

Powering India's solar future through household demand flexibility

Domestic consumers will account for ~31% of India's electricity demand in 2031-32 but have limited avenues to contribute to the country's clean energy shift. The Ministry of Power's Electricity (Rights of Consumers) Amendment Rules, 2023 on solar-hour time of day tariff brings domestic consumers under its ambit and is set to take effect from April 1, 2025.

If implemented effectively, this shift could empower households to actively participate in India's clean energy transition journey. This paper attempts to analyse the implication of this Rule in business-as-usual scenarios and provide the recommendations for its implementation based on the inferences drawn from the analysis.

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About Ember

Ember is an independent, not-for-profit energy think tank that aims to shift the world to clean electricity using data. It gathers, curates and analyses data on the global power sector and its impact on the climate, using cutting edge technologies and making data and research as open as possible. It uses data-driven insights to shift the conversation towards high impact policies and empower other advocates to do the same. Founded in 2008 as Sandbag, it formerly focused on analysing, monitoring and reforming the EU carbon market, before rebranding as Ember in 2020. Its team of electricity analysts and other support staff are based around the world in the EU, UK, Turkey, India, China and Indonesia.

Time of day tariff is a key tool to enhance grid flexibility and stability

India's push toward high solar capacity needs flexible grid operations and from the demand side, time of day tariffs offer an effective mechanism to ease peak stress and align the demand with solar generation.

India's projected electricity requirement and peak electricity demand at an all-India level are expected to reach [2,473.7 BU and 366.4 GW by 2031-32](#) up from [1,547.78 BU and 249.9 GW in 2024-25](#). Of this, 31% of electricity requirement in 2031-32 is expected to come from the domestic consumer category.

To meet the overall demand, the [National Electricity Plan \(NEP\)-14](#) has set targets for various resources including renewable energy (RE) resources – solar and wind. With an installed capacity of [105.6 GW solar](#) as of March 2025 and projected capacity of 364.5 GW by 2031-32, solar is leading the clean energy transition in India.

However, the increasing share of variable RE in the energy mix is [now posing challenges](#) and flexibility is becoming increasingly crucial to manage the penetration of variable RE in the power system. To provide the necessary flexibility, the energy storage systems and demand response are the most sought-after solutions. Time of day (ToD) tariff structure is one such [demand response](#) mechanism that provides essential flexibility to the power system by encouraging shifts in electricity consumption patterns.

What is the time of day tariff?

ToD tariff is a pricing mechanism where electricity rates vary based on the time of use. Electricity is priced lower during off-peak hours—when supply is abundant and generation costs are low—and higher during peak hours when demand is high. The key objective of ToD tariffs is to incentivise consumers to shift their usage to off-peak periods, helping reduce grid stress and enabling better integration of renewable sources like solar energy.

Many Indian states are set to double their solar capacity by 2035 and solar-hour ToD tariffs can enable a faster uptake

Solar-hour ToD tariff is a forward-looking policy aimed at aligning electricity consumption with solar generation patterns. It is especially crucial for states with rising solar shares, in building long-term grid flexibility.

