India Solar Module Degradation 2026: Warranty, ALMM, QA and EPC Risk Guide

By Sudarshan Karweer · 14 September 2026 · growthifye.com

A 2026 India guide to solar module degradation, warranties, ALMM sourcing, QA tests, EPC risk allocation and lender due diligence.

India's utility-scale and C&I solar market has become much sharper on yield modelling, commissioning and evacuation risk. The next major differentiator in 2026 is module degradation management: understanding how fast output actually declines in Indian operating conditions, how warranty language maps to cash flow, and how EPC, developers, lenders and C&I consumers should allocate the risk.

This matters because module choice is no longer a simple nameplate-cost decision. ALMM-linked procurement windows, rapid shifts in TOPCon product offerings, increasing deployment in high-irradiance and high-temperature states, and tighter debt sizing assumptions mean a seemingly small degradation miss can have a measurable impact on DSCR, merchant upside and long-term O&M budgets.

For Indian buyers, the practical question is not whether a module carries a 30-year performance warranty. Almost every mainstream supplier does. The practical question is whether the bill of materials, factory controls, quality records, transport handling, installation practice and contract structure are strong enough to make that warranty economically meaningful.

This guide looks at module degradation from an EPC and financing lens for 2026 India.

Why degradation is now a board-level issue in India

A 50 MW AC project with a CUF-sensitive tariff or open-access savings model can lose significant annual value if actual degradation is even 20 to 30 basis points worse than base case over time. On a C&I project displacing power at roughly Rs 6.0-8.5/kWh, a modest underperformance gap can materially change payback. For utility-scale projects with tariffs around Rs 2.4-3.2/kWh depending on procurement route and location, the margin for error is thinner, especially where debt terms assume disciplined long-term yield.

In 2026, three factors are increasing scrutiny:

- Higher use of n-type TOPCon modules, where field history in Indian conditions is improving but still shorter than legacy p-type PERC fleets
- More projects in hot, dusty and high-UV zones such as Rajasthan, [redacted], Telangana, Andhra Pradesh and parts of Maharashtra
- Greater lender focus on generation downside after seeing curtailment, availability and equipment quality issues affect operating portfolios

The common base-case assumption in Indian financial models remains around first-year degradation of 1.0% and annual linear degradation of 0.40% to 0.55%, depending on supplier tier, technology and use case. But these are model assumptions, not guarantees of field behaviour. Strong projects validate whether these numbers are realistic for the exact module family, factory line and site environment.

The degradation mechanisms that actually matter on site

Developers often discuss degradation in generic terms. EPC and asset teams need a more specific failure-mode view.

The key module degradation pathways in India include:

- UV-induced degradation of encapsulant and polymeric backsheet or backsheet-equivalent materials
- Potential induced degradation, especially where system voltage, humidity, module construction and grounding strategy interact poorly
- LeTID and related carrier-lifetime effects, particularly relevant to certain cell processes and thermal histories
- Solder bond fatigue and interconnect stress due to large thermal cycling amplitudes
- Cell microcracks from transport, unloading, tracker-induced torque, poor module handling or excessive clamp stress
- Junction box, connector and cable-related heating that appears initially as module underperformance or hotspot behaviour
- Moisture ingress leading to corrosion, insulation failure or long-term power loss
- Hotspots caused by cracked cells, poor soldering, partial shading, mismatch or manufacturing defects
- Glass breakage or edge damage aggravated by handling, wind events or mounting errors

Indian climate increases the importance of thermo-mechanical stress. In many states, backsheet temperatures can remain elevated for long periods, while day-night variation creates repetitive expansion-contraction cycles. If transport and installation quality are weak, latent defects often show up only after the defects liability period.

That is why module degradation cannot be reviewed separately from mounting design, logistics, string design and O&M thermography.

2026 technology context: TOPCon, HJT and BOM volatility

For mainstream Indian projects in 2026, n-type TOPCon dominates new utility-scale and larger C&I procurement. HJT remains selective due to cost, supply-chain concentration and BOS implications, while p-type PERC continues in some price-sensitive or stock-led transactions.

The technology shift changes how teams should review degradation.

