pumps

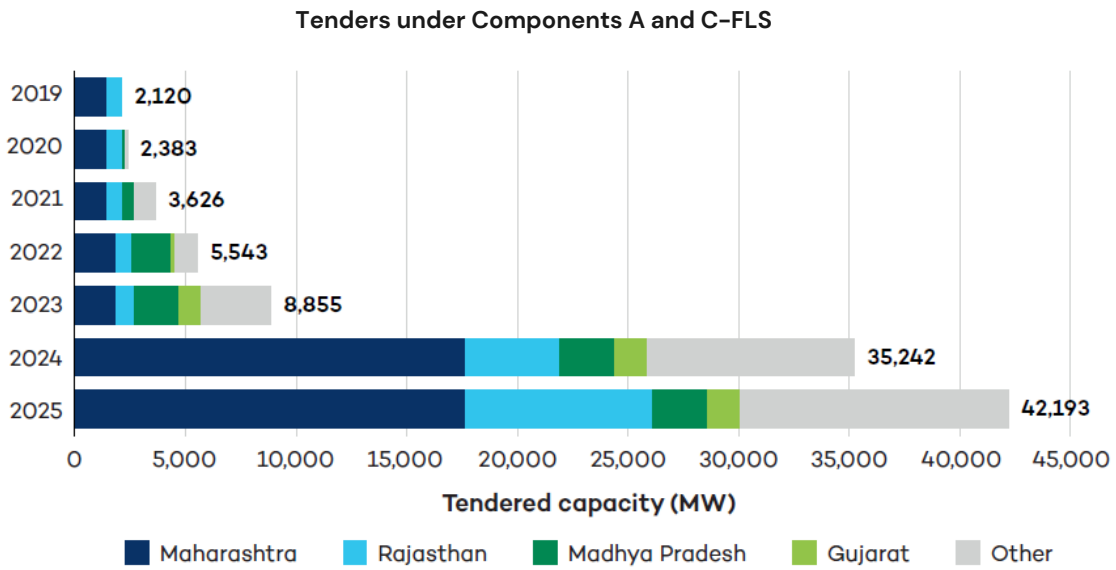
~10 GW
Component C
Solarisation of Agricultural Pumps and Agricultural Feeders

Source: https://pmkusum.mnre.gov.in/#/landing

*The opportunity described is under the central scheme; incremental opportunity from state-level programs is additional and is also gaining traction.

KUSUM — Tendering Tractions for Component A & C-FLS

Steep rise in tenders with Maharashtra leading



Massive step-up in tendering

5x growth in 2 years; Solar tenders surged from ~9 GW in 2023 to ~42 GW in 2025 (cumulative)

State concentration with Maharashtra leading

Maharashtra dominates recent tenders, with incremental contributions from Rajasthan, MP, and Gujarat

PPA's signed for 50% of tenders issued under Component A & C-FLS

PPA's are signed for ~21 GW

KUSUM scheme has scaled beyond initial expectations, with strong participation from state governments driving additional tenders - expanding it from an originally envisaged ~35 GW program to **~50–55 GW** of tenders issued

Source: Scaling Solar Power for Irrigation in India Lessons from PM-KUSUM Components A and C-FLS, IISD REPORT

Agricultural Solarisation — Opportunity of 191 GW

Top 7 states contribute ~73% of opportunity size

State-wise opportunity if 100% Agri-solarisation

Analysis of solar capacity requirements by state for agricultural demand

State	Agricultural Demand - 2030P (BU)	Required Solar Capacity (GW)	% of Total
Rajasthan	45.4	**27.3**	14.3%
Maharashtra	40.6	**24.4**	12.8%
Madhya Pradesh	37.5	**22.5**	11.8%
Karnataka	29.5	**17.7**	9.3%
Uttar Pradesh	28.0	**16.8**	8.8%
Gujarat	25.9	**15.6**	8.2%
Telangana	24.5	**14.7**	7.7%
Others	85.7	51.5	27.0%
Total	**317 BU**	**191 GW**	**100%**

Insight: ~191 GW opportunity vs ~50–55 GW tenders → significant headroom; Likely push for new schemes to accelerate adoption

What large-scale agricultural solarisation can deliver by 2030

₹3+L Cr
Cumulative direct subsidy savings for the state government.

₹1+L Cr
Cross-subsidy requirement avoided, easing tariff pressure on C&I consumers.

6–24%
Reduction of the average cost of supply relative to a no-solarisation trajectory in 2030.

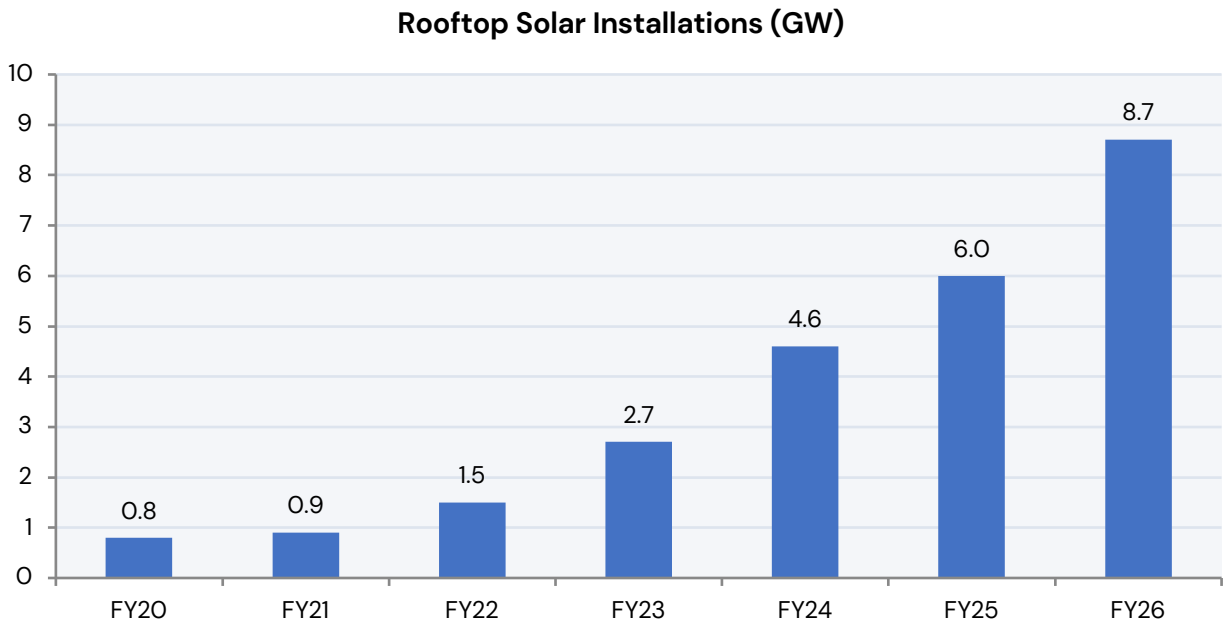
~160 $MtCO_2e$/year
Annual emissions reduction.

~8L full-time equivalent (FTE) jobs
Supported across manufacturing, installation, and operations.

Source: CEEW, IISD & CSTEP, Solarising Agricultural Power Demand by 2030, Issue Brief, April 2026

Rooftop — PM Surya Ghar Driving Acceleration

Current annual demand 9–10 GW p.a.; 11.5 GW application pipeline = >1 year forward visibility



Current annual demand

9–10 GW

Current annual demand level

Application pipeline

11.5 GW

Application pipeline providing ~1yr visibility

Andhra + UP's share

>50%

as a % of total applications across India

Budget allocation

22,000 Cr

Budget allocation to scheme for FY27 period

~30L installations achieved vs 1 Cr target (~30%)

~40L pending applications provide visibility

C&I rooftop is also experiencing traction

Source: JMK Research

Solar Installations Outlook — Strong Drivers Underpin Growth

Visibility of ~50 GW annual additions across utility, C&I, rooftop & other segments

Strong segment-wise demand drivers underpin confidence in ~50 GW annual installations.

Annual installation capacity by segment with key drivers

Segment	Annual Installation (AC)*	Driver
Utility	23 GW	Signed PPA's
C&I	9 GW	Cost savings + ESG commitments
Rooftop	10 GW	Central subsidy
KUSUM	8 GW	Subsidies + Signed PPA's
Total	**~50 GW**	All segments combined

*Reasonable visibility for FY27 & FY28

Source: VQ Research

Option Value – Demand Engines Not in Any Model

Data centres, green hydrogen & Night-time connectivity will add additional demand of 15-20GW annually from FY29 - uncaptured

AI / Cloud Data Centres

30-40 GW
Power demand by FY30

100%
Preference for 24x7 clean power

India approved **300+ data centre projects**. AWS, Microsoft, Google all committed ₹2–3L Cr each.

AI inference requires 24x7 firm power — only Solar+BESS can deliver this at scale cost-effectively.

Each 100 MW data centre needs **~250 MW Solar + 150MW wind + ~450 MWh BESS** to run 24x7 on renewables.

Not in CEA demand forecasts. Not in analyst models. This is additive demand.

Green Hydrogen

5 MT
India's 2030 green H_2 target (NGHM)

~20 GW
Solar needed per 1 MT H_2

National Green Hydrogen Mission: 5 MT/year by 2030. Each MT requires ~20 GW dedicated solar.

Green H_2 electrolysers run best at stable, high-load factor — needs large solar + storage plants.

PLI scheme for electrolysers: **₹17,490 Cr**. SECI tendering 1.5 MT of H_2 offtake.

Even 10% of target = 10 GW of additive solar demand invisible in current estimates

Night-time connectivity

~110 GW
Ground mounted Installed base

20-30%
Existing base conversion

~110 GW Ground mounted Installed base; same connectivity usable during non-solar hours.

BESS enables time-shifting, not generation — needs extra solar input.

Acts as a bridge until transmission build-out catches up. Incremental capacity needed to charge BESS.

25–35 GW Same interconnection point used for higher energy throughput

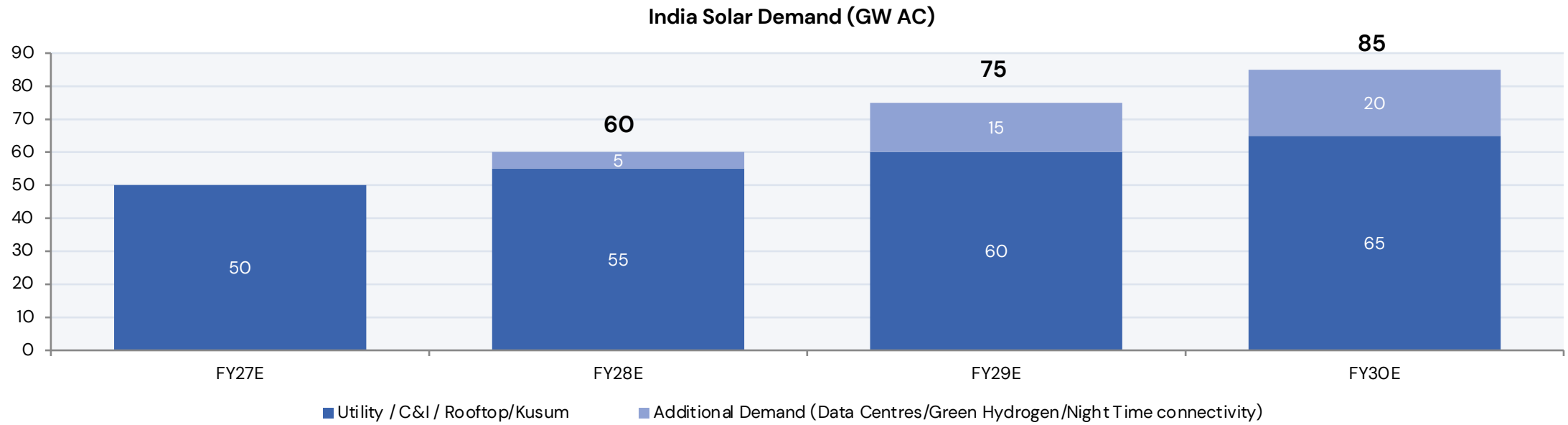
Source: VQ Research

Quantifying the Solar Demand — FY27 to FY30

~85 GW by FY30 with module requirement of 120GW

Strong segment-wise demand drivers along with new demand drivers coming up through data centres/Green hydrogen/Night-time connectivity.