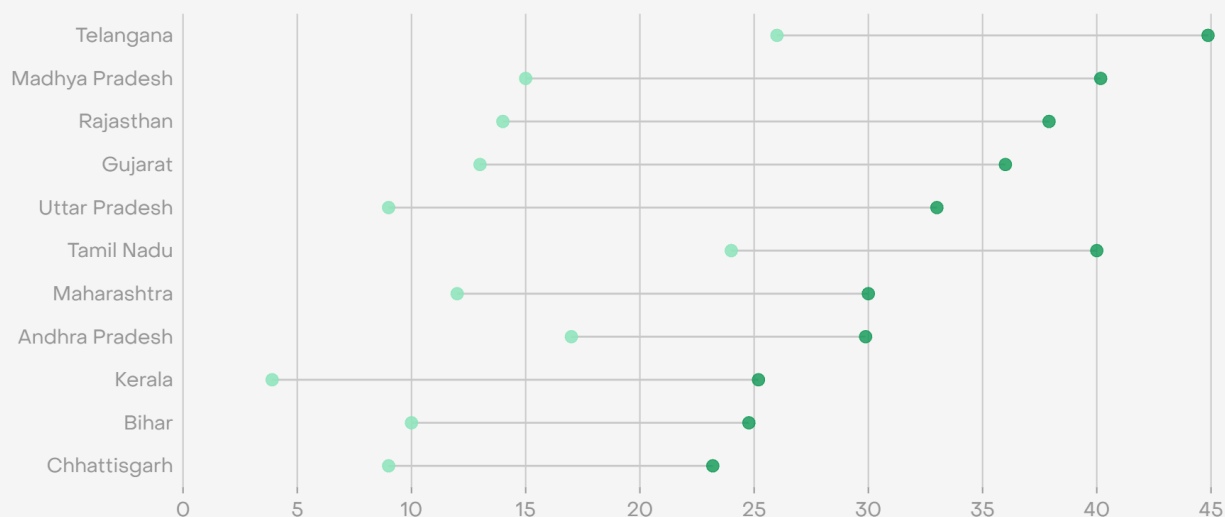
India is planning a significant expansion of non-fossil fuel-based generation capacity dominated by solar in the coming years. Although solar generation currently meets only part of daytime demand, progress toward NEP14 targets could [push daytime RE shares up to 83% by 2032](#), this share at the state level, especially in high-solar states can go even beyond 83% in some hours.

Ember's analysis based on the latest [resource adequacy study reports](#) finds that states of Telangana, Karnataka, Tamil Nadu, Andhra Pradesh, Madhya Pradesh, Rajasthan, Gujarat, and Maharashtra already have solar share in contracted capacity ranging between 10% - 26% and are expected to increase this share by 2-3x to reach [25% - 45% of their overall projected contracted capacity](#) as depicted in the following chart.

Solar capacity share is expected to be more than double in many Indian states

Solar share in contracted capacity, actual and projected (%)

● Projected (2030–35) ● Actual (2023/2024)



Source: CEA Resource adequacy study reports

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As solar is cheaper and generated during the day, aligning demand to these hours through cost-reflective pricing could benefit the consumers and enable faster solar uptake.

In June, the Ministry of Power (MoP), formally introduced a solar-hour-based ToD tariff structure to encourage efficient consumption of solar-generated electricity through the [Electricity \(Rights of Consumers\) Amendment Rules, 2023](#) (the Rule, 2023). As per the notification, ToD tariffs will apply to commercial and industrial (C&I) consumers with a maximum demand exceeding 10 kW from April 1, 2024, and to all other consumers, including domestic users (excluding agriculture), from April 1, 2025.

