



# Enabling investments to inch closer to 24/7 renewable energy for industries in India

## ASIA CLEAN ENERGY FORUM 2025

Empowering the Future: Clean Energy  
Innovations, Regional Cooperation and  
Integration, and Financing Solutions

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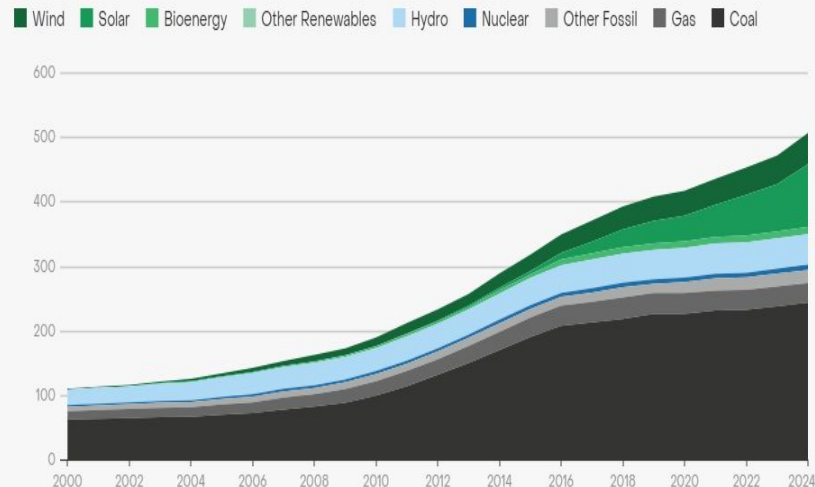
# **Brief overview of RE procurement by corporates**

Insights and outlook

# C&I procurement is a key RE growth driver in India

## India installed capacity by source

Gigawatt

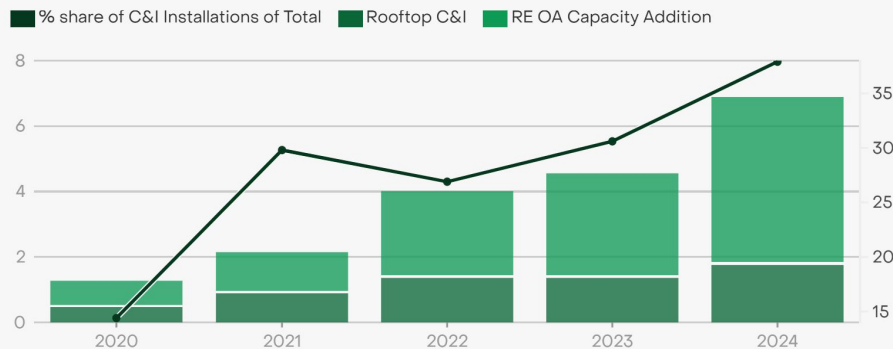


Source: Ember Electricity Data Explorer, [ember-energy.org](https://ember-energy.org)

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## C&I procurement has significantly boosted demand for Solar PV capacity.

RE OA capacity addition, rooftop C&I in GW, and % share of C&I installations of total capacity



Source JMK research  
Renewable Energy Open Access (RE-OA): Allows C&I consumers to procure renewable energy directly from producers through the grid.

Rooftop C&I Solar: Solar systems installed on C&I for captive power generation, reducing grid dependence.

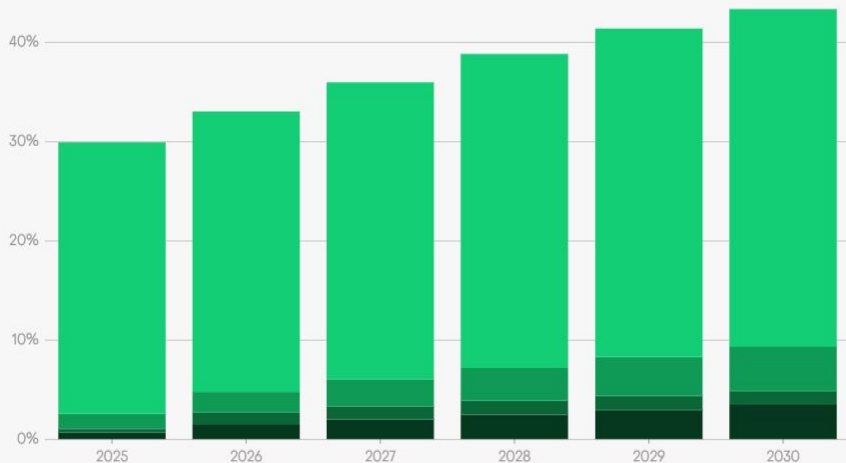
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# Policy support and cost advantages have fueled growth

