

Round-The-Clock (RTC) Clean Electricity Procurement

RTC Tender Design Lessons from India's FDRE-RTC-V

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Oct 2026

From Renewable Energy to Time-Specific Delivery

India's renewable procurement has progressively moved beyond annual volumes toward firmer, time-specific delivery.

HYBRID

Primarily annual renewable-energy / CUF requirements



Firm and Dispatchable Renewable Energy (FDRE)

Firm renewable supply during specified periods



Round the Clock (RTC)

Different delivery requirements across the day. Performance assessed in 15-minute blocks.

What does RTC mean in India's tender?

Demand Fulfilment Ratio (DFR) = Scheduled Injection in a particular time block (MW) ÷ Contracted Capacity (MW)

- Procurement is in power (MW) terms
- Mandatory Energy Storage System
- Renewable + storage portfolio optimised by developer
- Not 100% renewable supply in every interval

KEY MESSAGE

India is progressively putting a value not only on how **much** renewable electricity is supplied, but **when** it is supplied.



PART 1

How Indian Tenders Define Delivery Requirements and Manage Shortfalls

Tightening toward true round-the-clock

Each round added stricter monthly, peak and finally 15-minute time-block floors.

Tender	Supply and firming requirement	Comment
RTC-I (2019)	RE-based supply, with optional ESS; annual CUF $\geq 80\%$ and monthly CUF $\geq 70\%$.	First RTC tender; compliance primarily based on energy supplied over monthly/annual periods.
RTC-II (2020)	RE complemented by coal-based thermal power; $\geq 85\%$ annual availability and $\geq 85\%$ annual Peak-Hour availability; $\geq 51\%$ annual energy from RE.	Thermal power allowed for firmness; availability compliance remains annual.
RTC-III (2022)	RE complemented by another source or storage; 90% annual availability, 90% monthly availability in at least 11 months, and 90% annual peak-hour availability.	Adds monthly and peak-period requirements, but performance can still be averaged.
RTC-IV (2024)	RE firmed through storage/portfolio optimisation; 80% annual DFR, 75% monthly DFR, and 90% average monthly Peak-Hour DFR.	Scheduled-injection DFR; shortfalls could still average out
FDRE-RTC-V (2026)	In every 15-minute block: $\geq 90\%$ DFR in Peak Hours; 50%–60% in Solar Hours; and $\geq 70\%$ in Remaining Hours.	Most granular RTC design. Originally issued as Round-the-Clock Thermal Mimic (RTC-TM-V)

FDRE-RTC-V: The Tender Design Evolved Through Amendments

Granularity existed from the start; each amendment progressively refined accountability, flexibility and the shape of delivery.

ORIGINAL RfS

March 2026

- DFR already defined at 15-minute resolution
- Peak $\geq 90\%$ · Off-Peak $\geq 80\%$, with limited seasonal relaxation
- Additional Annual DFR $\geq 90\%$ requirement



AMENDMENT-01

Accountability tightened

- Peak $\geq 90\%$ / Off-Peak $\geq 70\%$
- DFR capped at 1
- Shortfalls added up block-by-block; penalty time-block-wise, reconciled monthly
- Removed annual-DFR “higher-of” penalty rule



AMENDMENT-02

Configuration flexibility

- DFR / accountability mechanism unchanged
- Refined Battery Energy Storage System (BESS) vs. Pumped Storage Plant (PSP) siting
- Commissioning timelines and financial/ security provisions updated



AMENDMENT-03

Delivery profile refined

- RTC-TM-V $\rightarrow$ FDRE-RTC-V
- Added 3-part structure: Peak $\geq 90\%$ · Solar 50–60% · Remaining $\geq 70\%$
- Same 15-min shortfall mechanism; Solar Hours linked to GRID-INDIA/ General Network Access (GNA)

Final Design: Different Firmness for Different Hours

RTC does not mean a flat 100% requirement - the tender deliberately requires different levels of firmness at different times.