TOPCon typically offers stronger low-light response, improved temperature coefficient versus older PERC products, and attractive warranty positions such as 1% first-year and 0.40% annual degradation thereafter, or even 0.35% in some offers. But practitioners should not stop at the brochure.

Review these points line by line:

- Exact cell supplier and process maturity
- Glass-glass versus glass-backsheet construction
- Encapsulant type and supplier consistency
- Backsheet or rear glass thickness and edge-seal design
- Junction box brand, diode rating and potting process
- Factory line traceability and EL image record retention
- Whether the offered module family has undergone recent BOM substitutions

In 2026, BOM churn remains a real issue because manufacturers continue to optimise cost and ramp domestic lines under changing demand and policy conditions. Two modules with the same datasheet and model family may not be equivalent if the encapsulant, glass, frame alloy, connector or cell line has changed.

For that reason, ALMM inclusion is necessary but not sufficient as a quality proxy. ALMM helps on approved domestic sourcing and policy compliance, but it does not replace project-specific technical due diligence.

How to read module warranties like a risk professional

A module warranty has two main components:

- Product warranty, often 12 to 15 years or higher for workmanship and materials defects
- Performance warranty, often specifying minimum power retention over 25 to 30 years

The trap is assuming these are straightforward recovery tools. They are not.

Important questions for Indian projects include:

- Is the performance warranty tied to STC flash-test output, and who bears testing cost?
- What sample size and test method are needed to prove a claim?
- Does the claim trigger only after average underperformance at batch level, or can serial defects be claimed module by module?
- Is replacement the sole remedy, or is transport, removal, reinstallation and generation loss covered?
- Is there a pro-rata or current-market-value adjustment?
- What are the notification timelines?
- Which entity is the warrantor: manufacturing SPV, brand owner or parent company?
- What is the governing law and dispute venue?

In practice, replacement-only remedies may leave owners under-compensated. If a module supplier replaces failed units in year 8 but does not cover dismantling, retesting, rest-stringing, crane or labour costs, the economic pain remains with the project.

For lenders and sophisticated C&I buyers, a stronger position is to align the supply contract, EPC contract and O&M performance obligations so no obvious gap remains during the first operating years.

Typical negotiation points in 2026 include:

- Back-to-back assignment of manufacturer warranties to owner and lenders
- Defined response times for RMA processing
- Pre-agreed field test protocols for EL, IR and flash testing
- Clear allocation of removal and reinstallation cost
- Batch quarantine rights where serial defects are suspected
- LDs or retention linked to unresolved quality claims during DLP

QA framework: what developers and lenders should insist on before dispatch

The cheapest degradation risk is the one prevented before modules leave the factory. Once installed across 100,000+ modules, forensic quality control becomes slow and expensive.

A practical QA plan should include factory and field gates.

Recommended pre-dispatch controls:

- Supplier technical due diligence on line capability, quality systems and recent claim history
- Review of type-test certificates and extended reliability testing, not just standard IEC compliance

- BOM freeze declaration for the exact PO lot
- Witnessed flash-test calibration review
- EL imaging at factory with traceable serial mapping
- Visual inspection for glass defects, frame alignment, sealant consistency and junction box workmanship
- Sampling for wet leakage, insulation and mechanical load verification where relevant
- Packaging review for long-haul Indian transport conditions

For larger portfolios, it is sensible to require additional reliability screens on representative samples, such as:

- Damp heat beyond baseline certification thresholds
- Thermal cycling extension
- PID resistance checks
- UV preconditioning review
- Mechanical stress and dynamic load suitability for tracker or high-wind sites

At site, receiving inspection should not be superficial. Teams should verify:

- Pallet integrity and shock or water exposure signs
- Serial number reconciliation with dispatch list
- Random EL checks before installation
- Open-circuit voltage and current sampling consistency
- Connector compatibility and crimp-quality discipline
- Mounting clamp location compliance with manufacturer instructions

This is where capabilities such as [Procurement & vendor management](/coreservices/epc/procurementandvendormanagement) and [QA/QC & HSE enforcement](/coreservices/epc/qaqcandhseenforcement) matter more than many owners initially realise. A disciplined EPC can materially reduce long-tail degradation risk through process control rather than reactive claims handling.