## Indian industries are mandated to replace more than 40% of captive power with renewables by 2030

Share of captive power mix as mandated under the RPO

Wind Hydro Distributed Renewable Energy Other (incl. solar)



Source: RPO guidelines by Ministry of Power, India

RPO stands for Renewable Purchase Obligation. Distributed Renewable Energy includes projects of up to 10 MW

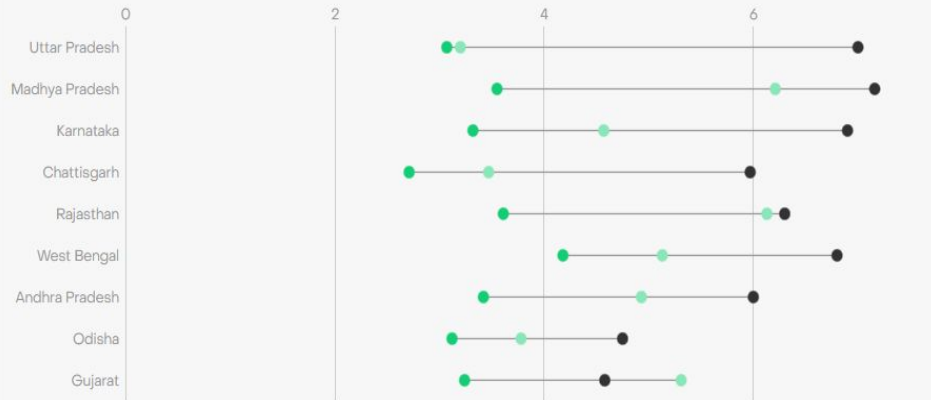
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## Procuring renewable power via open access mechanisms is cheaper than grid power for industries in most Indian states

Landed RE versus grid tariffs for industries across various states, in Rs./kWh

States ordered by biggest difference in grid vs open access prices

RE captive RE third-party Grid



Source: Based on states' latest tariff orders available up to November 2024. Grid tariff considers only the variable component, and excludes fixed charges.

Open access allows consumers to procure power privately from generators using the common grid. Renewable energy (RE) tariffs here refer to solar power priced at Rs. 2.5/kWh plus state-wise applicable open access charges.

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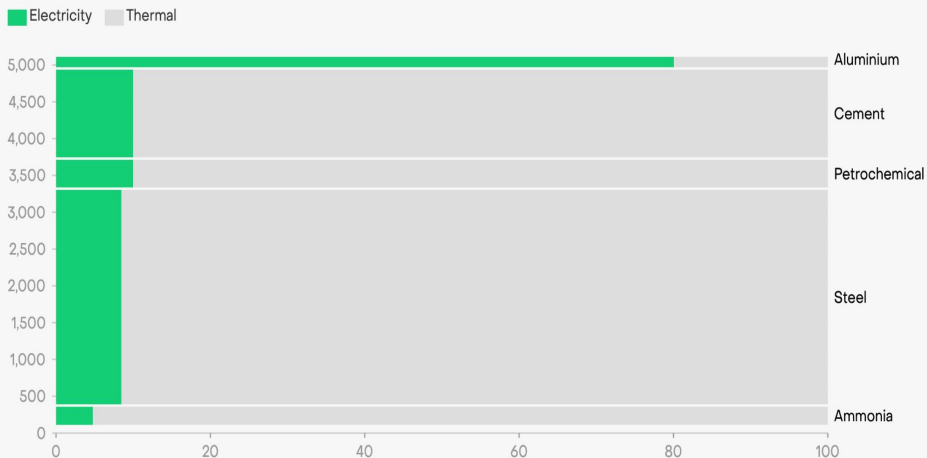
+ ESG commitments or subscription to RE100 charter

# RE growth potential in the industrial sector remains strong

## Electricity use varies widely across India's industrial sectors

Electricity as a share of total energy consumed (%) in 2022

Height of the bars show total energy consumption by sector in petajoules (PJ)



