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WORKING PAPER

India's Renewable Energy Breakthrough: Coal-Like Reliability at a Lower Fixed Price

Decoding SECI's thermal-mimic Rs 5.25/kWh FDRE-RTC auction

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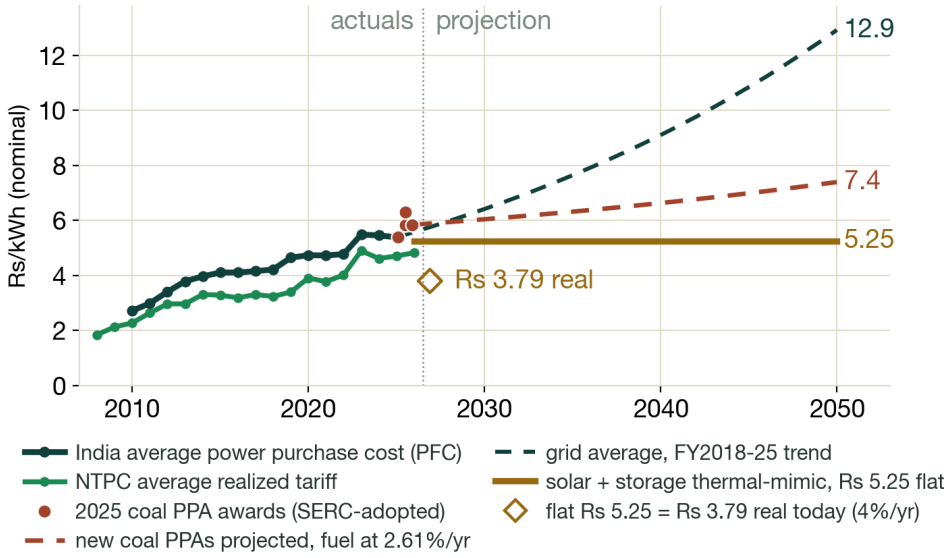
Coal-like reliability at a lower fixed price

Solar + storage against SECI's Rs 5.25/kWh thermal-mimic discovery, tested across ten states and ten years of weather

SUMMARY

- SECI's FDRE-RTC-V tender auctioned 1,000 MW of firm supply: 90% of capacity through the six evening-to-morning peak hours, 50-60% in solar hours, 70% the rest, every 15 minutes; shortfalls pay a 1.5x penalty. The shape is India's net load: high through the evening and night, capped at midday when surplus solar floods the grid.
- We estimate that a plant of 3.0 GW-AC solar and 12 GWh of battery per 1 GW delivers this profile at Rs 5.15 per kWh, below the Rs 5.25 discovered, with penalties of just 0.5% of revenue; at Rs 5.28, half a gigawatt more solar takes penalties to zero. Shortfalls cluster in the hours before dawn; the evening peak carries only about 5% of the decade's missed energy, and April-May, the grid's peak season, are the plant's strongest months. The high-solar northwest needs 3.0 GW of solar; other states need 3.5 GW to ride through the monsoon months.
- This happens because India's solar is remarkably consistent: the worst month in ten years still delivers 80% of the best, whereas German winter solar delivers 9-18% of its June output and Britain's 10-15%. Firm supply here therefore requires only daily battery storage, not the seasonal storage a European winter would demand.
- New coal PPAs signed in 2025 open at Rs 5.38-6.30 and climb with fuel costs; this contract stays at Rs 5.25 for 25 years. Adjusted for inflation, that is Rs 3.79 in today's rupees.
- Until now, open access meant buying plain midday solar. At these prices, industry can buy firm clean power in the shape it needs: round-the-clock supply for data centres and green steel, or constant power for aluminium smelters that cannot stop.

THE PRICE IN CONTEXT



This auction sets a benchmark for firm clean power in India. Planners will have to rethink what baseload means: for decades it meant coal. **Solar and storage now hold that shape, at a lower fixed price.**

All numbers from the hourly ten-state, ten-weather-year simulation described on the method slide; canonical results in results/scenario_table_v4.csv. Sources and derivations on the slides that follow.

SECI's 1000 MW thermal-mimic tender cleared at Rs 5.25-5.26/kWh

SECI-FDRE-RTC-V: 1000 MW, ISTS-connected, RfS March 10 2026; reverse auction concluded August 6, result announced August 7, 2026

THE SUPPLY OBLIGATION, PER 15-MINUTE BLOCK

Window	Definition	Required DFR
Peak hours (6 hrs/day)	buyer-chosen day-ahead, 18:00 to 10:00 window	**>= 90%**
Solar hours (Grid-India)	roughly 08:00-18:00	**50% floor, 60% cap**
Remaining hours	all other non-solar hours	**>= 70%**

- **Penalty: 1.5x the PPA tariff** on every block's shortfall below the floor, reconciled monthly. No monsoon relaxation survived Amendment-01.
- **5% market allowance.** The developer may buy up to 5% of the annual required energy, about 292 GWh per GW-year, from the green market to fill shortfalls.
- **Excess solar-hour power above the 60% cap** earns only 50% of tariff if the buyer takes it under its day-ahead right of first refusal; otherwise it is a merchant sale.

Solar hours are not fixed clock times: Amendment-03 defers to Grid-India's state-wise GNA declarations. The 08:00-18:00 window follows SECI's own penalty illustration, which prices the 08:00 and 17:00-18:00 blocks at the 50% tier.

THE RESULT: 7 WINNERS AT RS 5.25-5.26

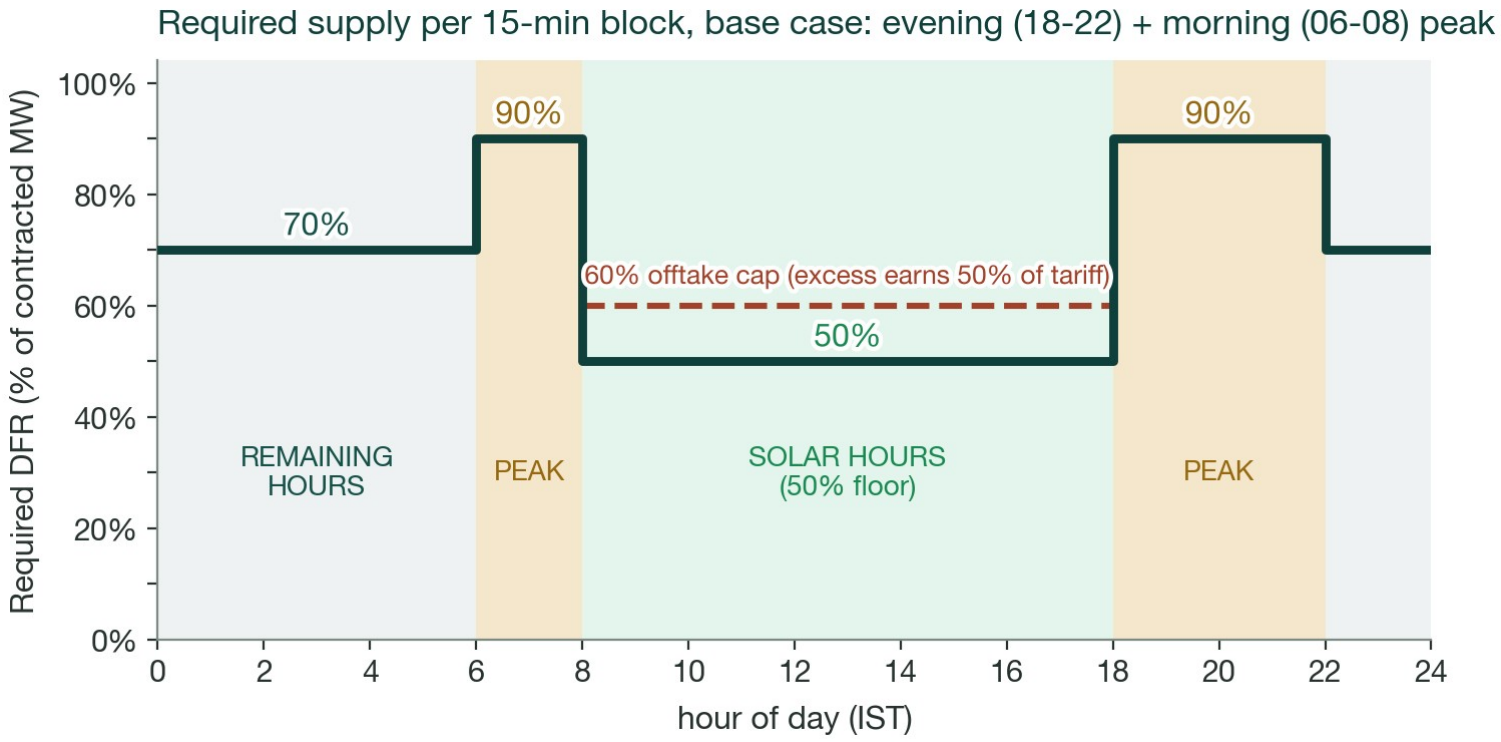
Winner	Capacity	Rs/kWh
Kengeri Prime Solar (Rays Power)	180 MW	**5.25**
Resolven Four Energy	150 MW	**5.25**
Hexa Climate Solutions	150 MW	**5.26**
Hero Solar Energy (Hero Future)	120 MW	**5.25**
EMIF II Holding V II Cooperatief	100 MW	**5.25**
Purvah Green Power (RPSG)	70 MW	**5.25**
Juniper Green Energy	230 MW	**5.26**

16 companies bid. Profile rewritten mid-tender: Amendment-03 (June 25) replaced the two-tier 90/70 profile with the three-tier thermal mimic above.