EPC design and construction mistakes that accelerate degradation

Not all degradation is a manufacturer issue. Many field failures originate in EPC execution.

Common EPC-linked causes include:

- Inappropriate module handling leading to invisible microcracks
- Walking, leaning or point-loading modules during installation
- Over-tightening clamps or using non-compliant clamp zones
- Mixed connectors or poor DC mating practice causing heating
- Cable dressing that induces long-term connector strain
- Poor earthing and insulation management increasing PID exposure
- Inadequate tracker tuning creating torsional stress under wind
- Array layouts with persistent edge shading and hotspot exposure

For rooftop C&I projects, additional risk arises from uneven purlins, insufficient clearance, thermal expansion mismatch and maintenance traffic. In coastal plants, corrosion control of fasteners, earthing interfaces and cable accessories also influences module-area reliability over time.

This is why bankable EPC scope should not end at equipment supply. The integration of module handling SOPs, installation QA records, torque logs, EL checkpoints and final as-built traceability should be embedded into project delivery. Firms with hands-on experience in [Solar & hybrid plant EPC](/coreservices/epc/solarandhybridplantepc) and Testing, commissioning & handover are usually better placed to close this loop.

Modelling degradation in financial cases: a better 2026 approach

Too many models still use a single degradation line without scenario testing. That is weak practice.

A better approach for India 2026 is to run at least three cases:

- Base case: first-year degradation and annual linear degradation per validated supplier assumptions
- Downside case: 10-20 basis points worse annual degradation plus minor availability and mismatch penalties
- Stress case: serial defect event affecting a defined percentage of modules, with replacement lag and temporary generation loss

For example, a 100 MW AC plant using 1% first-year and 0.40% annual degradation might appear robust. But if actual long-term decline trends closer to 0.55%, the year-15 energy delta versus base case becomes meaningful. If combined with a 2-3 month warranty-resolution delay on a defect batch, lender metrics can tighten sharply in lower-tariff projects.

C&I portfolios should also account for tariff-escalation logic. Where grid tariffs are rising 3-5% annually, long-term generation loss can be more costly than in a flat-tariff assumption. Conversely, merchant-exposed plants should test degradation against afternoon price shapes, especially where storage retrofits may later change dispatch value.

A practical due-diligence checklist for owners, lenders and policymakers

For developers and C&I offtakers:

- Validate module family, factory location and ALMM status at order placement
- Freeze critical BOM items contractually
- Require lot-wise quality documentation and traceability
- Define incoming inspection and EL sampling protocol
- Align warranty remedies with actual field replacement costs

For lenders:

- Review independent engineer assumptions on degradation, not just headline warranty
- Ask for claim history on the same product family
- Check whether parent support or stronger warranty backing exists
- Verify spare strategy and field-failure response plan
- Stress-test DSCR under higher degradation and delayed replacement scenarios

For utilities and policymakers:

- Support better field-performance data collection from operating fleets

- Encourage standardised reporting of serial defects and warranty outcomes
- Improve quality surveillance without creating unnecessary dispatch delays
- Align domestic manufacturing policy with deeper reliability transparency, not only capacity addition

The central point is simple: module degradation is no longer a back-end O&M issue. It is an up-front procurement, design, contract and finance issue.

Indian solar buyers that treat modules as interchangeable commodities will face more avoidable yield surprises. Those that combine disciplined technical diligence, ALMM-aware sourcing, robust EPC controls and realistic financial modelling will protect returns better over the full project life.

If you are evaluating module selection, ALMM-compliant sourcing, warranty risk allocation or project QA strategy for a solar portfolio, contact Growthifye’s advisory desk for practical support on bankable procurement and execution.

Explore Growthifye's related capabilities

This analysis connects directly to our advisory practice: [Solar & hybrid plant EPC](/coreservices/epc/solarandhybridplantepc) · [BESS system integration](/coreservices/epc/besssystemintegration) · [Balance of system & civil works](/coreservices/epc/balanceofsystemandcivilworks) · [Procurement & vendor management](/coreservices/epc/procurementandvendormanagement).

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