~85 GW annual installations for FY30P with module requirement of 120GW



Source: VQ Research

SECTION 02

Total Cell & Module Requirements

Aggregating all segments and why module demand structurally exceeds GW-of-projects thinking

Total Cell & Module Requirements

One of the most persistent errors in how the market models this sector is treating gigawatts of tenders as equivalent to gigawatts of modules required. That assumption was reasonable when most projects were plain solar. It no longer holds.

With the rapid shift toward FDRE, RTC and Solar+BESS structures, ~50 GW AC of tenders in a complex tender scenario requires ~87 GW DC of modules — compared to ~64 GW DC under a plain solar tenders' scenario. **That is a 36% structural uplift in module demand** from the same headline numbers.

The ALMM policy cascade: demand locked in by regulation

Overlay the ALMM policy sequence and the demand picture becomes more specific. Three layers of localisation are being progressively mandated:

- **ALMM-I (active):** Only listed modules eligible for domestic market. Module assembly is the domestic value-add.
- **ALMM-II (June 2026):** Mandatory domestic cells for all government tenders issued post Aug'25 and C&I projects. DCR module demand spikes from 18 GW in FY26 to 55 GW in FY28.
- **ALMM-III (June 2028):** Mandatory domestic wafers. India currently has only ~5GW capacity, the next big upstream bottleneck.

The key takeaway: the headline GW number for India's solar market systematically understates the volume of domestically manufactured components required.

Module Requirement — Evolving

~50 GW AC of installations require ~87 GW DC of modules

Module Demand

Comparison of plain solar vs Solar+BESS/FDRE/RTC tenders

Plain Solar vs Complex Projects

TYPE OF PROJECT	PLAIN SOLAR			SOLAR+BESS/FDRE/RTC TENDERS		
	TENDERED (GW AC)	INSTALLATIONS (GW AC)	MODULE REQ.** (GW DC)	TENDERED (GW AC)	INSTALLATIONS* (GW AC)	MODULE REQ.** (GW DC)
Utility Scale (Plain/Complex)	22	22	25	22	33	46
Open Access (C&I)	10	10	11	10	15	21
KUSUM	6	6	7	6	6	8
Rooftop	12	12	9	12	12	12
TOTAL	**50 GW**	**50 GW**	**64 GW**	**50 GW**	**66 GW**	**87 GW**

India requires ~87 GW DC of modules required for ~50 GW AC installations for complex projects while plain solar installations required ~64GW DC modules

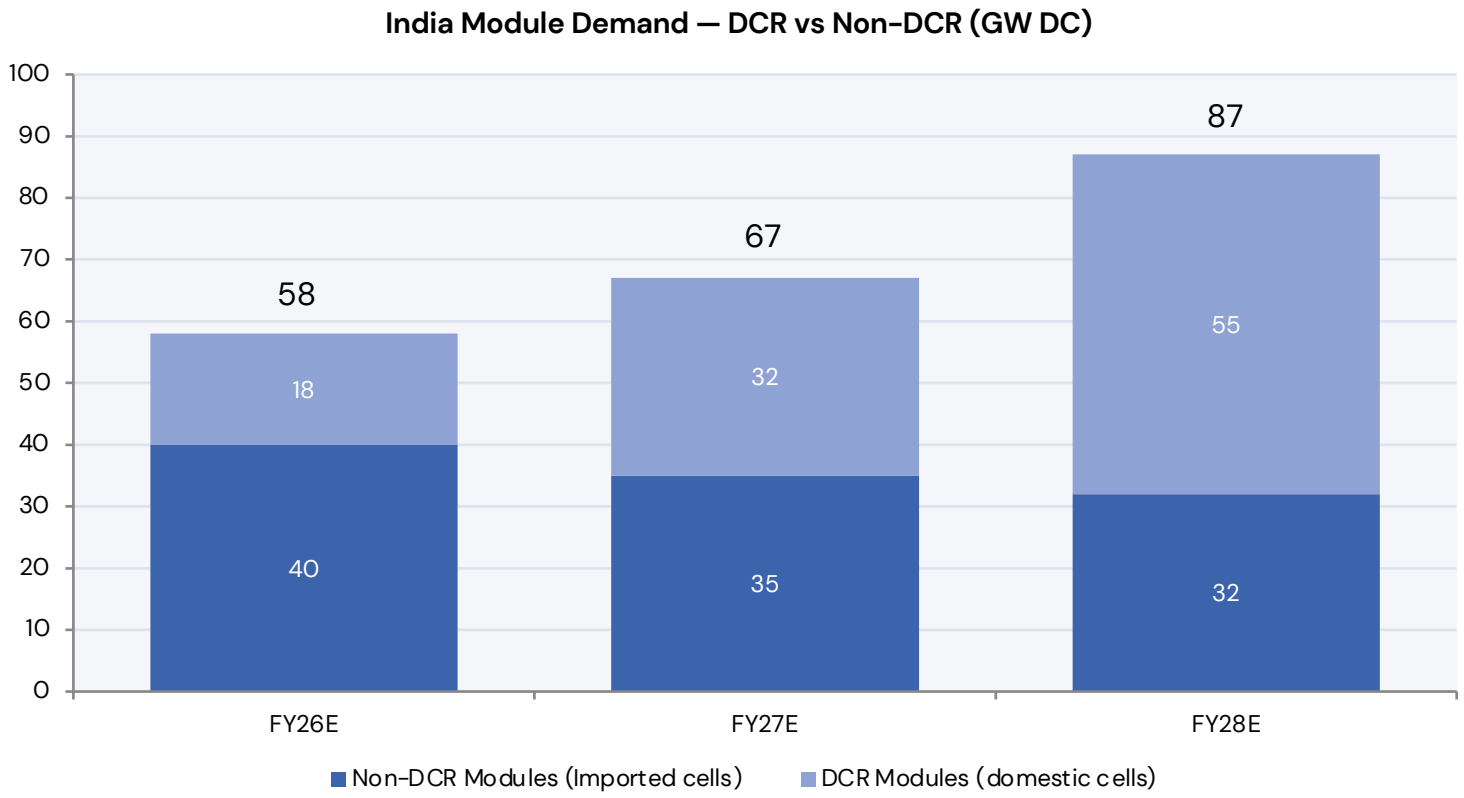
* Oversizing factor of 1.5x for utility & C&I driven by firm power requirement

** AC/DC Ratio – 1.4x

Source: VQ Research

India Cell Requirement — DCR Spike from ALMM-II

June 2026 ALMM-II mandate to drive a sharp pivot toward domestic cells, while non-DCR demand remains resilient led by execution of legacy tender pipeline.



Source: VQ Research

ALMM (2021) — Modules

Status: Active

- Only listed modules in govt/CPSU projects. Ensured quality + India-preference.

ALMM-II (June 2026) — Cells

Status: Imminent

- Mandatory domestic cells for govt project tenders issued post Aug'25 & C&I installations.
- Immediate spike in domestic cell demand from C&I segment.

ALMM-III (June 2028) — Wafers

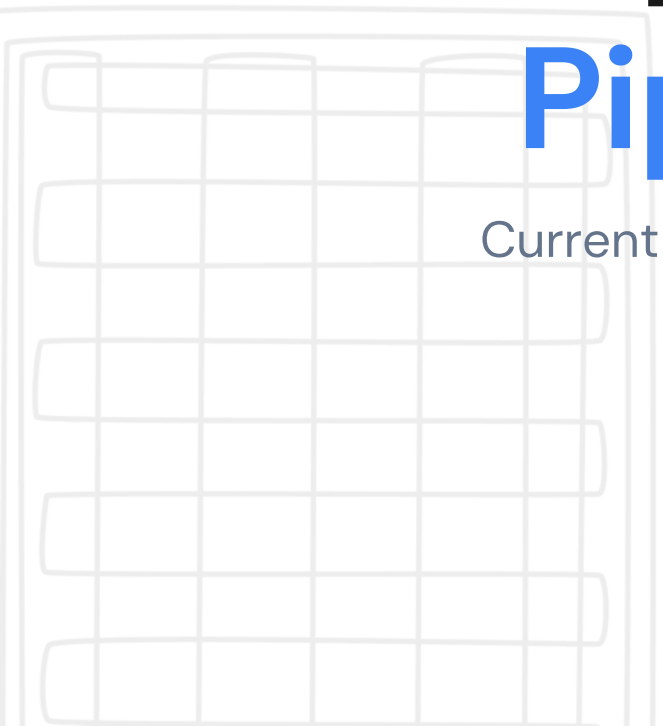
Status: Upcoming

- Applicable when >3 manufacturing units operate independently.
- Aggregate capacity >15GW.
- Demand from FY29 onwards.

SECTION 03

Supply: Installed Base & Pipeline (Cell & Wafer)

Current capacity by player, monthly run-rates, new entrants and the upstream bottleneck



Supply: Installed Base & Pipeline

The market consensus on supply is built on announced capacity, which looks abundant. The more accurate picture built from actual production data at the player level is considerably tighter, and it gets tighter the further upstream you go.

Cell manufacturing: the real constraint

India has ~33 GW of nameplate solar cell manufacturing capacity with ~30GW of ALMM-II listed capacity across 12 players. At 66% average utilisation on ALMM-II listed capacity (with several plants only recently commissioned), FY26 actual output was ~19 GW. Even running the full installed base at 85% utilisation, maximum output is ~25 GW.

Capacity expansions are underway, Waaree scaling from 5.4 to 15.4 GW, Premier from 3.6 to 10.4 GW, Mundra from 4 to 10 GW, Jupiter from 2 to 10.4 GW, but announced capacity and operational capacity are very different things. Ramp-up, commissioning and ALMM-II qualification all take time.