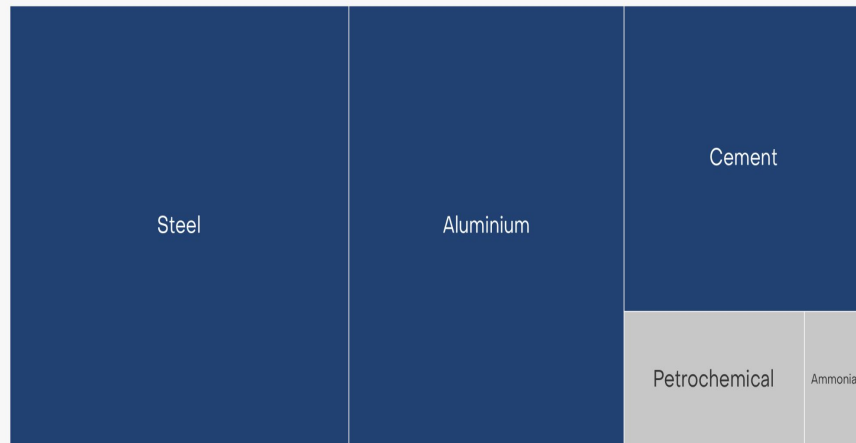
Source: Ember's analysis of thermal and electricity energy inputs for various industrial sectors for 2022 (latest year with data availability).

Electricity includes power requirement from heating technologies like electric arc furnaces for steel making

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## 91% of India's 'heavy' industry electricity use comes from steel, aluminium and cement sectors

Electricity consumption (TWh) by sector in 2022



Source: Ember's estimates based on electricity consumption data for various industrial sectors for 2022 (latest year with data availability).

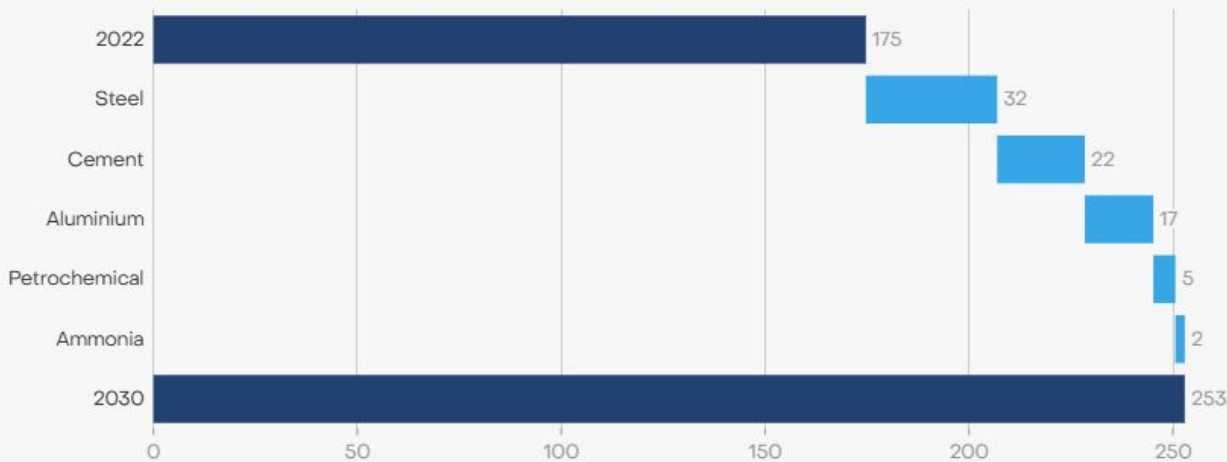
Electricity consumption includes power requirement from heating technologies like electric arc furnaces for steel making

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# RE growth potential in the industrial sector remains strong

## India's heavy industry electricity use is expected to grow 45% by 2030

Electricity consumption, change between 2022 and 2030 (TWh)



Source: Ember's estimates based on electricity consumption data for various industries for 2022 (latest year with data availability) and industry growth projections to 2030

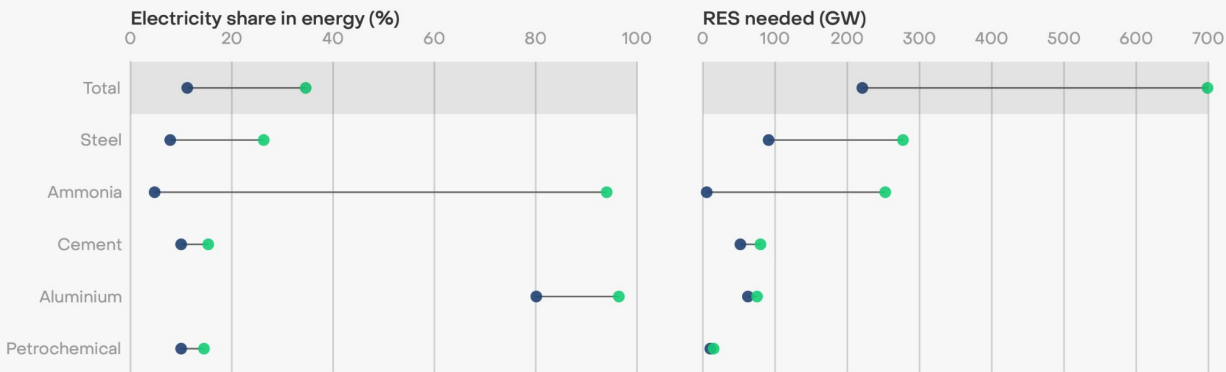
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# Electrification will add 3X more power demand for industrial sector