Firm renewable power at Rs 5.25: reliable, inflation-proof, and below every coal PPA India signed in 2025. MNRE Secretary, August 7: *"If you look at this RTC bid, it almost matches the nuclear power. Yet, I must commend our developers who ... have the confidence that Rs 5.25 is* ***an inflation-proof price; they will be able to supply for the next 25 years."***

Sources: SECI RfS SECI/C&P/IPP/13/0020/25-26 (Mar 10, 2026), Amendments 01 (Apr 2), 02 (Apr 27), 03 (Jun 25, 2026), Clarifications-01 (Apr 27, 2026), seci.co.in tender SECI000240; results per Juniper Green Energy press release (Aug 10, 2026), SaurEnergy, Energetica India, and MNRE Secretary S.K. Sarangi's remarks at the 7th CII International Energy Conference, Aug 7, 2026, as reported by PTI (Juniper awarded 230 MW of its 300 MW quote under bucket-filling).

The required profile: 90% in night peaks, 50-60% in solar hours



THE ENERGY MATH, PER GW

Peak, 6 h x 90%	**5.4 GWh**
Solar hrs, 10 h x 50%	**5.0 GWh**
Remaining, 8 h x 70%	**5.6 GWh**
Total per day	**16.0 GWh**
Effective CUF	**67%**
Annual required energy	**5,840 GWh**
5% market allowance	**292 GWh**
Non-solar hours (14 h), battery-served	**11.0 GWh**

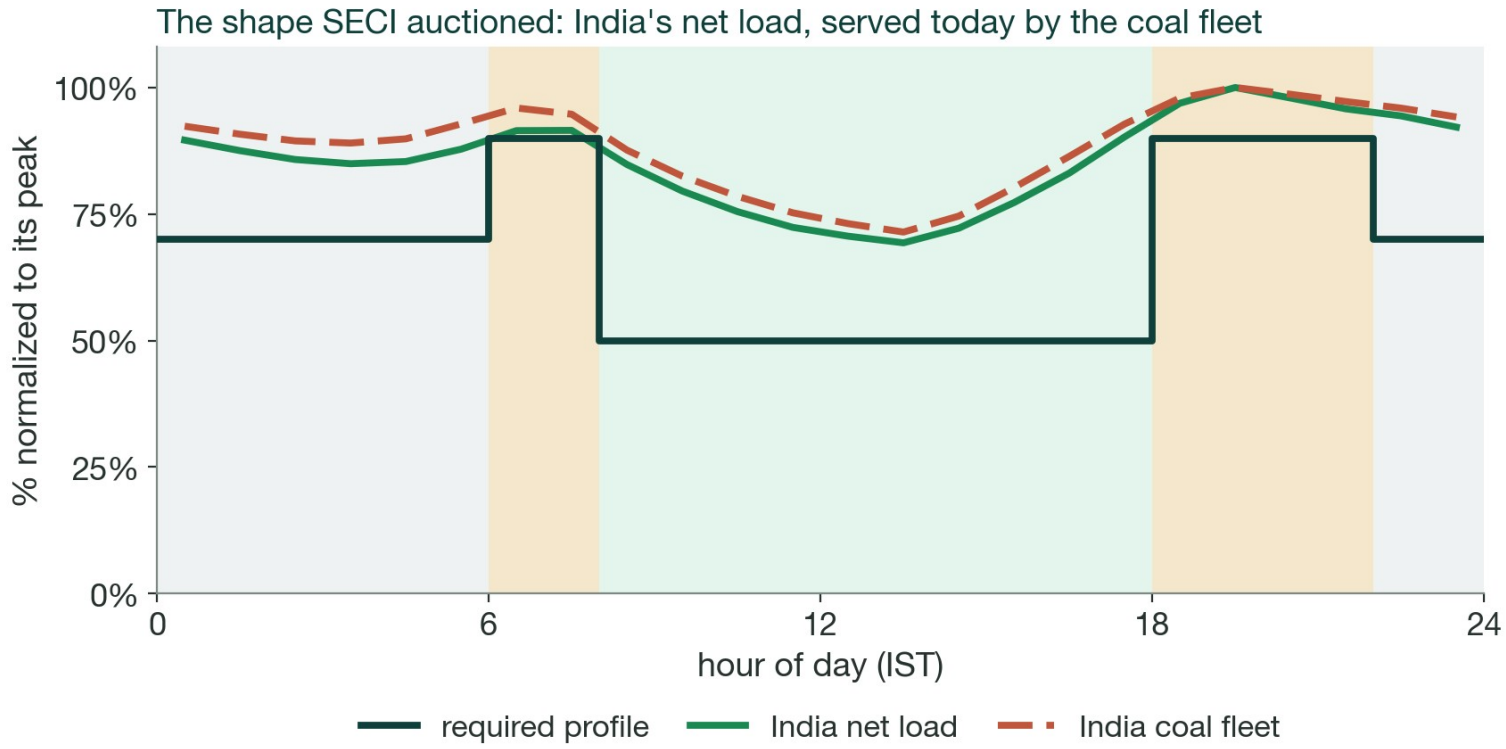
The buyer picks the 6 peak hours day-ahead, anywhere from 18:00 to 10:00 the next morning: the design must survive evening, morning, and split peaks.

Why this leans on the battery: the profile demands 11.0 GWh through the 14 non-solar hours, 69% of each day's energy, on storage alone. After round-trip losses it draws about 12 GWh of stored energy down every night, which is what the 12 GWh usable buys. The battery, not the panels, sets the design.

Profile per RfS Clause 8.1.a as amended by Amendment-03 (Jun 25, 2026); peak-hour mechanics per Clause 8.1.c as amended by Amendment-01 (Apr 2, 2026); solar hours per Grid-India GNA state-wise declaration, modeled as 08:00-18:00 IST per the Annexure-C illustration; 15-minute blocks modeled at hourly resolution. Market allowance: Clause 8.1.j permits sourcing 5% of the annual energy required to be supplied (5% of 5,840 = 292 GWh per GW-year) from the green market, on an annual basis with no monthly sub-cap; PPA Article 4.4.9's 'based on Contracted Capacity' wording would read as 438 GWh, and this analysis uses the tighter 292 throughout.

The profile SECI auctioned is India's net load profile

The tender profile against India's net load and the coal fleet's own daily shape, each normalized to its peak; Grid-India 15-min SCADA, Aug 2025 - Jul 2026



SECI IS PROCURING THE NET LOAD

- **The tender drew India's net load.** High through the evening and night, capped at midday: the demand left after solar. The peak window opens at 18:00, as net load nears its 211 GW peak.
- **Coal already runs this shape:** the coal fleet peaks at 19:00 with the net load and throttles back through midday. Thermal mimic is literal: the tender asks solar + storage to run the way coal runs today.
- **The midday cut is deliberate:** solar floods the grid at noon and net load falls to 69% of the evening peak; no discom wants more Rs 5 afternoon power there. So the tender caps solar-hour delivery at 60% and pays only half tariff for anything above it.

