Mitigating Module Reliability Risk in India's Solar Market

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Introduction

As a leading growth economy, India has an important role to play in adopting clean energy solutions. The country already has ambitious targets for renewable energy deployment and electric vehicles.

Solar energy is a large portion of the 450 GW renewables target by 2030, and various states have already announced 100% EV adoption across categories.

However, there are unique challenges and opportunities in accessing the Indian solar market. New market entrants must learn the intricacies of their target regions and model their business plans in the context local conditions.

According to a June 2022 Report from *BloombergNEF*, there are three main types of risk, with some overlap, for developers.*

Regulatory Risks:
- Land acquisition
- Payment delays
- Curtailment
- Scheduling rules
- Taxes on equipment
- Decommissioning risks

Technical/Project Risks:
- Resource estimation error
- Timely grid connection
- Extreme weather events
- Plant downtime
- Changing technologies

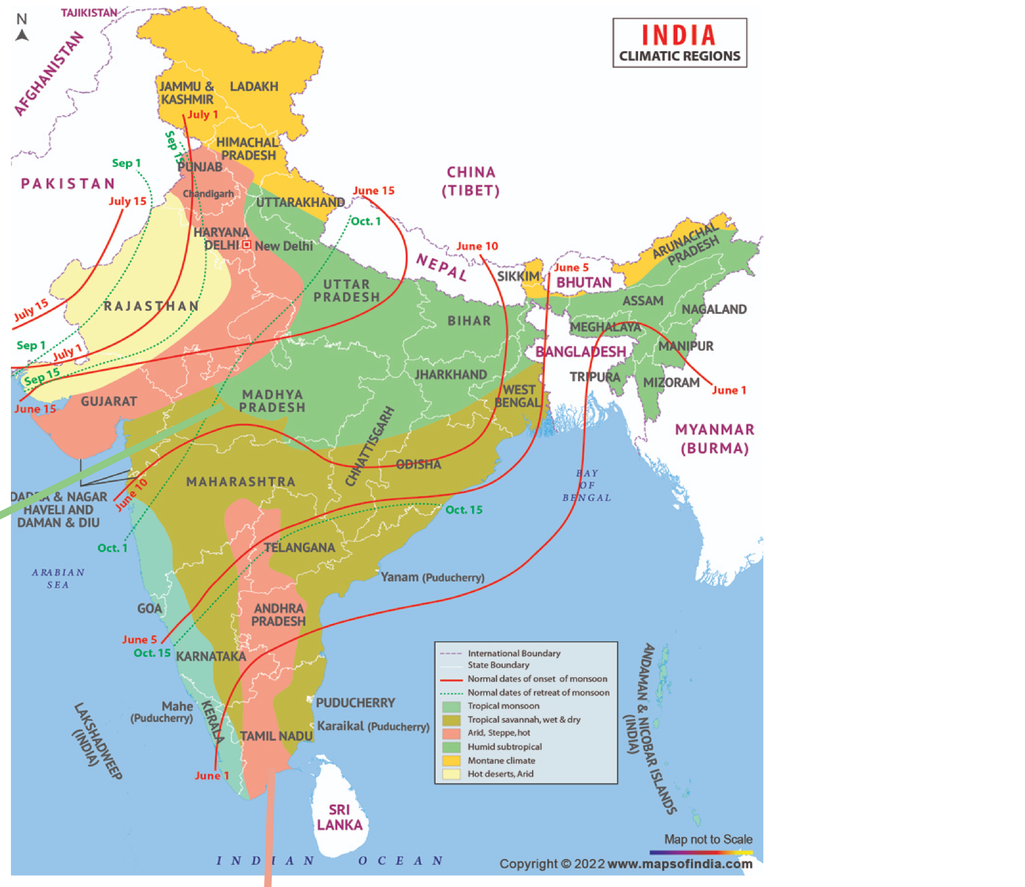
Financing Risks:
- Rising interest rates
- Rupee depreciation
- External commercial borrowing rules
- Banking laws
- Corporate and dividend taxes
- Sovereing credit rating

Planning for Various Climate Zones in India

India has a variety of climate zones throughout the country, from tropical in the south to temperate and alpine in the north. New market entrants must learn the intricacies of their target regions and model their business plans in the context of local conditions.

Technical risks can be assessed through comprehensive product testing. PVEL's Product Qualification Program (PQP) for solar modules comprises a suite of lab and field tests that help inform solar procurement and investment decisions.