## Green electrification of India's heavy industries could triple their 2050 electricity share in energy use and RES requirements

Electricity as a share of energy consumption & RES required to green electricity

● Existing technologies ● Advanced electrification technologies



Source: Ember's analysis based on the electrification potential of various industrial sectors and average capacity factor of renewable energy based on the 14th National Electricity Plan. Assumes that major new technologies, currently under development, electrify the existing thermal processes in the industries wherever possible by 2050. RES refers to renewable energy sources that include solar, wind, small hydro and bio

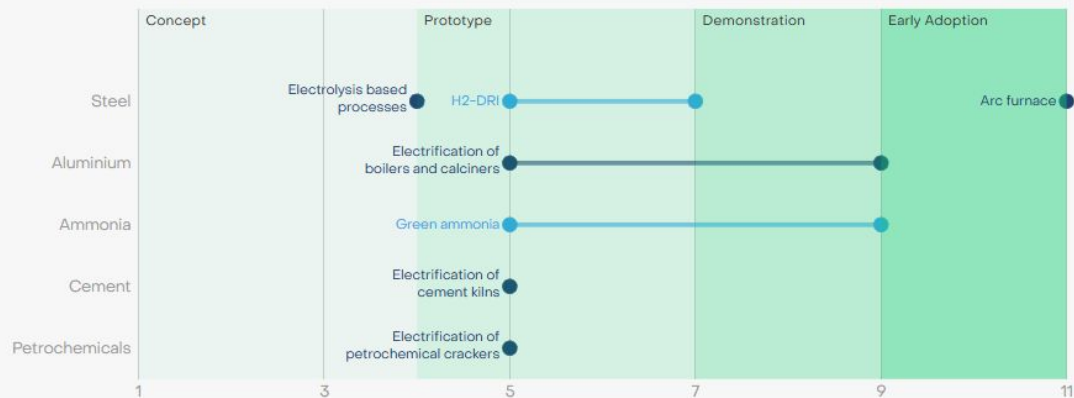
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# Electrification: The way forward?

## Technologies to electrify thermal processes of various industries are at different readiness levels

Technology readiness level, score from 1 (basic idea) to 11 (maturity)

Electrification: ● Direct ● Indirect



Source: Ember's analysis of technology readiness levels data from the International Energy Agency, World Steel Association, Energy Transitions Commission, European Aluminium and Ramboll  
H2-DRI refers to hydrogen in the direct reduction process. Technology readiness level is based on the scale proposed by the IEA for different clean energy innovations

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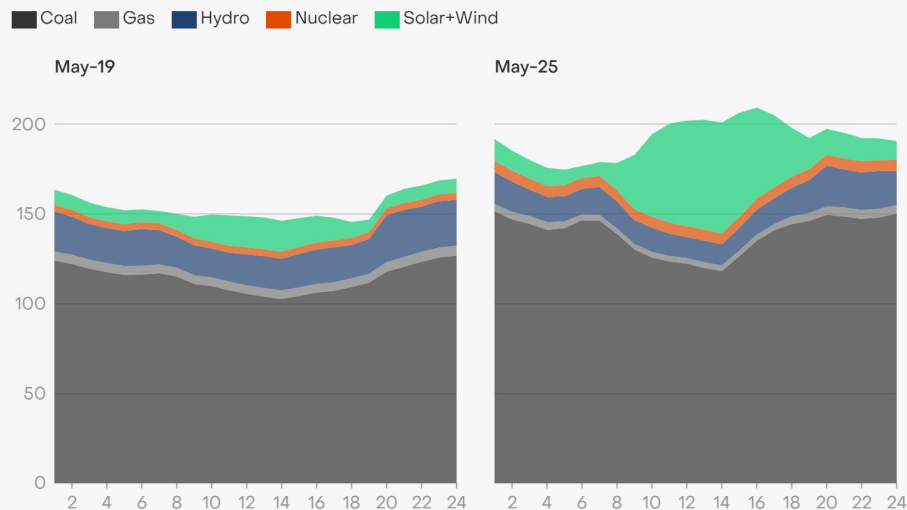