Wafers and ingots: the next bottleneck (FY29)

If ALMM-II creates cell tightness through FY28, ALMM-III resets the cycle at a higher level. India today produces virtually no wafers or ingots, the supply chain is 100% import-dependent on China for this layer. Once ALMM-III is notified in June 2028, cell manufacturers cannot use imported wafers, but building domestic wafer capacity takes 2–3 years and requires ₹650–700 Cr per GW. Only 3–4 players have the balance sheet and PLI support to enter. The first mover will own the pricing and the relevant market for the first few years of the cycle.

Current Installed Base — Solar Cell Manufacturing

33 GW nameplate; ~30 GW ALMM II enlisted capacity; ~19 GW FY26E production at 66% average utilisation

Solar Cell Manufacturing Capacity

Player-wise capacity, run-rates and utilisation analysis

Player	Nameplate (GW)	Actual Cap. (ALMM-II List)	FY26E Prod. (GW)	Utilisation
Tata Power	4,813	4,813	3,683	76%
First Solar	3,433	3,433	2,840	83%
Renew#	2,500	1,766	1,845	105%
Premier*	3,600	3,283	2,235	80%
Mundra	4,000	4,237	2,693	62%
Emmvee#	2,900	1,553	1,600	103%
Waaree	5,400	5,251	2,283	44%
Jupiter*	2,000	1,770	726	80%
Websol*	1,200	1,202	699	77%
Evervolt	1,200	1,074	382	34%
UTL Solar*	1,000	437	110	44%
Reliance	1,240	1,238	-	NA
TOTAL	**33,286**	**30,057**	**19,096**	**66%**

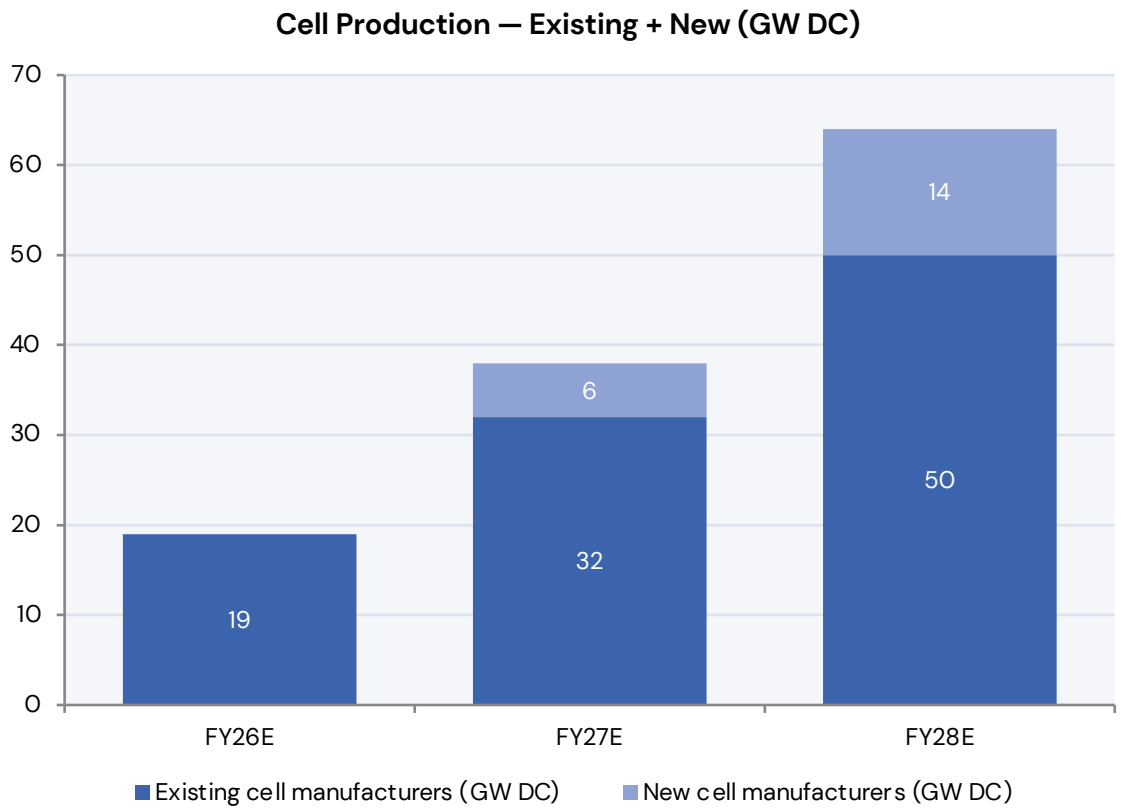
*Jupiter, Premier & UTL's additional capacity began production in Q4FY26 & Websol's new capacity began production in Q3FY25. Utilisation is adjusted accordingly. #Renew & Emmvee's capacities are still not enlisted in DCR portal due to which it shows >100% utilisation

Existing capacities if operated at **85% utilisation** can produce **25 GW cells** annually

Source: MNRE, DCR Portal Data

New Players Entering: FY27–FY28 Ramp

New capacity concentrated in modules, not cells/wafers — upstream remains the real constraint



Waaree Energies
Existing capacity of 5.4 GW expanding to 15.4 GW in FY27E

Premier Energies
Existing capacity of 3.6 GW expanding to 10.4 GW in FY28E

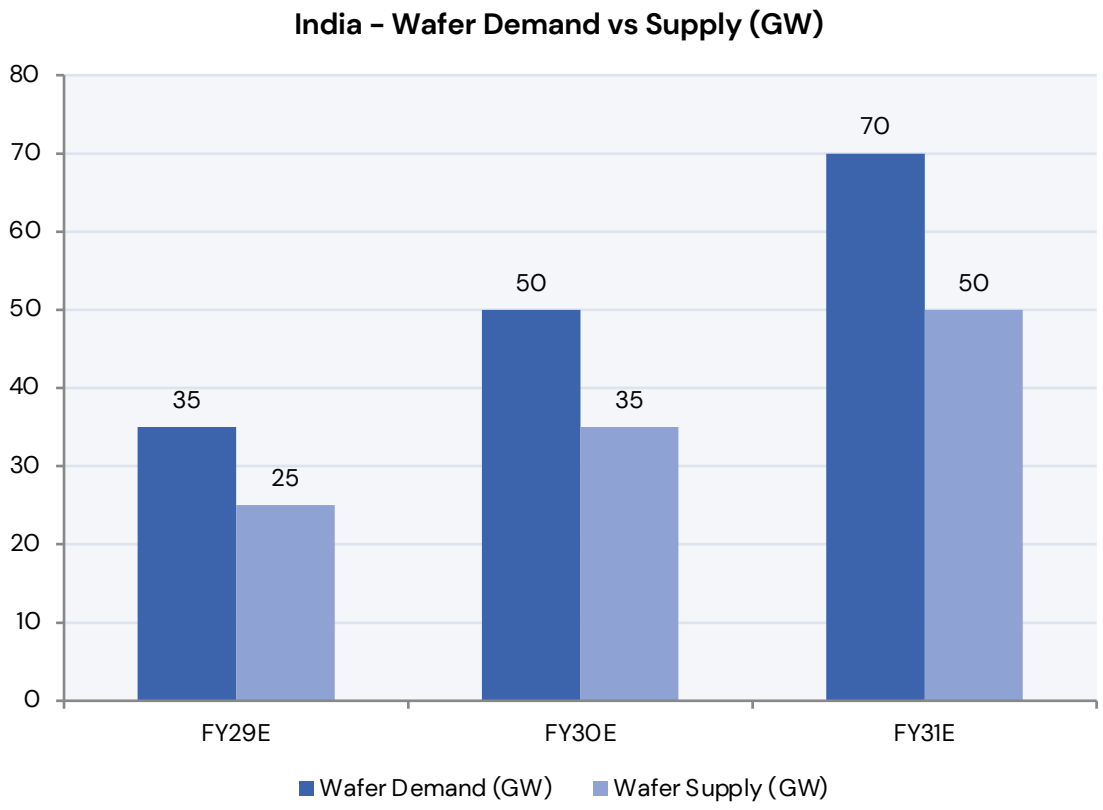
Mundra Solar
Existing capacity of 4.0 GW expanding to 10 GW in FY28E

Jupiter International
Existing capacity of 2.0 GW expanding to 10.4 GW in FY28E

Source: VQ Research

India's Wafer & Ingot Landscape — The Next Bottleneck

ALMM-III will mandate domestic wafers. India has virtually no operational capacity today. This opportunity will kick off from FY29.



Only ~5 GW today*

India has very little meaningful wafer/ingot production at present. **100% import dependent on China** for this layer.

ALMM-III = Hard Stop

Once notified in **June 2028**, cell manufacturers cannot use imported wafers. Demand is immediate; supply takes **2–3 years** to build scale.

Capital Intensity is High

Wafer/ingot lines require **₹650–700Cr per GW**. Only players with strong balance sheets and PLI support can enter.

First-Mover Wins

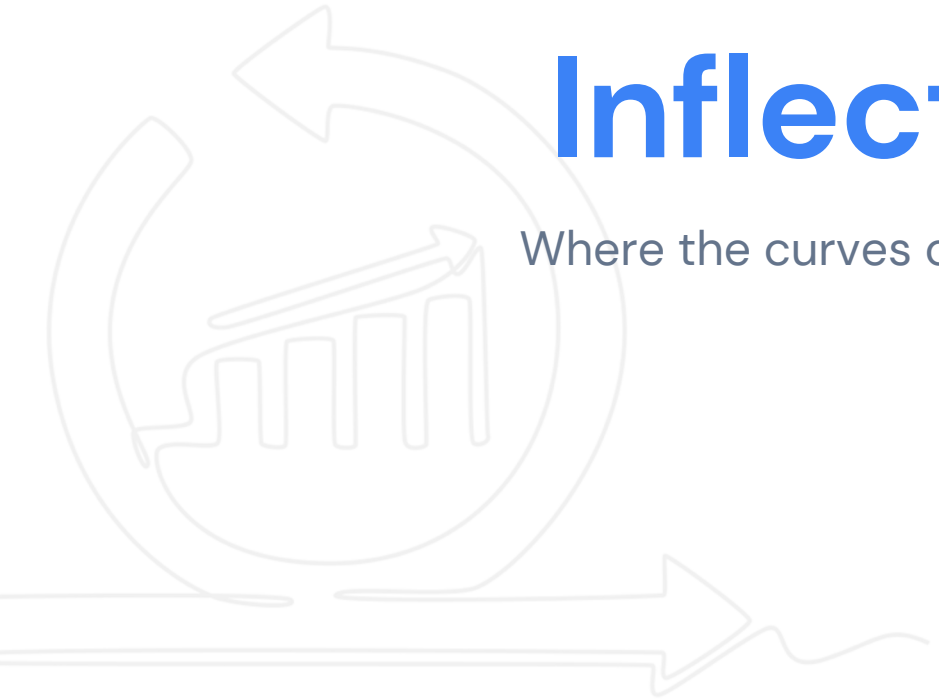
With **2–3 years of supply scarcity** post-ALMM-III, the first mover captures pricing power and long-term contracts.

