

Enabling a Consumer-centric Smart Metering Transition in India

Insights from a Survey of Six States

Shalu Agrawal, Sunil Mani, Simran Kalra,
Bharat Sharma, and Kanika Balani

Report | March 2023





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ceew.in



A smart meter installation is the first step when consumers interact with the technology. More than 90 per cent of consumers in our sample were satisfied with installation practices followed by the discoms.

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We identified smart-metered consumers for the survey, after visually verifying that their electricity meters have the word 'smart meter' written on them.

Foreword

India's power sector has made great strides over the years, by evolving from deficit to power surplus, achieving one-nation one-grid, and ensuring universal access to electricity. The sector is a key driver of the country's economy and its digitisation would further act as a catalyst on this journey. Various new technologies are paving their way into the distribution space, with focus on enhancing operational efficiency and driving business sustainability, with smart metering expected to act as the backbone and gateway for nurturing ground-breaking initiatives in the sector.

The Revamped Distribution Sector Scheme (RDSS) introduced by the Government of India aims to install 250 million smart prepaid meters by 2025-26 across the country. This vision would aid power discoms in enhancing their operational efficiency through improved billing and revenue collection processes, while also allowing customers to monitor and manage their electricity consumption expenses. This would enable consumers to play an active role in the growth of the power sector, thereby, pushing discoms to revisit their traditional business operations from a consumer-centric point of view.

As the smart metering programme under RDSS is picking up steam, this study paves way for the transformational journey and sheds light on consumers' experience and outlook towards smart prepaid meters. It provides a snapshot of consumer experience starting from meter installation, to bill generation and payment. It has also identified various drivers for evaluating consumer satisfaction metrics and has assessed the effectiveness of communication channels for driving consumer engagement initiatives. Based on the findings, this study concludes with recommendations for various stakeholders across the power value chain.

I appreciate the efforts put forward by the Council on Energy, Environment and Water (CEEW) and REC Limited team for carrying out this study, with necessary support from state discoms. I believe that consumer acceptance remains a critical factor for successful roll-out of the national smart metering programme and this study provides useful measures to build consumer confidence about the technology.

I believe that this report will aid in knowledge sharing and bring forth actionable insights for power sector stakeholders, including policymakers and regulators. It also brings out the understanding on beneficiary's perspective and satisfaction levels with service delivery, thereby placing consumers at a pedestal for the growth of the power sector.



R. Lakshmanan

Former Executive Director, REC Ltd.; presently Joint Secretary,
Ministry of Ports, Shipping and Waterways



We provided a thorough training to all the survey enumerators involving classroom discussions of the questionnaire, role-play exercises, and mock surveys in the field. CEEW's Simran Kalra at Indore doing a mock survey with enumerators, in Nov 2022

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Many electricity users acknowledge improvement in billing and payment after switching to smart meters.

Executive summary

In 2020, the Government of India unveiled the Revamped Distribution Sector Scheme (RDSS), focused on the financial turnaround of discoms. One of the scheme's components aims to replace 250 million conventional electricity meters with smart prepaid meters by 2025–26. The thrust for smart meter deployment is linked to their role in helping power distribution companies (discoms) improve their billing and revenue collection efficiency, while also enabling consumers to track and manage their electricity consumption and expenses.

A. Smart metering in India: The need to understand consumers' perceptions and experiences

As of February, 2023, nearly 5.5 million smart meters have been deployed in the country (NSGM 2023).¹ Meeting the RDSS's target would require deployment at a rapid scale (5.6 million smart prepaid meters per month). However, switching to universal smart metering would necessitate a change in consumer behaviour concerning the receipt and payment of electricity bills. This may involve teething issues and the risk of compromising consumer trust in the technology. A granular assessment of consumer perceptions and experience with using smart meters, especially in the prepaid mode, could be instrumental

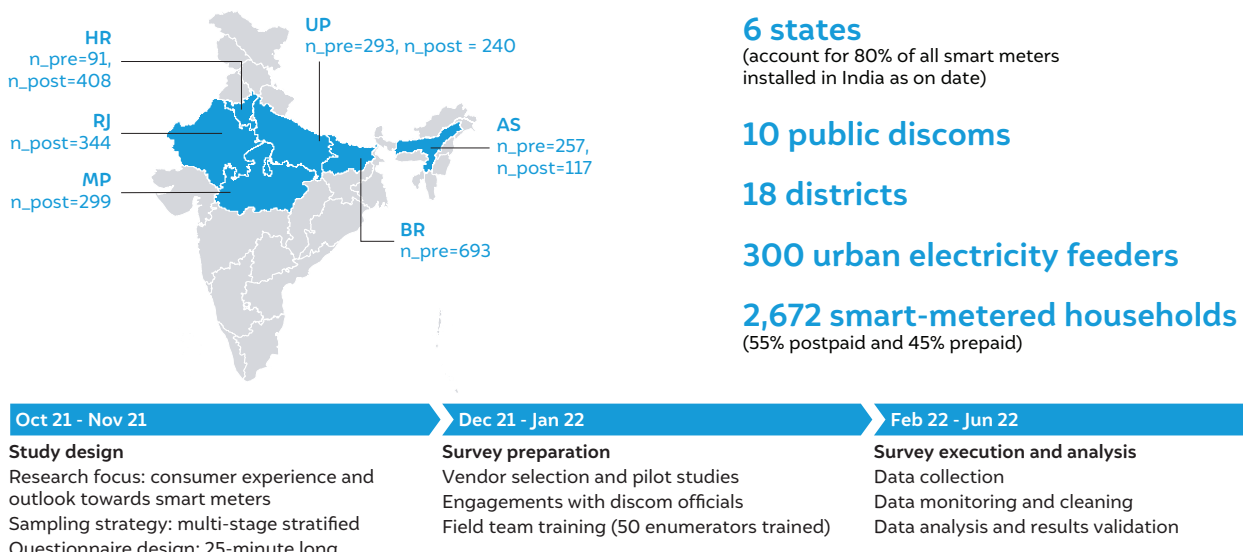
in pre-empting potential bottlenecks and ensuring the smooth transition of consumers to a new billing and payments regime.

B. Study objectives and methodology

To inform a consumer-centric deployment strategy for smart (prepaid) meters, we, the Council on Energy, Environment and Water (CEEW), conducted an independent survey of ~2,700 domestic consumers using smart meters (in the postpaid and prepaid modes). REC Limited (formerly Rural Electrification Corporation), the nodal agency for implementing the RDSS, facilitated the study by supporting engagements with discoms and helped in identifying areas with smart meter installations.

Our survey aimed to capture the consumer experience and perceived benefits of using smart meters, along with the challenges faced, if any. The survey was conducted between March and April 2022. It covered ~1,200 prepaid and ~1,500 postpaid consumers in six Indian states with the highest smart meter deployment – Assam, Bihar, Haryana, Madhya Pradesh (MP), Rajasthan, and Uttar Pradesh (UP) (Figure ES1). The surveyed consumers were sampled from 300 distribution feeders spread across 18 districts and 10 public discoms. We also interviewed relevant discom staff to understand their experiences with managing the new infrastructure.