PEAK HOURS

≥90% DFR

- Any 6 hours
- Selected by Buying Entity, day-ahead
- Within 18:00–10:00 next morning

SOLAR HOURS

50–60% DFR

- Based on GRID-INDIA / GNA Solar Hours
- Defined for the project's state*

REMAINING HOURS

≥70% DFR

- Non-Solar Hours outside selected Peak Hours

Every requirement applies in each 15-minute block · A Day runs 00:00–24:00 Hrs (96 blocks/day)



*varies by the state where the project sits (since actual solar generation windows shift with latitude/season across India)

Every 15-Minute Shortfall Matters

Monthly settlement does not mean monthly performance measurement - every deficient 15-minute block counts.

1

Measure

DFR calculated for each 15-minute block

2

Identify shortfall

Compare each block against the applicable minimum DFR

3

Aggregate

Add up shortfalls separately for Peak / Solar / Remaining

4

Penalise

Penalty calculated on a time-block-wise basis

5

Reconcile

Aggregate penalty recovered monthly

DFR is capped at 1 - over-delivery in one block can never offset a shortfall in another, in any category.

PERFORMANCE MEASUREMENT

15 minutes

SHORTFALL CALCULATION

15 minutes

FINANCIAL RECONCILIATION

Monthly

Accountability + Flexibility

SECI defines the delivery outcome and shortfall consequences, while leaving developers room to optimize generation, storage and excess electricity.

SHORTFALL

**Penalty = 1.5 × PPA tariff
× shortfall energy**

Persistent DFR failure can ultimately trigger contractual default provisions.

STORAGE CONFIGURATION

BESS: subject to co-location requirements

PSP: may be located offsite under specified conditions

EXCESS POWER / PORTFOLIO OPTIMISATION

- Power above Contracted Capacity may be sold to third parties / power exchanges
- If purchased by the Buying Entity: PPA tariff in Peak/Remaining Hours; 50% of PPA tariff in Solar Hours*
- During Solar Hours, supply above the 60% DFR maximum may be sold externally only after giving the buyer first right of refusal

WHY PORTFOLIOS OUTPERFORM SINGLE ASSETS

Weather-driven shortfalls across Indian states correlate only 30–60% even between neighbours, and near zero between distant states. A single plant can miss a 1 GW firm target in roughly 8% of hours; a fleet diversified across many states misses almost none.

* Plus SECI trading margin. Portfolio-reliability analysis: India Energy & Climate Center / UC Berkeley Goldman School, FDRE-RTC-V companion study.



PART 2

What Tender Outcomes Reveal About Prices and Developer Participation

Strong Developer Participation

A relatively demanding 15-minute delivery product still attracted more than three times the capacity being procured.



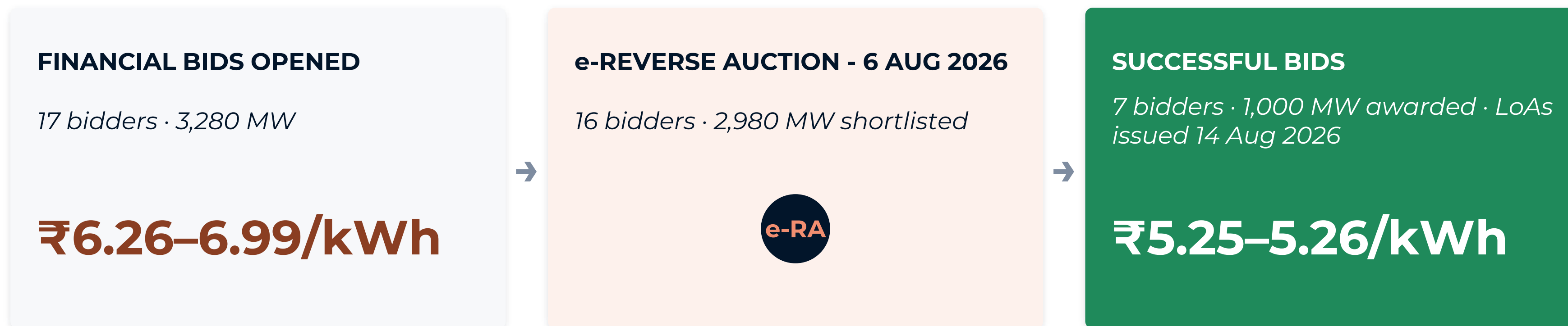
Successful developers: EMIF II, Hero Solar, Purvah Green Power, Resolven Four Energy, Kengeri Prime Solar, Hexa Climate Solutions and Juniper Green Energy.