Source: VQ Research, *includes Adani & First Solar

SECTION 04

Demand–Supply Inflection: FY26–FY32

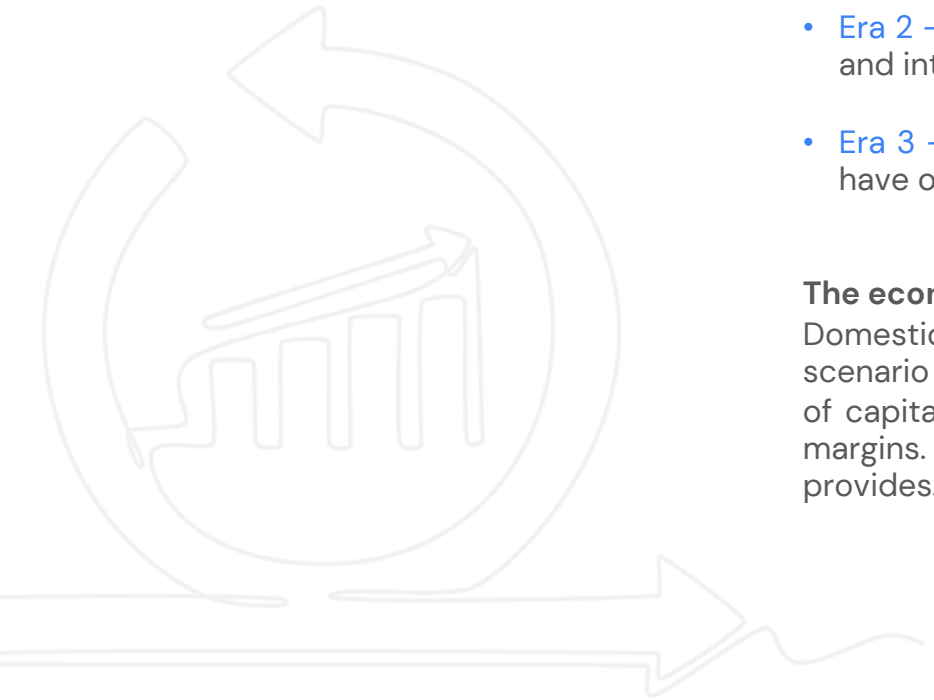
Where the curves cross and why FY29 is not the end of the story, it's the start of a new chapter



04

Demand–Supply Inflection: FY26–FY32

The most important structural insight from this report may not be a specific number but a pattern: each time India's ALMM policy moves one step upstream, the profit pool moves with it. The company positioned correctly at the right layer for each era captures a protected margin premium.



Three eras of margin migration

- Era 1 — FY22–FY25 (Modules): BCD and ALMM-I protect module assembly margins. Cells are largely imported. Domestic value-add is at the assembly layer.
- Era 2 — FY25–FY28 (Cells): DCR scheme & ALMM-II forces domestic cell manufacturing. Cell manufacturers and integrated cell+module players dominate. Pure assemblers lose pricing power progressively.
- Era 3 — FY29–FY31 (Wafers): ALMM-III pushes margins upstream to wafers and ingots. Few companies will have operational capacity. Scarcity premium is structural.

The economics validate the thesis

Domestic cell manufacturing delivers ~61% ROCE at current realisations. Even in a compressed pricing scenario — where realisations fall from $0.14 to $0.10/Wp — ROCE remains ~36%, comfortably above the cost of capital. A fully integrated wafer+cell facility delivers ~34% ROCE on ₹1,200 Cr of capex, with 53% EBITDA margins. These are not commodity-level returns — they reflect the structural demand protection that policy provides.

Profit Pool Migration: Where the Margin Lives in Each Era

As policy moves upstream, margin concentrates among integrated players.

Policy Drivers	Market progression		Margin Drivers			
ALMM-I 2022 Modules	**Era 1: FY22–FY25** Module Assembly	Modules are the domestic value-add. BCD + ALMM protect module margin. Cells imported except for DCR schemes.	Polysilicon (import)	Wafer/Ingot (import)	Cell (import/blend)	**Module** (India ✓)
ALMM-II 2026 Cells	**Era 2: FY25–FY28** Cell Integration + DCR demand	DCR schemes & ALMM-II forces domestic cells. Integrated cell+module & cell players dominate.	Polysilicon (import)	Wafer/Ingot (import)	**Cell** (India ✓✓)	Module (India ✓)
ALMM-III 2028 Wafers	**Era 3: FY29–FY31** Wafer Integration	ALMM-III pushes margin to wafers/ingots. Few companies will have wafer capacity. Scarcity premium sustained.	Polysilicon (import)	**Wafer/Ingot** (India ✓✓)	Cell (India ✓)	Module (India ✓)

Each ALMM layer moves the margin concentration one step upstream. The cell manufacturers or integrated players today in cells, tomorrow in wafers always wins the cycle.

Normalised Cell ROCEs still remain attractive

Analysis of current vs forecast economics for 1 GW cell manufacturing capacity

Cell Economics — 1 GW

Comparison of current vs forecast financial metrics

Metric	Unit	Current	Forecast
Capacity	MW	1,000	1,000
Capex / GW	INR Cr	600	600
Working Capital	INR Cr	83	59
Total Capital Employed	INR Cr	683	659
Production Efficiency		80%	80%
Production	MW	800	800
Realisation/wp	USD	0.140	0.100
EBITDA / wp	USD	0.070	0.045
Revenue	INR Cr	1,008	720
EBITDA	INR Cr	504	324
EBITDA Margin	%	50%	45%
ROCE	%	**61%**	**36%**

Source: VQ Research

Super Normal Return

Normalised Return

Wafer + Cell ROCEs

Analysis of forecast economics for 1 GW combined wafer and cell manufacturing capacity

Cell + Wafer Economics — 1 GW (Forecast)

Metric	Unit	Forecast
Capacity	MW	1,000
Capex / GW	INR Cr	1,200
Working Capital	INR Cr	95
Total Capital Employed	INR Cr	1,295
Production Efficiency		80%
Production	MW	800
Realisations / wp	USD	0.160
EBITDA / wp	USD	0.085
Revenue	INR Cr	1,152
EBITDA	INR Cr	612
Depreciation	INR Cr	171
EBIT	INR Cr	441
EBITDA Margin	%	53%
ROCE	%	**34%**

Source: VQ Research

SECTION 05

Policy Architecture & Value Chain Shifts

ALMM, DCR, PLI, BCD, how each layer of policy is engineered to protect and migrate margins upstream

05

Policy Architecture & Value Chain Shifts

The single most common misreading of India's solar sector is that Chinese module pricing sets the competitive floor. It does not at least not for the domestic market. India has built a deliberate, five-part policy architecture that insulates domestic manufacturers from global pricing and concentrates margin in integrated players.

The five-tool policy toolkit

- ALMM: Quality and localisation gatekeeper — excludes unlisted imports from government projects.
- BCD: 40% duty on modules, 27.5% on cells — makes Chinese equipment unviable for most use-cases.
- PLI: Production-linked cash rebates that reduce effective manufacturing costs versus imports.
- DCR: Domestic content requirements for specific categories, demand locked in regardless of global prices.
- CPSU: Government procurement at scale with full DCR requirements, assured, multi-year offtake.

Integration wins every phase

Pure domestic module assemblers have low margin protection and limited pricing power. Integrated cell+module & cell players have high margin protection and volume certainty. Wafer+cell+module players will have very high protection across all dimensions.

TAM

Policy systematically advantages depth of integration and the TAM rewards it

India's solar + energy manufacturing opportunity grows from ₹51,000 Cr in FY25 to ₹4.5 lakh Cr by FY35 as each new component layer is localised.

The Localisation Roadmap – A Rolling 20-Year Opportunity

India will localise each component layer in sequence. Each layer creates a new protected profit pool for 5–7 years.

Wave 1
2020–25 **Established**

First wave of localisation focused on module assembly and basic components. ALMM established for domestic preference.

Components

- Modules (ALMM)
- BOS components
- Inverters (partial)
- EPC services

Wave 2
2025–30 **Underway**

Second wave expanding into cell manufacturing and storage. ALMM-II driving domestic cell adoption.

Components

- Solar Cells (ALMM-II)
- BESS (DCR proposed)
- Solar Glass
- EVA Film/Backsheet

Wave 3
2028–33 **Emerging**

Third wave targeting upstream manufacturing with wafer and ingot production. ALMM-III mandates domestic wafers.

Components

- Wafers & Ingots (ALMM-III)
- Inverter full localisation
- Power Transformers (DCR)
- BESS cells/chemistry

Wave 4
2031–36 **Planning**

Fourth wave focusing on polysilicon and advanced manufacturing. Full supply chain integration.

Components

- Polysilicon
- Electrolyser manufacturing
- Green H_2 equipment
- Offshore wind components

Each wave creates a new protected profit pool for 5–7 years. The manufacturing opportunity keeps compounding as new components get localised, with the TAM growing from ₹51K Cr in FY25 to ₹4.5L Cr by FY35.

The Government's Full Policy Toolkit

Every layer of the supply chain is being deliberately protected — this is not a free market

ALMM
Approved List of Models

Approved List of Models & Manufacturers. Only listed products in govt projects. Quality + localisation gatekeeper.

Impact:

Excludes cheap imports

BCD
Basic Customs Duty

40% duty on imported modules. 27.5% on imported cells. Makes Chinese imports economically unviable for most use-cases.

Impact:

Protects domestic manufacturer margins

PLI Scheme
Production Linked Incentive

Production Linked Incentive — cash rebate on output. Reduces effective cost of Indian manufacturing vs imports.

Impact:

Subsidises domestic capacity build-up

DCR
Domestic Content

Domestic Content Requirement — certain project categories must use Indian-made modules/cells. Demand is locked regardless of global prices.

Impact:

Structural demand support for local players

CPSU Programme
Govt Procurement

Govt agencies (SECI, NTPC) procure at scale. Full DCR requirements. Stable, multi-year revenue visibility.

Impact:

Assured offtake from government-backed entities

Integrated vs Pure-Play: Who Wins Each ALMM Phase?

Policy systematically advantages integration. Pure module assemblers lose pricing power with each ALMM layer.