Figure ES1 ~2,700 urban households from six Indian states were surveyed to assess their experience and outlook towards smart meters



Source: Authors' analysis

Note: n_pre: the number of prepaid consumers surveyed in the state; n_post: the number of postpaid consumers surveyed in the state.

¹ Around 28 per cent of ~5.5 million smart meters installed in the country operate in the prepaid mode (the rest operate in the postpaid mode).

C. Findings

What do consumers like about smart (prepaid) meters?

- Smooth installation experience:** The first time a consumer interacts with a smart meter is during its installation, and 92 per cent of consumers in our survey report a smooth installation experience.² Those who face difficulties (8 per cent) cite delays in meters getting connected to the discom server and incorrect wiring.
- Consumers receive bills more regularly:** Nearly 50 per cent of the surveyed consumers report improvements in billing regularity since switching to smart meters. This could be attributed to three factors: a change in billing frequency (e.g., from bimonthly to monthly in Rajasthan), getting bills on the same date every month, and the base effect (a return to regular billing after the disruptions caused by Covid). Gaps in billing regularity despite the switch to smart meters (15 per cent) are mainly due to customers' limited access to detailed bills (discussed in Section 3.2).
- Bill payment is easier and more flexible for most consumers:** Two-thirds of the surveyed consumers feel that paying bills is easier with smart meters, as they pay bills using smart meter mobile apps and in varying amounts (small/large). Around 30 per cent of prepaid users recharge more than once a month, with the highest share in UP (38 per cent), indicating the need to promote this feature more.
- Multiple perceived co-benefits:** More than a third of the surveyed consumers report co-benefits to using smart meters: a greater sense of control over electricity expenses, a drop in instances of electricity theft, and improved supply to the locality. These perceptions are linked to enhanced access to consumption/bill information and infrastructure upgrades that accompany smart metering deployment.
- Lack of access to detailed bill breakup:** Nearly 44 per cent of the surveyed consumers cannot access detailed bills; the share is higher among prepaid users and households whose income earners have relatively less education (67 per cent for households with primary income earner uneducated as compared to 30 per cent for households with primary income earner being a graduate or above). Some discoms, particularly, in Assam, Bihar, and UP, have stopped distributing (or are in the process of withdrawing) paper bills to smart meter consumers, assuming they can access bills through the smart meter app. However, due to poor digital literacy and a lack of awareness of smart meter apps, many consumers rely solely on SMS updates, which do not provide break-up of bills. As a result, the majority (70 per cent) of surveyed consumers would like to continue receiving paper bills.
- Limited awareness and use of smart meter mobile apps:** Only half of the surveyed consumers are aware of the mobile apps, and just 45 per cent use them. App usage is highest in Bihar (80 per cent), followed by Assam (47 per cent); it is, however, extremely low in Haryana (14 per cent) and MP (13 per cent). The variation across states is linked to the presence of prepaid users: app usage among prepaid users (72 per cent) is three times that among postpaid users (24 per cent).
- Some consumers face difficulties in paying bills or recharging:** Nearly 12 per cent of consumers report that paying bills has become difficult since the switch to smart meters for multiple reasons: fear of disconnection upon failing to recharge in time, cash flow issues, and barriers to digital payments.
- Delays in recharging and reconnection:** A third of prepaid users had their electricity disconnected at least once when they failed to recharge on time. For a third of consumers for whom the electricity got disconnected at least once, it took more than 30 minutes to reconnect even after a successful recharge, which is a cause for concern.

What are consumers' concerns about smart (prepaid) meters?

Notwithstanding the positive outlook of many consumers on smart (prepaid) meters, we encountered several issues that adversely affect the experiences of consumers with smart meters; these problems merit the close attention of discoms.

Consumers reported improvement in billing regularity and ease of making payments, after switching to smart meters.

² Discoms are deploying smart meters as part of their infrastructure upgrade exercise, which does not require consumer consent. However, when deploying prepaid smart meters, there are variations in practices across discoms. Most discoms have made the switch to prepaid smart meters optional for consumers (e.g., in Haryana, UP, and Assam), whereas some discoms (e.g., in Bihar) are deploying all smart meters in the prepaid mode.

How satisfied are consumers, and what drives their satisfaction?

- **The majority of the surveyed consumers (60 per cent) are satisfied** with their billing and payment situation, and they would recommend smart (prepaid) meters to their friends and relatives.³ There appear to be four key determinants of satisfaction: a smooth installation process, access to detailed bills, knowledge of how pending arrears are adjusted towards present/future bills, and the co-benefits of smart meters such as reduction in theft and improved quality of supply.
- **More prepaid smart meter consumers are satisfied (63 per cent) and willing to recommend the technology to others (69 per cent),** as compared to postpaid consumers (55 per cent of postpaid consumers are satisfied while 53 per cent are willing to recommend the technology to others). This difference can be explained by the fact that a higher share of prepaid consumers use smart meter apps to check their bills and consumption and have flexible payment schedules. This is important given that most discoms, barring those in Bihar, have made the prepaid mode optional.
- **Out of all postpaid smart meter users, only a few are aware of the prepaid functionality (26 per cent) and even fewer are willing to switch to it (13 per cent).** A lack of awareness of the prepaid mode, status quoism, and a fear of disconnection are the three key reasons for the limited willingness to switch. Of those who are willing, more than three-fourths believe that switching to the prepaid mode would enable more conscious and judicious use of electricity (due to daily deductions).

D. Ensuring a consumer-centric transition to smart (prepaid) meters

In view of our findings, we propose the following recommendations.

- **Discoms, along with REC Limited, should undertake sustained consumer engagement to spread awareness of the benefits and features of smart meters and their mobile apps.** Discoms should use diverse channels to reach consumers; particularly, they should encourage one-on-one interactions with consumers by the field staff installing smart meters, in addition to promoting smart meters via social media,

pamphlets, and loudspeakers. The smart meter app needs to be made available to consumers in a user-friendly format and in vernacular languages to promote ease of use. Creative video explanations in regional languages should be featured on social media such as YouTube, WhatsApp, and Facebook.

- **Discoms should continue giving paper bills and phase out their withdrawal.** Where bills have already been discontinued, consumers may be given the option to opt for paper bills.
- **Discoms should help consumers use the flexible payment feature to generate acceptance of prepaid meters.** We propose three steps: i) link the minimum recharge amount with the consumption level – high minimum recharge amounts (e.g., INR 500 in Haryana) may constrain low-consumption households from making partial payments; ii) waive any additional fee (convenience charge) associated with recharging or making digital payments and give rebates to prepaid users; and iii) educate consumers about these benefits, the applicable tariff structure, and the bill deduction process.
- **Discoms should send out timely alerts and facilitate a smooth recharge experience to dispel the fear of disconnection among prepaid consumers.** They may consider four steps: i) regularly update discom records with consumers' mobile numbers and send multiple notifications/SMS upon exhaustion of the recharge amount (e.g., when there is five days' worth remaining); ii) have generous 'happy hours/days' when no disconnection happens and inform consumers of these times; iii) ensure timely reconnection following recharge through the strict enforcement of advanced metering infrastructure service provider (AMISP) contracts; and iv) facilitate innovative offline payment modes like mobile ATMs and e-wallets operated by neighbourhood shopkeepers or women's self-help groups (SHGs), especially in areas with poor mobile network connectivity.