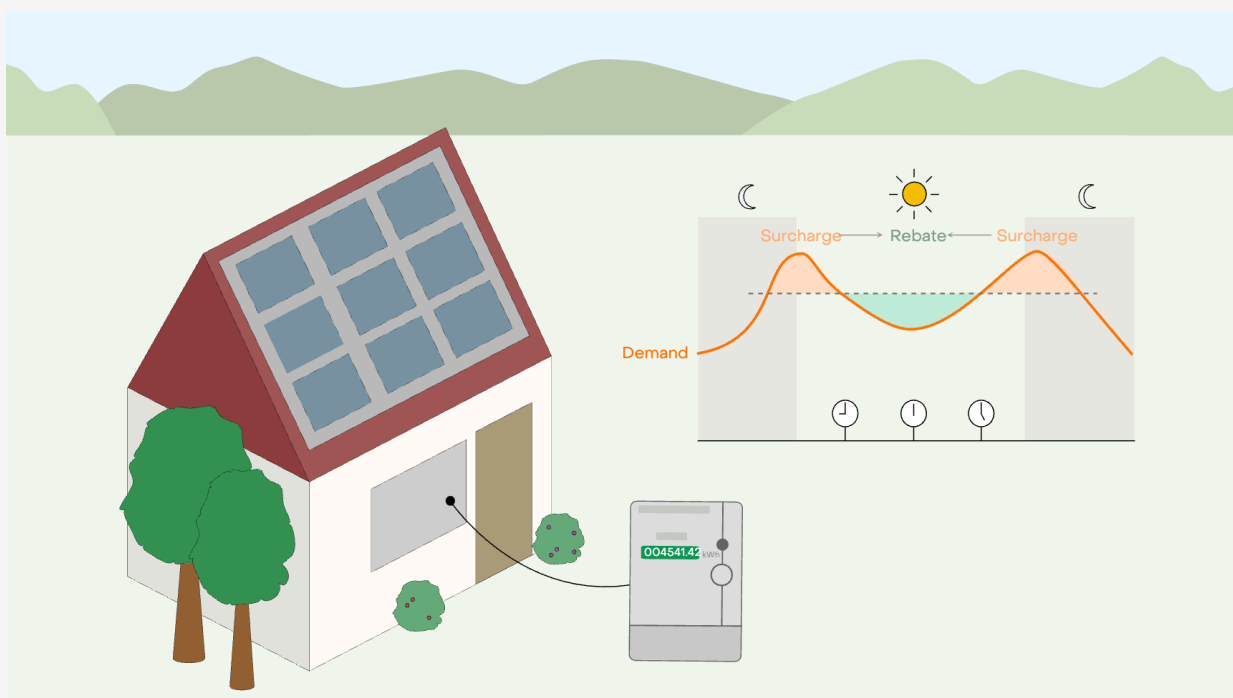
This tariff structure designates solar generation hours (typically 9 a.m. – 5 p.m.) as "solar hours or off-peak hours" and peak hours occur beyond solar hours. The Rule,

2023 also proposed a surcharge during peak hours and rebate during solar hours; during the peak hours, ToD tariff for C&I consumers should be at least 1.2 times of the normal tariff and for other consumers, the ToD tariff should be at least 1.10 times the normal tariff. Whereas in solar hours, the ToD tariff should be at least 20% lower than the normal tariff. The responsibility of defining the peak, normal and solar time slots, and ensuring that peak hours do not exceed the solar hours, lies with the state electricity regulatory commissions (SERCs).

Implementing ToD tariffs require accelerated deployment of smart metering infrastructure

As per the Rule, 2023, applicability of solar-hour ToD tariff structure depends on the adoption by the states with required infrastructure in place. In terms of infrastructure, installation of smart meters to study hourly consumption patterns at consumer level is crucial for successful implementation of solar-hour ToD tariff structure. However, the required infrastructure i.e. smart consumer meters that can track hourly consumption data, is yet to be deployed at scale in India. Of the total sanctioned smart consumer meters across the country, [only 10.8% have been installed as of March 2025](#).

Introducing a solar-hour time of day tariff in India could shift demand to daylight hours but smart meters are needed