Competitive Positioning Matrix — By ALMM Phase

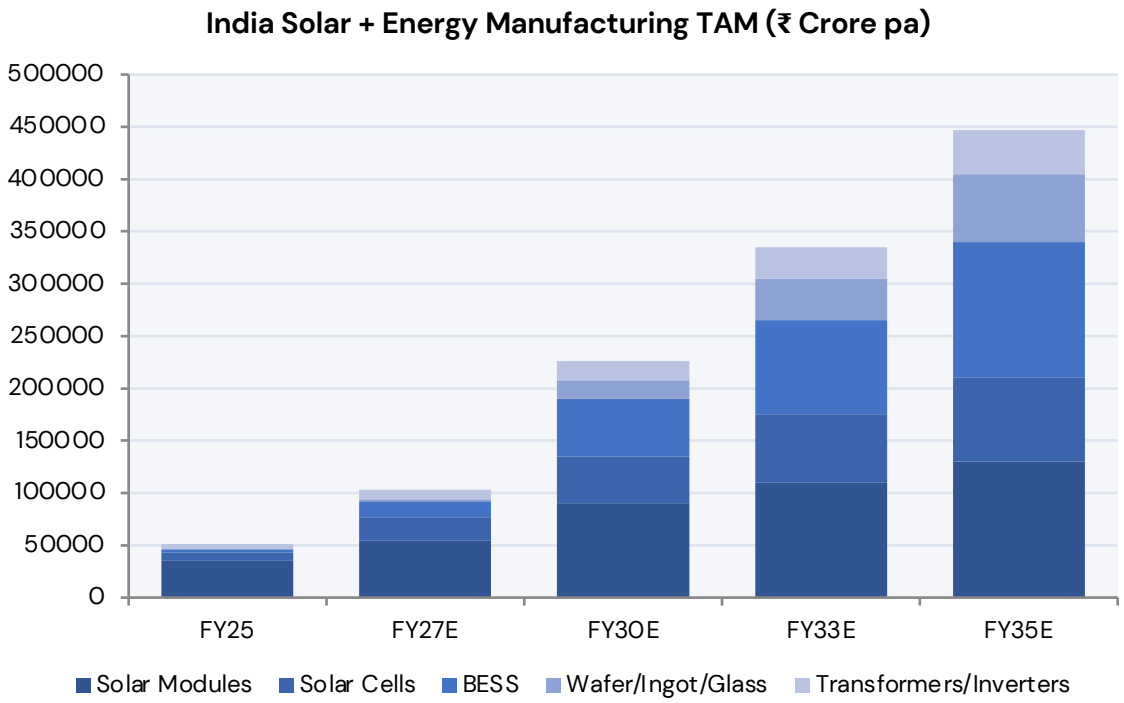
Analysis of margin protection, pricing power, and competitive positioning across different integration levels

Category	Module Only	Cell + Module	Wafer + Cell + Module
Margin Protection	Low	High	Very High
Pricing Power	Low	High	Very High
DCR Eligibility	Full (ALMM-I)	Full (ALMM-II)	Full (ALMM-III)
Volume Certainty	Medium	High	Very High
Export Optionality	High	Low*	Low*
Capital Requirement	Low	Medium	High
Overall Edge	★★☆	★★★★☆	★★★★★

* Subject to final determination of AD/CVD applicability on imports into US from India. If preliminary determination is reversed, Indian players can serve the sizeable US market

The TAM Grows With Each Wave — ₹4.5+L Cr Opportunity by FY35

The manufacturing opportunity keeps compounding as new components get localised



FY25

₹51K Cr

India solar manufacturing TAM

FY27E

₹1.0L Cr

Cell + BESS + modules combined

FY30E

₹2.3L Cr

Full supply chain localising

FY35E

₹4.5L Cr

Wafer + BESS chemistry + transformers

→ **₹51K Cr → ₹1.0L Cr → ₹2.3L Cr → ₹4.5L Cr** (10-year growth trajectory)

SECTION 06

India Power Generation

Thermal PLF trends, coal flexibility and the incremental demand hypothesis

06

India Power Generation

Declining coal PLFs are widely read as a warning sign, grid stress, overcapacity, demand weakness. They are none of these things. Falling PLFs signal that renewable energy is successfully displacing thermal as the primary generation source. Coal is transitioning from baseload to flexible backup. That is the transition working.

RE generation (solar & wind) has grown from 9% to 15% of India's energy mix in six years. Coal generation peaked around CY24 and has since plateaued. The government's target of reducing Minimum Technical Load (MTL) for coal plants to 40% by 2030 will enable faster ramping, creating more room on the grid for solar during peak generation hours.

The BESS tipping point has arrived

Battery storage costs fell ~90% in a decade, from $700/kWh in 2014 to ~$75/kWh in 2024. In 2024, Solar+BESS crossed below new coal's levelised cost in India for the first time. The arithmetic now conclusively favours renewables plus storage for any new capacity addition. Solar+BESS can today reliably meet 90% of India's electricity demand at ~₹5.06/kWh, cheaper than the average power purchase cost in most major states.

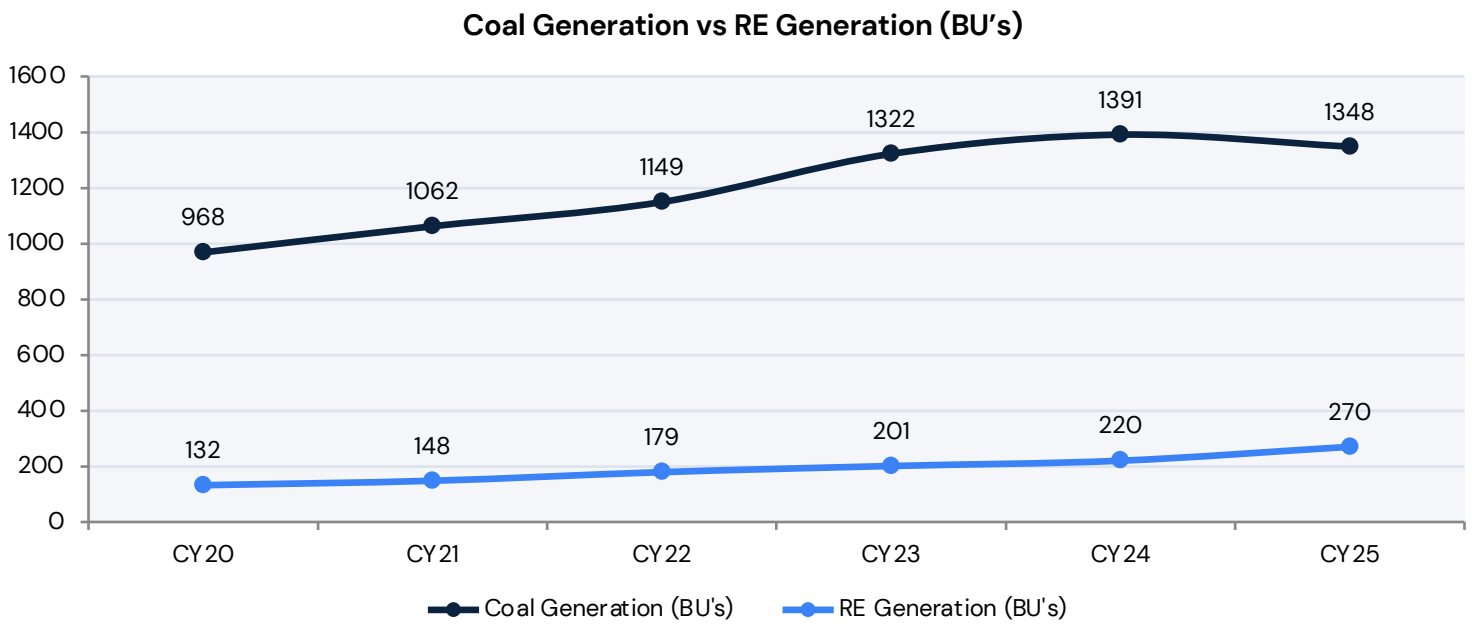
The engineering required: 4.9 GW of solar (DC) and 13.5 GWh of BESS serves 1 GW of average demand load around the clock. The primary remaining challenge is no longer the economics it is bridging multi-day monsoon periods and building the transmission to move power to where it is needed.

Grid instability is accelerating storage deployment

As solar penetration rises, the thermal evening ramp-up the volume of power thermal plants must provide as solar generation falls off at dusk jumped from ~7,000 MW in 2023 to 46,000 MW in 2026. A 557% increase in three years. This grid stress is now a structural driver of BESS procurement, independent of government mandates. India BESS additions are projected at 7 GW in FY27, 25 GW in FY30 and 47 GW by FY32.

Coal Flexibility: Thermal Must Adjust to Accommodate RE

Govt targets 40% Minimum Technical Load (MTL) by 2030 coal becomes the balancing fuel



Coal PLF Scenarios

If coal PLF falls to **55%**: significant capacity freed. If PLF falls to **50%**: coal effectively becomes pure backup - RE takes primary load role.

CEA's 40% MTL Target

CEA plans to reduce **Minimum Technical Load to 40% by 2030**. Enables much faster ramping and shut-downs - allowing more solar on the grid.

Incremental Demand → Solar+RE

Historical growth: **5–6% pa**. Emerging: **7–8%** driven by cooling, EVs, manufacturing. All incremental demand likely served by Solar+RE+BESS.

Despite flattish power demand growth in CY25, RE generation has been showing rising trend. It has grown from being **9% to 15%** of the energy mix in past 6 years.

Source: Ambit

Coal Flexibility: Scenario Build Up

Govt targets 40% Minimum Technical Load (MTL) by 2030 — coal becomes the balancing fuel

Particulars	2025	Scenario A (2030E)	Scenario B (2030E)
Thermal Capacity (GW) (A)	225	260	260
PLF (B)	66%	55%	50%
No. of Hours (C)	24	24	24
No. of Days (D)	365	365	365
Thermal Generation (BU's) (A×B×C×D / 1000)	1301	1253	1139
Shortfall (BU's)	-	-48	-162
Cumulative Solar required to fill this Gap (GW)	-	24	81

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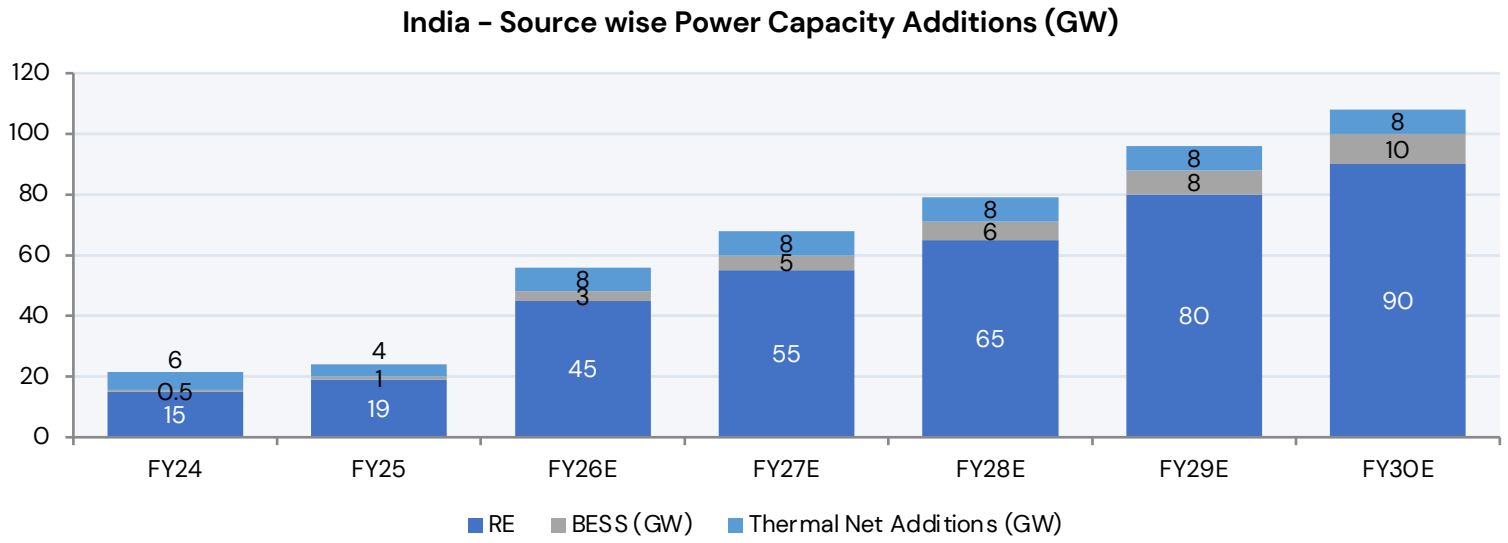
Despite 35GW capacity addition, lower PLFs drive a decline in thermal generation. The grid is transitioning from coal-centric to renewable-centric, with coal becoming the flexible backup rather than the primary source.