The smart meter transition should include consumers as important allies by making consumer-friendly policies and carrying out sustained engagement with them.

³ Although discoms do not seek consumer consent when replacing conventional meters with smart meters, consumer satisfaction and willingness to recommend the product are important to building social acceptance for this technological transition.

- **State electricity regulators should issue smart (prepaid) meter guidelines to ensure a uniform consumer experience.** Currently, provisions for smart meters are scattered across different regulatory orders and directives, which makes them inaccessible to key stakeholders, especially consumers who are often unaware of key provisions such as rebates or specified disconnection hours. Dedicated smart meter guidelines in each state for meter installation and charges, billing, recharge, payments, and rebates would help ensure a smooth consumer experience.
- **REC Limited must facilitate cross-learning and the sharing of best practices among discoms.** Both the survey findings and our interactions with discom staff during field visits indicate several opportunities for cross-learning between states. For instance, Assam has the highest share of consumers who are satisfied and feel that smart (prepaid) meters have enabled greater control over electricity expenses. Bihar reports the most awareness and uptake of the smart meter app, partly because of the intensive consumer engagement efforts by discoms. More than half of the smart meter users in MP claim that electricity theft has reduced; this is partly because discoms leverage smart meter data for vigilance activities.
- **End-to-end ownership of the smart meter programme by discom leadership.** Our study suggests that the success of the smart meter rollout is closely linked to the involvement of discom officials across the hierarchy with smart metering service providers and consumers during the on-ground implementation. The proactive participation of state governments and end-to-end ownership of the smart meter rollout efforts by top management in the discoms are critical to India's vision to digitise the power distribution infrastructure and to paving the way for the clean energy transition.

1. Introduction

At the 26th session of the Conference of the Parties (COP 26), India committed to an accelerated energy transition and to achieving net-zero carbon emissions by 2070 (MoEFCC 2022). Ensuring financial sustainability of electricity distribution companies (discoms), promoting efficient electricity use, and managing the rising electricity demand effectively are key to a successful energy transition. Advanced metering infrastructure (AMI) comprising smart electricity meters and related components can help achieve these objectives.

Smart meters can enable real-time demand and supply monitoring, pre-emptive network maintenance, and the implementation of time-varying tariffs. They can also help discoms improve the billing and revenue collection efficiency, with features such as timely and accurate billing without manual intervention, remote disconnection following the non-payment of bills, or the supply of electricity in the prepaid mode (Box 1).

To capitalise on the advantages that smart meters offer, the Government of India plans to support the replacement of 250 million conventional meters with smart prepaid meters by March 2025, under the Revamped Distribution Sector Scheme (RDSS). The scheme aims to improve the overall financial sustainability of discoms and to bring their aggregate commercial and technical losses (AT&C) below 15 per cent by 2025 (Ministry of Power 2022). As of February 2023, close to 5.5 million smart meters have been installed, while a much larger number of 105 million smart meters are sanctioned (NSGM 2023). Nearly 28 per cent of the installed meters are working in prepaid mode, and more than 85 per cent of these are installed in Bihar.

Box 1 What is a smart meter?



Image: Shalu Agrawal/CEEW

In addition to the general functionalities of conventional meters, smart electricity meters have a module which allows two-way communication between the consumer and discom.

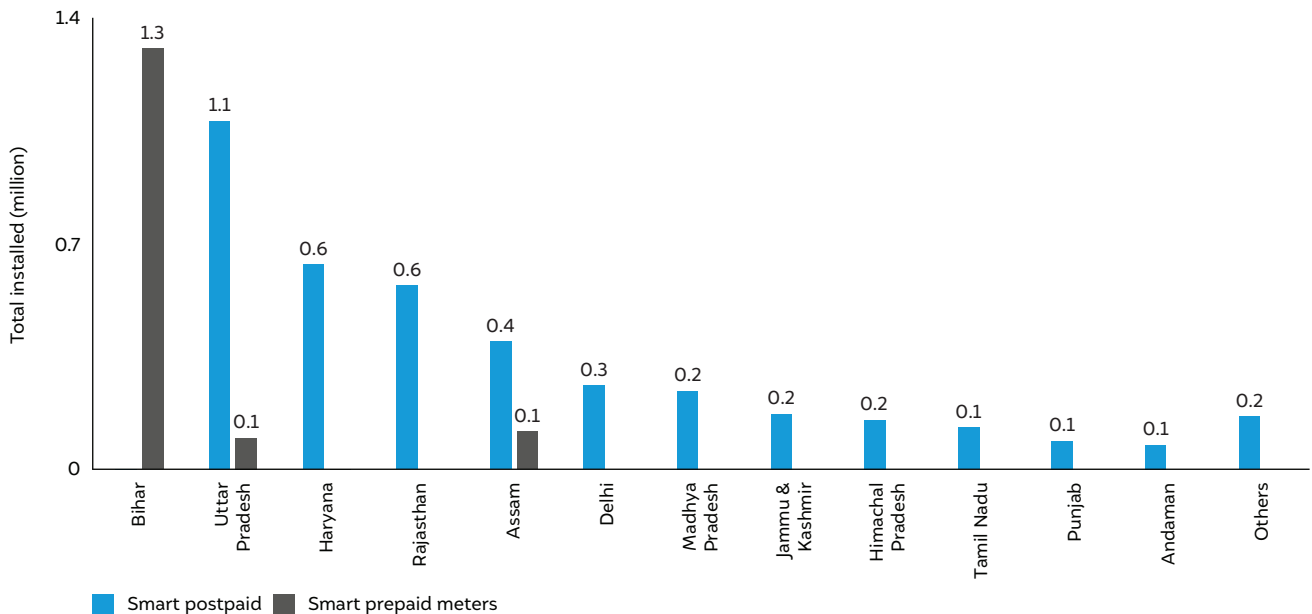
Smart meters can enable discoms to

- regularly observe electricity consumption and supply parameters in real time at the user end (e.g., every 15 or 30 minutes).
- remotely control meter operations (such as connection, disconnection, reconnection, limiting load, etc.), and automate them.
- supply power on a prepaid or postpaid basis.
- implement net metering, time-of-day tariff, and demand–response features.

The high-frequency data provided by smart meters can help discoms improve the accuracy and periodicity of their billing operations. Further, targeted vigilance activities and infrastructure upgrades based on energy auditing can help to curb electricity theft and leakages. Granular insight into consumption patterns can also help discoms undertake demand forecasting and to plan with greater precision.