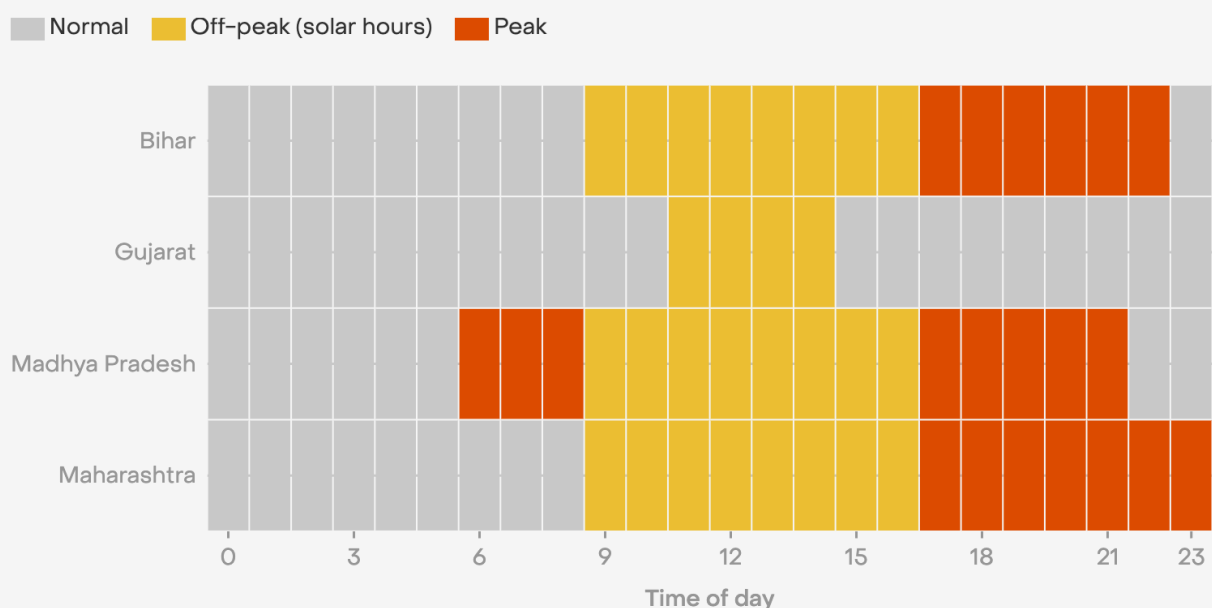
Solar-hour ToD tariff is applicable to domestic consumers from April 2025

Bihar, Gujarat, Madhya Pradesh, and Maharashtra have adopted the Rule, 2023 by including domestic consumers under the solar-hour ToD tariff structure, whereas Karnataka has deferred its implementation due to the current unavailability of surplus solar energy.

The Rule, 2023, comes into force with effect from 1 April 2025 and as of 1 April 2025, states of [Bihar](#), [Gujarat](#), [Madhya Pradesh](#) and [Maharashtra](#) have brought the domestic consumer category under the ambit of solar-hour ToD tariff structure through their retail supply tariff orders for FY 2025-26. However, the state of [Karnataka](#) has not included solar-hour ToD for this financial year as no surplus solar energy is available in the state at present.

Rebate and surcharge vary between Indian states with varying definitions of normal, peak and solar hours

Definitions as per retail supply tariff order FY 2025-26



Source: FY2025-26 Tariff orders released by State Electricity Regulatory Commissions (SERCs) as of 1 April 2025

ToD tariffs could reduce electricity bills for non-RTS consumers but may alter the payback period of RTS systems

Bihar, Madhya Pradesh, and Maharashtra have set solar hours from 9 a.m. to 5 p.m., while Gujarat has shorter solar hours from 11 a.m. to 3 p.m. Bihar and Madhya Pradesh followed the Rule, 2023, with a 20% rebate during solar hours and a 10% surcharge during peak hours. Gujarat and Maharashtra have offered a fixed rebate of INR 0.60 and INR 0.80 per unit, respectively, with no peak-hour surcharge. Notably, only Madhya Pradesh considers a morning peak and Gujarat treats all other hours as normal.

While states continue to include domestic consumers under solar-hour ToD tariff structure, it became important to understand how this rule would play out across different consumption profiles and states. We conducted an analysis to evaluate the potential impact of the new tariff structure on both non-rooftop solar (non-RTS) and rooftop solar (RTS) domestic consumers, using three representative consumption profiles.

- a. <150 units with 30% consumption between 9 a.m. – 5 p.m.
- b. <200 units with 35% consumption between 9 a.m. – 5 p.m.
- c. <300 units (30% consumption between 9 a.m. – 5 p.m.

Category 1: non-RTS consumers

Non-RTS consumers stand to benefit directly from the solar-hour ToD tariff, which offers rebates for daytime usage and surcharges during peak hours. The extent of benefit depends on the number of solar and peak hours, the level of rebate/surcharge, and consumption patterns.