Increasing RE share in electricity  
consumption need storage investments

# Storage is key to unlocking further solar growth

## The duck curve waddles in with increasing solar penetration

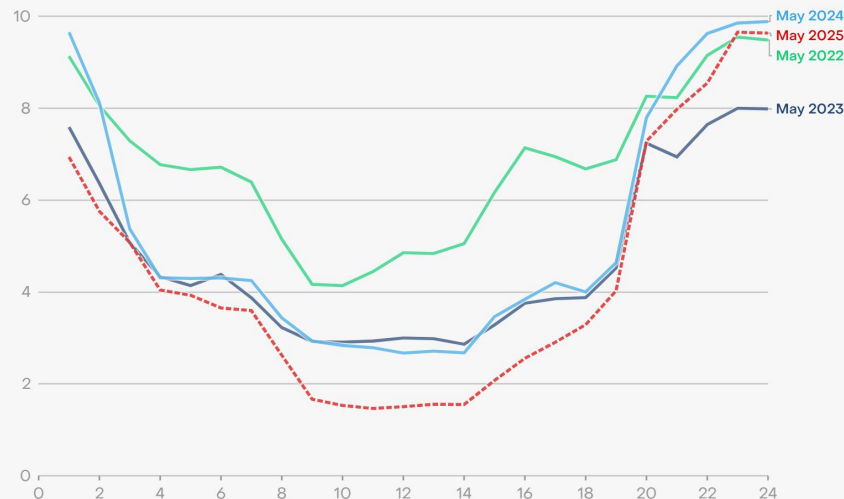
Hourly source-wise generation (GW) for a typical day in May 2019 and May 2025



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## Power exchanges are witnessing a widening midday price dip driven by surplus solar generation

Average market clearing price in ₹/kWh for the month of May from 2022–2025



Source: Indian Energy Exchange (IEX) – Day Ahead Market

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As the level RE procurement increases—from 50% to 24/7 RE—costs, balancing complexity, and the risks increase significantly

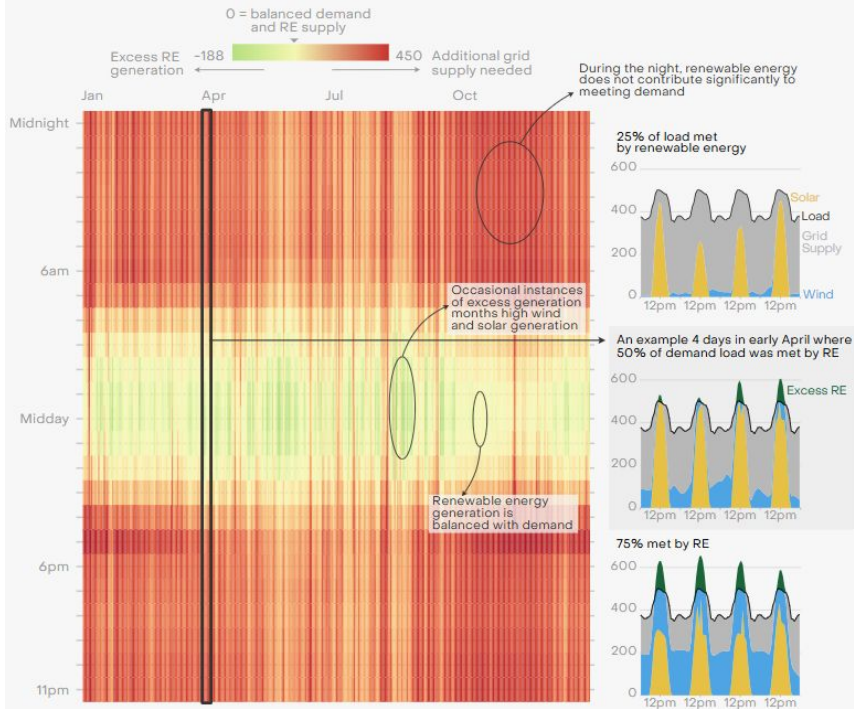


RE Procurement Level	Cost Competitiveness	Supply Matching	Risk / Complexity	Procurement Strategy Needed
50% RE	Competitive prices	Partial matching (daylight hours)	Low–Moderate	Solar
				Wind
80% RE	Moderate premium (~10–20%)	Better matching (still gaps at night)	Moderate	Solar++
				Wind--
				Storage (BESS)
				Excess generation
100% / 24/7 RE	Challenging & expensive Very high premium	Full matching (hourly basis)	High – Complex	Solar++++
				Wind ----
				Storage (BESS)++++
				Excess generation+++++