Source: VQ Research

The Central Hypothesis: All Incremental Demand → RE Lead by Solar

As coal becomes the flexible backup, every new GW of power demand goes to Solar + RE + BESS



7–8%

Power demand growth

Cost parity

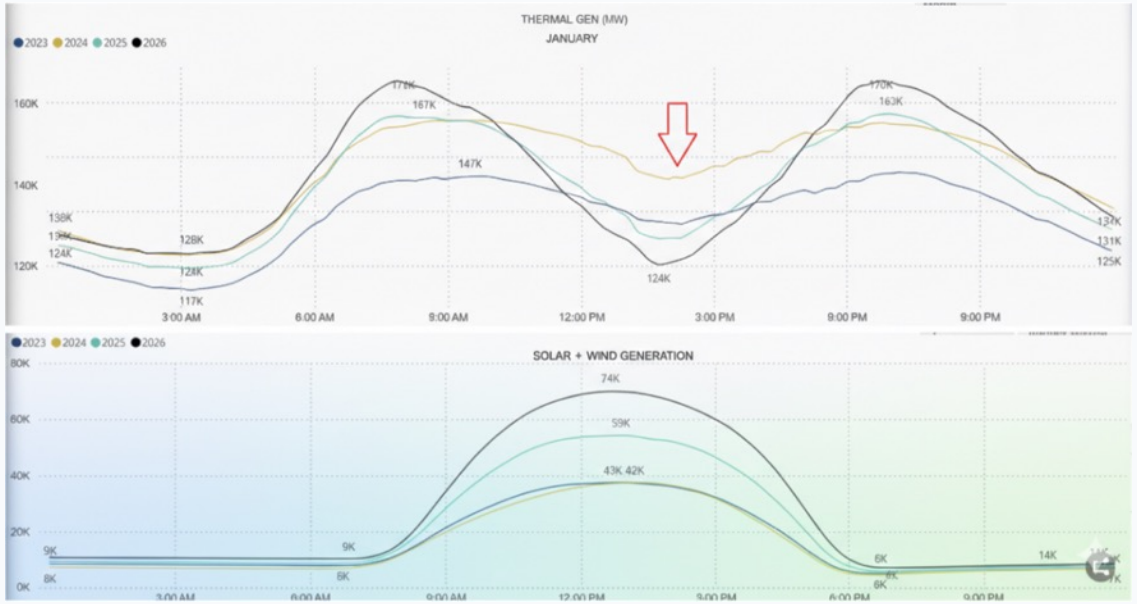
Solar+BESS competitive vs new coal

As coal becomes the flexible backup, every new GW of power demand goes to Solar + RE + BESS. The transition is driven by cost competitiveness and grid stability requirements, with Solar+BESS now the preferred solution for incremental demand.

Source: VQ Research

Grid Instability: Case for Batteries

Peak to valley ratio for thermal has risen leading to increased grid stress – hence battery becomes necessary



Metric	Year 2023	Year 2026	% Change / Delta
Renewable (Solar/Wind) Peak	43,000 MW	74,000 MW	+72%
Renewable (Solar/Wind) Valley	8,000 MW	9,000 MW	+12.5%
RE Daily Swing (Peak-Valley)	35,000 MW	65,000 MW	Nearly Doubled
Thermal Peak (Max Demand)	147,000 MW	170,000 MW	+15.6%
Thermal Midday Valley (Solar Peak)	~140,000 MW	124,000 MW	-11.4%
Thermal Evening Ramp-Up	~7,000 MW	46,000 MW	+557%
Thermal Peak-to-Valley Ratio	1.25	1.37	Increased Stress

Rising RE penetration is amplifying thermal cycling stress, making storage essential for grid balance

BESS: Turning Solar into Firm Power — A New DCR-like Opportunity

BESS + Solar integration creates next-gen moat for Indian manufacturers. DCR requirement for batteries under proposal.

FDRE Mandates Oversizing + BESS

Every **FDRE/RTC/Solar+BESS** project needs both modules and storage. Module and BESS procurement are linked — same developer, same DCR requirement.

Solar+BESS Now Cost-Competitive

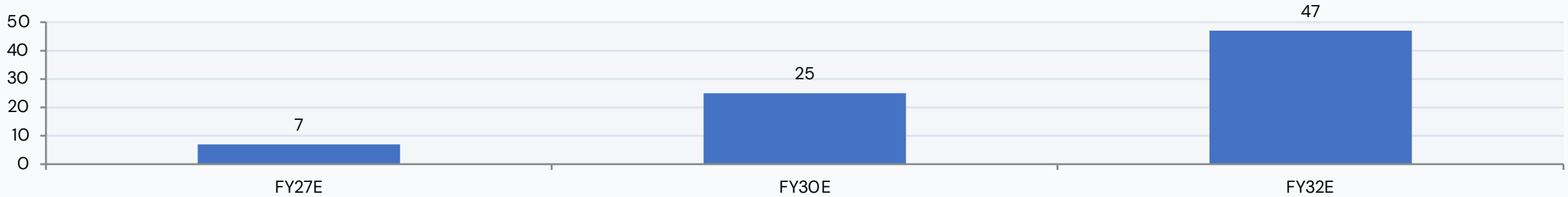
Levelised cost of **Solar+BESS has crossed coal** in India for new capacity. This permanently shifts incremental demand to renewable + storage.

DCR for Batteries — Next Policy Move

MNRE exploring **domestic content requirement** for battery storage. If implemented, mirrors ALMM for modules — creating a protected Indian BESS ecosystem.

Integrated Players — The 2030 Vision

Companies that own the **full stack (cells + modules + BESS integration)** will be irreplaceable infrastructure providers, not commodity manufacturers.



Source: NEP

Solar + BESS: Able to meet 90% of Electricity Demand

Solar + BESS – cheaper than average power purchase costs of most states

The Tipping Point: Solar + Battery is Now the Economic Baseline

THE CAPABILITY

90%

Solar + batteries can reliably meet 90% of India's national electricity demand today.

THE ECONOMICS

₹5.06/kWh

Achievable at an LCOE $56/MWh.
This is cheaper than average power purchase costs in most major Indian states.

THE PARADIGM SHIFT

The primary constraints is no longer shifting daytime solar to nighttime. It is merely bridging the multi-day monsoon season.

The question is no longer if solar can power India, but how fast it can scale.

The Old Rule (Status Quo)

Solar is the cheapest daytime electricity, but expensive coal is required for nighttime and baseload reliability.

The New Rule

Turnkey battery economics have fundamentally broken this rule in the last 24 months.
Round-the-clock solar is now economically dominant. Intermittent daytime energy is now dispatchable, 24/7 power.

Source: Ember report

1GW Power Demand — Catered by ~5 GW Solar + ~13 GWh BESS

Converting solar to RTC by use of BESS – 1 GW demand can be fulfilled by 4.9 GW solar + 13.5 GWh

The Blueprint: The "Golden Ratio" for Grid Transformation

The Unit Formula: To meet 90% of electricity demand at maximum economic efficiency, the required system architecture per 1 GW of average demand load is:

INPUT 1: GENERATION

4.9GW

Solar Capacity (DC)

INPUT 2: STORAGE

13.5GWh

Usable Battery Capacity

THE OUTPUT

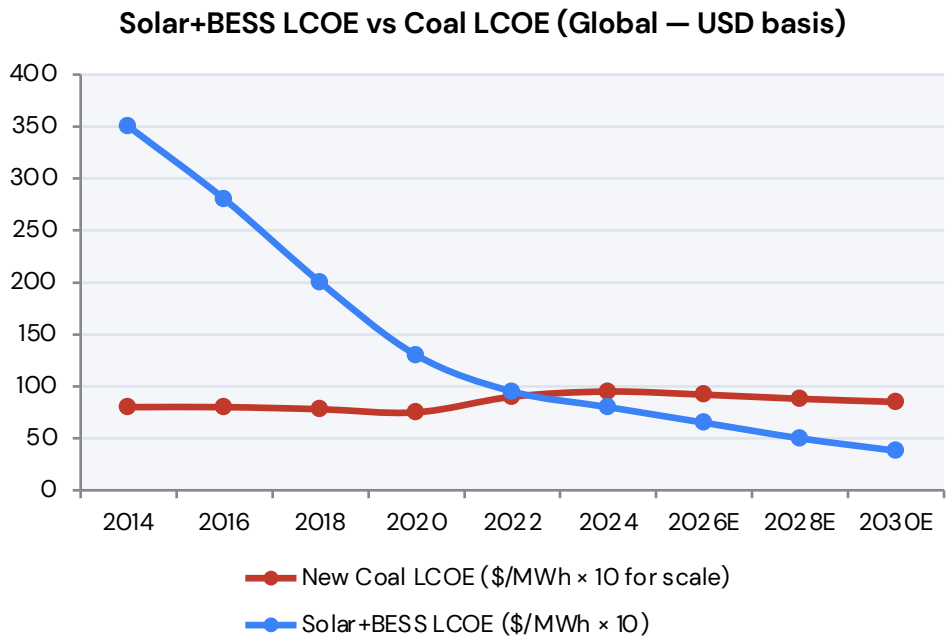
Reliable 24/7 power matching 90% of total load.

High Efficiency: Only 5% of annual solar generation is curtailed (wasted) in this specific configuration.

Source: Ember report

BESS Cost Curve: The Tipping Point is Here

BESS costs fell 90% in 10 years. Solar+BESS now cheaper than new coal. This permanently shifts the demand structure.



BESS Cost Decline

90%

2014→2024 (from $700 to $75/kWh)

Solar+BESS Crossover

2024

Year Solar+BESS crossed below new coal LCOE in India

Projected BESS Cost

$32/kWh

By 2030 — enables 8hr storage at scale

Module Demand Multiplier

3x

For 8hr BESS vs plain solar project

Key insight: BESS cost decline has made Solar+BESS competitive vs new coal

Source: VQ Research

SECTION 07

NAP / NEP Transmission Plan & RE Infrastructure

India's National Electricity Plan mandates massive grid upgrade to absorb renewable energy at scale

NAP / NEP
Transmission Plan & RE Infrastructure

Solar energy and batteries are the visible face of the energy transition. The less visible layer, equally essential, is transmission infrastructure. Without a grid capable of absorbing and routing renewable power at scale, generation capacity becomes stranded. India's National Electricity Plan takes this seriously.

The NEP 2023–32 mandates transmission infrastructure for 600 GW of non-fossil capacity by FY32. The investment required: ₹4.9 lakh Crore in transmission capex, 76,787 circuit kilometres of new lines and 497 GVA of new transformer capacity all to be added between FY27 and FY32.