KEY MESSAGE

This is an important correction to earlier interpretations - the latest tender does not show thin developer participation.

Competition Compressed the Price

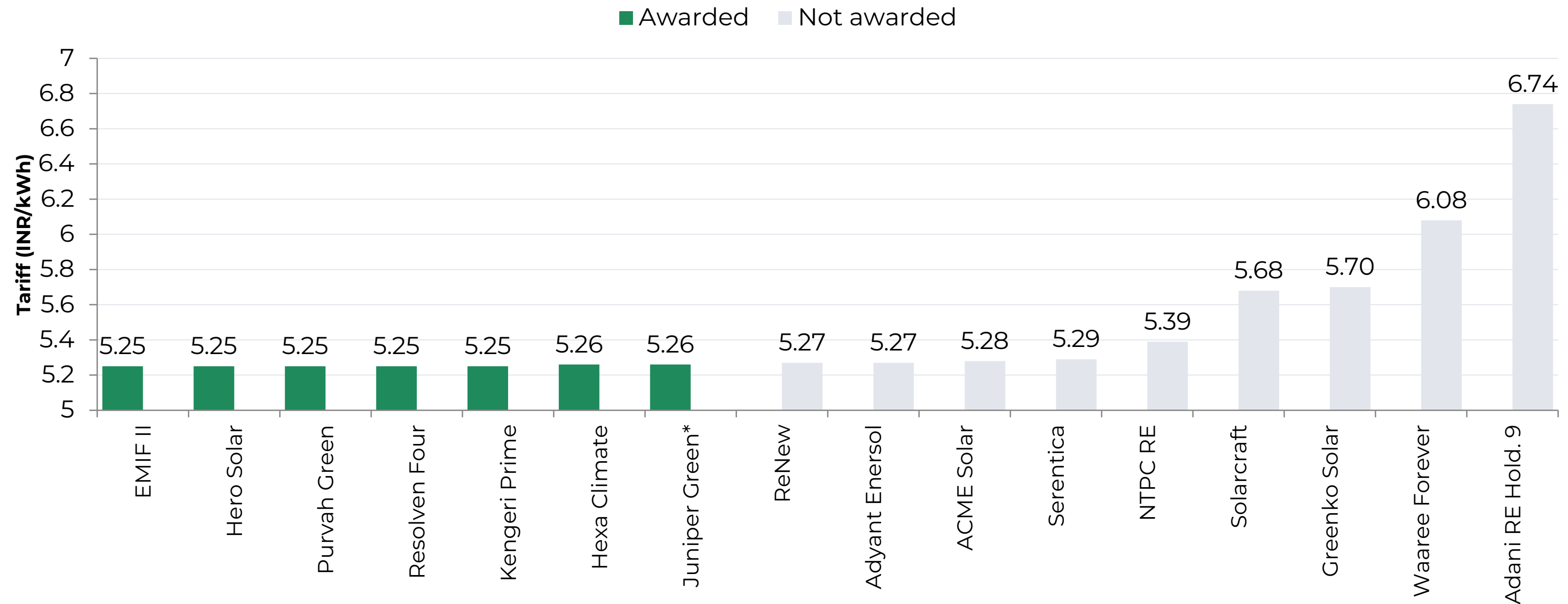
Initial bids ranged ₹6.26–6.99/kWh; the e-reverse auction produced winning tariffs tightly clustered at ₹5.25–5.26/kWh.



At ₹95.21/USD: ₹5.25/kWh ≈ US\$55/MWh

The Auction Was Highly Competitive at the Margin

The e-reverse auction produced a very narrow clearing range around the 1,000 MW cut-off.



