ENERGY ANALYTICS LAB
Department of Management Sciences
Indian Institute of Technology Kanpur

ISSN: 2583-2409 (O)
Volume 8 | Issue 3
January 2026

Power Chronicle

Renewable Energy Market: DSM Tightening, REC Reforms, Green/High-Price RTM & BESS Regulations

Editorial

Gradually transferring responsibility of grid discipline to Renewable Energy (RE) sources, which are likely to become the dominant source of grid supply in the future, is essential to support deeper RE integration. An implementable framework, grounded in this philosophy and suggested by EAL, has been adopted in principle in the proposed draft by CERC. A key requirement is a robust methodology to generate a benchmark RE generation profile, against which deviations can be measured objectively. A modified version of the moving average approach can address uncertainties in the generation profile. The extreme weather events, which cause significant deviations in solar and wind energy generation, may be conferred as a force majeure condition, based on a predefined set of criteria in consultation with the Indian Meteorological Department (IMD). This also presents an opportunity for the financial sector to develop insurance products for RE deviation.

The Renewable Energy Certificate (REC) market can play an even greater role in ensuring RPO/RCO compliance while widening stakeholder participation in price discovery for the REC market. Issuing REC for every unit of RE generation in the country, and using it as a currency of origin, would improve compliance monitoring, and increase liquidity in the REC market.

A Green Real Time Market (G-RTM) product can provide an opportunity for Distributed RE generators as well as drawing entities to balance expected variation in solar and wind generation closer to the time of delivery. However, an integrated G-RTM structure, akin to an I-DAM, may deliver greater value than a standalone product, enabling market participants to harness green attributes to the feasible extent before transitioning into RTM, while avoiding unnecessary fragmentation of products. The eligibility conditions for participation in the High Price RTM (HP-RTM) should be technology-agnostic, especially in the context of energy storage systems. A peculiar case of differentiating pure hydro versus stored hydroelectric power in a pumped storage plant (PSP) may be addressed by specifying a minimum storage capacity as a proportion of the overall capacity of a PSP.

Energy Storage Systems (ESS) can play a significant role not only across market products but more specifically in addressing grid deviations and contributing towards ancillary services support. Regulatory frameworks for ESS should be largely technology-agnostic. The dual role of ESS, as load and generator, must be explicitly recognised to ensure responsibilities under the Electricity Act, 2003, the Indian Electricity Grid Code, and associated regulations are clearly assigned and enforceable.

Anoop Singh (Editor)
Founder & Coordinator, Energy Analytics Lab

Keywords: Deviation Settlement Mechanism (DSM), X-Factor, Variable Renewable Energy (VRE), Forecasting, Hybrid RE, Renewable Energy Certificates (RECs), Renewable Consumption Obligation (RCO), Power Exchange, Battery Energy Storage Systems (BESS), Ancillary Services, Grid Stability, Distributed Energy Resources Aggregator (DERA), Banking, Un-Requisitioned Surplus (URS), Vehicle to Grid (V2G)

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Publisher: Energy Analytics Lab (EAL)
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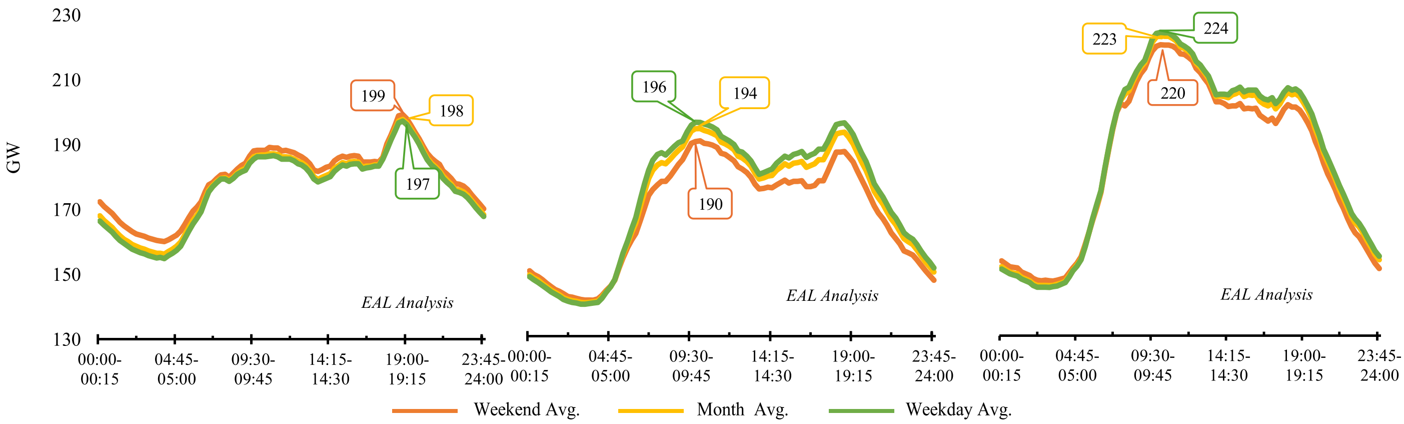
Power System Overview & Analysis

All India Demand Met Profile

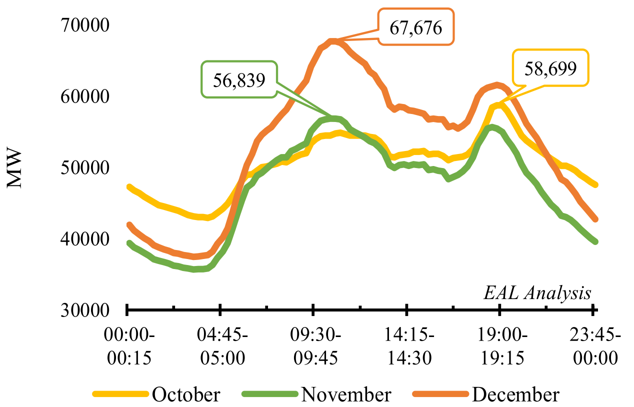
October 2025 | **November 2025** | **December 2025**



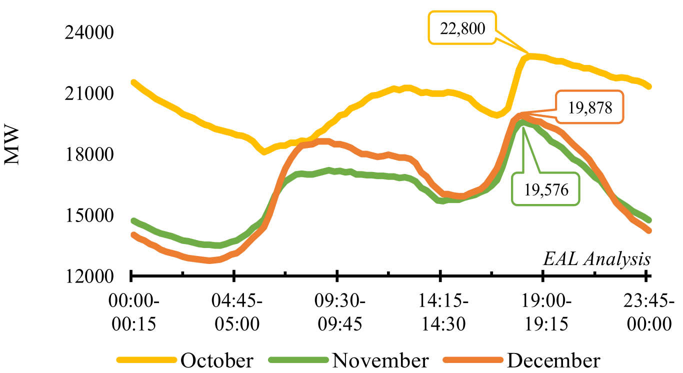
From October to December quarter, all India peak demand reached 239 GW (10:00 - 10:15) on 30th December, 2025, about 12.7% higher than the previous year's peak demand recorded at 212 GW (10:00 - 10:15) on 13th December, 2024, during the same quarter.

Region-wise Demand Met Profile

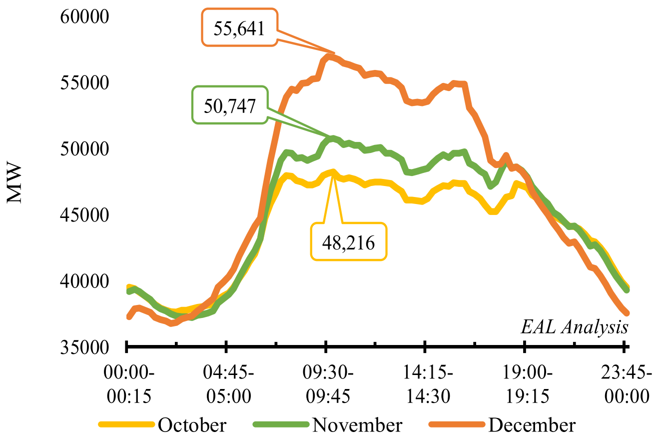
Northern Region



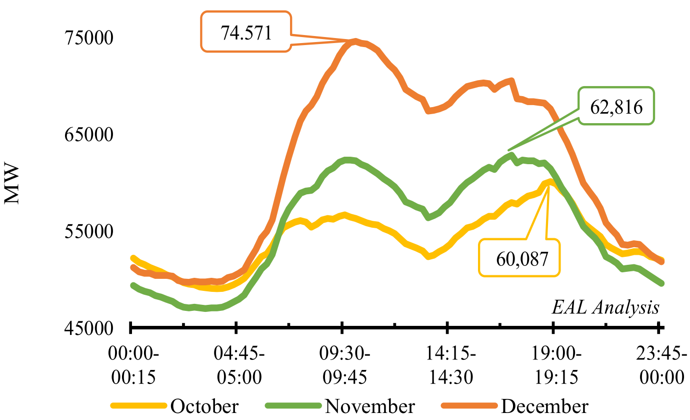
Eastern Region



Southern Region

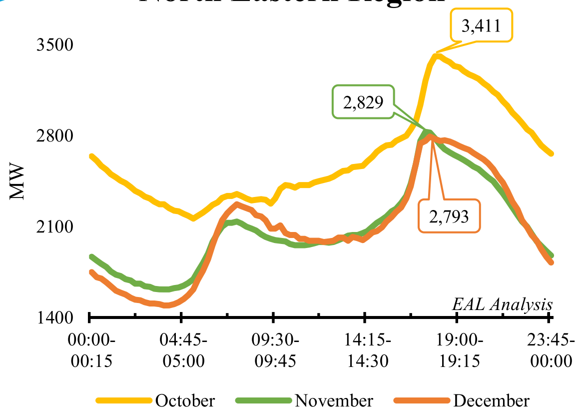


Western Region



For more information Click here

North Eastern Region

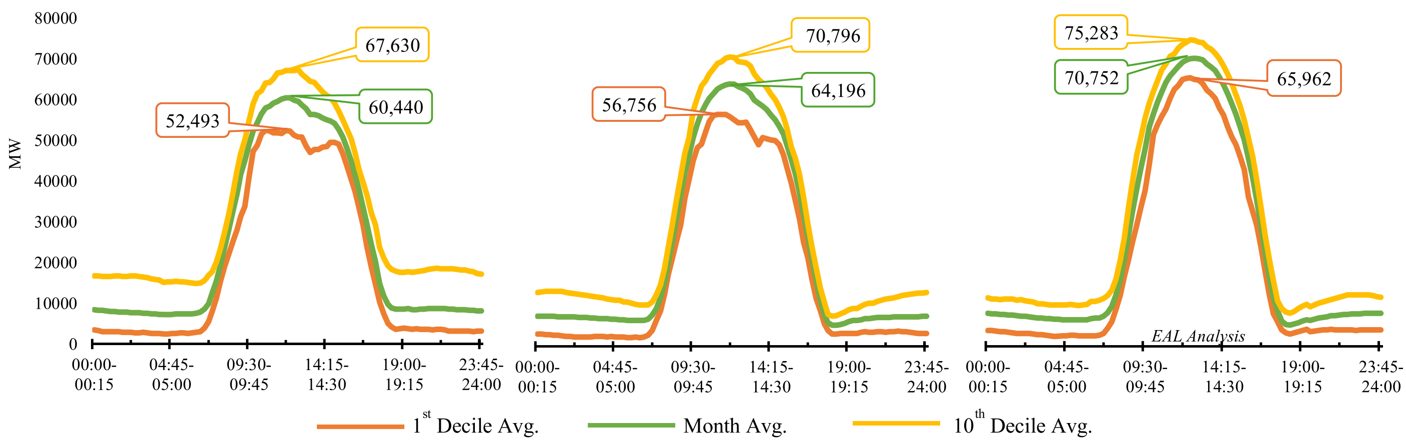


- Significant increase in demand can be observed for Southern and Western region and from 04:45 to 07:30 hrs in all three months respectively.
- Decrease in demand can be observed for Northern, Southern, Western and North Eastern and Southern regions from 19:00 to 23:45 hrs in all the three months respectively.
- Average demand is found to be higher for Western region as compared to the other regions in the month of December.

