"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."

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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 behaviour 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.
The document can be accessed here.

CER Opinion

1. **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 finetuning of the same is proposed herein.

2. **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.

3. **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 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.

[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.
[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

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:

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

Where:

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

X_t = Actual generation in time block t

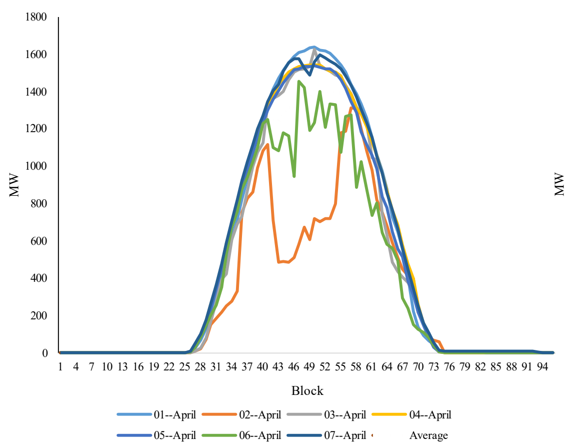
n = Number of periods in moving average (e.g. 3, 5, 7)

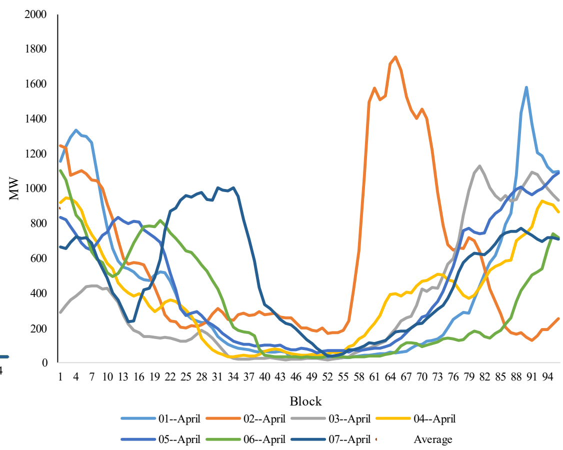
n = 2k+1, so k = (n1) / 2

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

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

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.





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 1 : Daily solar & wind generation over a week

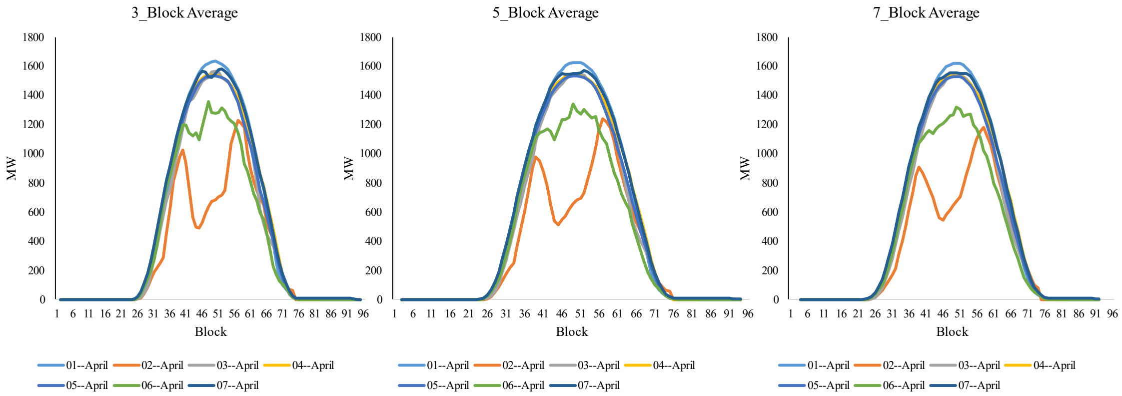


Figure 2: Block-wise moving average for daily solar generation over a week (3, 5, 7 Blocks)