A thermal mimic is a net-load product. The demand left after cheap midday solar is what India's coal fleet serves today, and the seven coal PPAs India signed in 2025 start at Rs 5.38 to 6.30. **Solar + storage fits the same shape at Rs 5.25, flat for 25 years.**

Sources: Grid Controller of India (NLDC) daily Power Supply Position reports, 15-minute SCADA time series, Aug 1 2025 - Jul 31 2026 (98.0% of blocks), accessed via the Grid-Sentinel open dataset, github.com/HalcyonVector/Grid-Sentinel (CC BY-SA 4.0); demand is grid-served demand met; net load = demand minus grid-scale solar; coal fleet curve = thermal (coal + lignite) generation from the same SCADA series, hourly means, each curve normalized to its own peak. Cross-checked against NITI Aayog ICED national load curves (iced.niti.gov.in) and POSOCO daily-report compilations (robbieandrew.github.io/india). Net-load framing and validation: Sanyal and Dev, The Duck and The Camel, EAC-PM Working Paper 53/2026 (eacpm.gov.in); this series reproduces its May-2026 peak statistics exactly. 2025 coal PPA year-one tariffs Rs 5.38-6.30 across the seven TBCB awards of Mar-Nov 2025 (11.9 GW; average Rs 5.81, midpoint Rs 5.84; SERC adoption orders; sources on the fuel-price slide).

METHOD

How we priced it: hourly simulation under the tender's own rules

We simulate a solar + battery plant at 64 sizing configurations in each of ten states, through ten years of real weather, and bill it under the contract

WHAT WE SIMULATED

A DC-coupled solar + battery plant behind a 1 GW grid connection (1.4 DC-AC ratio), simulated at every combination of:

10 states, best solar site in each

x

10 NREL weather years, 2015-2024, hourly

x

64 configurations: solar 2.5-6.0 GW-AC x battery 6-24 GWh

THE ENGINE: EVERY HOUR, IN ORDER

1. Solar arrives, derated 3% for equipment failures
2. Hold this hour's floor: 90 / 70 / 50-60%
3. Surplus charges the battery first (92% round trip)
4. After dark, the battery holds the floor alone
5. Above the 60% solar cap: half tariff, or curtail
6. Still short? Market energy first, then 1.5x penalty

Output, for each configuration and weather year: the all-in tariff at which the plant breaks even, and penalties as a share of revenue.

ASSUMPTIONS (BASE CASE)

Solar capex	**Rs 3.75 cr/MW-AC**
Battery capex, nameplate	**Rs 8,550/kWh ($90)**
Battery cell replacement, yr 15	**in capex (PV Rs 870 cr)**
Battery round-trip efficiency	**92%**
Minimum battery charge in reserve	**10%**
WACC 10% · 25 yr · O&M 1.5%/yr	
Physical capex per GW, 3.0 GW + 12 GWh	**Rs 22,650 cr**
Penalty at Rs 5.25 tariff (1.5x)	**Rs 7.88/kWh**
Market energy: Rs 4.50/kWh, cap	**292 GWh/yr**

Kept conservative on purpose: no grid charging, single-site, battery never discharges above the floor, and every hour is held to its full requirement.

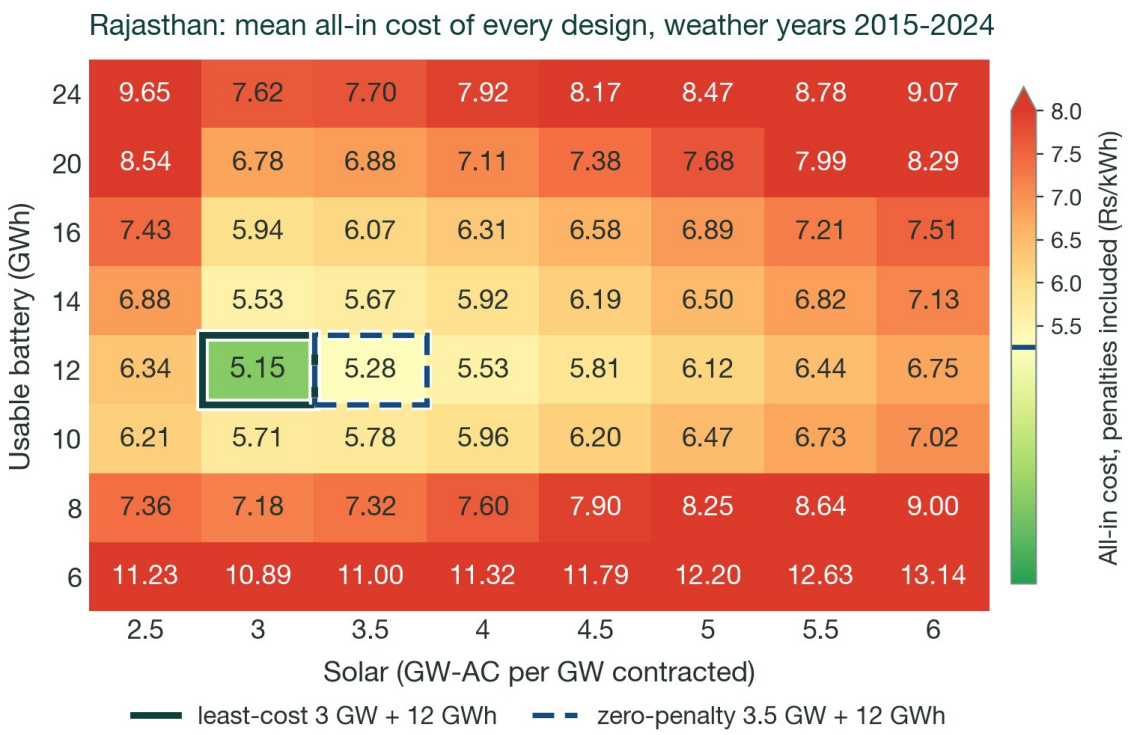
All-in cost = (annualized capex + O&M + market purchases + penalties) ÷ billed energy (incl. spill at 50% tariff)

Chronological minimum-compliance dispatch, not optimization: the plant holds each block's floor and never discharges above it. Hourly resolution stands in for four identical 15-minute blocks (small bias); no separate battery C-rate limit behind the 1 GW connection; market fill billed at full tariff, spill fully sold, initial SOC full. Solar profiles: NREL India via reV, DC-coupled, ILR-1.4 clipped. Financials: WACC 10% nominal, 25 yr, CRF 0.110168, O&M 1.5% of physical capex; battery nameplate = usable / 0.9 (10% SOC floor); Rs 95/USD. Beyond the base sweep: three peak-placement scenarios and a flat-90% counterfactual. Engine: sim/rtc5_sim.py; headline numbers reproduce from results/scenario_table_v4.csv.

All-in cost: Rs 5.15 lean, or Rs 5.28 with zero penalty, in Rajasthan

Left: all 64 Rajasthan configurations priced, solar 2.5-6.0 GW-AC x battery 6-24 GWh, penalties included. Right: the cost anatomy of six of them

EVERY RAJASTHAN DESIGN PRICED



Reading the grid: colour pivots at Rs 5.25; only one design beats the discovered price: 3 GW + 12 GWh at Rs 5.15 (solid box); dashed box = the zero-penalty design (3.5 GW + 12 GWh, Rs 5.28).

SIX DESIGNS, TAKEN APART (RS/KWH)

Design (per GW)	Solar	Battery	Market	Penalties	ALL-IN	Pen avg/worst
3.0 GW + 12 GWh	2.37	2.54	0.21	**0.03**	**5.15**	0.5% / 3.0%
3.5 GW + 12 GWh	2.69	2.47	0.13	0.00	**5.28**	zero, 10 yrs
4.0 GW + 12 GWh	3.02	2.43	0.08	0.00	**5.53**	zero
3.0 GW + 14 GWh	2.38	2.97	0.18	**0.01**	**5.53**	0.1% / 1.1%
3.5 GW + 14 GWh	2.69	2.88	0.09	0.00	**5.67**	zero
4.0 GW + 14 GWh	3.03	2.84	0.05	0.00	**5.92**	zero

Half a gigawatt more solar does the job. The optimum serves the profile at Rs 5.15 with a small penalty risk; 3.5 GW makes it penalty-free across all ten weather years, at Rs 5.28.

The remaining shortfall is mostly bought, not fined. The 5% market allowance covers most of what the plant misses (Rs 0.21/kWh of market energy); penalties are just Rs 0.03, 0.5% of revenue on average and 3.0% in the worst year.