Demand and generation profiles at National, Regional and State-level can be accessed on EAL's web portal.

All India Renewable Energy Generation Profile

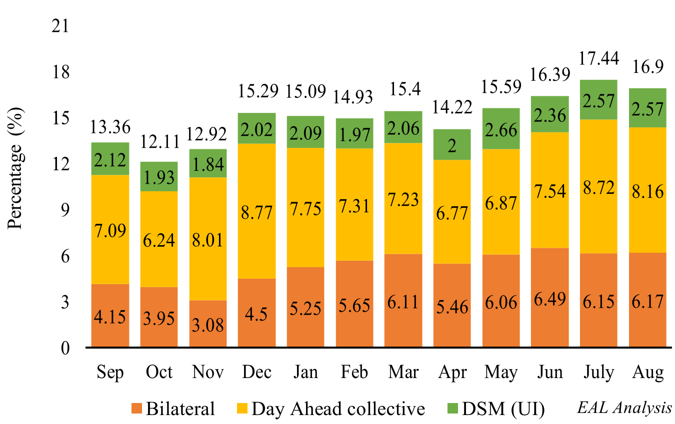
October 2025 **November 2025** **December 2025**



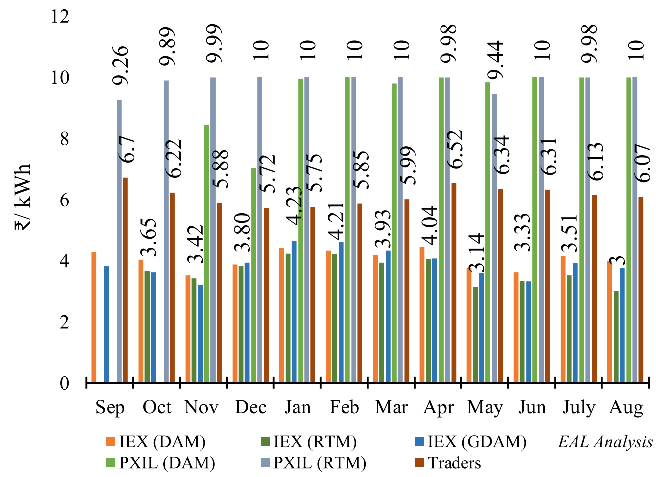
All India peak RE generation reached 75.67 GW (12:30 - 12:45) on 9th December, 2025, about 28.66% higher than the previous years' peak of 58.81 GW (12:45 - 13:00) on 10th December, 2024, during the same quarter.

Short-term Energy Transactions

Share of Short-term Energy Transaction of Total Electricity Generation (Sept 2024-Aug 2025)

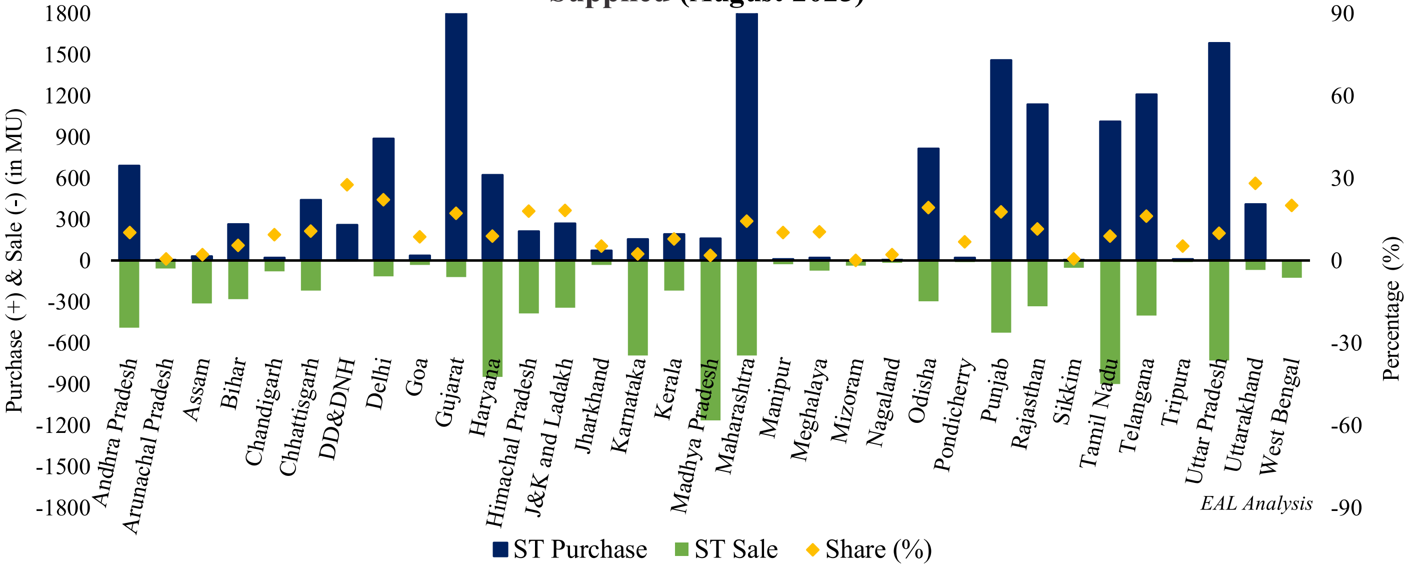


Weighted Average Prices of Short-term Transactions (Sept 2024-Aug 2025)



Monthly Power Purchase and Sale Quantum through Power Exchange across States

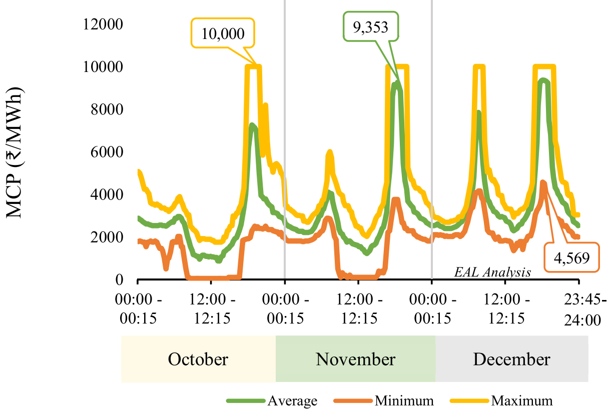
ST Energy Sale, ST Energy Purchase and share of ST Purchase on Total Energy Supplied (August 2025)



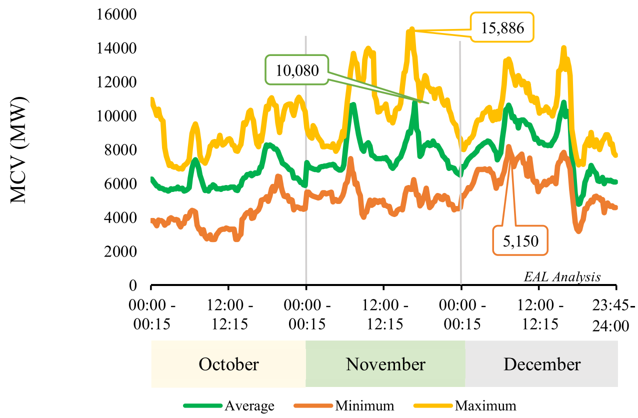
Power Market Overview & Analysis

DAM - Market Clearing Price (MCP) & Market Clearing Volume (MCV)

DAM Monthly Average, Maximum & Minimum MCP

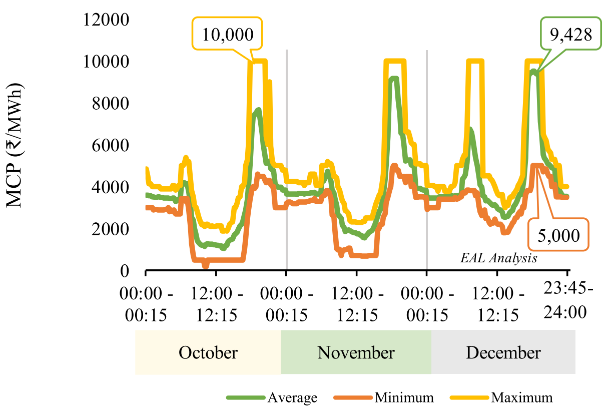


DAM Monthly Average, Maximum & Minimum MCV

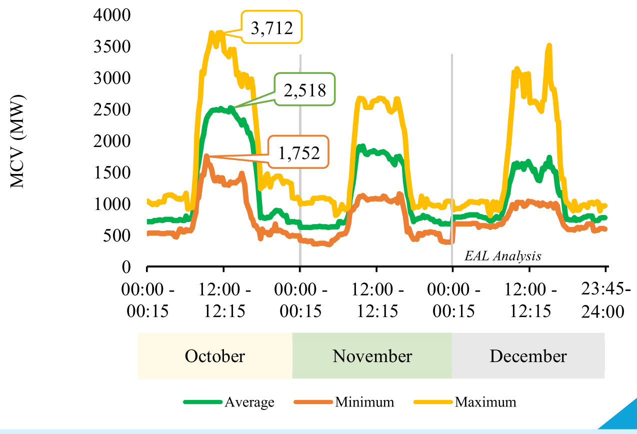


G-DAM- Market Clearing Price (MCP) & Market Clearing Volume (MCV)

G-DAM Monthly Average, Maximum & Minimum MCP

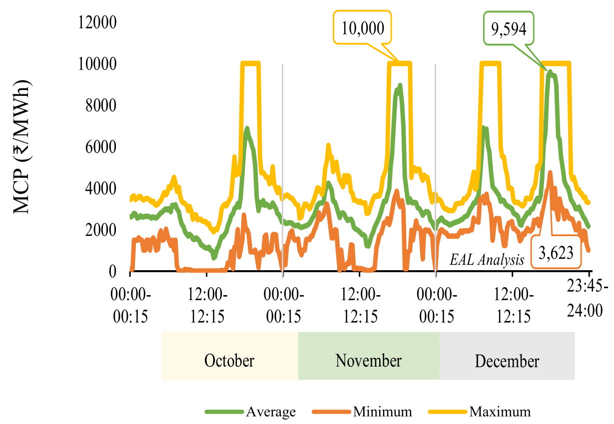


G-DAM Monthly Average, Maximum & Minimum MCV

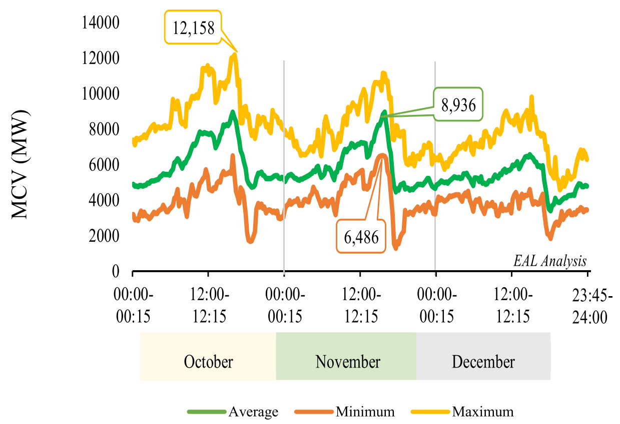


RTM -Market Clearing Price (MCP) & Market Clearing Volume (MCV)