- Bihar: With 8 solar and 6 peak hours and a 20% rebate and 10% surcharge, consumers can see up to 3–4% reduction in bills without shifting usage.

- Madhya Pradesh: State designates 8 hours each for solar and peak. Due to this overlap, bill reduction is lower—1–2%, even with the same rebate and surcharge levels.
- Gujarat: Provides only a 4-hour solar window (11 a.m. – 3 p.m.) with a ₹0.60/unit rebate and no surcharge. The reduced solar hour benefit reflects in the lower bill reduction of 1–2%.
- Maharashtra: Offers 8 solar and 7 peak hours, with a ₹0.80/unit rebate and no surcharge, leading to a 2–2.5% bill reduction.

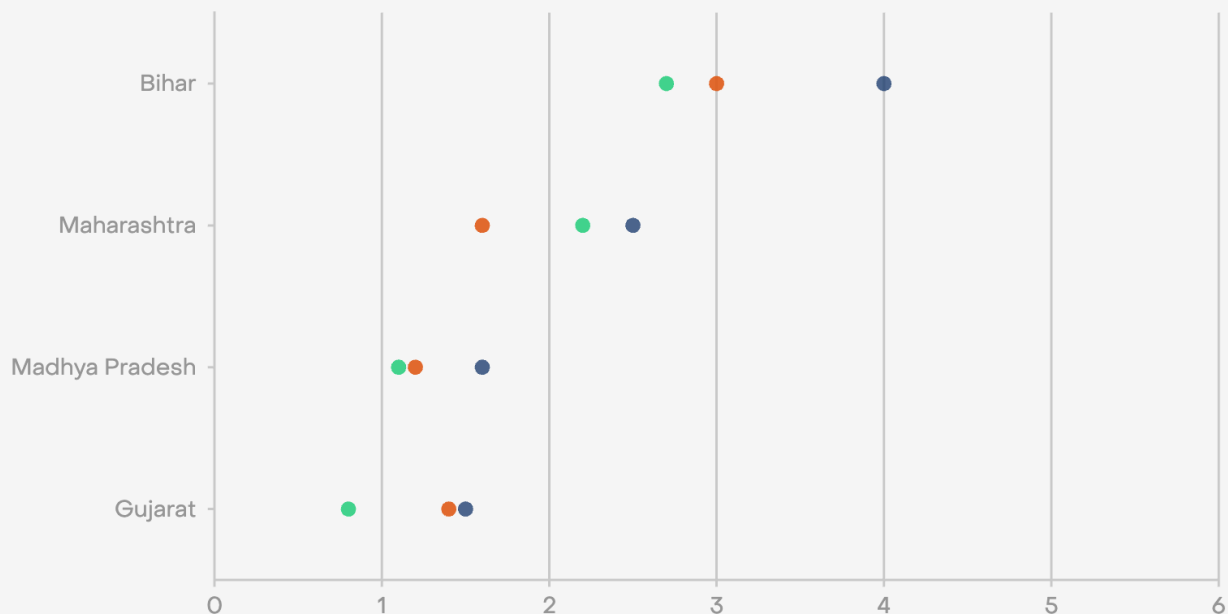
In summary, non-RTS consumers benefit the most when they have higher daytime usage, especially under policies that include broader solar-hour windows and both rebate and surcharge elements. For instance, consumers using ~200 units/month with 35% daytime usage see the highest bill reduction across states.

Indian households can reduce electricity bills by up to 4% without shifting usage, under solar-hour time of day tariffs

Savings on electricity bill (%)

Monthly consumption (units)

- <150 (30% between 9 am – 5 pm)
- <200 (35% between 9 am – 5 pm)
- <300 (30% between 9 am – 5 pm)



Source: Ember's analysis based on solar-hour ToD announced by SERCs of Bihar, Gujarat, Madhya Pradesh and Maharashtra for three different hourly consumption patterns

Category 2: RTS consumers

For RTS consumers, the ToD structure affects monthly savings and the payback period of their already installed rooftop solar systems. Since RTS systems typically meet daytime demand, the rebate often provides little to no additional value—while peak surcharges are still applicable.