The same 64-configuration sweep run in every state; heat map = mean all-in cost over weather years 2015-2024, colour capped at Rs 8/kWh; table from results/agg_Rajasthan_split.csv; market energy and penalties inside every number; split peak scenario. Table components rounded independently and may not sum exactly.

WHERE IT WORKS

The high-solar northwest clears Rs 5.25; every state lands within 7%

Each state's least-cost design and its zero-penalty design (GW-AC + GWh usable), priced with penalties inside, over the same ten weather years

State	Least-cost design	Rs/kWh	Zero-penalty design	Rs/kWh
Jammu & Kashmir	3.0 GW + 12 GWh	**4.93**	3.0 GW + 12 GWh	4.93
Rajasthan	3.0 GW + 12 GWh	**5.15**	3.5 GW + 12 GWh	5.28
Gujarat	3.0 GW + 12 GWh	**5.22**	4.0 GW + 12 GWh	5.56
Tamil Nadu	3.5 GW + 12 GWh	**5.41**	4.0 GW + 12 GWh	5.61
Madhya Pradesh	3.5 GW + 12 GWh	**5.51**	4.5 GW + 12 GWh	5.91
Karnataka	3.5 GW + 12 GWh	**5.52**	4.0 GW + 12 GWh	5.64
Andhra Pradesh	3.5 GW + 12 GWh	**5.54**	4.5 GW + 12 GWh	5.92
Telangana	3.5 GW + 12 GWh	**5.54**	4.0 GW + 12 GWh	5.67
Haryana	3.5 GW + 12 GWh	**5.58**	4.5 GW + 12 GWh	5.94
Maharashtra	3.5 GW + 12 GWh	**5.58**	4.5 GW + 12 GWh	5.94

WHY THE MAP LOOKS LIKE THIS

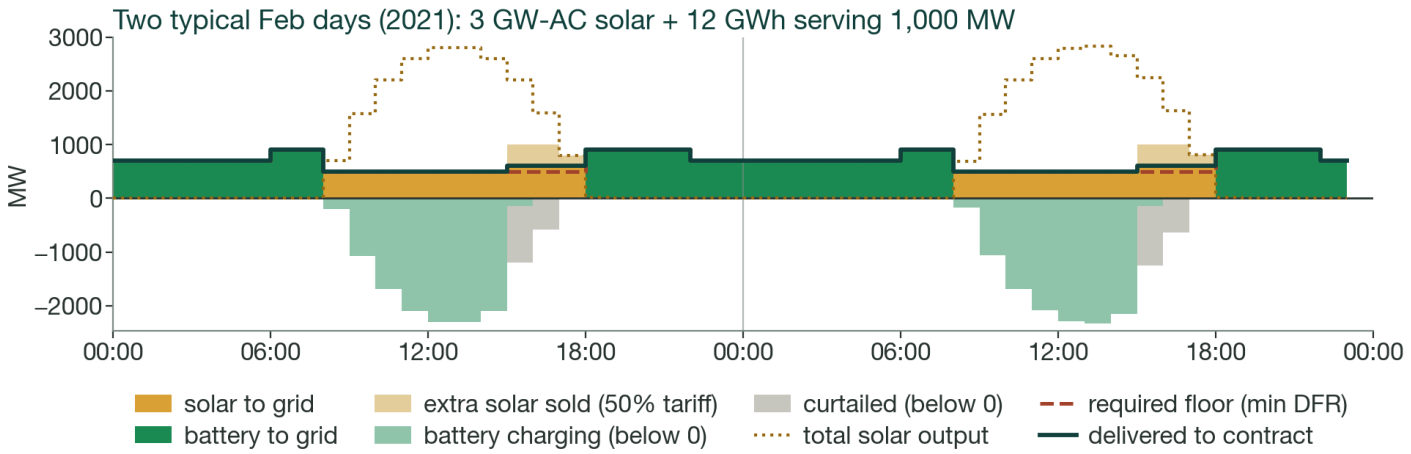
- **The northwest has the energy; the rest must build it.** At 3.0 GW of solar, only J&K, Rajasthan and Gujarat cover the year's full 5,840 GWh obligation (100-102% of it, market allowance included). The other seven stop at 95-98%: an energy gap no battery can close.
- **The summer monsoon decides who pays more.** June-September cloud carries 70-79% of the decade's shortfall in Gujarat, Madhya Pradesh, Karnataka, Telangana and Maharashtra, and in bad years those four months consume the whole annual market allowance. Rajasthan's desert keeps 87% of its sun through July; the monsoon belt keeps 76-81%.
- **Two states answer to a different season.** Tamil Nadu's worst month is November or December in all ten weather years: the northeast monsoon, not the southwest. Haryana's is January, when its weakest sun meets the year's longest nights.
- **The half-gigawatt is penalty insurance; the battery is arithmetic.** The extra solar is nearly free: net of its own energy sales it costs at most Rs 0.09/kWh (in some states it pays for itself outright), and it removes Rs 0.23-0.35 of average-year penalty exposure. The battery stays 12 GWh because 14 non-solar hours at the tender's floors draw 11 GWh a night; at 92% round-trip efficiency, that is 12 GWh, in every state.

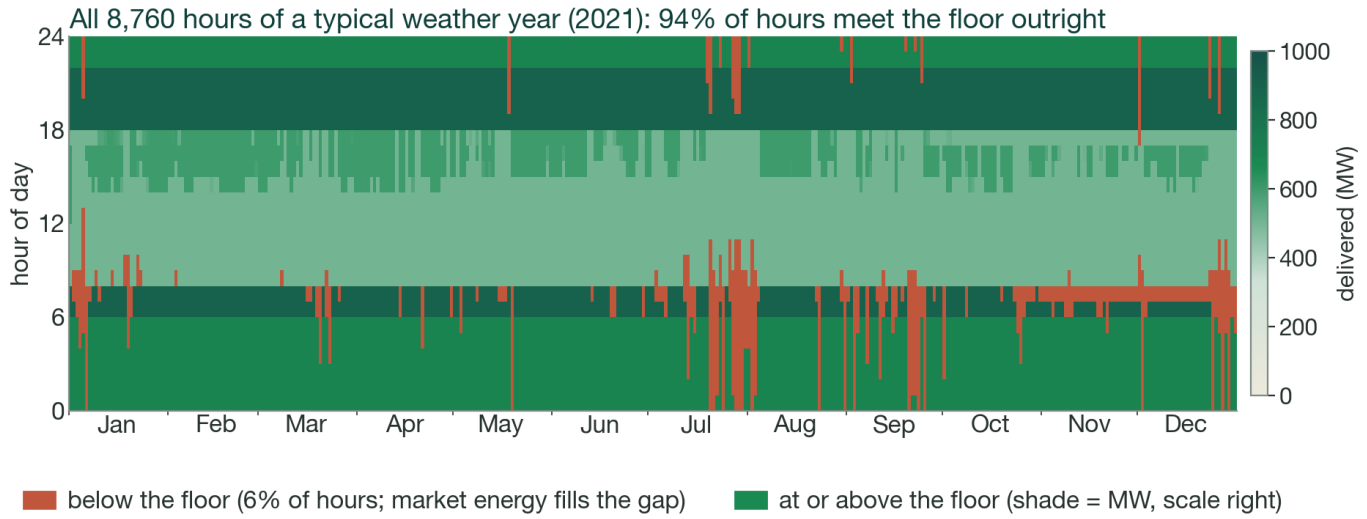
The price travels. The northwest clears Rs 5.25 outright; the median state lands 5% above it, and no state is more than 7% away.

Least-cost = the cheapest of 64 configs per state; zero-penalty = the cheapest with zero penalty in every weather year (worst-year threshold 0.05% of revenue); zero penalty costs Rs 0.00-0.40 more than the least-cost build. All costs all-in at $90/kWh batteries, Rs 95/USD. Full table: results/scenario_table_v4.csv.