# Moving from plain vanilla to 24/7 RE: Supply Matching gets complex

Using renewable energy when it's available and the grid when it's not, Indian industries can meet 50% of electricity demand with RE

Net load = demand load — renewable generation (MW, modelled data)

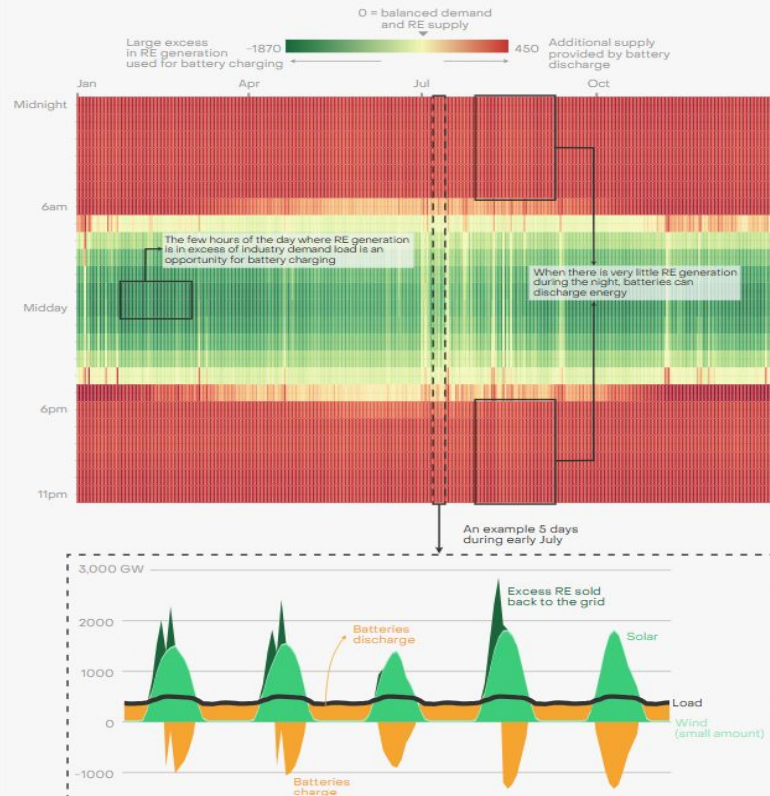


Source: Ember's renewable energy PPA model - Optimal solar and wind capacity for a 500 MW industrial consumer: 571 MW solar and 223 MW wind

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24/7 renewable energy in Indian industries requires batteries to supply about half of the total demand

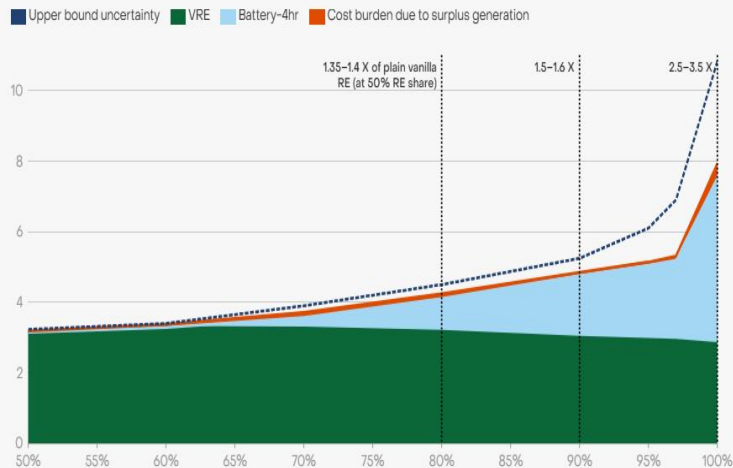
Net load = demand load — renewable generation (MW, modelled data)



# Moving from plain vanilla to 24/7 RE: Cost Competitiveness will be an issue

Increasing RE consumption from 50% to 80% comes at a moderate premium for Indian heavy industries, but achieving 24/7 RE could cost upto 3.5X

Component-wise levelised cost of supply for different shares of RE (Rs./kWh)



Source: Ember's RE PPA model - In the model, surplus electricity is assumed to be sold at ₹1.8/kWh, while the cost of generation ranges from ₹2.6 to ₹3.2/kWh. This loss per unit of surplus energy sold is reflected in the overall cost burden of the RE PPA.