Source: Authors' compilation

Figure 1 India has nearly 5.5 million smart meters installed, of which 97% are deployed in 12 states and union territories, and 27.7% operate in the prepaid mode



Source: Authors' compilation of data from NSGM (2023)

Note: Others include Andhra Pradesh, Chandigarh, Gujarat, Karnataka, Kerala, Odisha, Puducherry, Telangana, West Bengal, and Tripura.

To ensure a smooth universal transition to smart meter-enabled systems, we must learn from the experiences, challenges, and good practices of smart metering programmes in various states. This is imperative for two reasons. First, a switch to smart prepaid meters necessitates a change in consumer behaviour in the receipt and payment of electricity bills. Second, meeting the scheme's target requires deployment at a rapid rate (5.6 million smart prepaid meters per month), which may present teething issues and the risk of denting consumers' trust in the technology.

As per a nationwide survey conducted in 2020, 90 per cent of Indian households were not aware of the existence of prepaid meters, but those aware were inclined to adopt it (Agrawal et al. 2020). Besides the gap in awareness, smart meter consumers from various states report multiple issues: inflated electricity bills, widespread disconnections, and sub-optimal technology (Dhankhar and Behl 2021; Jha 2020; Hindustan Times 2021). Notwithstanding these claims, the evidence on consumers' experiences with the use of smart meters is rather limited.

We aim to fill this gap by delving into consumers' perceptions and experiences of using smart meters (in both the postpaid and prepaid modes), with the help of a primary survey, and to answer the following questions:

- What experiences have consumers had with smart meter installations, the associated billing processes, and payment mechanisms?
- What are consumers' practices and preferences while using smart meters in the prepaid mode?
- How do consumers' satisfaction levels and acceptance of smart metering technology differ across states, and what are the key driving factors?
- Based on the best practices and challenges observed, how can discoms in India learn from each other to ensure smooth smart meter deployment for potential consumers?

This paper is organised as follows. Chapter 2 describes the study design and methodology. Chapter 3 highlights experiences of smart meter consumers with meter installation, billing, payment, and smart meter apps. Chapter 4 delves into overall satisfaction among

consumers with smart meters. Chapter 5 deals with the mode of information delivery that smart meter consumers prefer and implications for future communication strategies, when smart meters are deployed at scale. In Chapter 6, we synthesise the key findings and provide recommendations for building a consumer-friendly smart metering infrastructure in the country.

2. Methodology

To understand consumer outlook on smart meters, we conducted a perception survey of 2,672 smart meter users from six Indian states. The six states – Assam, Bihar, Haryana, Madhya Pradesh (MP), Rajasthan, and Uttar Pradesh (UP) – together account for ~80 per cent of all smart meters (and 100 per cent of all smart prepaid meters) installed in India (Figure 1). The survey covered urban domestic electricity consumers who had used smart meters in the postpaid (1,478) or prepaid mode (1,194) for four or more months.

2.1 Multistage stratified strategy to sample smart meter consumers

In order to capture the diversity of consumer experiences, we employed a multistage stratified strategy to sample households from 10 discoms in 6 Indian states (Table 1). We sampled two to four circles from each discom, and two to four subdivisions from each circle, depending on the spread of smart postpaid meter and smart prepaid meter consumers.⁴ From each subdivision, we selected 5 feeders with support from subdivision offices and 10 domestic users with smart meters from each feeder.⁵ The survey included circles, subdivisions, and feeders with a high penetration of smart meters (50 per cent and above) and consumers who had been using smart meters for at least four months.

Though our survey included consumers from diverse socio-economic backgrounds and a wide distribution network, the sample is not statistically representative of all smart metered households. This is because a properly randomised sampling strategy requires a stable population base. However, smart meter installation is an ongoing process.

⁴ We obtained data from discoms on the number of smart meter consumers until the subdivision level, which was facilitated by REC Ltd.

⁵ We received support from discom officials (executive engineers, subdivision officers, junior engineers, and linesmen) to locate feeders with high smart meter penetration from the selected subdivisions.

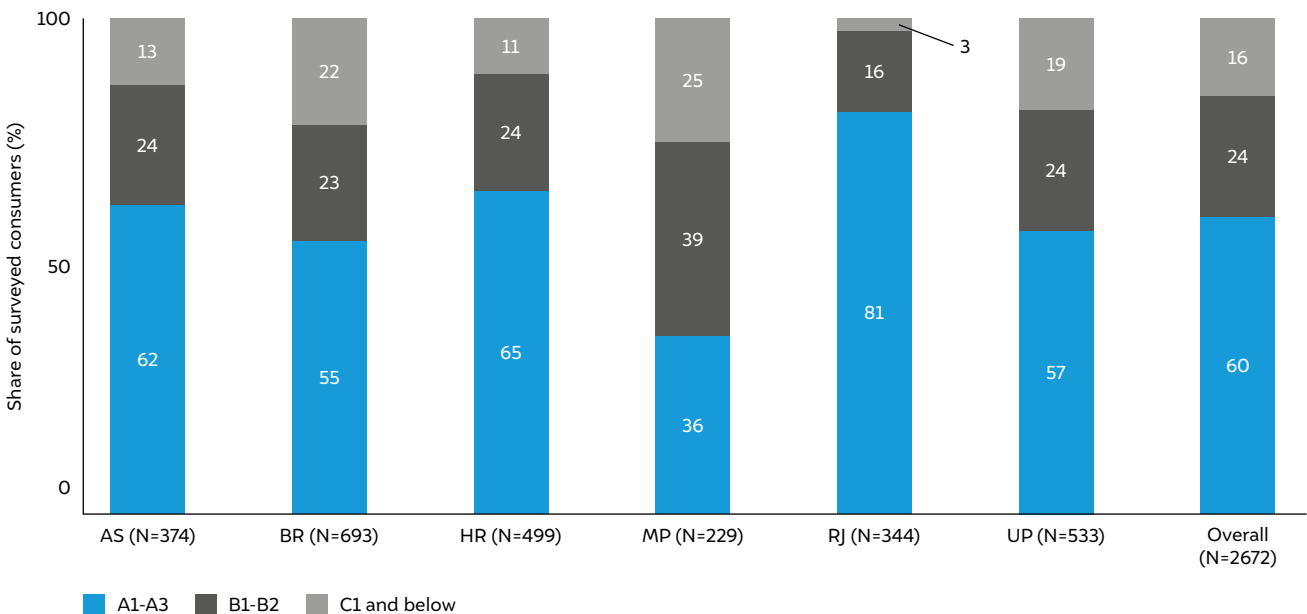
Table 1 This study employed multistage stratified sampling to survey smart meter consumers

6 states	10 discoms	18 districts	56 subdivisions	300 feeders	Survey sample			
					Planned sample (3,000)		Achieved sample (2,672)	
					1,600 postpaid users	1,400 prepaid users	1,478 postpaid users	1,194 prepaid users
Assam	APDCL	Kamrup Metro	4	30	200	100	257	117
Bihar	SBPDCL	Patna	8	40				
	NBPDCL	Begusarai, East Champaran, Samastipur, Vaishali	8	40	–	800	–	693
Haryana	UHVBNL	Panchkula, Panipat and Karnal	6	30	400	100	408	91
	DHVBNL	Gurugram	4	20				
Madhya Pradesh	MPPKVVCL (MP West)	Khargone, Mhow and Ratlam	4	20	200	–	229	–
Rajasthan	JVVNL	Jaipur and Bharatpur	4	20	400	–	344	–
	JdVNNL	Jodhpur	4	20				
Uttar Pradesh	MVVNL	Lucknow	8	40	400	400	240	293
	KESCO	Kanpur	6	40				

Source: Authors' compilation

Note: In Bihar, all smart meters are being installed in the prepaid mode and, in MP and Rajasthan, all smart meters are being installed in the postpaid mode. In some states, we could not survey the planned number of consumers due to logistical issues.