RTM Monthly Average, Maximum & Minimum MCP

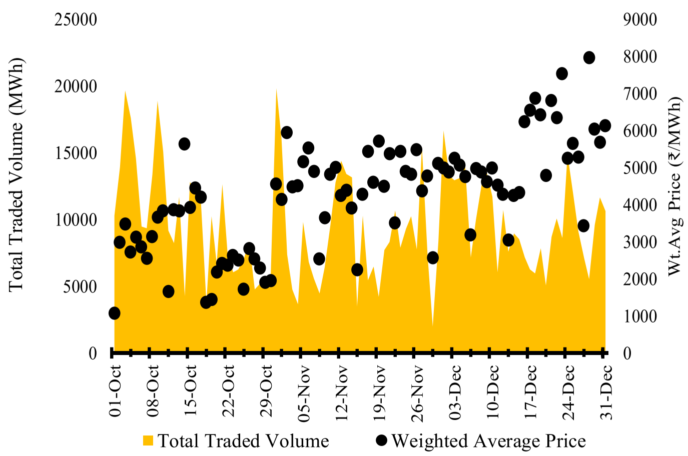


RTM Monthly Average, Maximum & Minimum MCV



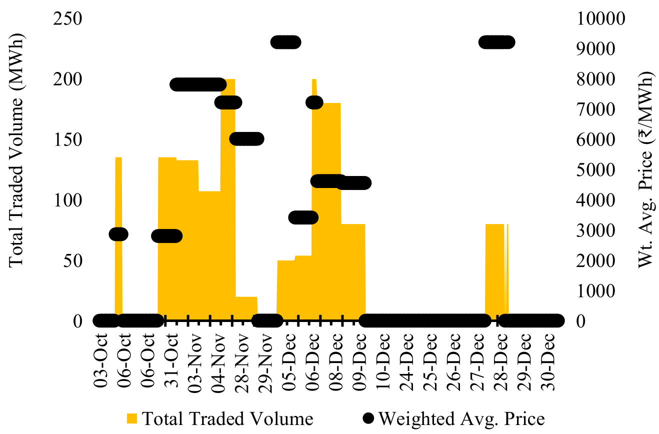
Term-Ahead Market

Day Ahead Contigency (Oct-Dec 2025)



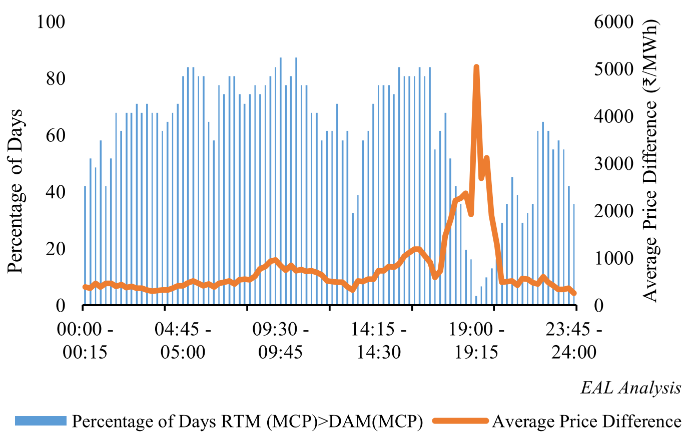
Green Term-Ahead Market

Daily Contracts (Oct-Dec 2025)

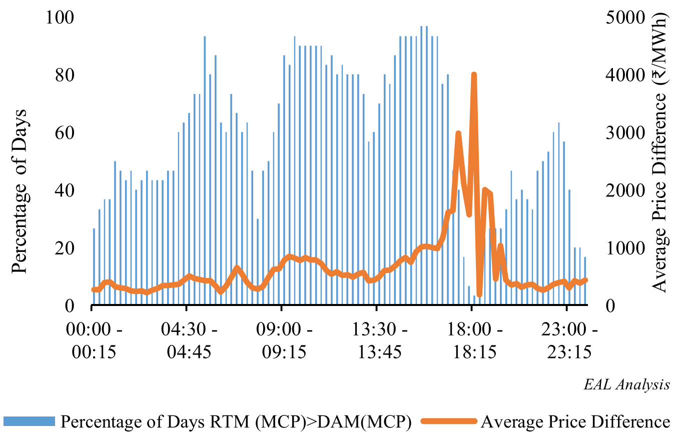


Price Difference between RTM & DAM

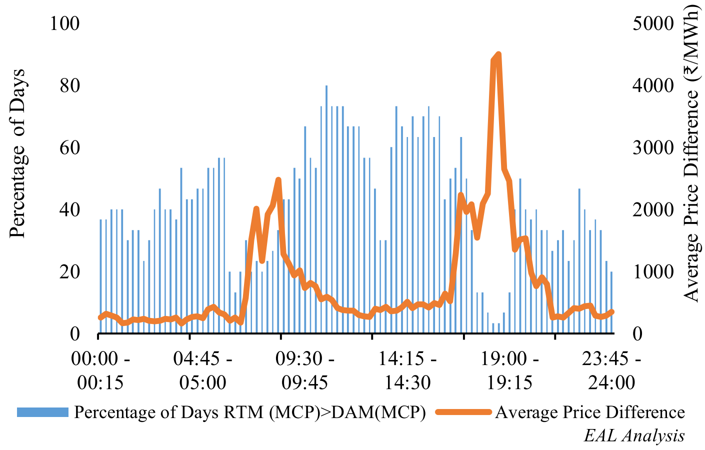
October 2025



November 2025



December 2025

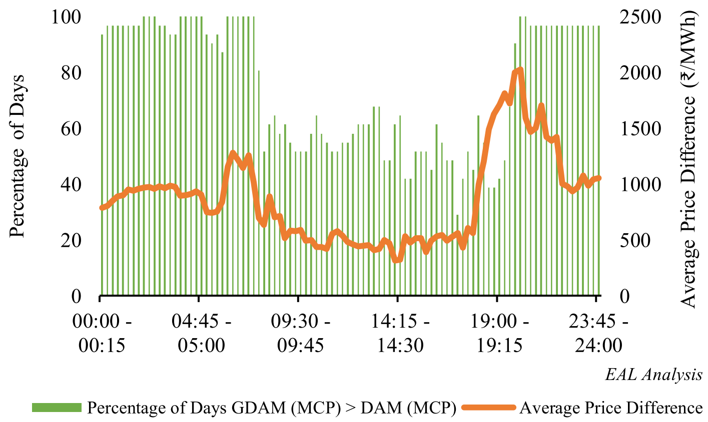


EAL Analysis

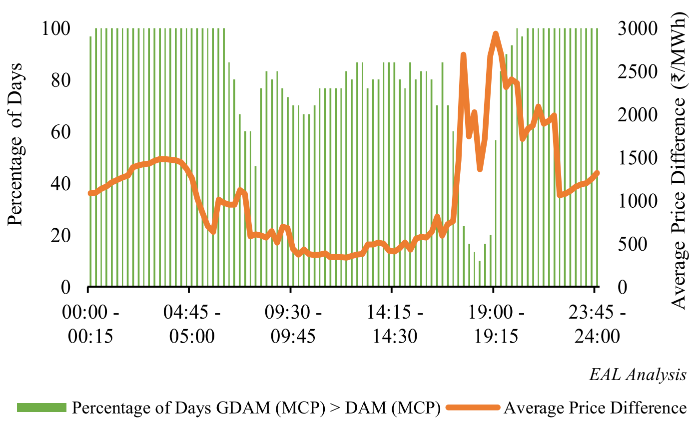
- The analysis is based on comparison between the average price difference of RTM and DAM, when MCP of RTM is greater than DAM for the third quarter of FY 2025-26.
- The graph shows the percentage of days, price for RTM is greater than DAM on the primary axis and the average price difference between the two on secondary axis.
- It has been observed that in 19:00-19:15 the highest average price difference is observed of Rs. 5.03/ kWh for the month of October, 2025.
- The average price difference between RTM and DAM is Rs. 0.73/ kWh for the quarter.

Price Difference between GDAM vs DAM

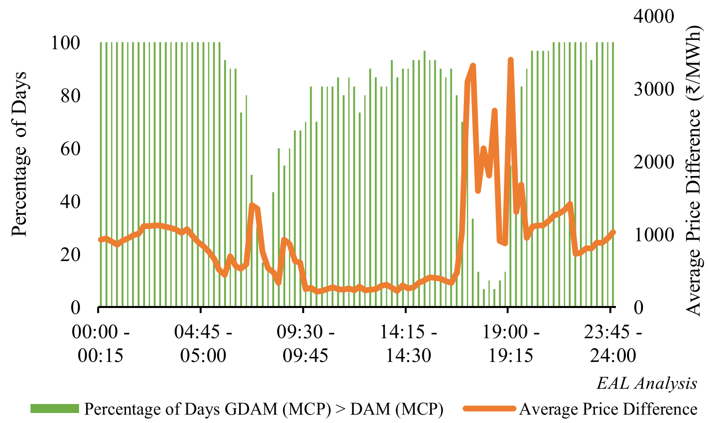
October 2025



November 2025



December 2025



EAL Analysis

- The analysis is based on comparison between the average price difference of G-DAM and DAM, when MCP of RTM is greater than DAM for the third quarter of FY 2025-26.
- The graph shows the percentage of days, price for G-DAM is greater than DAM on the primary axis and the average price difference between the two on secondary axis.
- It has been observed that in 19:00–19:15 the highest average price difference is observed of Rs. 3.39/kWh for the month of December 2025.
- The average price difference between G-DAM and DAM is observed to be Rs. 0.94/ kWh for the quater.

Opinion on CERC Discussion Paper on (Determination of value of "X" for computation of the deviation (in %) for Wind and Solar (WS) Sellers from 01.04.2026 onwards under the provisions of the Central Electricity Regulatory Commission (Deviation Settlement Mechanism and Related Matters) Regulations, 2024)

Cite

The CERC issued discussion paper on "Determination of value of "X" for computation of the deviation (in %) for Wind and Solar (WS) Sellers from 1st April, 2026 onwards under the provisions of the Central Electricity Regulatory Commission (Deviation Settlement Mechanism and Related Matters) Regulations, 2024", issued on 10th September, 2025. The main objectives of the proposed in the discussion paper are:

Objective: The draft proposal aims to determine the value of "X" for computing deviations of wind and solar sellers under the DSM framework from 1st April, 2026 onwards, enabling a phased transition from an available-capacity based approach to a schedule-based deviation mechanism. It seeks to tighten tolerance bands in line with improving forecasting capabilities, enhance grid discipline, and strengthen grid security as renewable penetration increases. The proposal is supported by a detailed study carried out by Grid-India on regional solar, wind, and hybrid projects across multiple seasons, assessing deviation behavior and revenue impacts under different values of "X". The study highlights the financial implications of tighter deviation norms, the benefits of aggregation through Qualified Coordinating Agencies, and the need for improved forecasting and scheduling practices to ensure a reliable and grid-supportive renewable energy ecosystem.