The anticipatory grid model

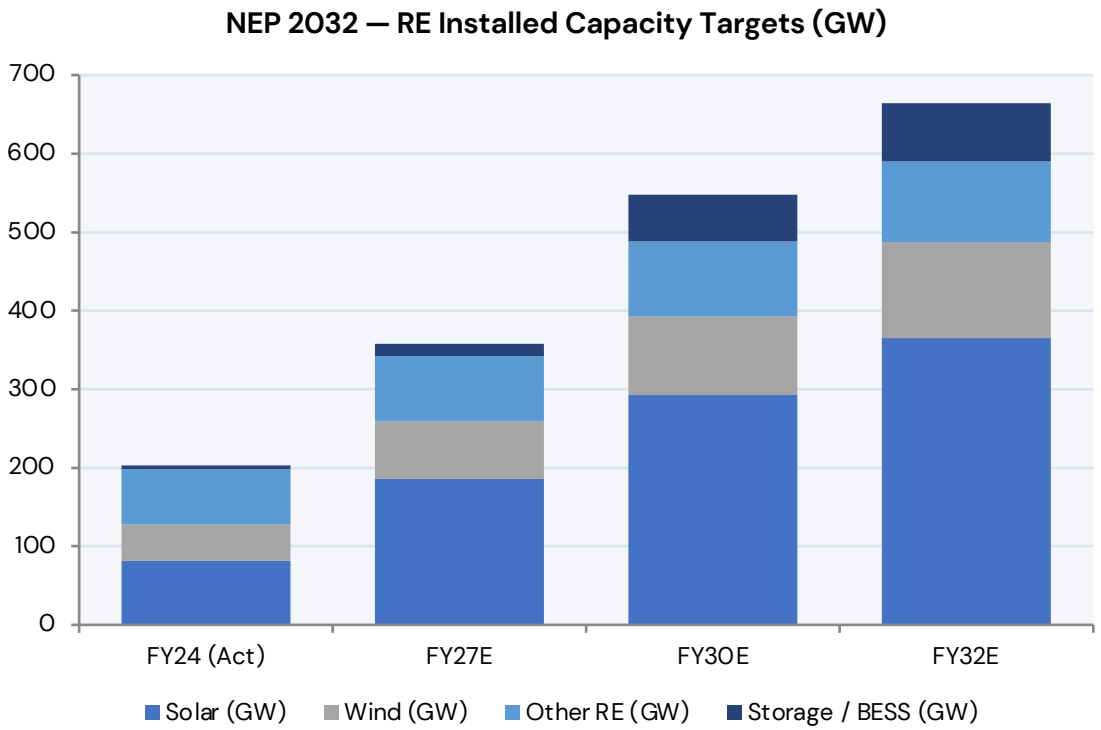
MNRE and SECI have identified 181.5 GW of Renewable Energy Zones for FY30 commissioning geographic clusters with high RE potential. The key design principle is that transmission is planned and built ahead of generation, bridging the mismatch between a 36-month line gestation period and an 18-month solar plant build time. Pooling stations at Khavda, Fatehgarh, Bhadla, Bikaner, Ramgarh and Leh are already under construction.

The HVDC backbone is also expanding from 34.5 GW to 66.75 GW at ±800 kV to move large volumes of renewable power from generation-rich states in the west and north to demand centres in the east and south.

The grid build-out is not a constraint on India's solar ambition. It is the foundation being laid to make that ambition physically deliverable.

National Electricity Plan: RE at the Core of India's Grid Strategy

NEP 2023–32 mandates transmission to be set up for 600 GW non-fossil capacity by 2032; transmission investment of ₹4.9L Crore



Source: CEA NEP Vol-II (Oct '24)

Non-fossil capacity target

600 GW

By FY32

Transmission network investment planned

₹4.9L Cr

FY27 - FY32

New transmission lines to be added

76,787 ckm

FY27 - FY32

New transformer capacity addition

497 GVA

FY27 - FY32

Renewable Energy Zones— Enabling RE at Scale

₹2.44L Cr for pooling stations for 181 GW of RE by FY30; broader NEP envisages ₹4.9L Cr transmission CapEx by FY32 to enable 600 GW RE

India's Transmission Build-Out — Key Programmes

Verified from CEA NEP Vol-II (Oct '24), MNRE, CERC & PGCIL filings

Programme	Capacity / Scope	Investment	Status	Beneficiary Sectors
GEC Phase-I (ISTS)	3,200 ckm + 17,000 MVA	₹11,369 Cr	Commissioned Mar'20	Solar / Wind
GEC Phase-I (InSTS)	9,700 ckm + 22,600 MVA; ~24 GW evac	₹10,142 Cr	Largely complete; tail in 4 states	Solar / Wind
GEC Phase-II (InSTS)	10,750 ckm + 27,500 MVA; ~20 GW evac	₹12,031 Cr	Under execution; target Mar'26	Solar / Wind / Hybrid
Renewable Energy Zones (REZ)	181.5 GW REZs identified (MNRE/SECI)	₹2.44L Cr (Tx for 500 GW)	Phased to FY30; pooling stations under build	Solar / Wind / BESS
HVDC Bi-pole Pipeline	+32 GW addition (34.5→66.75 GW); ±800 kV	Part of ₹4.91L Cr (FY28-32)	**Khavda-Nagpur, Bhadla-Fatehpur, Leh u/c**	Solar / Wind / PSP

REZ Model = Anticipatory Grid

181.5 GW of Renewable Energy Zones identified by MNRE/SECI for FY30 commissioning. Transmission planned ahead of generation to bridge the 36-month line vs 18-month plant gestation gap. Pooling stations at Khavda, Fatehgarh, Bhadla, Bikaner, Ramgarh, Leh.

Source: CEA NEP Vol-II (Oct '24); MNRE GEC scheme docs; PGCIL/BHEL HVDC contracts.

SECTION 8

Solar: A 20-Year Secular Story

Solar is still single-digit % of global electricity. The demand curve has two decades left to run.

Solar: A 20-Year Secular Story

Despite the pace of deployment, the world is now adding 1 GW of solar capacity every half day, solar still accounts for less than 10% of global electricity generation. India is at 11%. China is at 11%. Europe is at 10%. By any reasonable measure, the penetration story has decades to run.

The China case study provides the clearest preview. Solar capacity in China grew 25× in 10 years (from ~45 GW to ~1,150 GW), with solar generation CAGR of ~35–40% over five years. China is now at 11% solar share and still plans 1,800 GW of additional RE deployment. If a country at 11% penetration is adding aggressively, the saturation narrative is not well-founded.

Five things the market is getting wrong

- Demand: The market reads any utility slowdown as a system signal. The data shows four engines growing simultaneously — slowdown in one does not equal system slowdown.
- Supply: Announced module capacity is treated as real supply. Cells and wafers are the actual bottleneck — and the glut narrative does not hold before FY29.
- Modules: GW of projects is treated as equivalent to GW of modules required. The shift to FDRE/RTC/BESS structures means actual module demand is 40% higher than the headline implies.
- Policy: China pricing is assumed to set the floor. BCD, ALMM, DCR and PLI together mean it does not — the domestic market is structurally insulated.
- Power: Declining coal PLF is read as grid stress. It is coal successfully transitioning to backup all incremental demand going forward goes to Solar+RE+BESS.

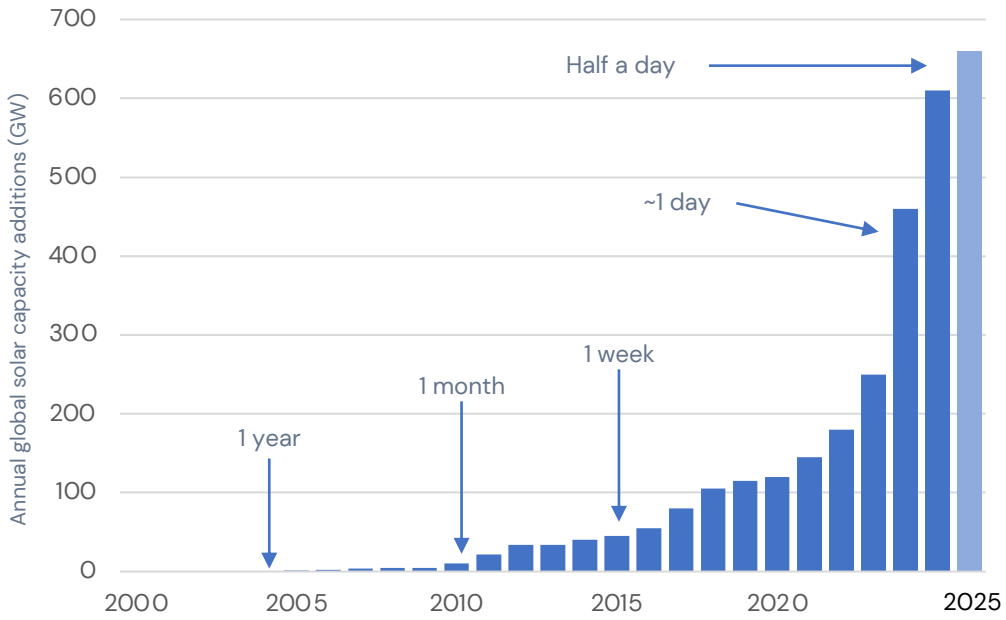
India's solar market is not slowing. It is accelerating in ways the market is not modelling. This is not a commodity cycle, it is a strategic build-out of India's energy independence, underwritten by policy, driven by economics and still in its early chapters.

Global Solar Build-out Hits Hyper-scale

Solar additions have accelerated from annual to sub-daily pace

The world is now adding 1 GW of solar capacity every half day

From 1 GW/year in 2004 to 650 GW/year in 2025



2025

Solar growth has reached hyper-scale — 1 GW added every half day

Solar capacity addition now at unprecedented speed

Annotations show time required to add 1 GW of solar globally. Data source: SolarPower Europe Global Market Outlook 2025

Solar is Still in Low Double Digits — Globally and in India

Global solar = ~9% of electricity. India = 11%. China = 11%. Even 'mature' markets have decades to go.