Figure 2 60% of the surveyed households belong to A1–A3 SEC category



Source: Authors' analysis

2.2 Questionnaire design

We designed a structured questionnaire to capture consumer outlook on smart meters, as well as socio-economic and demographic details. The survey instrument included questions about consumer awareness levels regarding smart(prepaid) meters; experiences with smart meter installation, using the smart meter mobile app, billing, and bill payments (recharge in the case of prepaid meters); preferences for the type of electricity bill (digital or paper); and overall outlook and benefits and challenges associated with using smart meters. We also looked into postpaid consumers’ willingness to switch to the prepaid mode. We tried to understand consumers’ media consumption patterns to identify the right mediums through which to engage with existing and potential consumers.

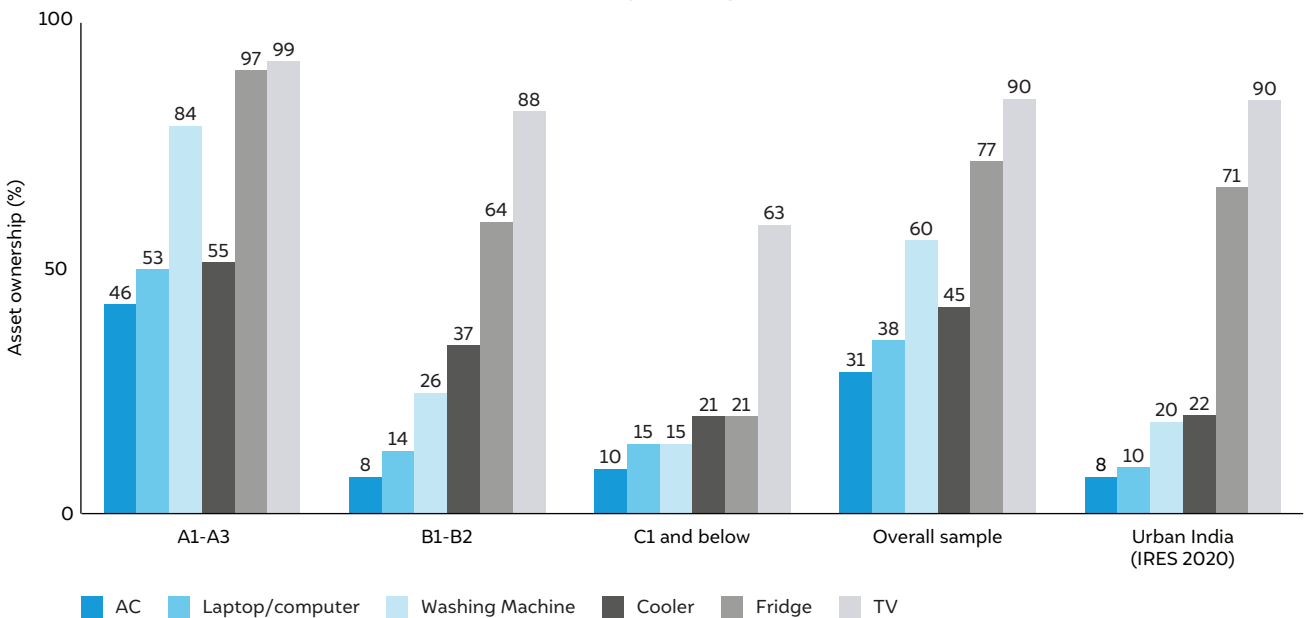
2.3 Understanding the sample composition

To understand the composition of our sample, we used the new socio-economic classification (SEC) system developed by the Market Research Society of India (MRSI 2011). Under this system, two variables – education level of the chief earner and the number of durables – are used to classify households into 12 grades ranging from A1 to E3, with the variable values declining from A1 onwards (see Annexure 1 for details).

Figure 2 shows the socio-economic composition of the sample as a whole and for each state covered. The sample comprises households from diverse socio-economic groups. However, more than 60 per cent of the surveyed consumers belong to wealthier categories (Figure 2). Figure 3 illustrates how consumers from various socio-economic categories differ in terms of asset ownership, and how they compare with an average urban Indian household (using data from the India Residential Energy Survey (IRES) 2020 conducted by Agrawal et al. [2021]).

The predominance of wealthier households in our survey sample reflects how smart metering drives have so far been concentrated in major urban centres. We also found a significant variation in consumers’ socio-economic profiles across states (Figure 2), depending on the deployment strategies followed by the discoms. For instance, in MP, the immediate objective of smart meter installation was to curb electricity theft and the associated losses. Therefore, discoms prioritised deployment in high loss areas (mostly comprising poorer consumers with relatively lower capacity to pay for electricity). In Rajasthan, discoms had focused on those with high consumption for smart meter installations (in line with instructions under the Ujwal DISCOM Assurance Yojana (UDAY) scheme).

Figure 3 Surveved consumers have high asset ownership as compared to national levels



Source: Authors’ analysis

Note: In order to get the comparative figures on asset ownership for urban India, we use IRES 2020 data conducted by Agrawal et al. (2021). However, since the sources of data (and the sampling strategies employed) are distinct, the comparison should only be seen as indicative.

2.4 Qualitative interviews with discom staff

We interviewed discom officials from the six states, including executive engineers, subdivision officers, junior engineers, linesmen, and contractual staff involved in smart meter installations. First, we spoke to them during field visits and pilot studies to understand their strategies for deployment and consumer engagement. These interactions provided us with significant inputs to develop the survey questionnaire. Once we completed the field survey of consumers, we interviewed discom staff during the analysis stage to validate key findings from the survey.

2.5 Study limitations

Even though we followed due diligence while designing the study, during data collection and analysis, we cannot completely rule out the possibility that biases common to primary survey processes affected our results. More importantly, we would like to acknowledge two key limitations of this study. One, while our findings indicate broad trends, the patterns are not statistically representative of the entire population of smart metered consumers. This is mainly because the smart meter consumer base is unevenly dispersed and growing fast. Second, our sample composition is skewed towards wealthier urban households, which further limits the generalisability of the results. Smart meter deployment is happening in phases and, in the initial waves, households with higher consumption in urban areas were/are being targeted. Thus, the study's findings do not reflect the experiences, outlook, and difficulties (nature and extent) of low-income households in small towns and rural areas.

Discom staff from the six states were interviewed to gain the necessary context and perspective.