EAL Opinion

- **Need for More Realistic Calculation for Deviation for RE:** Increasing share of variable renewable energy (VRE) would place greater imbalance burden on the power system. To ensure stability and resilience for the power system, a lenient regime for deviation settlement mechanism (DSM) for RE should make for a more harmonised one. However, this should be implemented in a graduated manner while considering uncertainty related to extreme weather situations allowing sufficient but definitive timeline for transition. In our previous opinion, we proposed the graded path (X-factor based) mechanism for gradual transition to scheduling-based deviation calculation from the current approach based on available capacity (Singh, 2024)[1]. The same has been adopted in principle in the proposed amendment. Given the uncertainty associated with VRE, some fine-tuning of the same is proposed herein.
- **Benchmark Generation Profile (BGP):** Calculation of percentage deviation should be benchmarked to a seasonally adjusted representative generation profile[2]. This can be established on the basis of a 2–3 day averaged profile from the moving average (MA) block-wise actual generation using following steps,
  - (i) Calculate moving average based block-wise profile for each day. For example, a 3 or 5 block moving average profile to be estimated as per the methodology described below.
  - (ii) Once daily MA profile has been obtained for each of the previous 2-3 days, the BGP would be an average profile estimated using MA profiles for the previous days.
- **Moving Average-Based Approach for Benchmarking Solar and Wind Generation Variability:**

  Due to high variability in renewable output, actual generation can fluctuate significantly across continuous time blocks. Replacement of availability for solar and wind with schedule would impose additional deviation cost. Although desirable to ensure stability of the grid, a two-way transitioned approach would provide an opportunity to

Suggested Citation: Singh A. (ed.). (2025), Opinion on CERC Discussion Paper on (Determination of value of "X" for Computation of the deviation (in %) for Wind and Solar (WS) Sellers from 01.04.2026 onwards under the provisions of the Central Electricity Regulatory Commission (Deviation Settlement Mechanism and Related Matters) Regulations, 2024) Power Chronicle (Vol. 08, Issue 03, pp. 7-12), Energy Analytics Lab (EAL), Indian Institute of Technology Kanpur. https://eal.iitk.ac.in/assets/docs/power_chronicle_vol_8_issue_3.pdf

[1] Singh (2024), Power Chronicle, CERC (Deviation Settlement Mechanism and Related Matters), 2024 (Draft), Energy Analytics Lab, IIT Kanpur, ISSN: 2583-2409 (O).

[2] Named as maximum potential generation profile (MPGP) in our earlier opinion. BGP also addresses misinterpretation of the previous one as being 'maximum' generation potential.

adjust to the new regime. The X-factor based weighted average, as proposed earlier and adopted in the draft regulation, is a transitional mechanism. The second part of the approach to transition involves adoption of a 'baseline schedule' in place of schedule. To smoothen variability in generation across time blocks, a moving average of actual generation over the previous few days may be adopted as a benchmark to replace sole reliance on final scheduled values.

The choice of window length (3/5 block) for calculation of moving average can be finalized based on analysis of actual generation across multiple sites for solar and wind energy. A larger window length would be counterproductive especially in case of solar, which has a clear ramp up/down trend for generation across time blocks[3]. A window with even number of blocks would introduce upward/downward bias in the moving average calculation.

A moving average smoothens short-term fluctuations in time-series data by averaging consecutive values over a defined window of time with consecutive time blocks

The n-block moving average for time block t can be calculated as:

$$MA_n(t) = \frac{1}{n}\sum_{m=t-k}^{m=t+k} X_m \qquad (1)$$

For 3-block MA: $MA_3(t) = (X_{t-1} + X_t + X_{t+1})/3$

5-block MA: $MA_5(t) = (X_{t-2} + X_{t-1} + X_t + X_{t+1} + X_{t+2})/5$

Where:

$MA_n(t)$ = n-block moving average for time block t

X_t = Actual generation in time block t

n = Number of periods in moving average (e.g. 3, 5, 7)

n = 2k+1, so k = (n-1) / 2

An average of the moving average value for actual generation over past few days (2-3 days) for t^th block could thus replace the denominator for calculation of the deviation.

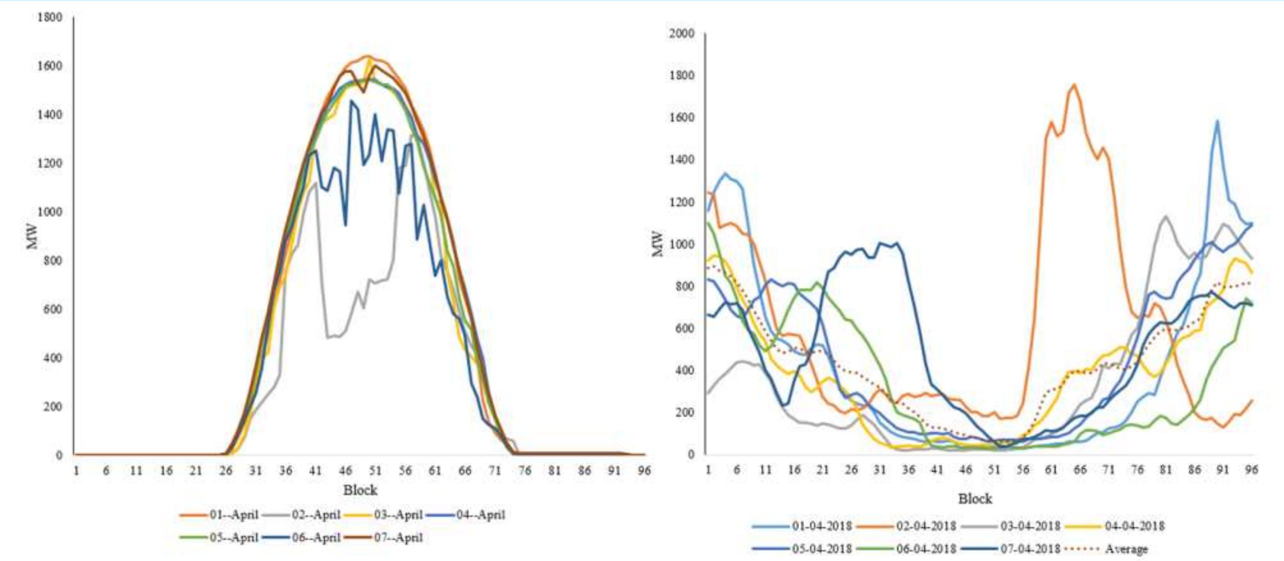


Figure 1. Daily Solar & Wind Generation over a week of April 2018

[3]This would be of particular concern while estimating moving average for time blocks witnessing peak generation in case of solar generators. The MA would underestimate the actual average generation profile for such time block(s). A separate adjustment would be required for the same. This can be done by using an adjustment factor estimated as a difference between the 'peak generation' in block t and average of generation in t-1 and t+1 block, based on the theoretical generation profile.

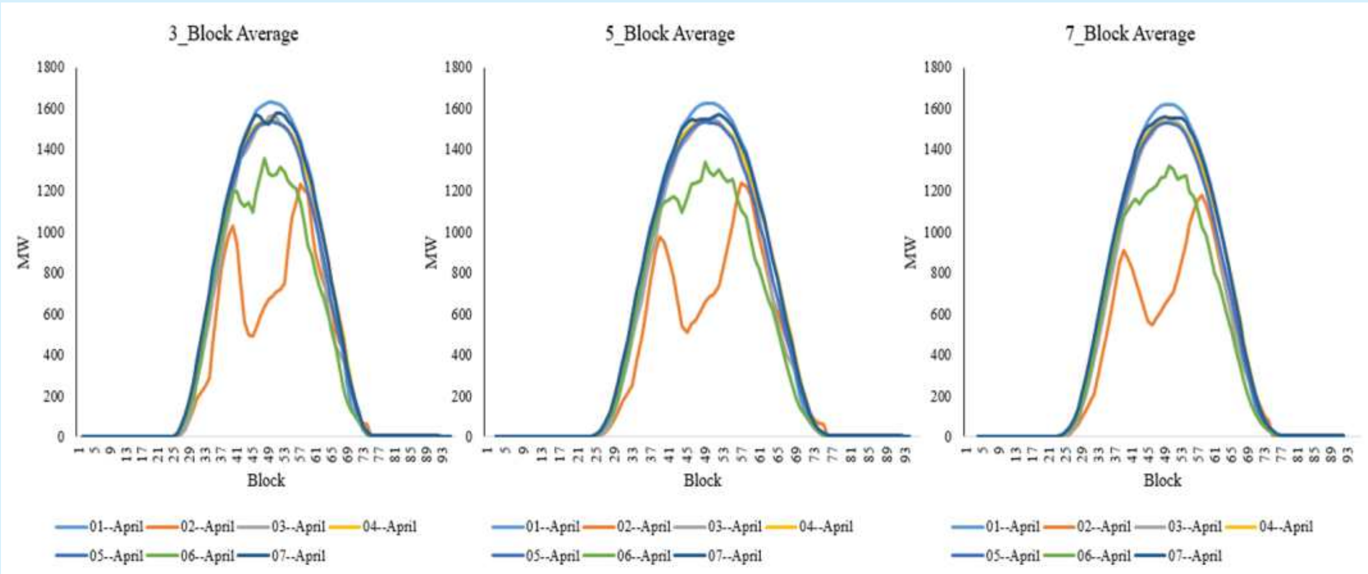


Figure 2. Block-wise moving average for daily solar generation over a week (3, 5, 7 Blocks)

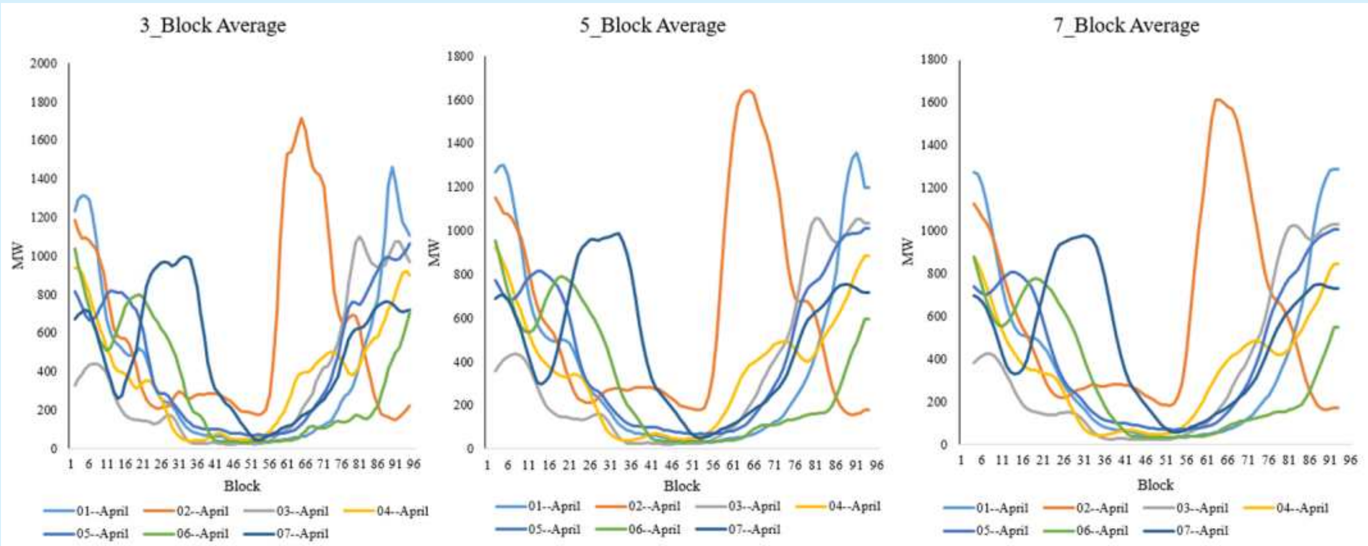


Figure 3. Block-wise moving average for daily wind generation (3, 5, 7 Blocks)

It is important to highlight that adoption of moving average approach should address the peculiarities during the first few and last few blocks that would witness a upward bias (Figure 5), while the peak energy generation block would witness a downward bias (Figure 6). This can be easily addressed by small tweak in the approach to calculate moving average for such time blocks by an adjustment factor calculated using historical data. The bias would be very limited in case of 3-block moving average (see Figures 5 & 6 below).

