# De-Risking India's Clean Power Transition through a Sandbox Approach

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The financial system tends to reward the past, not the future.

Move from 'rule of thumb' to a data-led, democratic approach of understanding investments risks and cost of capital:

- Map risks systematically
- Measure risks meticulously
- Mitigate risks strategically

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# Navigating risks to unlock 500 GW of renewables by 2030

Assessing investment risks is key to designing effective risk mitigation mechanisms. This becomes critical to ensure the necessary flow of capital to drive growth in the renewable energy sector.

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Neshwin Rodrigues Duttatreya Das

## Low-cost financing would be key for scaling-up

#### Solar Solar

India crosses 200 GW renewable milestone in 2024

Renewable energy capacity in GW, by source

Financing for renewable energy, storage, and transmission has to increase by 20% each year to meet India's 2032 RE target

Projected annual financing need in billion USD



Source: Ember's analysis of the investment required to achieve India's National Electricity Plan (NEP14) target - The values are for respective financial years

BESS, PSP, and ISTS stand for Battery Energy Storage System, Pumped Storage Project, and Inter-State Transmission System, respectively.



# Why finance finds it so hard to navigate into developing countries? Greater Risks.

#### Solar projects in India face 17-month delays due to land, transmission challenges

The Ember report pointed out that project delays typically arise from three main factors: land acquisition for setting up the plant, connectivity to the grid, and finalising PPAs

By Rishi Ranjan Kala Updated - February 27, 2025 at 07:56 PM. | New Delhi

### Missile strike destroys solar plant in Ukraine

Two Russian missiles have hit a ground-mounted solar plant near Kharkiv, Ukraine. According to the manager of the plant, the missile attacks produced holes at the site that measured 6 meters deep and 11 meters in diameter.

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### African solar looks beyond donor nations for investment

Multilateral organizations the World Bank and African Development Bank (AfDB) have played a key role in the development of African solar and want to attract more private capital to a continent with at least 40% of the world's solar irradiation but currently only 1% of its PV generation capacity.

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These delays are measured from the SCOD as specified in tender documents—typically 18 to 24 months from the date of execution of the PPAs. | Photo Credit: AMIT DAVE



Image: Screenshot from YouTube account of Suspilnie Kharkiv (Суспільне Харків)

Risks and cost of capital go hand-in-hand

## Double whammy of high cost of capital

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The cost of capital for solar projects has a significant impact on the cost of electricity generation

The levelized cost of electricity (LCOE) in Rs/kWh for different costs of capital

Capex and Opex (Rs/kWh) Financing (Rs/kWh) 8% 9% 10% 11% 12% 13% 14%

Capex covers upfront costs like panels, inverters, and installation, while Opex includes expenses like maintenance,

Affordability

Higher cost of capital could make India miss its 2030 RE target of 500 GW Optimal RE capacity (GW) in 2030 for different costs of capital



### Low RE buildout

Multiple risks impact a renewable project at various stages of its lifecycle

Project-specific risks \_\_\_\_ Sector-wide risks

	Development and Construction Phase (0-2 years)				Operational Phase (2-25 years)	
	Tender and Auction	Execution of Power Purchase Agreement	Permits for land and power evacuation	Construction and project commissioning	Electricity Production – Revenue Generation and Debt Servicing	Dismantle and recycle
Delay in land aggregation and power evacuation						
Delay in PPA execution						
Offtake risk due to PPA renegotiation, curtail- ment & payment delays						
Shortfall in electricity generation						
Technology risk associated with panels and battery						
Risk due to power market exposure						
Fluctuation in interest rate						
Rupee depreciation						
Regulatory risks such as mposition of new tariffs, penalties and risks						

# **Types of risks**

- Sector-wide risks,
- Project-specific risks

The sandbox focuses on exclusively modelling project-specific risks



## How we want to visualize risks for a particular market?



Illustration of multiple risks, how it adds to financing costs and how policy can de-risk

#### Source: IEA Cost of Capital observatory

## A primer on risk-premium: 'Cut your losses'

#### Uncertainty around expected events can impact returns in RE projects

Probability distribution of profits in an RE project



• Shortfall ( $\bigtriangleup$ )in profits make up the risk for any event

•  $\triangle$  = Profits @ P50 (average) -P90

(conservative)

Method of certainty equivalent to assess risk premium

# Risk of commissioning delays

## Average commissioning delay in solar projects is 17 months, can be significantly higher in extreme cases

Probability distribution of commissioning delay for solar projects, in months



Source: Central Electricity Authority (Data till September, 2024) · The data pertains to solar projects greater than 100 MW, based on information available until September 2024. Projects within solar parks are excluded due to unavailability of relevant data.

Major reasons for project delays:

- Timely signing of power purchase agreements
- Land acquisition
- Getting grid connectivity



## Risk of solar generation shortfall

#### 75% of solar plants in India exceed their generation commitments

Probability distribution of solar plants based on the percentage deviation between actual and expected P90 generation levels in 2023



Source: Central Electricity Authority

Minimum expected generation is determined using the reported P90 estimates in credit rating reports for individual solar projects. The analysis covers 24 projects, totaling 5GW.



#### 🗑 Swiss Re

### Protection against lack of solar irradiation

Insufficient solar irradiation can put solar farm operators under immense pressure. To protect them against loss of income resulting from this threat, Swiss Re has developed a dedicated index-triggered insurance product.

### India mandates co-locating energy storage with solar projects

India's Ministry of Power has mandated all renewable energy implementing agencies and state utilities must incorporate a minimum of two-hour co-located energy storage systems (ESS), equivalent to 10% of the installed solar project capacity, in future solar tenders.