3. Understanding consumers' experiences with smart (prepaid) meters

We break down consumers' experiences with smart meters into three phases: meter installation, bill generation, and bill payment. We also discuss whether smart meter consumers are able to realise other potential co-benefits from the technology.

3.1 Installation experience

The first interaction that a consumer has with the smart meter technology is during its installation. Around 92 per cent of the surveyed consumers report that they found the installation process smooth and did not face any inconvenience. Those who did face difficulties (8 per cent) report issues such as delays in meters coming online and incorrect wiring (making electrical faults more likely). This share varies marginally across states, with consumers in Bihar, UP, and MP making the highest number of complaints (Figure 4). We also observe that prepaid users had more issues than postpaid users during the installation.

During our field visit to the Madanpura subdivision in Haryana, in an apartment complex of 250 households, we found that there was incorrect wiring⁶ for 8 consumers. While the discom staff promptly resolved the issue, the incident underscores the need to effectively train the ground staff of smart meter deployment agencies⁷ to ensure smooth experiences for consumers from the initial stages.

3.2 Billing experience

The most important stage, when consumers start making an informed opinion about the smart meter technology, is when they start receiving their electricity bills. The regular receipt of detailed bills⁸ can go a long way in building trust among consumers. Nearly 50 per cent of the surveyed consumers reported improvements in the regularity of billing after switching from conventional meters to smart meters (Figure 5).

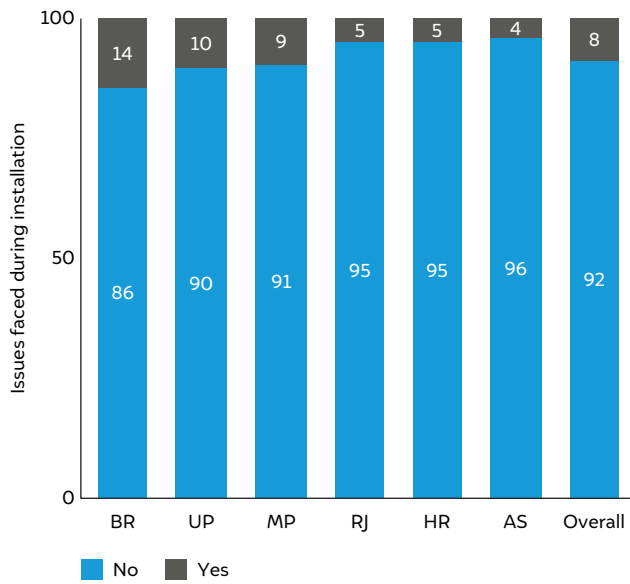
6 By 'incorrect wiring' we mean that the wiring was not properly done for a meter. In some instances, the wires were connected to the wrong meter, so the wrong consumer was tagged for the given meter.

7 Discoms hire an advanced metering infrastructure service provider (AMISP) which deploys smart meters and communication modules.

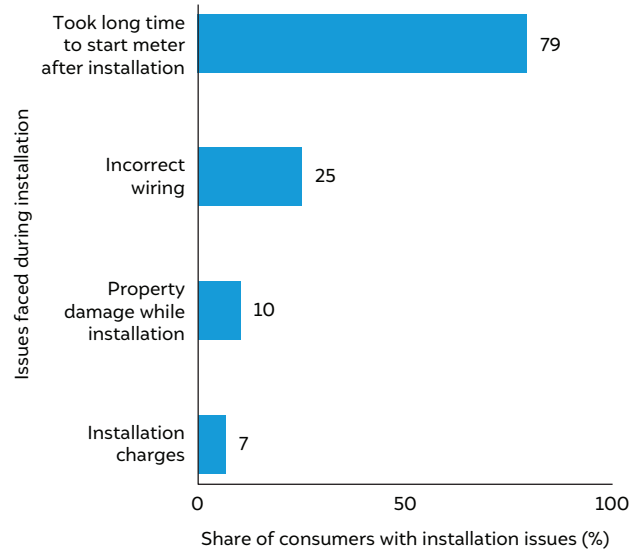
8 By 'detailed' bills, we mean a complete bill with reading date, consumed units, and the breakup of charges (including arrears, maximum demand, fixed charges, energy charges, meter rent, etc.) This information can be obtained in either paper or digital mode (using the smart meter app).

Figure 4 More than 90% of consumers did not face any issues during installation

Faced any issues during installation?



Source: Authors' analysis



Note: The sum is greater than 100 per cent as respondents selected multiple options.

These improvements could be for three key reasons:

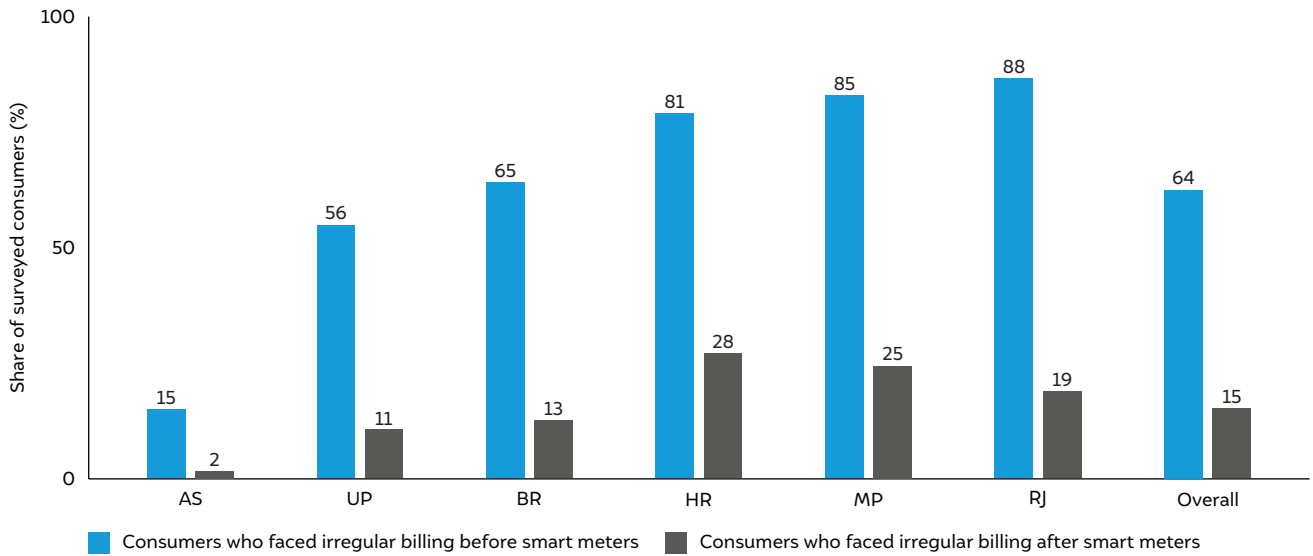
- Change in billing frequency:** For all smart meter consumers, bill generation takes place once every month. This is a significant improvement in billing frequency for consumers who earlier received bills once in two months (e.g., Rajasthan has bimonthly billing systems and Haryana is transitioning from bimonthly to a monthly billing system), or at an uncertain frequency. As per Agrawal et al. (2020), nearly 40 per cent of households (urban and rural) in Bihar and UP did not receive bills every month, as required by the state electricity regulations; this share was 28 per cent in Assam and 17 per cent in MP.
- Bill generation date:** For smart meter consumers, bills generation happens remotely and automatically on a fixed date each month. This is not the case with conventional meters – the bill generation date varies significantly depending on when meter readers can visit the consumer's premises and take a manual meter reading.
- Base effect:** During the Covid-19 pandemic, many consumers either did not receive their electricity bills or received them irregularly, due to lockdowns and social distancing-related restrictions. From our interactions with a few discom officials during our field pilot studies, we gathered that such issues could not be resolved in many regions even after the

restrictions were lifted. This significantly reduced the share of households receiving regular electricity bills. However, the switch to smart meters immediately addressed this gap, leading to a positive perception of billing regularity among consumers.