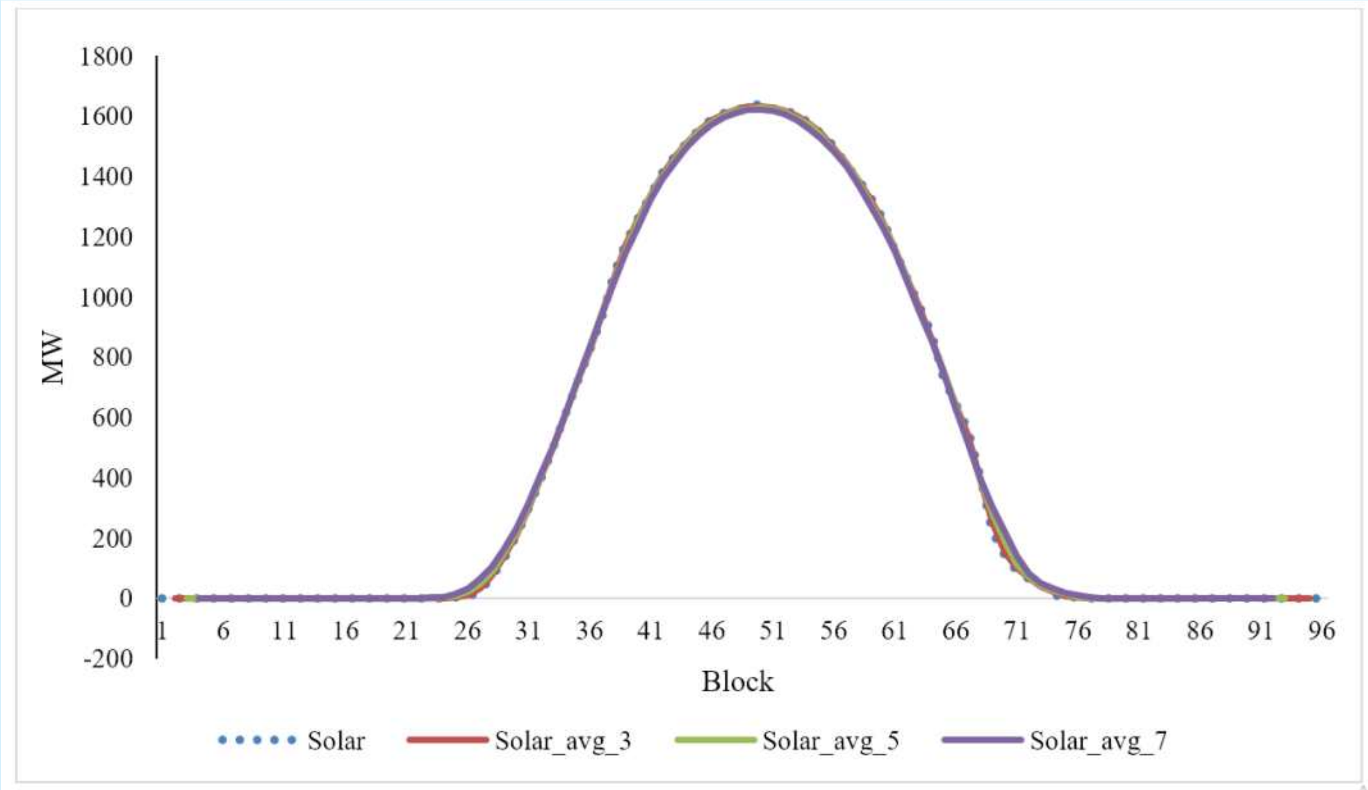


Figure 4. Block-wise solar moving average (3, 5, 7 Blocks) for one day

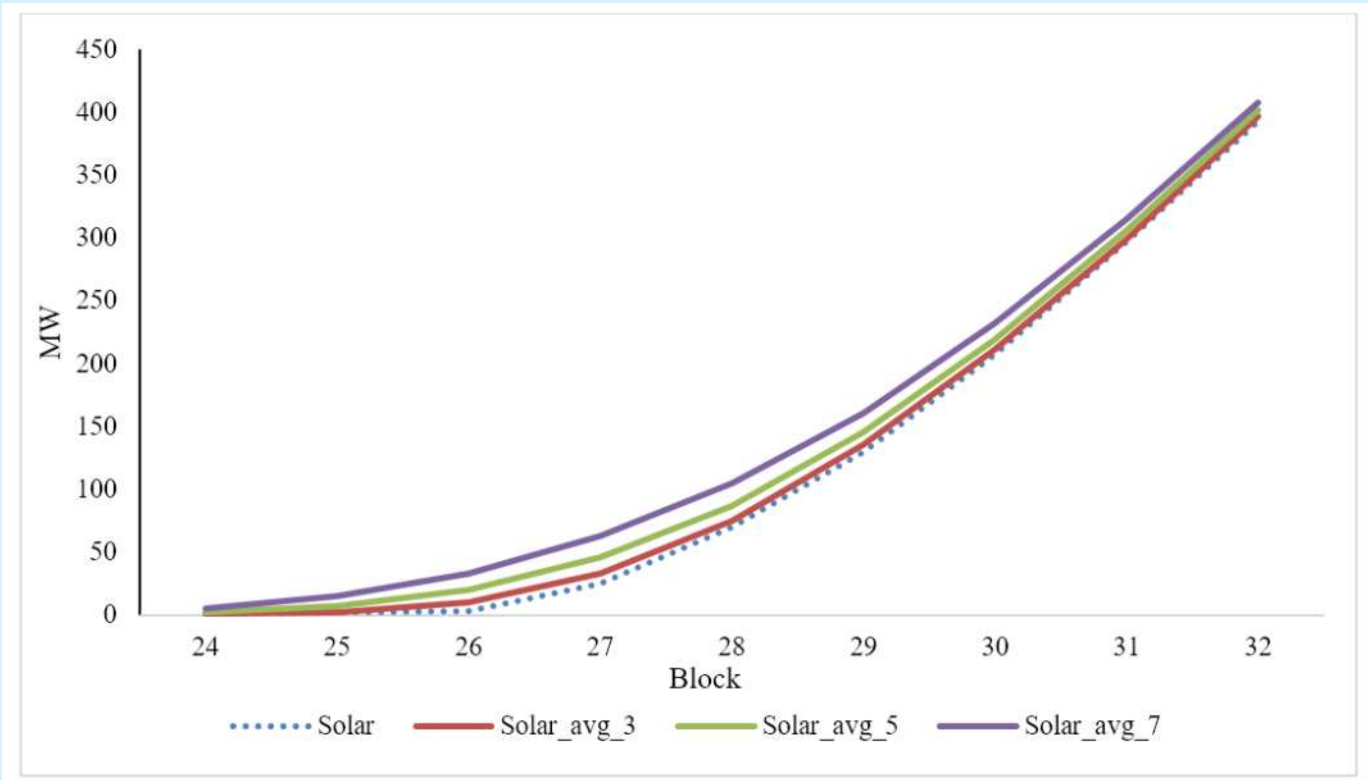


Figure 5. Block-wise solar moving average (3, 5, 7 Blocks) for block (24-32)

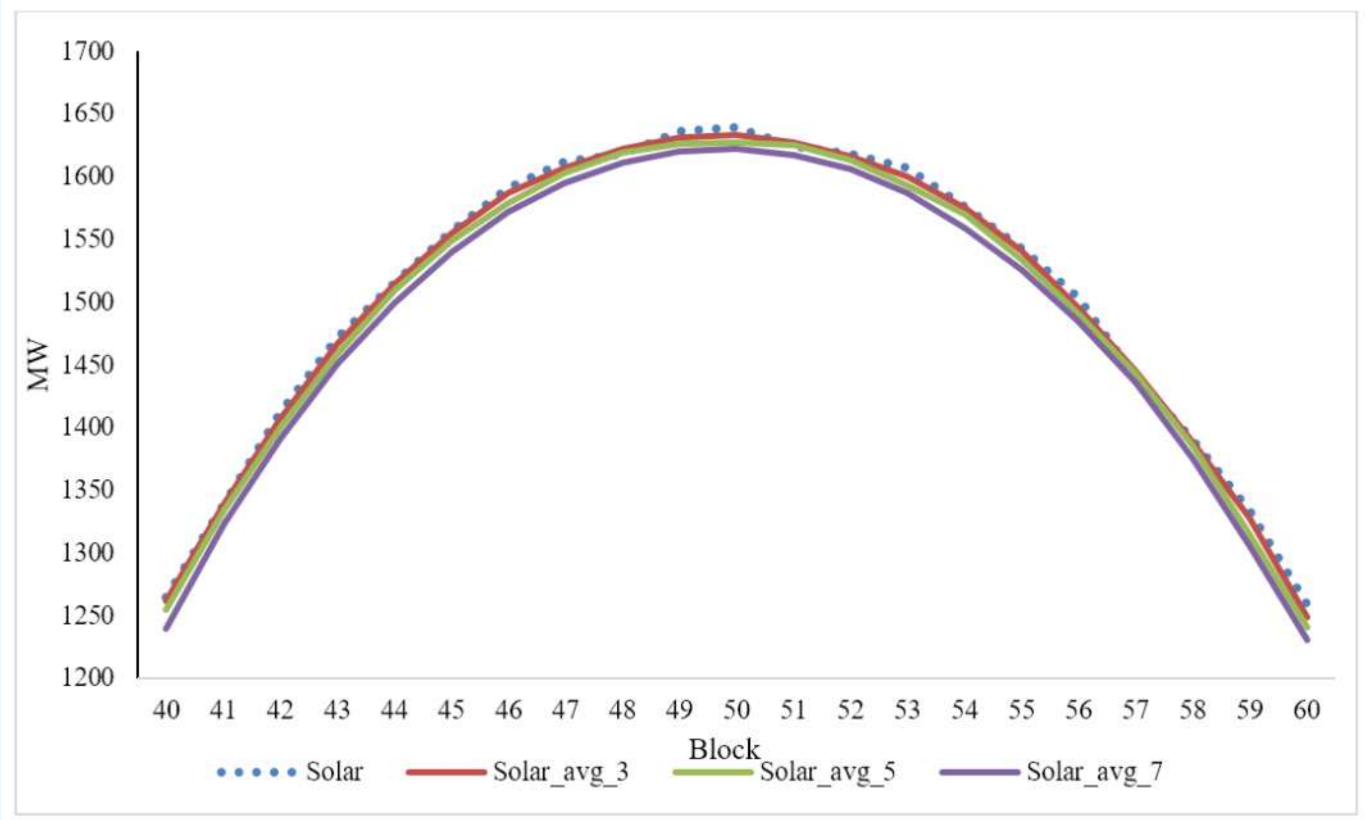


Figure 6. Block-wise solar moving average (3, 5, 7 Blocks) for block (40-60)

Limited analysis undertaken here suggests that solar variability can be addressed with shorter averaging window (3/5 blocks), whereas wind generation may require a wider smoothing window (5/7 blocks) to produce a reliable and representative profile, validating the tailored moving-average methodology. Further analysis using data across multiple sites may reveal further insights.

- **DSM Treatment and Forecasting Norms for Hybrid RE:** The draft order gives useful observations on how DSM charges and aggregation benefits apply to hybrid renewable systems. However, it does not specify what proportion of solar and wind was used in the hybrid models studied. This information is important because the generation pattern, deviation behavior, and forecasting performance can change significantly depending on the solar-wind mix. Furthermore, during late night a solar-wind plant would effectively function as a wind plant. Thus, the resultant deviation would not only depend on the capacity mix of the constituent RE technologies but also more specifically their share in the generation schedule. **A uniform approach to DSM application for all hybrid RE projects may not be effective. Alternatively, the applicable DSM itself can be derived using a 'weighted' approach by using weights of, say, solar and wind in the 'schedule' of a hybrid plant with pre-declared schedule.** This would also provide flexibility to the hybrid RE generators in declaring the right mix that would minimize their resultant deviation, which could very much be site specific.

- **Treatment of Deviation during Extreme Weather Events:** VRE generation is significantly influenced by extreme weather events. Numerous long-term weather models find that extreme weather events, such as droughts, floods and cyclones are expected to rise in number as well as intensity due to adverse impact of climate change. As per National Disaster Management Authority (NDMA), 5-6 tropical cyclones form each year around the Indian coasts. Of these, 2-3 take the extreme form. These events have significant impact on uncertainty of solar as well as wind energy generation. Given the dynamic nature of the cyclonic developments, and very limited historical data, it is not possible to reliably forecast its impact on generation by such plants. This enhances the probability of deviation beyond the reasonable limits expected during other periods.