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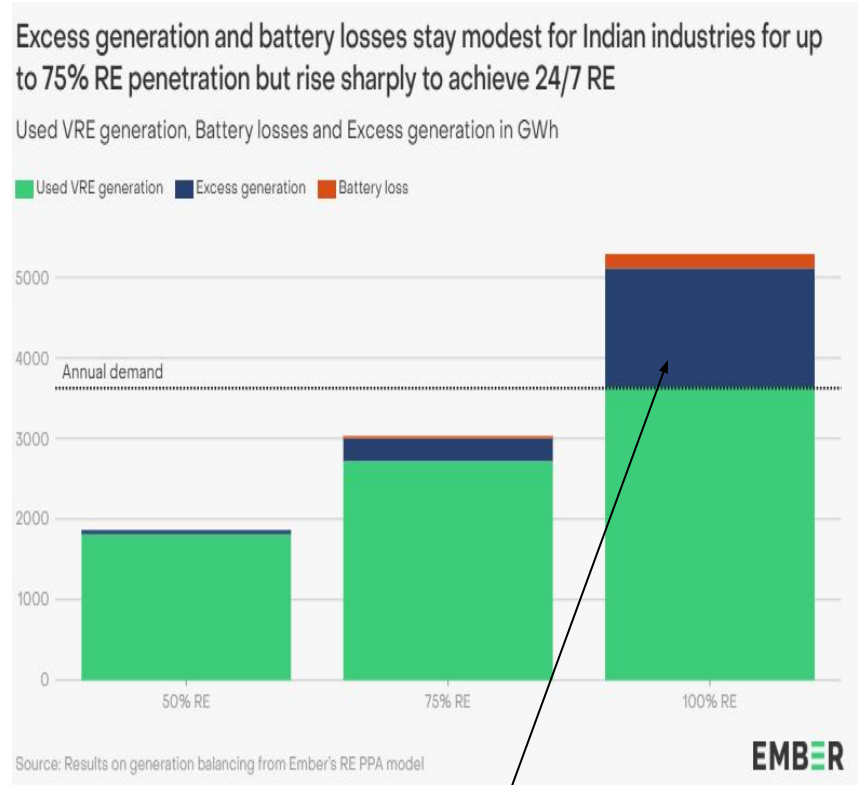
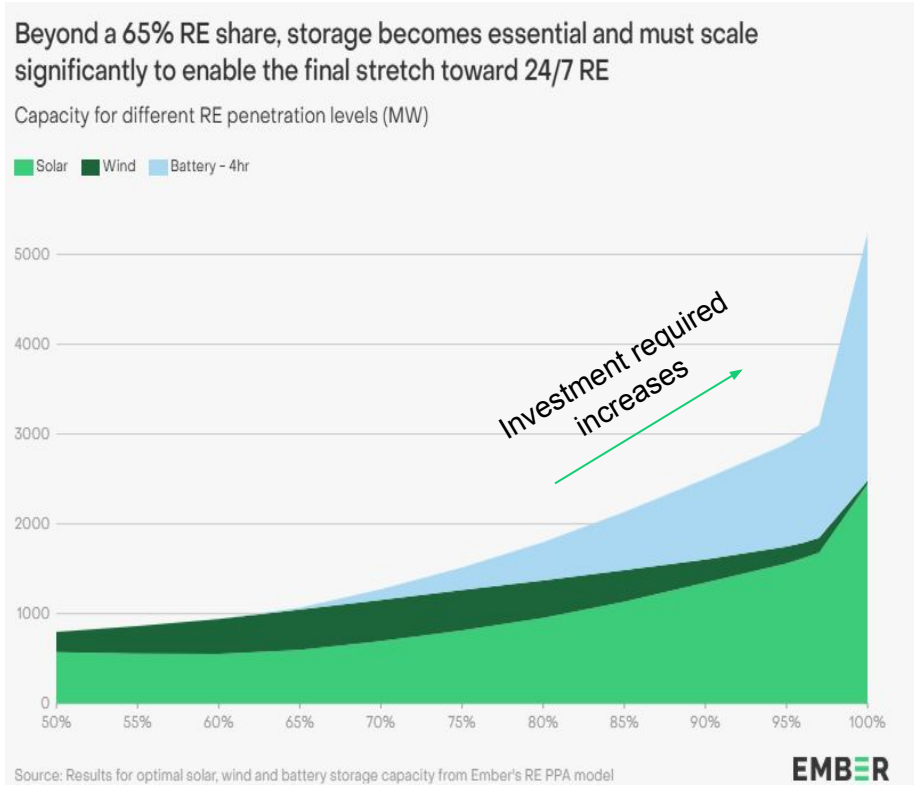
RE captive RE third-party Grid