Even though the billing situation improved for most, 15 per cent of the surveyed consumers report some issues with billing regularity, despite the shift to smart meters. This share is higher among postpaid users (18 per cent) as compared to prepaid users (11 per cent). We find that more than half of these consumers cannot access detailed electricity bills. In fact, nearly 44 per cent of all surveyed consumers report that they cannot access detailed bills, and rely on SMS to get the billed amount (Figure 5b).⁹ This is because many discoms stopped distributing paper bills to smart meter consumers, on the assumption that these consumers can access bills using the smart meter app. However, there are gaps in the uptake of smart meter apps (see the next section). As a result, majority (70 per cent) of the surveyed consumers would like to continue receiving paper bills, if given the option. This preference is more prevalent among households from lower socio-economic backgrounds, who are less likely to access digital bills because of gaps in digital literacy (Figure 5c). Consumers prefer paper bills, which are easy to understand and serve as important documentation (for instance, as address proof).

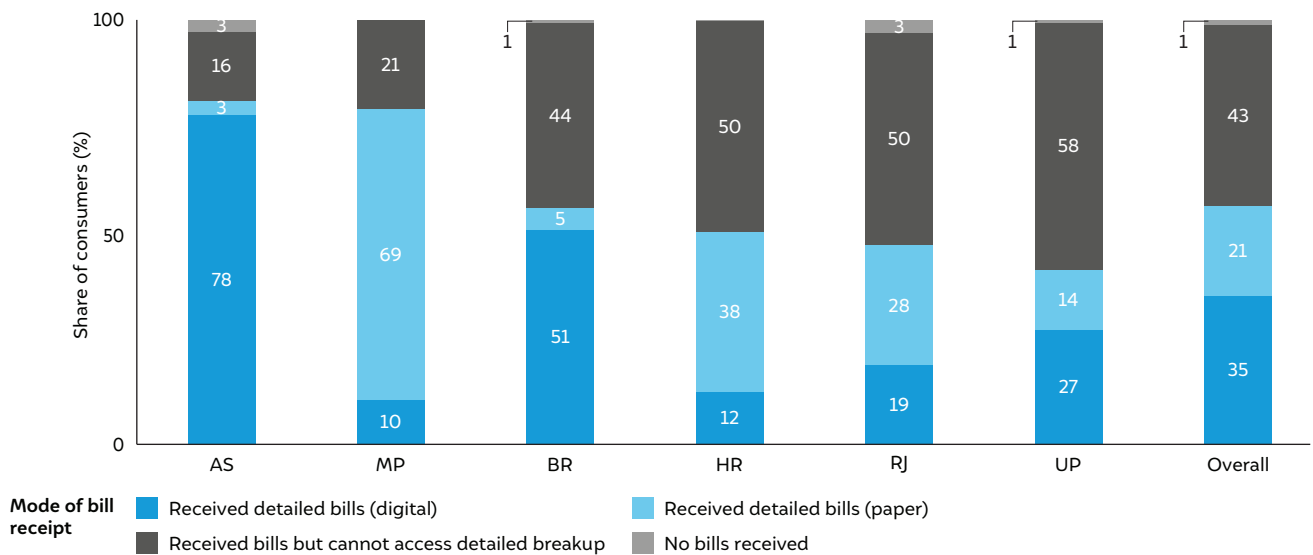
⁹ SMS may not display the detailed breakup of the bill. However, the detailed bill is provided in the smart meter app.

Figure 5a Nearly half of the surveyed consumers find that smart meters have improved the billing frequency



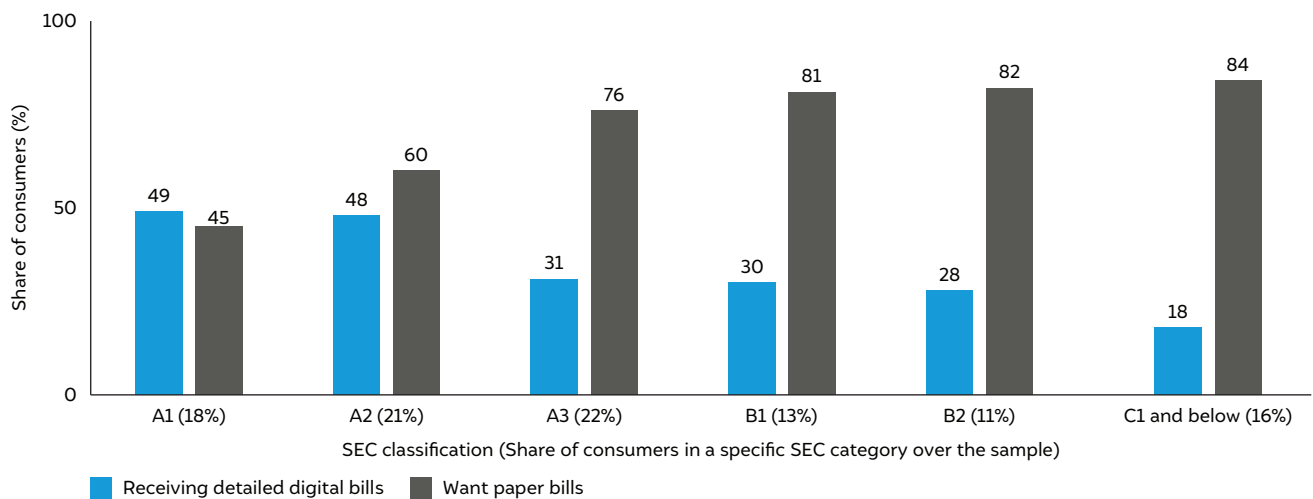
Source: Authors' analysis

Figure 5b Nearly half of the surveyed consumers could not access a detailed breakup of their electricity bill



Source: Authors' analysis

Figure 5c Majority of consumers in lower socio-economic categories want paper bills due to limited access to digital bills