The DSM regulation may provide for special treatment of deviation during such extreme events, beyond an identified limit, as this would also otherwise qualify as force majeure events. A maximum limit for deviation may be set for a limited number of time-period and within a spatial range around the path of the movement of cyclone as identified by the Indian Meterological Department (IMD). CERC, in consultation with IMD, may develop a procedure for declaration of such exemption for deviation beyond, say, 20% limit. **An alternative would be to introduce an insurance-based product, by general insurance companies, as described below.**

- **Deviation Insurance Products:** With growing share of renewables and rising weather uncertainty, time seems to be ripe for introduction of weather-related products offering insurance for payment of DSM charges beyond the expected range of deviation charges payable for a given time block. Since deviations from schedule are a site-specific phenomenon for the VRE plants, the generic weather derivatives do not offer an effective solution. Deviation/DSM insurance products may be better suited for the same. The general insurance companies should be able to design and offer such an insurance product offering hedge from financial impact of deviations beyond an identified range under a stable DSM regime. A 'group insurance' mechanism would help hedging their risk across a multiple sites spread across the country.

Opinion on CERC (Terms and Conditions for Renewable Energy Certificates for Renewable Energy Generation) (First Amendment) Regulations, 2025

Cite

The CERC notified draft on Terms and Conditions for Renewable Energy Certificates for Renewable Energy Generation (First Amendment) Regulations, issued on 22nd September, 2025. The main objectives of the proposed regulations are:

Objective: The draft regulation aims to align the Renewable Energy Certificate (REC) framework with the Renewable Consumption Obligation (RCO) regime under the Energy Conservation Act, 2001, and strengthen RECs as a credible compliance instrument. It expands the scope of obligated entities by including Designated Consumers, enables REC-based RCO compliance, and allows renewable captive generators with self-consumption to participate even if captive criteria are not fully met. The regulation introduces a principle-based REC multiplier methodology, provides long-term certainty through fixed validity of multipliers, clarifies treatment of RECs under Virtual Power Purchase Agreements, and strengthens guarantee-of-origin and accounting to ensure transparent, leakage-proof RPO and RCO compliance.

EAL Opinion

- **Issue of RECs for Over Compliance and Impact on Market Liquidity:** In the proposed Regulation 10 Clause (3) *"Application for issuance of Certificates shall be made by an eligible entity, being a distribution licensee or an open access consumer, within three months from the date of certification by the concerned State Commission about the purchase of electricity from renewable energy sources in excess of the renewable purchase obligations as determined by the concerned State Commission.*

  Provided that no Certificate shall be issued in case the application is made beyond the period of three months from the date of certification by the concerned State Commission."

  The obligated entities procure RE throughout the year and are obligated to ensure compliance for a financial year by submitting proof of the same after the end of the year. The respective ERC would then verify compliance. This would keep such RECs locked for a substantial period. In fact, most of the obligated entities (OE)/ designated consumers (DC), who would have over complied, would receive equivalent RECs for the over compliance at

Suggested Citation: Singh A. (ed.). (2025), Opinion on CERC (Terms and Conditions for Renewable Energy Certificates for Renewable Energy Generation) (First Amendment) Regulations, 2025 Power Chronicle (Vol. 08, Issue 03, pp. 12-13), Energy Analytics Lab (EAL), Indian Institute of Technology Kanpur.

https://eal.iitk.ac.in/assets/docs/power_chronicle_vol_8_issue_3.pdf around the same time. Such entities may like to offload the same around the same period creating excess liquidity pressure in the REC market. In contrast, a significant REC demand is generally witnessed before the end of the financial year as the OE/DC rush to ensure their compliance before the end of the financial year. **The cyclic nature of the liquidity pre- and post- the financial year should be avoided as it would also influence the price discovery for RECs. The regulatory approach should ensure that such artificial demand-supply imbalances do not crop up due to the regulatory framework.**

As an alternative, if each of the entity is issued RECs for the RE generation after the end of each month, the obligated entities/designated consumers would have the responsibility to submit the RECs to the respective ERC towards their obligation. The OE/DCs would be in a better position to estimate over compliance, if any, and offload the RECs before end of a particular financial year while also ensuring that excess RECs find their way to the market in a timely manner. Given the compliance penalty, the OE/DCs would decide to keep necessary buffer of RECs to tide over any uncertainty during the remaining part of the financial year. **The RECs thus become a currency for compliance and guarantee of origin[4].**

The diagram below depicts an example of the dynamic nature of over-/under-compliance across quarters of a year that may lead to overall overcompliance. Note that there may be a similar case with potential under-compliance necessitating purchase of RECs during the last quarter or earlier. The resultant liquidity mismatch could distort market dynamics and lead to volatility in REC prices.

To address the above concern, **it is suggested that the issuance and trading of RECs for surplus renewable energy be allowed at least on a quarterly basis.** This would enable smoother adjustment of excess or deficit compliance over shorter intervals, helping to stabilize liquidity in the REC market. Further, to prevent sudden surges of liquidity and to ensure that the OE does not face deficit on compliance for the remaining part of the year, a limited proportion (say 50%) of the cumulative excess RECs may be allowed for sale in each quarter.

Transfer and Extinguishment of Certificates under REC Mechanism: In proposed Regulation 14A (e) *"The Central Agency shall extinguish such Certificates after they are used for compliance with the Renewable Purchase Obligation or Renewable Consumption Obligation by the consumers or the designated consumers, and update its record."*

As per the provision, the Central Agency shall extinguish such Certificates after they are used for compliance with the Renewable Purchase Obligation (RPO) or Renewable Consumption Obligation (RCO) by the concerned consumers or designated entities.

However, in cases where entities (e.g., A and B) have a Virtual Power Purchase Agreement (VPPA), and Certificates are to be transferred from A to B, the Central Agency may facilitate the transfer directly. In such scenarios, if a dispute arises between the two parties such as non-fulfilment of obligations or non-payment, the Central Agency (or REC Registry/NLDC) could inadvertently be exposed to a dispute associated with commercial transaction between the parties involved.

To avoid such situations, it is suggested that transfer of Certificates under VPPAs should be initiated by the original generator (i.e., the seller under the VPPA). This ensures that, in case of any commercial or contractual dispute, only the two contracting parties (generator and buyer) are involved, thereby keeping the REC Registry and Central Agency insulated from legal exposure.

This approach would maintain regulatory clarity and safeguard the REC Registry from being entangled in commercial or legal disputes between market participants.

[4]Singh A., "A Market for Renewable Energy Credits in the Indian Power Sector", Renewable and Sustainable Energy Review journal, Elsevier, 13 (2009) 643–652 https://www.sciencedirect.com/science/article/pii/S1364032107001463

Singh A., "Economics, Regulation and Implementation Strategy for Renewable Energy Certificates in India", India Infrastructure Report 2010, OUP for detailed discussion on the use of REC as a currency of compliance and guarantee of origin
https://papers.ssrn.com/sol3/papers/cfm?abstract_id=3440253

Opinion on CERC Petition filed by HPX on (Introduction of Green RTM (G-RTM) and High Price RTM (HP-RTM) Contracts)

Cite

The Hindustan Power Exchange (HPX) Limited, filed petition to the CERC on Introduction of Green RTM (G-RTM) and High Price RTM (HP-RTM) Contracts, on 12th December, 2025. The main objectives of the petition are:

Objective: The petition aims to introduce Green Real Time Market (G-RTM) and High Price Real Time Market (HP-RTM) contracts on the HPX platform to enhance market depth, flexibility, and price discovery in the real-time segment. It seeks to provide a dedicated avenue for trading green power closer to real-time, thereby supporting renewable energy integration and enabling buyers to meet their sustainability and RPO requirements. The proposal also aims to address situations of high demand & supply tightness by offering HP-RTM as a premium price signal, while improving liquidity, operational efficiency, and risk management in the power market framework in line with evolving grid and market requirements.

EAL Opinion

- **Framework for Transition from Green RTM to Integrated Real-Time Market:** It is proposed that the Green Real-Time Market (G-RTM) be re-designated as the Integrated Real-Time Market (I-RTM), in line with the existing Integrated Day-Ahead Market (I-DAM) framework defined under CERC regulations. Under the I-RTM framework, two distinct sub-segments may be notified as Green RTM segment for transactions involving renewable energy sources and a Normal RTM segment for all eligible electricity transactions, thereby providing an integrated yet differentiated real-time market structure.
- **Technology Agnostic Energy Storage System (ESS):** It is recommended to define technologically agnostic criteria for "energy storage system (ESS)" rather than restricted eligibility for the "battery storage system". This would ensure that other technologies are not discriminated against by creating artificial barrier to entry through the eligibility criteria. ESS covers all forms of storage mechanical options such as pumped hydro, compressed air, flywheels, thermal storage technologies, electrochemical systems, and other emerging forms. The market design should permit broader eligibility, even while participation may depend on the respective economics of the storage technologies. This would also create an environment for competition amongst the alternate storage technologies.
- **Treatment of 'Pure' Hydro Vs 'Pumped Storage' within a PSP's Portfolio:** Development of pumped storage capacity can be undertaken on existing hydroelectric plants as well as those being developed on a greenfield basis. Furthermore, a pumped storage plant may have higher generation capacity through use of water in the upper reservoir[5], which is partly replenished by upstream flow and partly through the pumped water from the downstream reservoir. Thus, a PSP could have a 'pure' hydro output as well as that based on 'stored' energy. The treatment of energy generated and injected by Pumped Storage Plant should ideally be differentiated from 'pure hydro' energy as this would also affect eligibility of participation in the HP-RTM stage. For e.g., an existing 400 MW hydroelectric generating station with an upper reservoir operating on natural inflows and reservoir storage. Subsequently, a 100 MW of energy generated through 'storage cycle' is integrated into the same project, which draws water from a lower reservoir using grid electricity and pumps it back to the upper reservoir for later generation. In contast, a PSP may have 100 MW of pure hydro function whereas 400 MW may be added through an add-on pumped storage facility. In this context, it may be difficult to distinguish between the energy generated from the pure hydro storage and that generated from the pumping operation of the plant for the purpose of participation in HP-DAM, and for scheduling, and settlement thereof.

Suggested Citation: Singh A. (ed.). (2025), Opinion CERC Petition filed by HPX on (Introduction of Green RTM (G-RTM) and High Price RTM (HP-RTM) Contracts), 2025 Power Chronicle (Vol. 08, Issue 03, pp. 14-15), Energy Analytics Lab (EAL), Indian Institute of Technology Kanpur. https://eal.iitk.ac.in/assets/docs/power_chronicle_vol_8_issue_3.pdf

[5]This would be in case of a PSP plant based on a water body that also releases water for ecological, irrigation and other multipurpose plant in contrast, a closed cycle PSP plant would not have 'pure' hydro generation component.