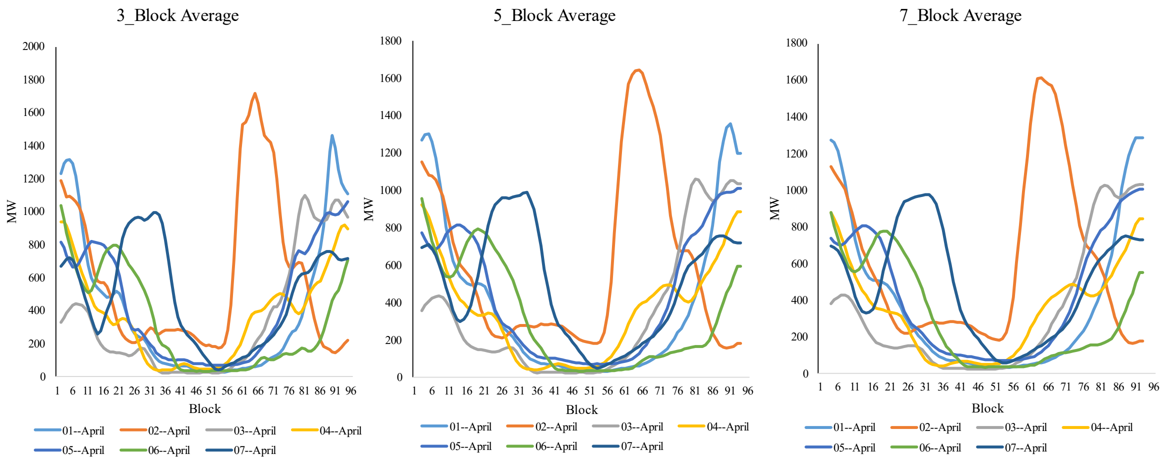


Figure 3: Block-wise moving average for daily wind generation (3, 5, 7 Blocks)

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).