* Juniper Green bid 300 MW; only 230 MW awarded to reach the 1,000 MW cap.

What Does ₹5.25/kWh Actually Buy?

This distinction is particularly important when taking the India experience to other markets.

IT DOES BUY

- ✓ Renewable power with time-specific delivery obligations
- ✓ Performance accountability every 15 minutes
- ✓ $\geq 90\%$ DFR during selected Peak Hours
- ✓ 50–60% DFR during Solar Hours
- ✓ $\geq 70\%$ DFR during Remaining Hours
- ✓ Mandatory storage
- ✓ Developer exposure to shortfall risk
- ✓ Long-term contracted supply (25 years)

IT DOES NOT BUY

- X 100% renewable electricity in every interval
- X A 100% 24/7 CFE outcome

KEY MESSAGE ₹5.25/kWh is the discovered tariff for a specific shaped and firmed renewable-power product - not the price of 100% 24/7 renewable electricity.

PART 3

Lessons for Other Markets

What Can Other Markets Learn from India?

The transferable lesson is not to copy India's percentages - it is to design procurement around the load, system conditions and risk allocation.

1 Define when electricity is needed

Move beyond annual renewable-energy volumes where continuous supply matters.

2 Firmness does not have to be uniform

India applies different requirements to Peak, Solar and Remaining Hours.

3 Make shortfall accountability granular

Monthly commercial settlement can coexist with 15-minute performance accountability.

4 Give developers configuration flexibility

Specify the delivery outcome rather than prescribing one generation/storage configuration.

5 Create routes for excess generation

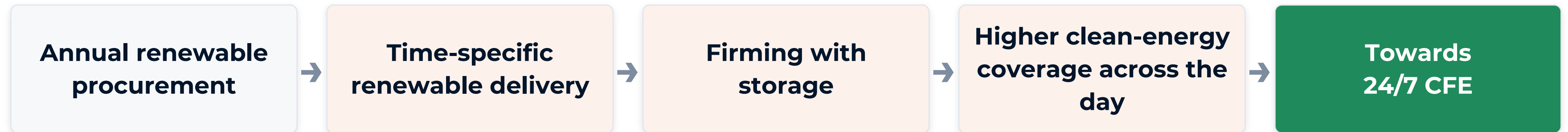
Merchant sales and excess-power provisions can support portfolio optimisation.

6 Build on existing market rules

SECI uses existing GRID-INDIA/GNA definitions for Solar/Non-Solar Hours.

From Firm Renewable Power to 24/7 Clean Energy

For continuous loads, firm and time-specific renewable procurement can provide a pathway towards 24/7 clean energy



For data centres and other continuous loads:

- Firm renewable products can provide a foundation for higher clean-energy coverage
- Solar, wind, storage and other flexibility resources can help address the difficult hours
- Granular tracking provides visibility into when clean electricity is generated and consumed
- This enables buyers to measure progress towards 24/7 CFE

KEY MESSAGE

RTC procurement and 24/7 CFE are not the same - but increasingly firm, time-specific renewable procurement can be an important pathway towards 24/7 CFE.

The Next Step: Make Clean Power Verifiable in Time

Procurement, tracking and 24/7 CFE each answer a different question.

PROCUREMENT

When is clean electricity contracted to be delivered?



GRANULAR TRACKING

When was clean electricity generated and consumed?



24/7 CFE

How closely does clean electricity match consumption across time?

KEY MESSAGE

As procurement becomes more time-specific, electricity accounting needs to become more time-specific too.

Three Takeaways from India

1

Firmness can be designed progressively.

India did not jump from annual renewable procurement to 100% clean electricity every interval.

2

Granular accountability can coexist with developer flexibility.

Every 15-minute shortfall matters, while developers retain significant freedom to optimise generation and storage.

3

Demanding delivery requirements can still attract competition.

3.28 GW offered for 1 GW, with winning tariffs tightly clustered at ₹5.25–5.26/kWh.

Don't copy India's tender. Learn from how India defines time-specific delivery, allocates risk and uses competition to discover the cost of firmness.