- Bihar and Madhya Pradesh: Consumers benefit little from the 20% rebate (as RTS offsets daytime demand) but still face a 10% surcharge during 6–8 peak hours, reducing monthly savings and lengthening RTS system payback periods.
- Maharashtra: With no peak surcharge, the impact on savings and payback period is minimal and has a limited rebate benefit.
- Gujarat: Offers a shorter solar-hour window (11 a.m. – 3 p.m.) and has no surcharge, so overall impact is negligible, however, the rebate opportunity is further constrained.

In conclusion, RTS consumers derive limited benefit—particularly in states where solar hours are narrow or where surcharges apply during peak hours. The design of the ToD structure thus plays a critical role in shaping consumer outcomes and influencing future solar adoption and demand behaviour.

Implementing ToD tariff structure at household level would need a state-specific, seasonal, and smart meter-enabled approach

A uniform solar-hour ToD tariff structure may not suit all states due to diverse consumption and solar generation profiles. Incorporating seasonal variation and clearly defining the normal tariff are essential for effective tariff design. Accelerating smart meter deployment is a crucial next step for successful implementation of solar-hour ToD tariff structure.

1. The adoption of a uniform solar-hour ToD tariff structure, as outlined in the Rule, 2023, may not yield optimal results across all states due to variation in both consumption patterns and solar generation profiles. States, through FY 2025-26 tariff orders, have already demonstrated this diversity by differing rebate and surcharge, as well as designated solar and peak hour windows. Therefore, it is expected that the SERCs will have to tailor the implementation of the solar-hour ToD structure to reflect local demand and solar generation profiles.
2. It is observed that hourly electricity consumption patterns at household level vary across months due to seasonal shifts in demand. As a result, the solar-hour ToD tariff structure will eventually need to incorporate seasonality in its design, particularly in determining rebates and surcharges.

3. Currently, domestic tariffs are based on total monthly consumption (volumetric-only rates) rather than hourly usage, creating ambiguity around normal tariff benchmarks in ToD pricing. Similar to other consumer categories, solar-hour ToD tariff structure for domestic consumers will benefit from a clear definition of the "normal tariff".
4. Applying solar-hour-based ToD tariffs to RTS consumers may introduce unnecessary complexity. The peak-hour surcharge under the ToD structure adds an additional cost burden, while the benefit from solar-hour rebates remains minimal for these consumers. Keeping the solar-hour ToD tariff structure distinct from RTS installations would provide consumers with greater flexibility to choose the most appropriate option—particularly benefiting those without access to rooftops for solar deployment.
5. Accelerating smart meter deployment for effective ToD implementation: To unlock full potential of solar-hour-based ToD tariffs, states must accelerate the deployment of smart consumer meters which are capable of tracking hourly consumption data.

Supporting information

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Methodology

To capture the implications of the Rule, 2023 on different electricity consumption patterns, three distinct domestic demand profiles synthesised using electricity consumption data provided by [Prayas Energy Group under its eMARC initiative](#), were studied. However, these profiles may not comprehensively represent the diversity of electricity usage across India due to significant regional variations in climate, seasonal weather patterns, and diurnal variations. Factors such as temperature fluctuations, household appliance usage, and regional lifestyle differences further influence the electricity demand.

For analysis, retail supply tariff orders of Bihar, Gujarat, Maharashtra and Madhya Pradesh were referred to gather details such as domestic category tariff slabs, ToD structure, rebates and surcharges.

To analyse the change in the electricity bill of non-RTS consumers, electricity bills are calculated with solar hour rebate and peak hour surcharge for each state and then compared with bills generated under existing tariff structure. For RTS consumers, changes in savings with reference to bills generated with a RTS system under existing tariff regime were calculated to understand the change in payback periods.