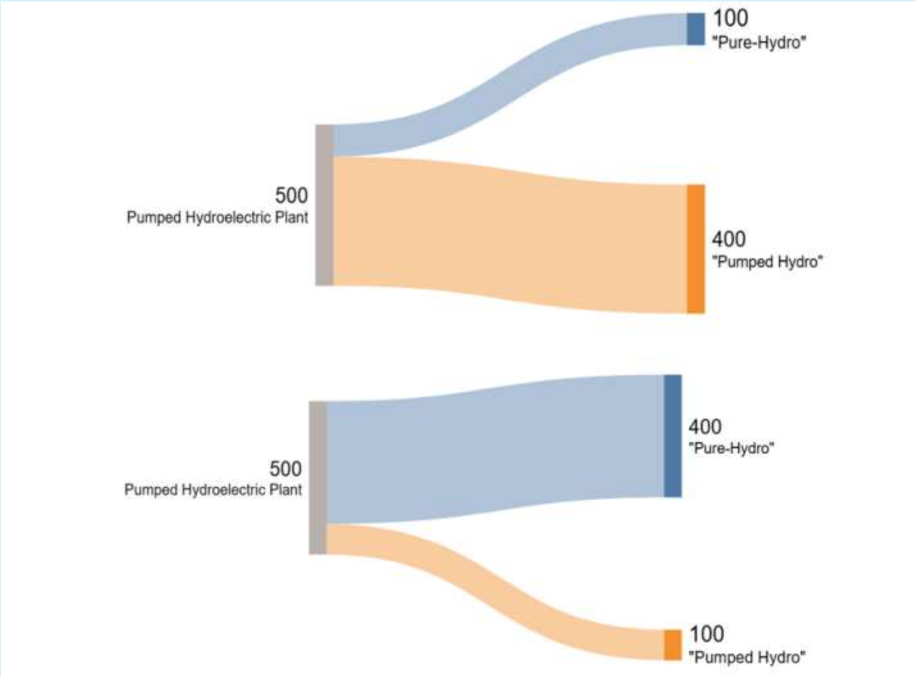


Figure 1. Sankey Diagram highlighting in both cases, entire hydroelectric plant qualifies as PSP even though proportion of "Pumped Hydro" and "Pure Hydro" vary. (figures in MW)

As per the current definition of PSP (by CERC), PSPs generate energy through 'stored' water through pumping from a lower to a higher reservoir. The complication arises in case a single a hydro complex that includes both a conventional large hydro station and a PSP unit sharing common injection point[6]. In such cases, care is needed to ensure that only the storage-related PSP component actually participates in market, and the conventional hydro output does not enter the mechanism indirectly.

It is suggested that a minimum proportional share of, say, 70-80%, of storage capacity be mandated to qualify for participation in the HP-RTM (similarly for HP-DAM) market segment.

- **Treatment of RE Schedules, RTM Participation and DSM Exposure:** When a renewable generator procures power through the Green RTM, the cleared volume becomes part of its firm schedule, and any residual mismatch is settled under the applicable DSM regulations, broadly similar to the treatment of I-DAM schedules. At present, once green power is scheduled in the Day-Ahead or Integrated DAM, that schedule is effectively locked for DSM purposes; if the generator subsequently observes lower-than-forecast wind or solar availability, the resulting under-injection attracts deviation charges at the notified DSM rates. **From a regulatory design standpoint, the key challenge for the Commission would be to determine the extent to which a generator may use RTM (including Green RTM) to hedge its deviation risk, and under what conditions such RTM trades are recognized as legitimate balancing actions rather than gaming.**

  When a renewable energy generator participates in the Green RTM, the cleared RTM volume shall form part of its firm schedule for the corresponding time block, and any deviation from this schedule shall be settled under the prevailing DSM framework. To minimize gaming, the Commission may specify conditions under which generators may utilize the RTM (including Green RTM) to mitigate bona fide forecast-related deviations, while disallowing strategies primarily aimed at arbitrage between DAM and RTM. **CERC's market monitoring operations would thus have to detect and address such a behaviour.**

[6] Or a conventional hydro plant with add on pumping facility for functioning partly as pumped storage.

Opinion on RERC (Battery Energy Storage Systems), 2025

Cite

The RERC notified draft on Battery Energy Storage Systems Regulations, 2025. The main objectives of the proposed regulations are:

Objective: The regulations aim to enable the deployment and utilization of Battery Energy Storage Systems (BESS) as integral components of generation, transmission, and distribution infrastructure, while facilitating their participation in ancillary services and energy markets. They seek to promote cost-effective energy storage solutions that enhance grid stability, support frequency regulation, and enable large-scale integration of renewable energy. The framework also provides regulatory clarity for aggregators and third-party BESS developers, allowing them to participate in electricity markets in a transparent and efficient manner, thereby encouraging private investment and fostering the development of a competitive and flexible energy storage ecosystem.

EAL Opinion

- **Role of Distributed Energy Resource Aggregator (DERA):** In the proposed Clause 2 (1)(b) *"**Aggregator(s)** or **Distributed Energy Resources Aggregator or DERA** means an entity registered/appointed with/by the distribution licensee to provide aggregation of one or more services like demand response services, Distributed Generation, Energy Storage, etc., within a license area."*

  The expression "registered/appointed with/by the distribution licensee" introduces ambiguity in the qualification process for Aggregator(s)/ DERA. Registration and appointment are two distinct regulatory actions with different legal implications, procedural requirements, and oversight mechanisms. The draft regulation needs to provide clarity as to whether an aggregator needs to be formally registered, or how would the 'appointment' mechanism work?

  The regulation should provide clear guidelines including eligibility and process for registration / appointment of Aggregator(s)/ DERA to ensure regulatory certainty and enforceability.

- **Modification in Terminology:** In the proposed Clause 2 (1)(c) "***Ancillary Service (AS) capacity obligation*** *is the capacity signaled for dispatch by the Nodal Agency under SRAS or the capacity procured by the Nodal Agency under TRAS". (emphasis added)*

  It is recommended to define the term "Ancillary Services Capacity Obligation" as "SRAS Capacity Obligation" to ensure alignment and consistency with other regulatory documents particularly those issued by the CERC. Adopting a standardized definition will help avoid any interpretational ambiguities and promote regulatory coherence.

- **Definition of Banking:** In the proposed Clause 2 (1)(d) "***Banking*** *means a facility through which the unutilized portion of energy from any of the Green Energy Sources during a billing month is kept in a separate account and treated in accordance with the conditions laid down in the relevant Regulations issued by the Commission.".*

Suggested Citation: Singh A. (ed.). (2025), Opinion RERC (Battery Energy Storage Systems), 2025 Power Chronicle (Vol. 08, Issue 03, pp. 16-18), Energy Analytics Lab (EAL), Indian Institute of Technology Kanpur. https://eal.iitk.ac.in/assets/docs/power_chronicle_vol_8_issue_3.pdf

The draft currently restricts the definition of banking to green energy only. Considering Rajasthan's existing regulations encompass banking for all types of energy, it would be prudent to specifically define "Green Energy Banking" under the new framework. This approach will ensure clarity while maintaining consistency with prevailing legal provisions.

- **Technology Agnostic Energy Storage System**: In the proposed Clause 2 (1)(f) "***Battery Energy Storage System Developer** or **"BESSD"** or **"Developer"** shall mean the entity owning/operating the BESS facility for the supply of power under this regulation*".

  Given the intention to cover diverse storage technologies, replacing the terms "Battery Energy Storage System (BESS)" and "Battery Storage Developer (BSD)" with "Energy Storage System (ESS)" and "Energy Storage System Developer (ESSD)" throughout the document is advisable. This substitution would support a technology-agnostic regulatory framework and thus promote competition across technologies leading to cost effective solutions. The proposed definition is thus also not aligned with objective (Clause 3.(c)), which highlights cost effective energy storage system.

- **Standalone Operation and Market Participation:** In the proposed Clause 2 (1)(i) "***Standalone BESS** means a BESS operating independently as a merchant unit that has the capability to engage in energy or capacity trading in power markets or AS*".

  Considering the technical and economic complexities associated with capacity trading by standalone BESS/ESS, it is suggested to revise the language to "participate in capacity trading and ancillary services through power exchanges or bilateral agreements." This wording would reflect current market context and also enable emerging opportunities in future..

- **Un-Requisitioned Surplus (URS):** In the Proposed Clause 2 (1)(n) "***Un-Requisitioned Surplus** or "**URS**" means the capacity in a generating station that has not been requisitioned and is available for dispatch, and is computed as the difference between the declared capacity **or maximum possible generation**, as the case may be, of the generating station and its total schedule". (emphasis added)*

  The URS should be calculated as the difference between the declared capacity and its total schedule. Insertion of 'maximum possible generation' may introduce additional legal/technical complexities. It is also important to clarify that URS provisions apply only to conventional generators under Power Purchase Agreements (PPAs) and not to renewable energy generators.

- **Terminology for Generators:** In the Proposed Clause 4.1 *"BESS may be developed and owned by Distribution Licensees, Transmission Licensees, **GENCOS, Independent Power Producers (IPPs),** Consumers, SLDC, Standalone BESS, Renewable Energy Developers, Aggregators, or any other third-party investors". (emphasis added)*

  The legal and regulatory framework in the power sector defines generation as one of the components. Terms such as "GENCO" and "IPP" should be replaced with standard terms like "generating station" or "generating plant" as applicable to align with legally defined terminology under the Electricity Act.

- **Business Model Reference:** The draft mentions the term "business model" without elaborating the same. Including examples or referencing established business models under CEA/CERC guidelines would provide stakeholders with much-needed clarity.

- **Planning Linkages:** In the proposed Clause 5.2. *"The Distribution Licensees and the State Transmission Utility (STU) shall plan the requirement of energy storage capacity within their respective areas of operation, keeping in view the technical considerations, system reliability, and load requirements.*

Provided that in the process of such planning, both the Distribution Licensees and the STU shall consult the State Load Dispatch Centre (SLDC). Provided further that the ***proposed storage plan shall be submitted for approval to the Commission along with ARR/Investment Plan.****". (emphasis added)*

With growing RE share, storage technology needs to be deployed to enhance system reliability. This is an integral part of a Resource Adequacy Plans (RAP) exercise. To ensure comprehensive planning, a clear linkage to Resource Adequacy Plans (RAP) should also be provided for in addition to the approvals under the Aggregate Revenue Requirement (ARR)/ investment plans.

- **Role of Distributed Energy Resource Aggregator (DERA):** The draft should explicitly recognize the role of Distributed Energy Resource Aggregators (DERA) in standalone ESS operations to support integration of distributed storage resources.
- **Vehicle-to-Grid (V2G) Integration:** Clarification regarding the regulatory treatment and participation of electric vehicle (EV)-based storage systems under Vehicle-to-Grid (V2G) models within the ESS framework is necessary to facilitate innovative solutions and grid services.
- **Legal Status of Storage Assets:** As per MoP notification, an Energy Storage System (ESS), except for standalone systems, would have a legal status based on it being part of generation, transmission, distribution or system operation. An ESS operates as a 'load' or as a 'generator'. There is a need to clearly define the legal and regulatory status of standalone Energy Storage Systems during their operation as load when charging and as generators when discharging. This clarity will assist in the due application of the relevant regulations.
- **Undefined Term - Energy Storage Element:** The term "energy storage element" remains undefined. Providing a precise definition or replacing it with a standardized term will enhance clarity.

Power Lexicon

CERC (Determination of X Factor)

X-Factor

The X-Factor is a weighting parameter specified by the Central Electricity Regulatory Commission (CERC) for computing the percentage deviation of Wind and Solar (WS) Sellers under the Deviation Settlement Mechanism (DSM) from 1st April 2026 onwards. It determines the relative contribution of Available Capacity and Scheduled Generation while computing deviation.

Deviation (%) is computed as:

$$D_{WS}\% = 100 \times \frac{(Actual\ Injection - Scheduled\ Generation)}{[X\% \times Available\ Capacity + (100 - X)\% \times Scheduled\ Generation]}$$

This enables a phased transition from available capacity-based deviation assessment to schedule-based assessment. The CERC has proposed a gradual reduction of X from 100% to 0% over time to align renewable generators.

Revenue-Neutral Deviation Band

The **Revenue-Neutral Deviation Band** is the specified range of permissible deviation between actual injection and scheduled generation within which a Wind and Solar Seller does **not incur any net financial gain or loss** under the DSM mechanism. Deviations falling within this tolerance band are settled in a manner that results in zero net revenue impact on the generator, while deviations beyond the band attract DSM charges or penalties. From 1st **April, 2026**, the Commission has proposed tighter revenue-neutral deviation bands, **±5% for solar and hybrid generating stations and ±10% for wind generating stations**, to reflect the increasing maturity of renewable technologies and to strengthen grid discipline and security.