Solar share has expanded significantly across key geographies; Rising from ~1–3% (CY15) to ~9–11% (CY25)

~9%

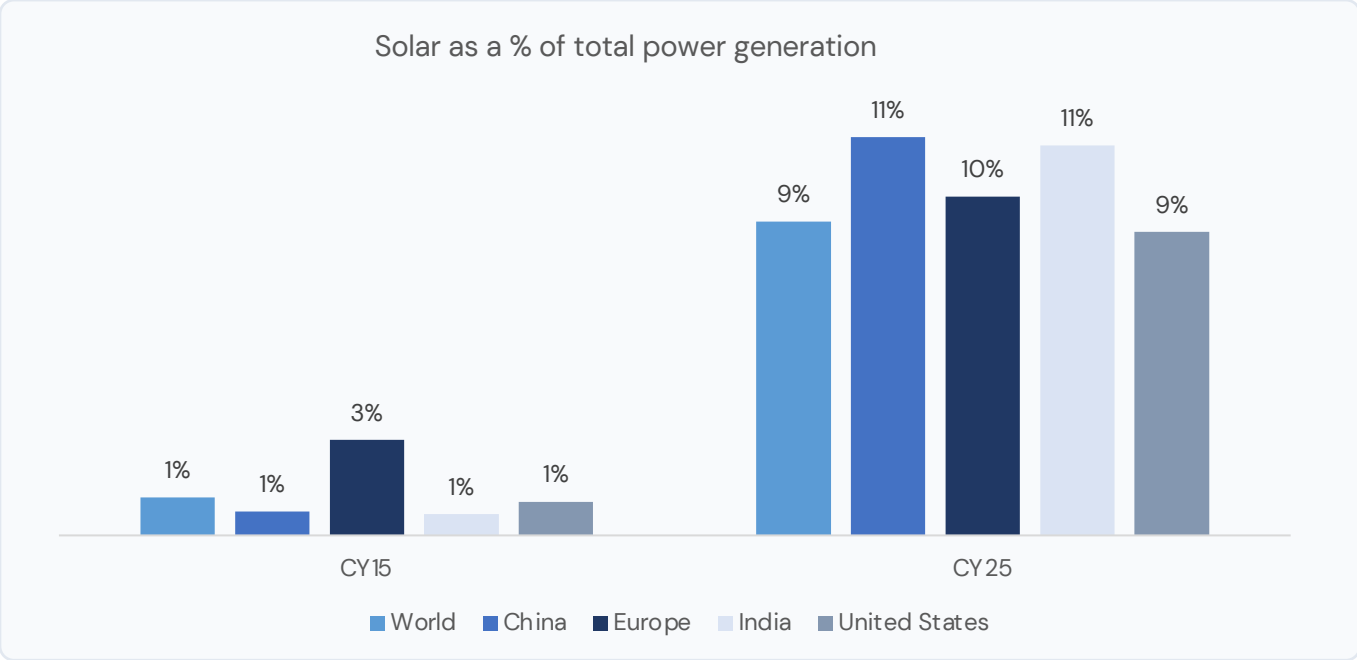
Global solar share of electricity

11%

India solar share of electricity

11%

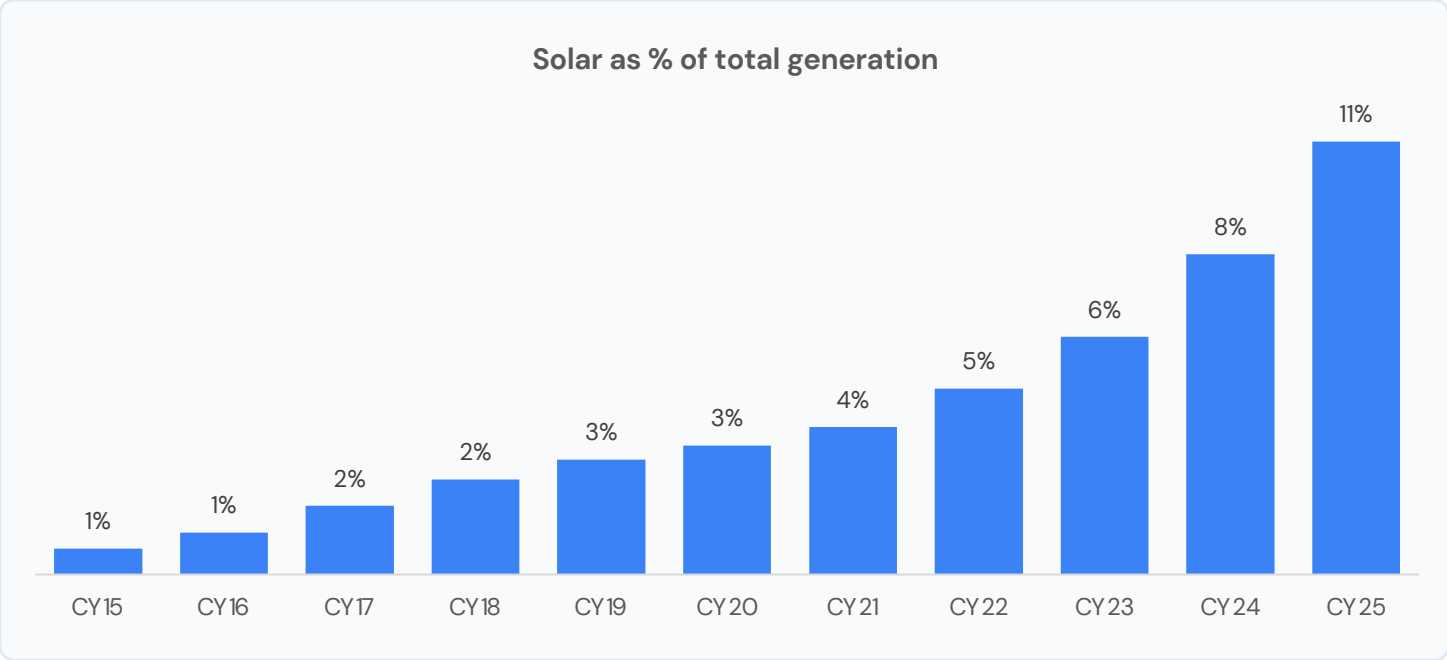
China solar share of electricity



Source: Ember

China Case Study

Solar now contribute ~11% of China's power mix, with rising scale.



Source: Ember

Capacity Growth

~25x

Capacity growth in last 10 yrs: ~45GW to ~1150GW

Future Deployment

1800 GW

Additional RE deployment expected as per govt. targets – solar to contribute to a larger share

Generation CAGR

~35%/40%

Solar generation CAGR over last 5yrs/10yrs

Market Narrative vs Market Reality

Five critical misreadings — all pointing in the same direction

Topic	✗ Market Narrative	✓ What the Data Shows
Demand	Demand slowing — utility slowdown is a system signal	Multiple growth engines: strong utility-scale momentum, record C&I traction, and sustained rooftop acceleration
Supply	Supply glut arriving FY27 — announced capacity = real supply	Effective supply lower; cells & wafers are the real bottleneck; glut not before FY29
Modules	GW of projects = GW of modules needed	FDRE/RTC/Solar+BESS needs 1.5–2.2x module oversizing — demand structurally 40% higher
Policy	Market-driven; China price sets the floor	BCD, ALMM, DCR, PLI — policy actively insulates India's supply chain from China pricing
Power	Coal PLF declining = grid stress / demand problem	Coal flexing down = RE succeeding; all incremental demand goes to Solar+RE+BESS

SECTION 9

Conclusion

India's Solar Market is not Slowing.
It is Accelerating in Ways the Market is not Modelling.

09

Conclusion

What appears to be a strong upcycle is, in reality, a long-duration structural shift in how India will produce and consume energy. Solar demand is no longer driven by a single variable. It is the outcome of multiple independent demand engines, each with its own economic and policy backbone, compounding simultaneously. And just as the market is getting comfortable with these, a new layer of demand from data centres, green hydrogen and round-the-clock power is beginning to take shape, largely outside current forecasts. The implication is clear. This is not a cycle that peaks. It is a curve that keeps extending.

At the same time, the industry is being measured through a lens that is increasingly outdated. The headline gigawatt number no longer captures the true scale of demand. As the system shifts toward firm and dispatchable renewable formats, each unit of capacity now requires significantly higher physical modules. Demand is not just growing, it is deepening in intensity. When the unit of measurement itself understates reality, the eventual size of the opportunity is often far larger than anticipated.

Overlay this with policy and the direction becomes even more decisive. India is not leaving outcomes to market forces. It is shaping the value chain with intent, steadily moving localisation upstream from modules to cells and eventually to wafers. As this progression unfolds, the centre of gravity of profits shifts with it. What begins as assembly-led economics evolves into manufacturing depth and eventually into control over core materials. Early signs are already visible. Cell availability is tighter than perceived and upstream manufacturing remains limited, setting up the next phase of the cycle.

The natural consequence of this evolution is that leadership in this sector will not be static. It will migrate alongside the profit pool. Companies that are able to deepen their capabilities across the value chain, align with the policy direction and scale with discipline will increasingly shape the industry structure. Over time, the advantage compounds in favour of those who move upstream and build integration ahead of the curve. In a market where demand is expanding, measurement understates reality and policy is directional, the enduring winners will be those positioned where the economics are moving, not where they have been.

Glossary

ALMM: Approved List of Models & Manufacturers — only listed products eligible for government projects.

ALMM-II: Effective June 2026 — mandates domestically manufactured cells for government and C&I projects.

ALMM-III: Effective June 2028 — restricts imported wafers, creating upstream supply constraints.

BCD: Basic Customs Duty — 40% on modules, 27.5% on cells; limits import competitiveness.

DCR: Domestic Content Requirement — mandates use of Indian-made cells/modules in select projects.

PLI: Production Linked Incentive — output-linked subsidy lowering effective manufacturing cost.

RPO: Renewable Purchase Obligation — mandated renewable share for DISCOM procurement.

CPSU: Government entities (e.g., SECI, NTPC) procuring solar capacity under DCR norms.

FDRE: Firm & Dispatchable Renewable Energy — assured supply; requires BESS; ~1.6× module oversizing.

RTC: Round-The-Clock power — 24×7 supply via solar + BESS; ~1.5× oversizing.

PPA: Power Purchase Agreement — long-term tariff contract between generator and buyer.

LOA: Letter of Award — project win confirmation prior to PPA execution.

KUSUM: कृषि solarisation scheme covering pumps, feeders, and decentralised plants.

C&I OA: Commercial & Industrial Open Access — direct procurement by large consumers.

BESS: Battery Energy Storage System — stores solar energy for non-solar hours dispatch.

AC/DC: Module capacity (DC) vs plant output (AC); typical ratio ~1.4×.

PLF: Plant Load Factor — actual generation vs installed capacity.

MTL: Minimum Technical Load — lowest stable coal plant output (~40% target by 2030).

REZ: Renewable Energy Zones — pre-developed high-resource zones with transmission access.

HVDC: High Voltage Direct Current — long-distance bulk transmission infrastructure.

LCOE: Levelised Cost of Energy — lifecycle cost per unit of electricity generated.

GEC: Green Energy Corridor — transmission network for evacuating renewable power.

ROCE: Return on Capital Employed — profitability relative to deployed capital.

EBITDA: Earnings before interest, tax, depreciation & amortisation — operating profitability metric.

TAM: Total Addressable Market — solar + energy manufacturing opportunity size.

IPP: Independent Power Producer — private sector renewable developers.

GW/MW/GWh: Capacity (GW/MW) vs energy storage (GWh); 1 GW = 1,000 MW.

BU: Billion Units — 1 BU = 1 TWh; standard electricity measurement in India.

MNRE: Ministry of New & Renewable Energy — policy authority for solar and clean energy.

CEA: Central Electricity Authority — planning, grid standards, and NEP publication.

SECI: Solar Energy Corporation of India — central tendering and demand aggregation agency.

DISCOM: State distribution companies — power buyers and retail distributors.

NEP: National Electricity Plan — long-term capacity and transmission roadmap.

NTPC: India's largest power generator; expanding renewable capacity via NTPC Green.

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