Source: Based on states' latest tariff orders available up to November 2024. - Grid tariff considers only the variable component, and excludes fixed charges. Open access allows consumers to procure power privately from generators using the common grid. Renewable energy (RE) tariffs here refer to solar power priced at Rs. 2.5/kWh plus state-wise applicable open access charges.

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# Moving from plain vanilla to 24/7 RE: More investment with uncertainty in revenue

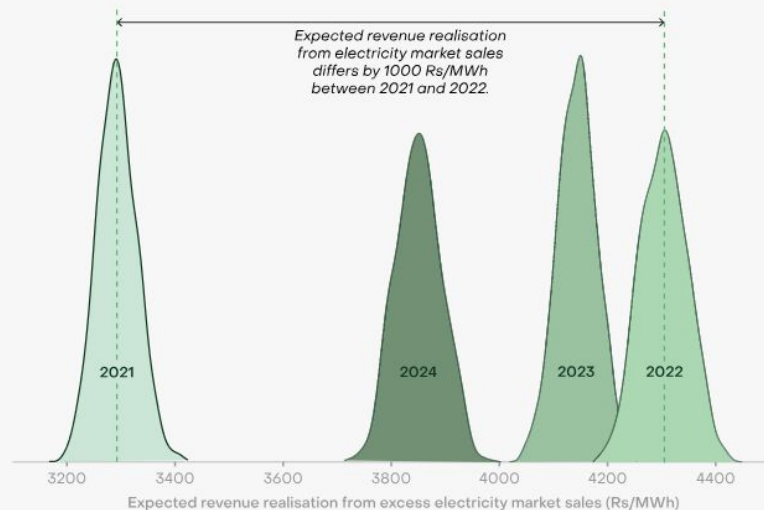


Revenue realization from sale of excess generation becomes important to the project

# Moving from plain vanilla to 24/7 RE: Market exposure risk has to be better understood through modelling

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)

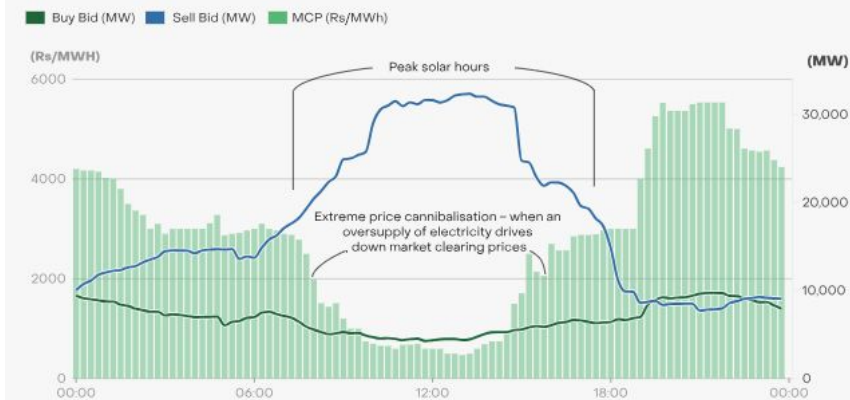


Source: Ember's analysis of revenue realization from the sale of excess generation in the wholesale electricity market from FDRE (Firm and Dispatchable Renewable Energy) projects. - Variations in annual revenue realization stem from differing capacities of solar, wind, and storage in FDRE projects and 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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India has started witnessing instances of price cannibalisation during solar hours in its wholesale electricity market

Total Buy and Sell Bids (MW) and MCP (Rs/MWh) for Each 15-Minute Settlement Period on August 23, 2024



Source: Data from IEX Day-Ahead Market

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.

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# Moving from plain vanilla to 24/7 RE: Dispatchable RE projects are riskier

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.





# The way forward

- Better tools to
    - estimate the risk of such projects
    - Help identify the “optimal” capacity mix of projects
  - More pilots for corporate 24/7 PPA
-

A background network diagram consisting of a series of interconnected nodes and lines. The nodes are represented by small circles, some in a light blue color and others in a light green color. The lines connecting them are thin and light blue. The network is more densely connected on the left side and becomes sparser towards the right.

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DATA INTO ACTION