How the plant operates: two typical days, and the full year

The optimal Rajasthan design (3.0 GW + 12 GWh): two ordinary days, then all 8,760 hours of a typical weather year (2021)





ONE DEEP BATTERY CYCLE A DAY

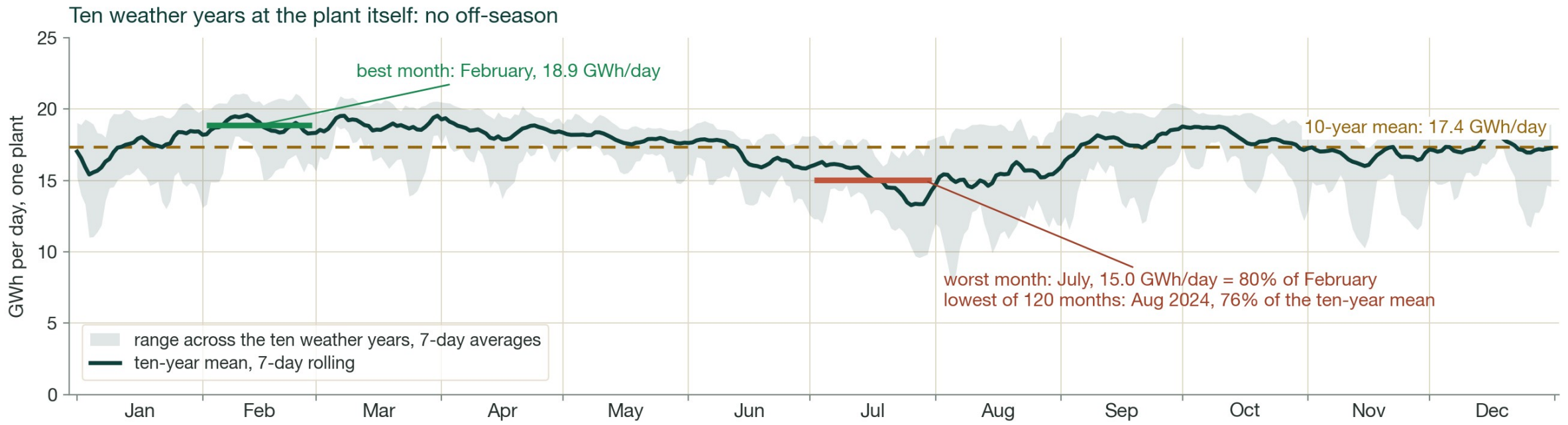
- **Charge by day, discharge slowly through the night.** Solar covers the midday floor and fills the battery through the afternoon; from sunset the battery runs the night down to dawn, one deep cycle a day.
- **India's solar is remarkably steady.** Read the year map left to right: the midday hours look the same in February as in July. Solar clears the daytime floor almost every day of the year.
- **94% of hours clear the floor outright.** Green on the year map is an hour served from solar and storage alone. The remaining 6% cluster in the monsoon months, with a lighter cluster in winter.
- **Nothing is curtailed until the wire is full.** Surplus charges the battery first: a stored MWh earns full tariff at night, twice the spill price. Once the battery fills, the plant sells the full 1,000 MW the connection allows; only what is left beyond that is curtailed.

Why the misses come before dawn. On a weak solar day the battery does not fill completely: it still carries the evening peak, but runs empty in the last hours before sunrise. **The next slides show when those weak days come.**

Top: two clean Feb days (above zero: solar, battery, spill at 50% tariff; below zero: charging, curtailment). Bottom: every hour of 2021 by delivered MW.

India has no solar winter

Daily solar generation at the plant itself: the Rajasthan site powering each 1 GW contract (3.0 GW-AC), ten weather years of NREL data (2015-2024)



India (8N-37N)

Worst month = 80% of the best

July vs February. Of 120 individual months, the lowest was 76% of the ten-year mean, and annual totals vary just 4.5% across ten years.

Germany / UK (47N-59N)

December solar: 9-18% of June's

9-18% in Germany, 10-15% in Britain (2022-24). A seasonal hole batteries cannot bridge: it needs months of storage, not hours.

What that means

Bridge the night, not the winter

India's solar problem is daily, not seasonal. That is a battery's job: no seasonal storage, no hydrogen caverns, no 3x winter overbuild.

Same NREL Rajasthan profile the simulation prices: 3.0 GW-AC at ILR 1.4 (4.2 GW-DC), hourly irradiance 2015-2024, with the 3% availability derate applied once to generation exactly as the dispatch applies it. Flat by month is not flat by week: the worst seven-day stretch of the decade delivered 44% of the mean and the worst calendar week 59%, which is what the battery and the shortfall slides are about. Germany: Fraunhofer ISE Energy-Charts, monthly total net solar generation (incl. self-consumption), 2022-2024 (api.energy-charts.info). Britain: Sheffield Solar PV_Live v4, GB national outturn 2022-2024.

Rajasthan's penalties: 0.5% of revenue. Across ten states, sizing decides

Each cell is one state-year's penalty as a share of revenue, ten weather years; left the auction-anchored 3.0 GW + 12 GWh everywhere, right 3.5 GW + 12 GWh everywhere

PENALTY AS % OF REVENUE: 3.0 GW + 12 GWH

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	10-yr avg
Jammu & Kashmir	0	0	0	0	0	0	0	0	0	0	0
Rajasthan	0	0	0.9	0	3.0	0.1	0.2	0.3	0.1	0.8	0.53
Gujarat	0	0.7	2.1	0.9	3.2	0.5	3.3	0.0	1.9	2.6	1.52
Tamil Nadu	4.1	2.0	4.1	3.4	1.0	5.8	8.0	6.3	5.0	6.7	4.63
Madhya Pradesh	6.8	3.0	3.8	5.0	10.1	5.6	9.3	5.4	6.8	7.9	6.36
Andhra Pradesh	4.0	3.8	7.0	3.6	6.0	11.0	9.9	8.6	5.9	9.1	6.89
Karnataka	3.3	6.3	4.8	5.8	7.7	8.2	9.5	9.3	5.1	9.5	6.95
Telangana	5.4	6.0	5.8	8.1	6.4	8.6	9.3	8.4	8.2	9.5	7.59
Maharashtra	5.8	4.2	4.5	8.6	8.7	10.3	9.3	6.7	9.9	9.3	7.72
Haryana	8.1	5.3	5.7	6.8	10.6	6.2	10.6	8.7	9.8	11.5	8.33
States paying no penalty	3/10	2/10	1/10	2/10	1/10	1/10	1/10	1/10	1/10	1/10	14/100