Renewable Energy Hybrid Project

A Renewable Energy Hybrid Project (RE Hybrid Energy Project) means a renewable energy generation project that produces electricity from a combination of two or more renewable energy sources and is connected to the electricity grid through the same common inter-connection point, such that the energy generated from all renewable sources is injected into the grid at the same interconnection point with unified metering.

A project shall qualify as a Renewable Hybrid Energy Project only if the rated capacity of at least one renewable energy source is not less than 33% of the total installed capacity of the hybrid project, and the project operates through the same interconnection point for grid injection.

Further, the minimum Capacity Utilization Factor (CUF) for a renewable hybrid energy project shall be 30%, measured at the inter-connection point where electricity is injected into the grid.

RERC (Battery Energy Storage System) Regulations

Firm & Dispatchable RE Power

Firm and Dispatchable Renewable Energy (RE) refers to renewable energy sources are combined or supported by enabling resources (such as storage) to deliver **assured, reliable, and controllable power**.

As per the Regulations, this includes configurations such as assured peak power, round-the-clock renewable power with firm delivery at rated capacity at any hour of the day, load-following renewable power delivery as per DISCOM demand, or clean energy projects providing firm power for fixed hours as specified by DISCOMs. The concept is intended to overcome the intermittency of renewable energy and ensure dependable supply comparable to conventional sources.

BESS

As per RERC draft, Battery Energy Storage Systems (BESS) are systems or projects that utilise **electrochemical batteries or other approved technologies** to store energy and deliver it as electricity. Under the Regulations, BESS may be deployed in multiple configurations, including standalone grid-connected systems, co-located with renewable or conventional generation, embedded in transmission or distribution networks, behind-the-meter at the consumer level, or integrated with electric vehicle infrastructure.

Vehicle to Grid (V2G)

Integration with EV infrastructure enables **Vehicle-to-Grid (V2G)** and Grid-to-Vehicle services, wherein electric vehicles and charging systems can act as distributed storage resources to supply power back to the grid or support grid services. The proposed regulations are technology-neutral and allow BESS to participate in energy markets, ancillary services, and consumer-level applications.

Consumer / Prosumer

A Consumer is an electricity user who may install **behind-the-meter BESS**, with or without a solar power plant, up to the level of their contract demand. A Prosumer is a consumer who both **consumes and produces electricity**, typically through distributed renewable generation coupled with BESS. Under the proposed RERC (Battery Energy Storage Systems) 2025, Regulations, consumers and prosumers are permitted to utilise BESS for self-consumption, energy arbitrage, injection of power into the grid during peak hours, participation in demand response programmes, and similar schemes, either directly or through an Aggregator. Such participation is subject to compliance with technical standards, safety norms, and metering and communication requirements specified by the Distribution Licensee.

Ancillary Services

Ancillary Services (as per IEGC, 2023) are the services required for secure, reliable, and quality operation of the power grid. They support the system operator in maintaining grid stability by continuously balancing generation and demand, including frequency regulation, reserve provisioning, voltage control, load following and black-start capability.

As per the IEGC definition, ancillary services include Primary Reserve, Secondary Reserve, and Tertiary Reserve services, which collectively help in responding to sudden disturbances, correcting short-term imbalances, and restoring reserves. They also cover active power support for load following, ensuring generation tracks demand variations smoothly over time. In addition, ancillary services include reactive power support for voltage control and black start capability, which helps restore the grid after a total or partial blackout. The definition also allows inclusion of any other similar support services as specified under the regulations.

As per the Draft RERC (Battery Energy Storage Systems) Regulations, 2025, BESS are explicitly recognised as a key grid resource and are eligible to provide Ancillary Services at the intra-state level. The regulations define BESS as a system/project using electrochemical batteries (or any other approved technology) that stores energy and delivers it as electricity.

Under the proposed Regulation 6, BESS may deliver services such as frequency regulation, spinning reserves, voltage support, black start services, and demand response services, along with any other services as applicable under the relevant grid framework. This highlights the role of BESS as a fast-response flexibility resource for balancing and reliability.

Open Access

Open Access, in the context of BESS, refers to the **non-discriminatory access to the electricity transmission and distribution network** for charging and discharging of Battery Energy Storage Systems. The Regulations specify that open access for BESS shall be governed by the applicable RERC Green Energy Open Access Regulations, as amended from time to time. The Commission may, based on petitions from licensees, generators, or the SLDC, issue separate orders specifying the methodology for charging or granting waivers related to open access for BESS where required.

HPX (Introduction of Green RTM (G-RTM) and High Price RTM (HP-RTM) Contracts)

Green Real-Time Market (G-RTM)

Green Real-Time Market (G-RTM) is a real-time electricity market segment proposed by Hindustan Power Exchange Ltd. exclusively for renewable energy to enable trading closer to delivery. It is designed primarily to facilitate the sale and purchase of leftover renewable power that remains unsold after participation in Green Day-Ahead Market (G-DAM) and Green Term-Ahead Market (G-TAM)

G-RTM operates on a rolling basis in 15-minute time blocks, follows the same bidding, matching, scheduling, settlement, and risk-management framework as the existing RTM, and is open to grid-connected renewable generators and eligible buyers with valid NOC/Standing Clearance from the RLDC/SLDC. Power transacted through G-RTM retains its green attribute and is proposed to be eligible for meeting the buyer's Renewable Purchase Obligation (RPO)

High Price Real-Time Market (HP-RTM)

High Price Real-Time Market (HP-RTM) is a real-time market segment proposed by HPX Ltd. to address situations where demand is unmet or supply remains uncleared in the existing market segments and where buyers are willing to pay a higher price to meet their real-time power requirements.

HP-RTM operates on the same 15-minute rolling real-time framework as RTM, with identical processes for bidding, matching, scheduling, and settlement, but allows participation by specific eligible high-cost resources, namely gas-based power plants using imported RLNG or naphtha, imported coal-based power plants, and Battery Energy Storage Systems (BESS).

The HP-RTM is not a green-exclusive market; rather, it provides an additional price discovery avenue for high-cost generation and storage resources in real time.

CERC (Terms and Conditions for Renewable Energy Certificates for Renewable Energy Generation) (First Amendment) Regulations, 2025

Certificate Multiplier

The **Certificate Multiplier** is a regulatory mechanism introduced under the Central Electricity Regulatory Commission (Terms and Conditions for Renewable Energy Certificates for Renewable Energy Generation) (First Amendment) Regulations, 2025 to determine the **number of Renewable Energy Certificates (RECs) issued per megawatt-hour (MWh)** of electricity generated from an eligible renewable energy source. Instead of issuing a uniform one REC for every one MWh of renewable electricity, the multiplier allows issuance of **more** than one REC per MWh for certain renewable technologies, depending on their characteristics and system value.

The Certificate Multiplier was introduced to address the limitations of a uniform REC framework, which treated all renewable technologies identically despite significant differences in **cost structure, technological maturity, and contribution to grid reliability**. The Commission recognised that mature and low-cost technologies such as solar and onshore wind were able to meet RPO demand easily, while relatively expensive or grid-supportive technologies such as biomass, hydro, pumped storage, offshore wind, battery energy storage systems (BESS), and hybrid renewable energy projects remained underrepresented. The multiplier mechanism was therefore designed to promote **technology diversity**, encourage **firm and dispatchable renewable capacity**, and align REC incentives with the **actual system value** provided by different renewable energy sources.

Under the amended regulations, the Certificate Multiplier is determined through a principles-based methodology provided in Appendix-1. Renewable technologies are assessed using three key parameters: **Tariff Range**, **Technology Maturity**, and **Capacity Credit/Peak Support**. Each parameter is assigned a score between 0 and 100, reflecting the technology's cost level, stage of commercial development, and ability to provide firm or peak-supporting power to the grid. The final multiplier is derived by combining these scores using specified weightages.

The Commission has assigned a higher weightage of 40% to Tariff Range, recognising that costlier renewable technologies may require greater support. Technology Maturity and Capacity Credit/Peak Support carry 30% weightage each, reflecting the intent to encourage less mature technologies and those providing stronger grid-support benefits. The weighted total score is then normalised and rounded to arrive at the applicable REC multiplier for each renewable source.

Once assigned, the multiplier remains valid for a period of 15 years from the date of commissioning. Beyond this period, certificates are issued at one REC per one MWh, ensuring investment certainty while avoiding indefinite higher incentives.

3rd Regulatory Manthan on the Draft Electricity (Amendment) Bill, 2025"

The Centre for Energy Regulation (CER) at the Department of Management Sciences, Indian Institute of Technology (IIT) Kanpur, recently organized the 3rd Regulatory Manthan on "The Draft Electricity (Amendment) Bill, 2025."

The event aimed to facilitate informed discussions on the key provisions and implications of the draft amendment for the Indian power sector, bringing together distinguished regulators, policymakers, legal experts, and industry leaders on a common platform.

The session commenced with a welcome and introductory remarks by the CER team, followed by opening remarks and a detailed presentation on the analysis of the Draft Electricity (Amendment) Bill, 2025, delivered by Prof. Anoop Singh (Founder and Coordinator, CER & EAL, IIT Kanpur). The subsequent panel discussion, moderated by Prof. Singh featured eminent experts, including Mr. V. P. Raja (IAS (Retd.), Former Chairman, MERC), Ms. Manju Gupta (Executive Director (Commercial), PGCIL), Mr. Abhishek Ranjan (CEO, BSES Rajdhani) Mr. Buddy A. Ranganadhan (Senior Advocate, Supreme Court of India), Mr. Chilukamari Chakrapani (Director, TGSPDCL) Mr. Prashant Verma (Director (Commercial), UPPCL) Ms. Paramita Sahoo (Head (Policy Advocacy), Tata Power) and Mr. Shantanu Dixit (Member, Prayas Energy Group).

The discussion centred on the key provisions of the Draft Electricity (Amendment) Bill, 2025, with particular emphasis on the proposed introduction of retail supply competition through shared distribution networks and the associated implementation challenges. Panelists also deliberated on the phased reduction of cross-subsidies for manufacturing, railways, and metro rail consumers with demand above 1 MW, along with proposed revisions to tariff determination timelines and the procedure for removal of members of Electricity Regulatory Commissions (ERCs). The proposal to establish an Electricity Council to strengthen Centre–State coordination was highlighted, and provisions relating to right of way were also examined in detail.

7th Regulatory Conclave on the Draft Electricity (Amendment) Bill, 2025

The Centre for Energy Regulation (CER), IIT Kanpur, successfully organised the 7th Regulatory Conclave on "The Draft Electricity (Amendment) Bill, 2025" on 20th November, 2025 in an online, closed-door format. The conclave was held exclusively for Chairpersons and Members of Electricity Regulatory Commissions (ERCs) across the country.

The session facilitated a structured and in-depth discussion on the key provisions and potential implications of the Draft Bill for India's power sector. Participants shared their perspectives on critical issues, including retail competition through a shared distribution network, exemptions from the obligation to supply, impacts on existing PPAs, phasing out of cross-subsidies, strengthening regulatory governance, non-fossil energy obligations, and the proposed roles of the Electricity Council and the Electricity Line Authority.

The conclave provided an effective platform for peer-level deliberation and knowledge exchange, reinforcing CER's role in fostering informed regulatory dialogue and contributing to policy-relevant insights for the sustainable development of India's power sector.

The editor thanks Power Chronicle team for their contribution in supporting the data analysis, copy editing and coordinating final production of this issue. The editor also acknowledges the support of the IT Team, led by Garima Bajpai and Rahul Shah.

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