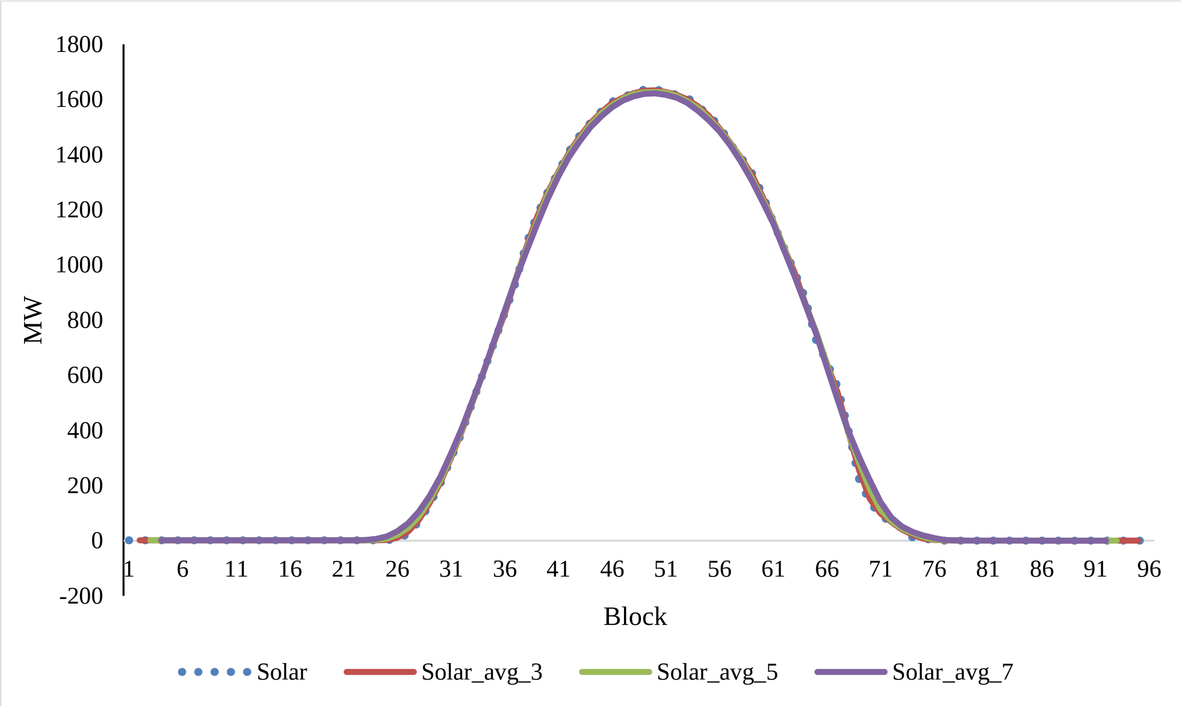


Figure 4: Block-wise solar moving average (3, 5, 7 Blocks) for day one

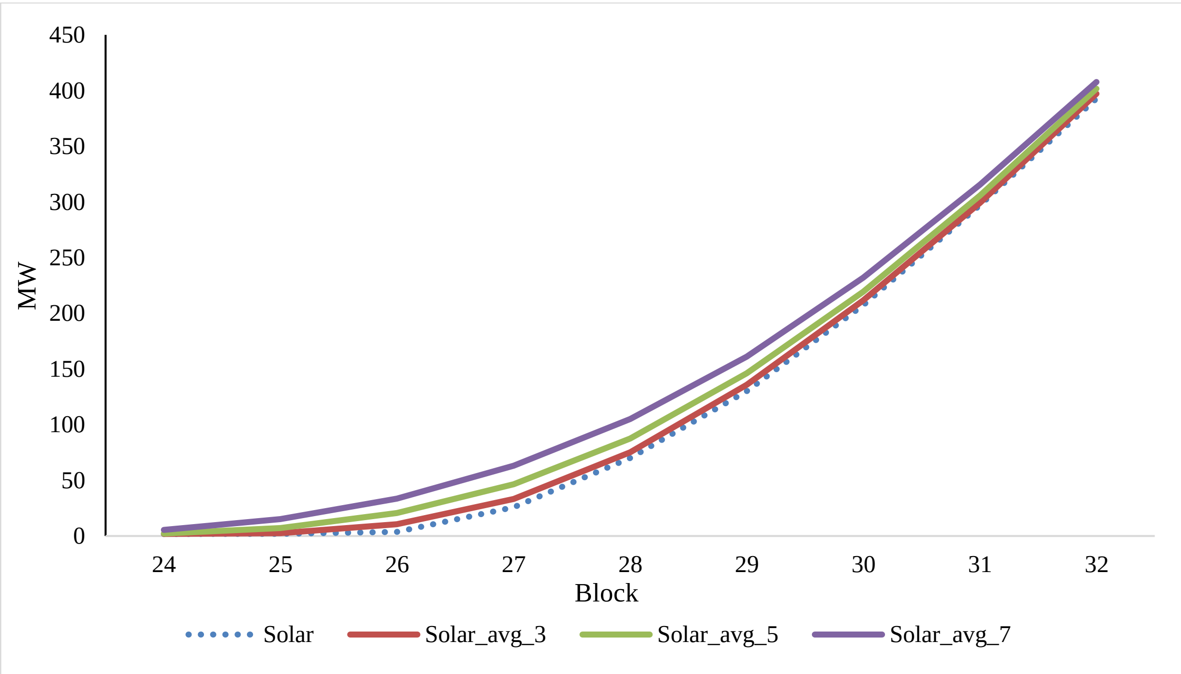


Figure 5: Block-wise solar moving average (3, 5, 7 Blocks) for block (24-32)

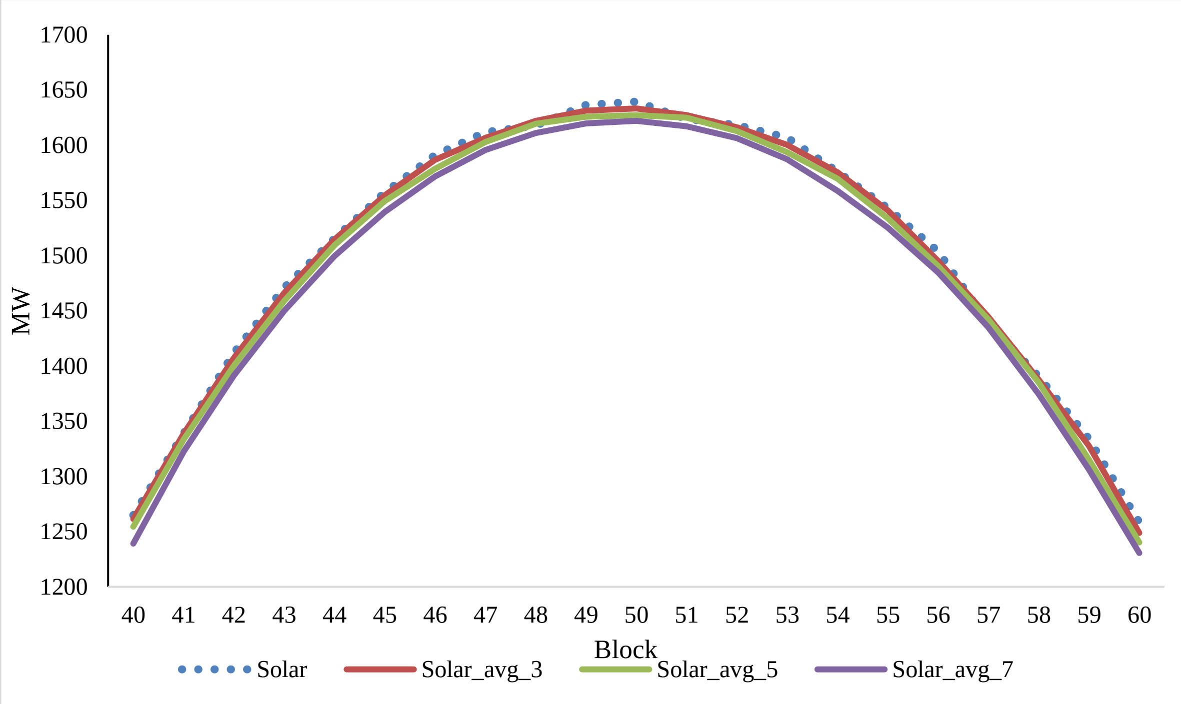


Figure 6: Block-wise solar moving average (3, 5, 7 Blocks) for block (40-60)

Limited analysis undertaken here suggests that solar variability can be addressed with shorter averaging window (3/5 blocks), whereas wind generation may 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.

4. **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 scheduled. 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.

5. **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 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 (NDM), 5-6 tropical cyclones form each year around the Indian coats. 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 unidentified 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 Metrological 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.**

6. **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 is 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.