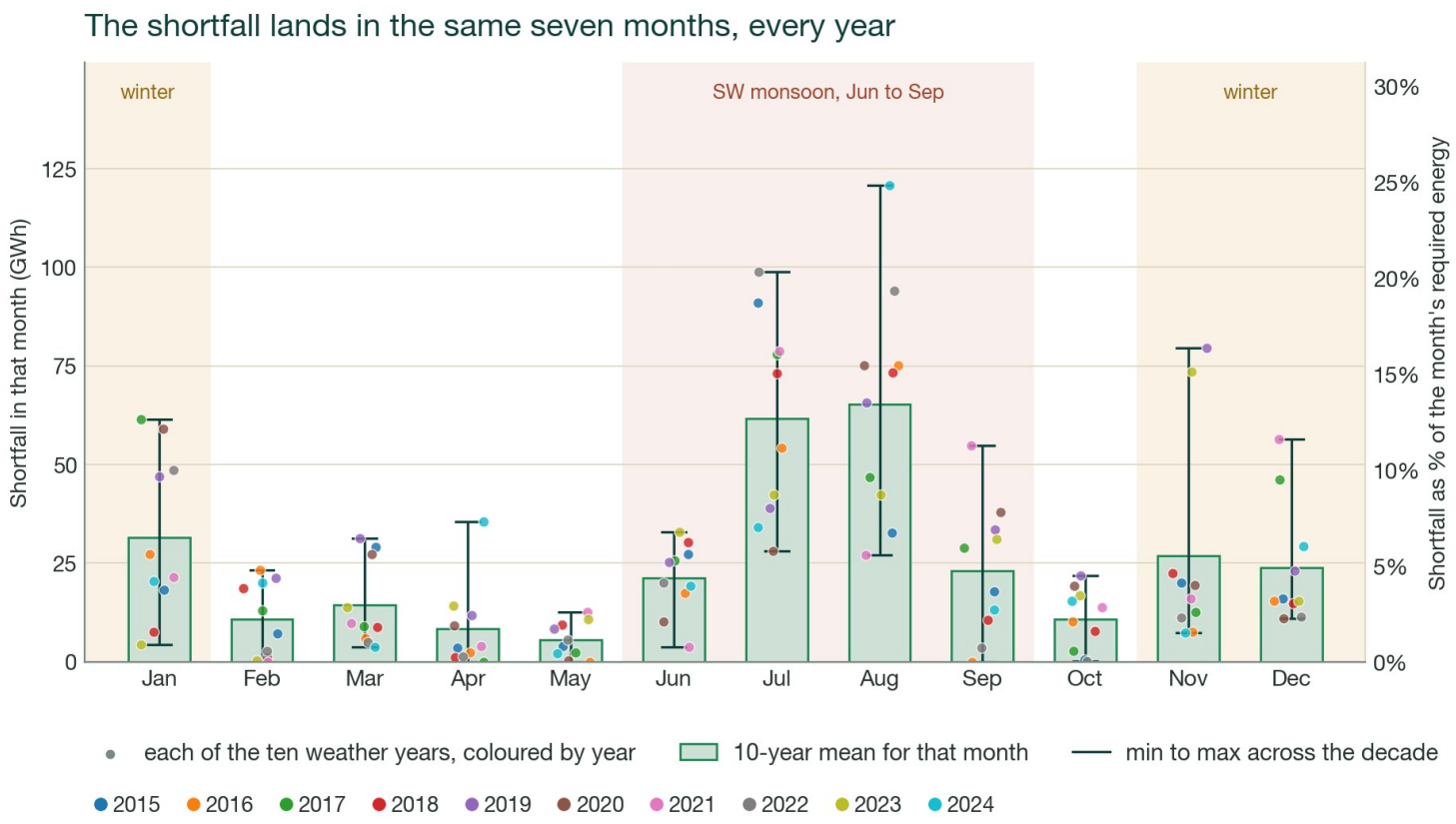
FOR 3.5 GW + 12 GWH

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	10-yr avg
Jammu & Kashmir	0	0	0	0	0	0	0	0	0	0	0
Rajasthan	0	0	0	0	0	0	0	0	0	0	0
Gujarat	0	0	0	0	0	0	0.1	0	0	0	0.01
Tamil Nadu	0	0	0	0	0	0.2	1.5	0.5	0.1	0.7	0.29
Madhya Pradesh	1.6	0	0	0.6	4.2	0.5	2.4	0.4	0.8	1.4	1.18
Andhra Pradesh	0	0	0.7	0	0.6	4.6	3.1	2.7	0	2.8	1.45
Karnataka	0	0.7	0	0	1.9	2.7	2.3	2.7	0	2.3	1.26
Telangana	0.2	0.6	0.0	2.1	0.2	1.3	1.7	1.6	1.8	2.4	1.18
Maharashtra	0.2	0	0	3.0	2.8	3.5	1.6	0.8	3.4	1.8	1.71
Haryana	2.4	0	0	0	2.5	0	3.0	2.4	1.8	4.0	1.62
States paying no penalty	6/10	8/10	8/10	7/10	4/10	4/10	2/10	3/10	5/10	3/10	50/100

Penalty is 1.5x the Rs 5.25 tariff on the shortfall left after the annual 292 GWh market allowance; revenue is billed energy at Rs 5.25. The allowance is ANNUAL by Clause 8.1.j and PPA Article 4.4.9 ('on annual basis'), so spring headroom banks into the monsoon, worth ~Rs 0.14/kWh against a monthly cap. Shared colour scale and row order across both panels. At 3.5 GW + 12 GWh, 93 of 100 state-years stay under 3% of revenue and the all-state average falls to 0.9%. The next two slides break the same shortfall down by month, then by hour. Per-state least-cost designs and tariffs: results/scenario_table_v4.csv.

Monsoon months are the worst; the grid's peak season is the strongest

Rajasthan, 3.0 GW-AC + 12 GWh per 1 GW contracted; bars are the ten-year mean, dots are each of the ten weather years



The tender's 292 GWh market allowance is annual with no monthly sub-cap, so no month above is billed on its own.
Right axis: share of an average month's requirement, 487 GWh per GW contracted.

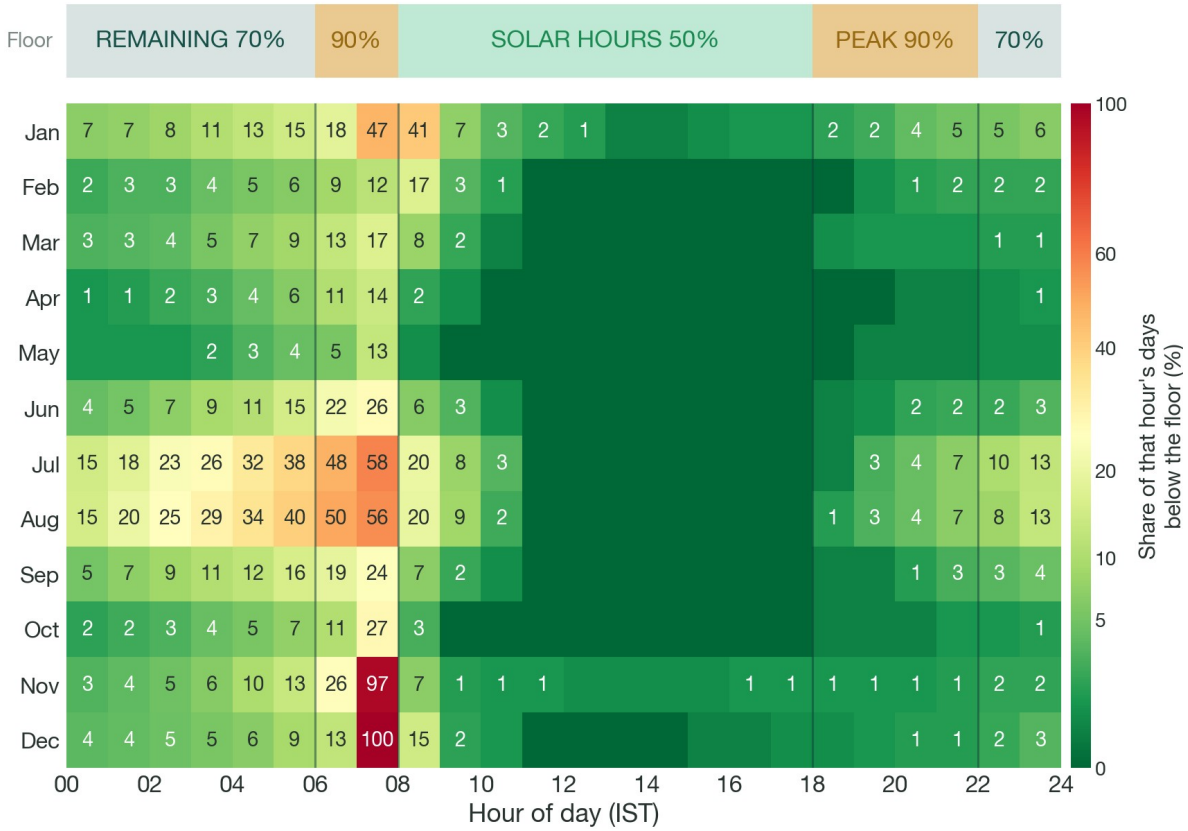
TEN YEARS, MONTH BY MONTH

- **Monsoon days do not make enough energy.** The plant needs about 17 GWh of generation a day to serve the profile and refill the battery for the night. The average July day makes 15; the cloudiest make barely 5. That missing energy is the shortfall.
- **June to September carries 56% of the decade's shortfall.** August is the worst month, averaging 65 GWh, or 13% of the energy required that month, and reaching 121 GWh in 2024, which was 24%.
- **May, a peak month for national demand, is the strongest.** Shortfall averages 5.5 GWh, 1.1% of the month's requirement, falls to zero in 2016, and never exceeds 12.5 GWh, or 2.5%, in ten years.
- **Winter is the second season.** Western disturbances cloud northwest India for days at a time. The decade totals 315 GWh in January and 270 GWh in November; the worst month, November 2019, reached 80 GWh, or 17%.