FEBRUARY 20, 2025 UMA GUPTA





## Technology risk: New variants & domestic manufacturing

## Higher degradation rates for some TOPCon modules warrant careful technology appraisal

Probability distribution of UV induced degradation of solar modules in percentage points



#### Source: RETC PV Module Index Report, 2024; Sen et al., 2024

The RETC PV Module Testing Program conducts evaluations of modules to simulate real-world field conditions. The UV exposure results from the 2024 program are presented here. UV refers to ultraviolet.

#### Mercomindia.com

## Project Developers Voice Concerns Over Quality of Domestic Solar Modules

The pace of energy transition is contingent on the steady supply of components necessary for project development. Solar is a major component...

20 Sept 2024

#### Mercomindia.com

#### Rising Costs and Supply Shortages of DCR Modules Challenge Solar Programs

The increasing cost and limited supply of solar modules complying with domestic content requirements (DCR) threaten these programs' progress.

3 Feb 2025



## **Risk of excess curtailment**

Uncompensated curtailment is expected to be around 3% but could be as high as 4.5% under current rules





Source: Ember's analysis uses a Monte Carlo simulation to assess uncompensated curtailment under current regulations. The figure illustrates probabilistic curtailment under these rules, not historical data. Uncompensated curtailment occurs when generators face reductions in power generation without reimbursement.

# State of art: A paradigm shift in RE projects in India

Moving from plain vanilla solar and wind tenders to round-the-clock renewable projects:

- Solar + BESS
- Firm and dispatchable RE (FDRE)
- Load following

Major risk characteristics:

- Lots of moving parts, still new in terms of industry experience
- Risk of penalty for not meeting precise annual or monthly targets, e.g., meeting peak power
- High capital costs for the contracted amount
- Wholesale market exposure (25-45% outside PPA)

## Round the clock projects: Wholesale market exposure

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#### **Price cannibalization**

India has started witnessing instances of price cannibalisation during solar

Total Buy and Sell Bids (MW) and MCP (Rs/MWh) for Each 15-Minute Settlement Period on August 23,

Source: Data from IEX Day-Ahead Market

2024

Market Clearing Price (MCP) refers to the price at which supply equals demand in a competitive market, ensuring all buyers willing to pay this price and all sellers willing to accept it can trade.

#### Market volatility

Expected revenue from electricity sales from solar in the wholesale market has been volatile

Distribution of expected revenue realization from excess electricity market sales (Rs/MWh)



Source: Ember's analysis of revenue realization from the sale of excess generation in the wholesale electricity market from FDRE (Firm and Dispatchable Renewable Energy) projects. · Variations in annual revenue realization stem from differing capacities of solar, wind, and storage in FDRE projects and the time period of excess electricity generation. Prices are based on IEX data for respective years. FDRE refers to Firm and Dispatchable RE

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Buy Bid (MW) Sell Bid (MW) MCP (Rs/MWh)

hours in its wholesale electricity market

Round the clock projects: Risk of penalty of not meeting the given generation targets Optimising for dispatchable RE requirements may involve not fully meeting the total demand

Variation of cost of supply for different DFRs (Rs/kWh)



Source: As per Ember's analysis of the SECI-FDRE-IV 1260MW tender - The Demand Fulfillment Ratio (DFR) is the ratio of the actual renewable energy supplied by the generator to the contracted demand profile specified in the Power Purchase Agreement (PA). DFR below 90% entails penalties as per the tender.

\*Cost of supply refers to the generation and storage cost and includes the penalty of not meeting DFR threshold. FDRE refers to Firm & Dispatchable RE



# Counterparty risk: Not getting paid (on time) by distribution utilities



consumers within a region.

# Risk of not generating as per schedule and facing a penalty (Deviation Settlement Charges)

## In India, penalties for schedule deviations have become stricter over time, with risks of further tightening

Penalty for solar under-generation as a percentage of the electricity sale price under different DSM regulations for different deviation levels.



Source: Central Electricity Regulatory Commission

Deviation Settlement Mechanism (DSM) rules regulate penalties and compensations for power generation deviations from scheduled quantities to ensure grid stability and discipline. Contracted rate refers to the tariff for sale or purchase of power. In the power sector, a schedule refers to the declared generation or consumption of electricity submitted in advance to the grid operator, which must be followed to maintain grid stability



## How do the risk premiums add up for Indian RE markets

New-age RE projects are expected to significantly drive the cost of capital

Premiums calculated for various risks in percentage points



Source: Ember's analysis on individual risks. New Age Firm and Dispatchable RE (FDRE) projects incorporate variable RE capacity with integrated storage to incorporate dispatchability. BESS refers to Battery Energy Storage System. DSM refers to Deviation Settlement Mechanism. \*Cost of Capital (CoC) is derived using the buildup method, and excludes some project-specific or macroeconomic risks, and may therefore be underestimated. Best in class refers to RE projects with the lowest CoC, adjusted for India's country risk premium obtained from secondary sources.

- FDRE projects and commissioning delay can contribute more than 1/3rd to the total risk premium
  - Land and grid connectivity related delays are expected to persist
  - PPA delays have mainly resulted from bureaucratic hurdles arising out of 'lengthy processes' in place

# How do we de-risk projects ? Innovation in technology, policies and contracts

Have you heard about India's Green Energy Corridor Project? It is a connected network which integrates renewable energy with the main grid.

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#DidYouKnow



Solar park policy: Plug-and-play model

Green energy corridors: Dedicated grid buildout from RE rich regions to demand centres



### Advanced O&M

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Protection against Wind Resource Volatility

Wind farm operators are at the mercy of fluctuating winds. To protect against loss of income, Swiss Re has developed index-triggered insurance for Wind Resource Volatility.



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