The PQP includes product testing for **Damp Heat** and **Thermal Cycling,** shown below.



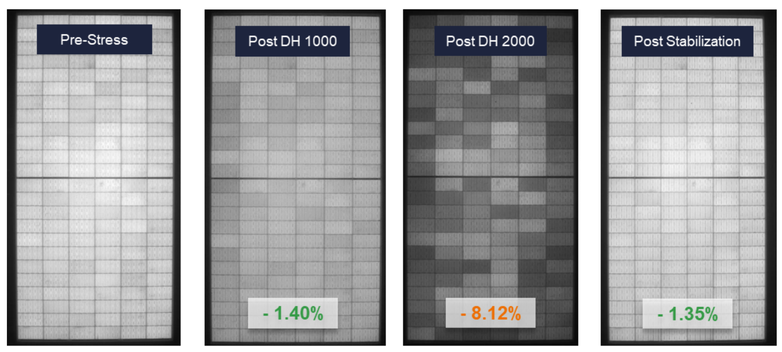
Damp Heat Test Results - Different Modules

PVEL's Damp Heat (DH) test evaluates the impact of heat and humidity on PV module reliability. We assess susceptibility to moisture ingress, delamination, and corrosion. Projects in hot environments with high humidity require PV modules with top-performing DH results

In the below examples, we show the impacts of DH testing on two different module BOMs.

PVEL's DH Test Sequence

- Damp Heat
- DH 1000
- Characterization
- DH 1000
- Characterization
- Stabilization 85°C, Isc, 48 hrs
- Characterization



This boron-doped BOM from 2018 suffered from significant BO-destabilization, which was reversed with the 48 hrs stabilization step.

This gallium-doped BOM from 2021 was from the same manufacturer. No more BO destabilization, but a more traditional corrosion-based Damp Heat failure mode is apparent.

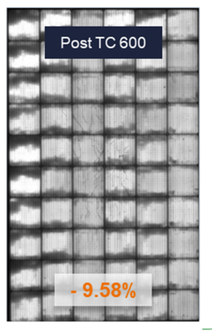
Thermal Cycling Test Results - Same Module

PVEL's Thermal Cycling (TC) test assesses a PV module's ability to withstand changes in temperature. While ambient temperatures vary daily and seasonally in most solar markets, top-performing TC results are most critical in locations where temperatures are much lower at night than during the day, such as desert environments and high-altitude regions.

PVEL's TC Test Sequence

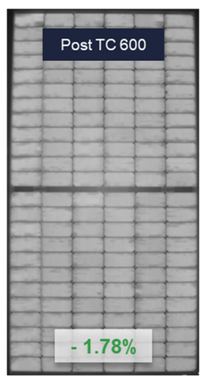
- Thermal Cycling
- TC 200
- Characterization
- TC 200
- Characterization
- TC 200
- Characterization

Thermal cycling results on two BOMs from the **same manufacturer**, separated by five years (2016 and 2021). The soldering process has become much more reliable.



› Tested in 2016 on an early adopter of MBB

› Clearly some issues to resolve in cell soldering



› Five years later, the manufactuer has corrected past issues

Key Takeaways

- India was the most attractive emerging market for clean power investment in 2021 with the announcement of **500 GW** of renewable energy to be deployed **by 2030**, requiring **$223 billion**. Within a decade, the country aims to have half of its electricty come from non-fossil fuel power sources.*
- This **massive market opportunity** exists across solar and electric vehicles, from utility-scale and distributed renewables to electric mobility and charging infrastructure.
- However, there is also **risk due to varying climate conditions**. Technical project risks can best be managed through **comprehensive product testing** via PVEL's PQP.

RE+ Poster Code

About PV Evolution Labs

PV Evolution Labs (PVEL) is the leading independent lab for the downstream solar and energy storage market and a member of the Kiwa Group. As a bankability testing pioneer, PVEL has accumulated more than a decade of measured reliability and performance data for PV and storage equipment. Our lab and field testing and technical services help mitigate risk, optimize financing and improve performance in solar and storage assets.

To learn more about PVEL's field testing services, contact PVEL's business development team at info@pvel.com.

References

*Bloomberg NEF Report, **Financing India's 2030 Renewables Ambition**, June 22, 2022 (Link: https://about.bnef.com/blog/financing-indias-2030-renewables-ambition/)

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