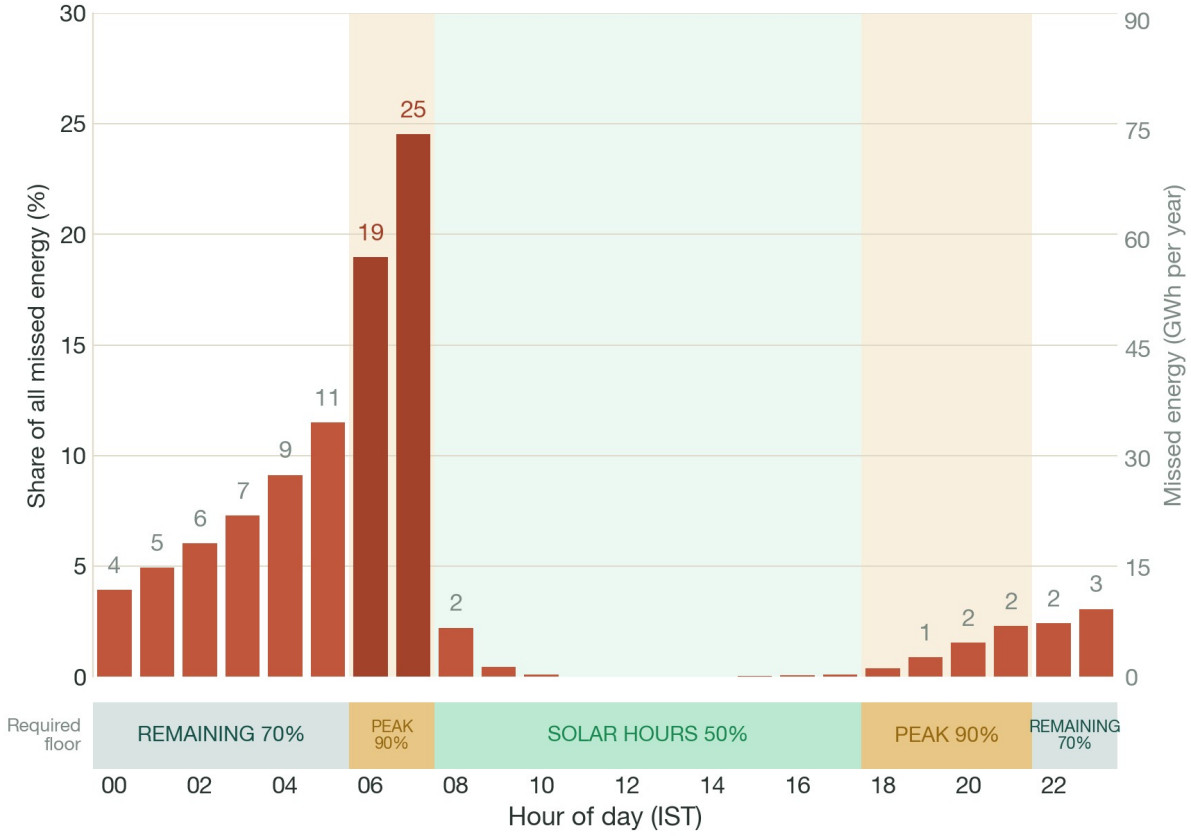
Monthly figures are physical shortfall before market energy; the 5% market allowance is annual with no monthly sub-cap (RfS Clause 8.1.j, PPA Article 4.4.9). Quiet months from February to May bank the headroom the monsoon spends; a monthly cap would have cost about Rs 0.14 more per unit. Generation need: 16.0 GWh/day delivered plus battery round-trip losses at 92%.

The misses happen at dawn, when the battery runs empty

Rajasthan, 3.0 GW-AC + 12 GWh per 1 GW, ten weather years 2015-2024: where missed energy lands by clock hour; about 304 GWh in an average year



How often each month-hour lands below its floor (% of days)



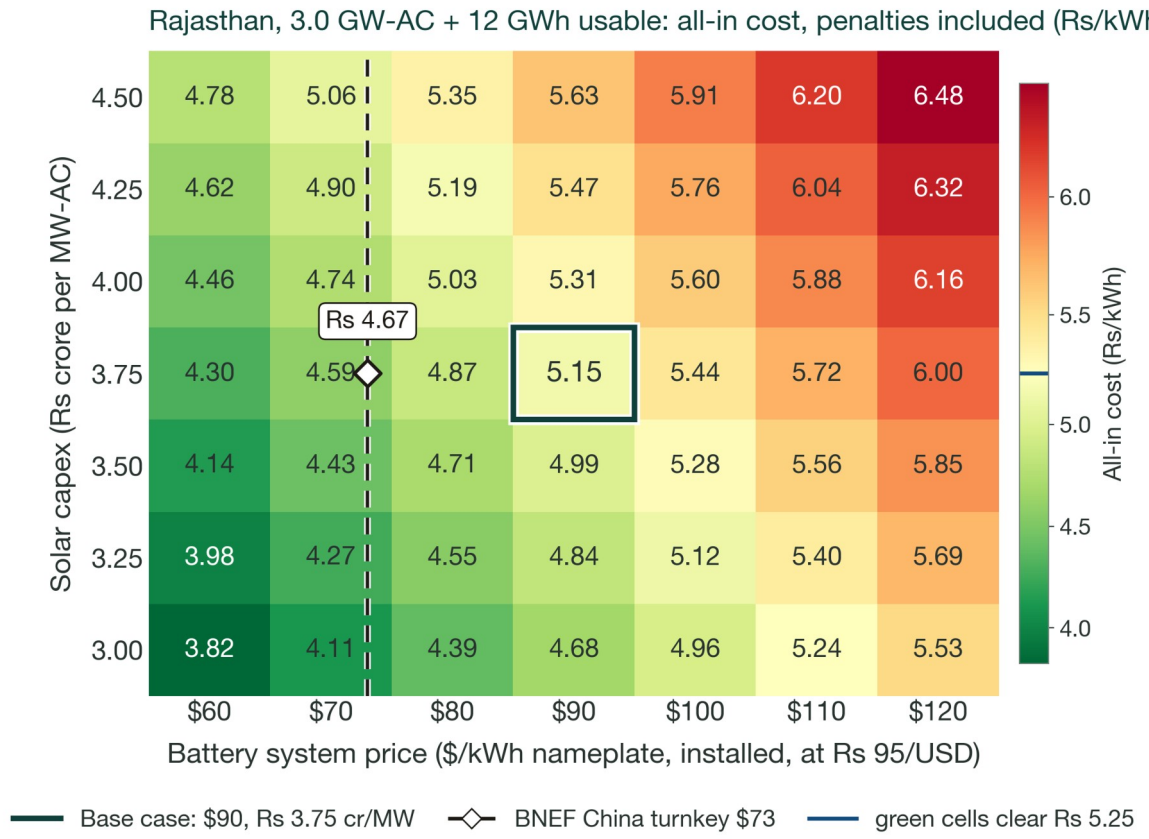
Share of the decade's missed energy by clock hour (%)

The generation is not enough to get through the night: on a weak day the battery enters the evening only part-full, holds the peak, and runs empty in the last hours before sunrise.

Rajasthan 3.0 GW-AC + 12 GWh per 1 GW contracted, split peak scenario, 2015-2024; the six heaviest cells are July-August at 06:00-07:00 and November-December at 07:00.

Further cost declines would make it even cheaper

All-in Rajasthan cost at 3.0 GW + 12 GWh across battery system price and solar capex; green cells clear the discovered tariff



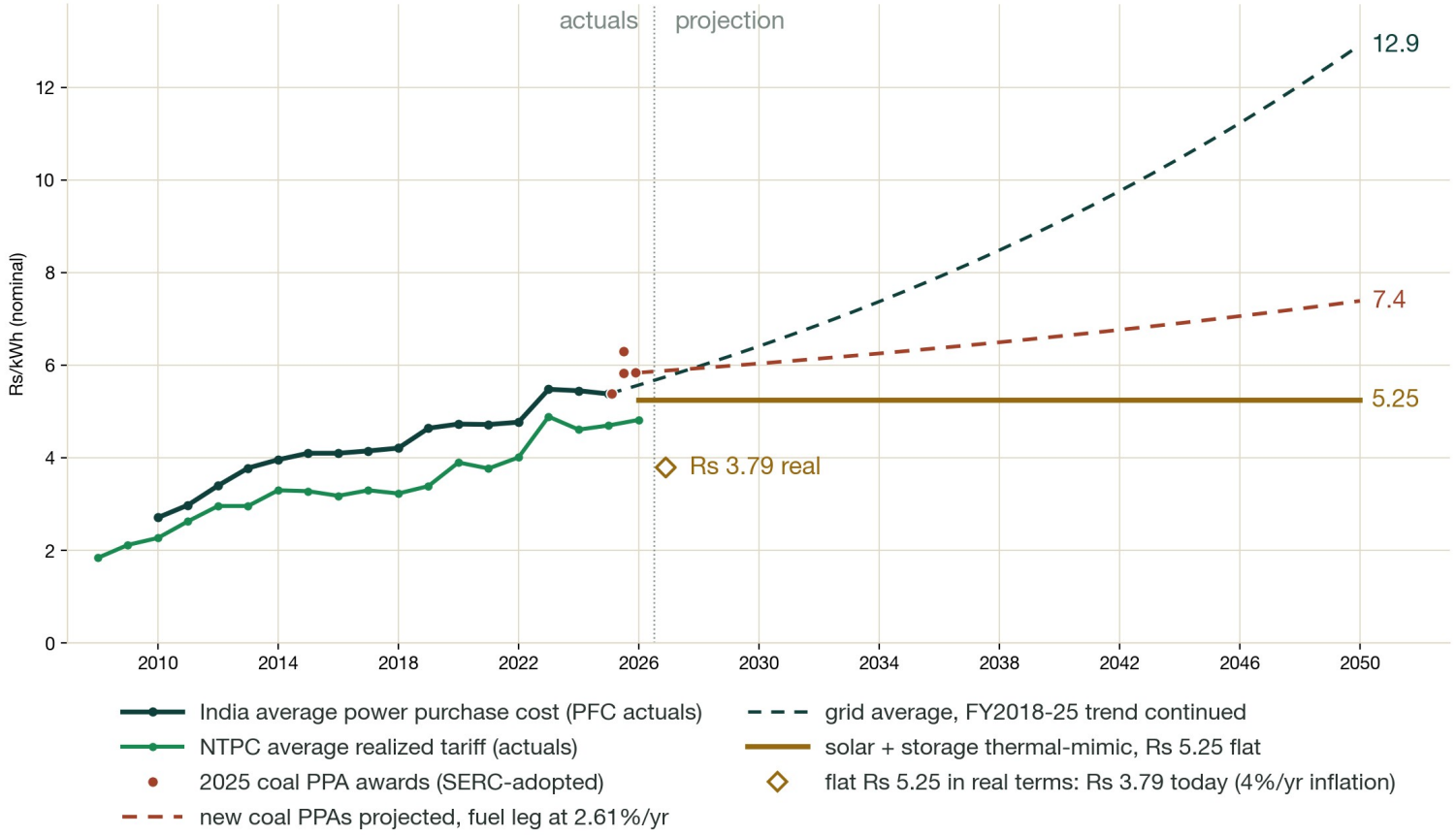
SENSITIVITY TO INPUT PRICES

- **Today's costs sit inside the green.** At $90/kWh batteries and Rs 3.75 crore solar the all-in cost is Rs 5.15; the bid clears with battery headroom to $93, and at BNEF's China 4-hour turnkey $73 the same plant costs Rs 4.67. The median state needs $81 batteries to clear.
- **Every $10 decline moves the tariff.** Each $10/kWh off the battery system price takes Rs 0.28 off the tariff; each $10/kW off solar capex takes about Rs 0.06.
- **The trajectory: the next auctions clear lower.** At $60-65 batteries the price lands near Rs 4.3-4.4 at today's solar prices; if solar capex also falls from Rs 3.75 to 3.00 crore, the corner of the map reads Rs 3.8. Thermal PPAs signed in 2025 sit at Rs 5.4-6.3.

All-in cost on the 3.0 GW + 12 GWh design's mean Rajasthan dispatch outcome (billed energy, spill, penalties and market purchases held fixed); battery cell replacement scales with system price, panel augmentation with solar capex, O&M at 1.5% of scaled capex; WACC 10%, 25 yr, Rs 95/USD. BNEF 2025 China turnkey price $73/kWh; thermal PPAs Rs 5.4-6.3 per the tariffs discovered in the 2025 TBCB coal bidding (Ministry of Power, Rajya Sabha reply, 9 Feb 2026, PIB 2225430; award-level orders on the fuel-price slide); SECI FDRE-IV cleared Rs 4.98 (easier profile, Jul 2024).

India already pays above Rs 5.25; this contract stays flat for 25 years

What India actually paid for coal and grid power, FY2008-FY2026, and where prices go over this contract's 25 years



THE CONTRACT IS A HEDGE

- **India's power costs have grown about 4% a year for 15 years:** the national average power purchase cost rose from Rs 2.71 (FY2010) to Rs 5.38 (FY2025), 4.7% a year, has been above Rs 5.25 since FY2023, and on its FY2018-25 trend reaches Rs 13 by 2050; NTPC's realized tariff rose from Rs 2.63 (FY2011) to Rs 4.82 (FY2026).
- **This contract is nominally flat; new coal starts higher and climbs:** the seven coal PPAs signed in 2025 open at Rs 5.38 to 6.30, midpoint Rs 5.84; with the fixed charge flat and only the fuel leg escalating, at CERC's 2.61% a year, that midpoint reaches Rs 6.4 by 2036 and Rs 7.4 by 2050.
- **Flat Rs 5.25 nominal is Rs 3.79 in real terms:** the contract price never moves while everything around it inflates. At 4% a year inflation, flat Rs 5.25 over 25 years is equivalent to about Rs 3.79 in today's rupees.
- **In dollars, the price falls every year:** Rs 5.25 is $55/MWh at Rs 95 per dollar; at the rupee's historical 3% annual depreciation it is $41/MWh by 2036 and $27/MWh in the contract's final year.

Actuals: PFC, Reports on Performance of Power Utilities, 2009-10 to 2024-25 editions (power purchase cost; FY2010-12 reconstructed from expenditure annexures); NTPC annual reports FY2012-FY2026 (average realized tariff, standalone). Projections: seven TBCB coal PPAs Mar-Nov 2025 (11.9 GW, Rs 5.38-6.30, average 5.81; line anchored on the Rs 5.84 midpoint per SERC adoption orders: UPERC 2228/2025, MPERC 121/2025, WBERC, BERC 36/2025, AERC), 69% fixed charge held flat, fuel leg at CERC's notified 2.61%/yr (Eco-E/2026-CERC); grid-average line continues its FY2018-25 trend; trend continuations, not forecasts. Rs 3.79 real: 25-year NPV equivalence at a 10% discount rate. Dollars at Rs 95/USD with 3%/yr depreciation (historical range 2.8-3.5%/yr). Nominal rupees throughout.

At this price, firm clean power becomes economical for industry

Green steel, data centres and aluminium clear their economics at this price; hydrogen needs roughly one more price step

Green steel

Rs 5.25 corresponds to $55/MWh. Hydrogen-route steel requires roughly 4 MWh of electricity per tonne, making power the largest cost component. UC Berkeley's green steel analysis (May 2026) finds that at $55/MWh firm clean power, Indian green steel comes within about 5% of the conventional route, and undercuts it in the EU market from 2030 as CBAM's phase-in bites.

Data centres

Data centres run flat, day and night: about 1.5 GW today, 4-5 GW by 2030, and their operators have promised customers round-the-clock clean power. A profile like this, delivered via group captive, gives them that at around the auction price, cheaper than the grid power they buy today, and clean.

Aluminium and continuous-process metals

A smelter cannot stop: the electrolyte freezes within four to five hours of a power loss, so India's smelters run on captive coal. A firm profile like this, wheeled through open-access mechanisms, can now serve that continuous load at prices below new captive coal, with no fuel-price exposure.

Green hydrogen and ammonia

An electrolyser running only on daytime solar sits idle much of the day, and that low utilisation raises the cost of every kilogram. A near-flat block like this one keeps it running around the clock; as the block's price falls with battery prices, green hydrogen and ammonia come into range. Their interstate transmission charges are waived.

Cheap clean power was never the hard part. Firm clean power was. It now has a price, and the price is competitive. **What sets the pace from here is open-access rules, not economics.**

Sources: IECC (UC Berkeley) green steel report, May 2026 ($55/MWh firm-power assumption; 66 kg H2/t at 52 kWh/kg plus 0.6 MWh/t EAF, ~4.0 MWh/t); new-build captive coal cost from CEA resource-adequacy basis 2026 (Rs 12 cr/MW); hydrogen 50-60 kWh/kg (IEA, IRENA); data centres ~1.5 GW in 2025 (CBRE, Colliers, Savills); group-captive adder ~Rs 1.22/kWh, cross-subsidy-surcharge exempt under Electricity Act 2003 s.42(2) fourth proviso; green hydrogen and ammonia ISTS waiver per MoP orders under the Green Energy Open Access Rules 2022.

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India's Renewable Energy Breakthrough: Coal-Like Reliability at a Lower Fixed Price

Decoding SECI's thermal-mimic Rs 5.25/kWh FDRE-RTC auction

Umed Paliwal, Amol Phadke, Nikit Abhyankar

August 2026