Source: Authors' analysis

3.3 Awareness and usage of the smart meter app

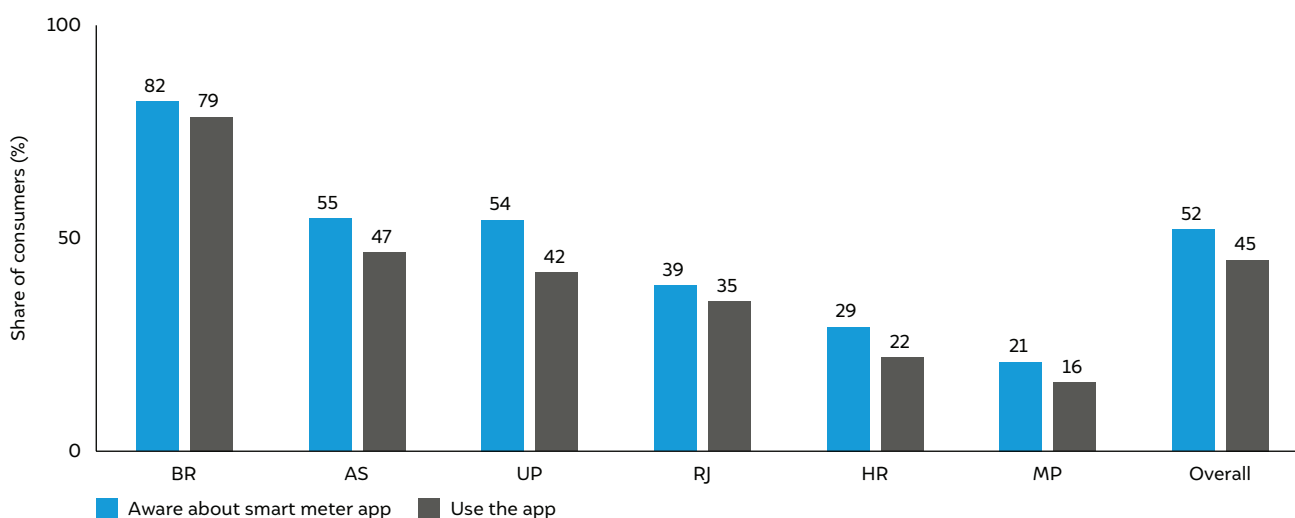
To enable consumers to benefit from smart meter technology, discoms have rolled out smart meter mobile apps. Most apps have features to help consumers track their daily/monthly electricity consumption, access detailed electricity bills, pay bills, and recharge meters or view the remaining balance (for prepaid users).¹⁰ The use of such apps assumes much importance as most discoms have stopped the distribution of paper bills to smart meter consumers.¹¹

In our survey, we find only moderate awareness and usage of the smart meter apps. Around 52 per cent of the surveyed consumers are aware of such apps and only 45 per cent report using them. The awareness and uptake of the apps vary significantly across states, with Bihar having the highest adoption and MP having the lowest (Figure 6).

The variation observed across states can be attributed to the share of prepaid meter users, the extent of discoms' efforts to educate consumers, and consumer characteristics.¹² We find that app usage is three times higher among prepaid consumers than postpaid ones (Figure 7).

In fact, after controlling for all other factors, such as consumers' receipt of detailed information, education levels, and socio-economic profiles, prepaid consumers are almost five times more likely to use the smart meter app than postpaid consumers (Annexure 2). One potential reason for this could be that prepaid consumers are more conscious about their consumption and bills, as deductions from the balance happen daily.¹³ Our field visits in Bihar reveal that many prepaid consumers visit the discom office to understand the billing process. Survey data also suggests that three out of four prepaid users with the smart meter app use it to track their daily usage and to access detailed bills.

Figure 6 Bihar has the highest number of consumers aware of and using the smart meter app



Source: Authors' analysis

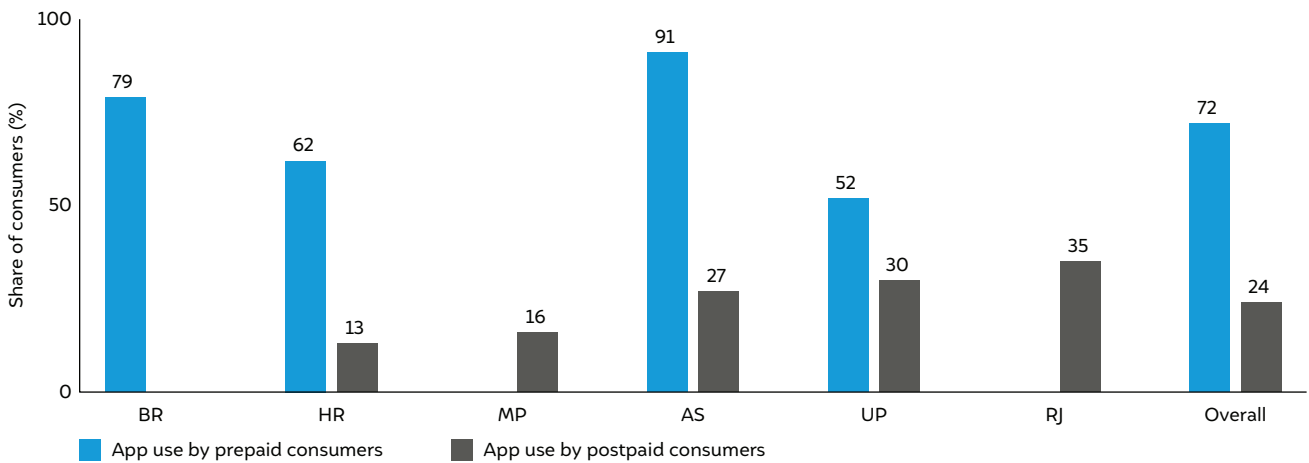
¹⁰ Consumers can recharge their smart prepaid meters using online platforms (e-wallets, discom websites, or smart meter apps) or offline platforms (e.g., at discom counters, neighbourhood shops, etc.).

¹¹ Even though consumers can view electricity consumption and recharge balance on their meters, the process of doing so is not as smooth as using a smart meter app. For instance, to view information on smart meters, consumers may have to click on buttons that they may not know about. Further, consumers may not have access to meters at all times. In certain areas, like Haryana, meters are being installed on poles outside houses and consumers do not always know which meter belongs to them.

¹² These are three key determinants of app usage based on a logistic regression. See Annexure 2 for detailed results.

¹³ Consumers using smart meters in the prepaid or postpaid mode have similar power tariffs. However, postpaid users have to pay their electricity bills once in a month. Meanwhile, for prepaid users, energy and fixed charges for using electricity are deducted on a daily basis and other applicable charges like electricity duty and surcharges are payable at the end of each month. The treatment of arrears (pending dues from consumers) also varies across states. For instance, in Bihar, pending arrears are to be recovered on a daily basis over one year, while in UP, consumers can switch to the prepaid mode only after clearing all pending dues.

Figure 7 More prepaid consumers are using the app than postpaid consumers



Source: Authors' analysis

Finally, well-educated consumers from wealthier households are more likely to use smart meter apps. This underscores the need for awareness and engagement campaigns to target consumers from lower socio-economic backgrounds.

3.4 Bill payment experience

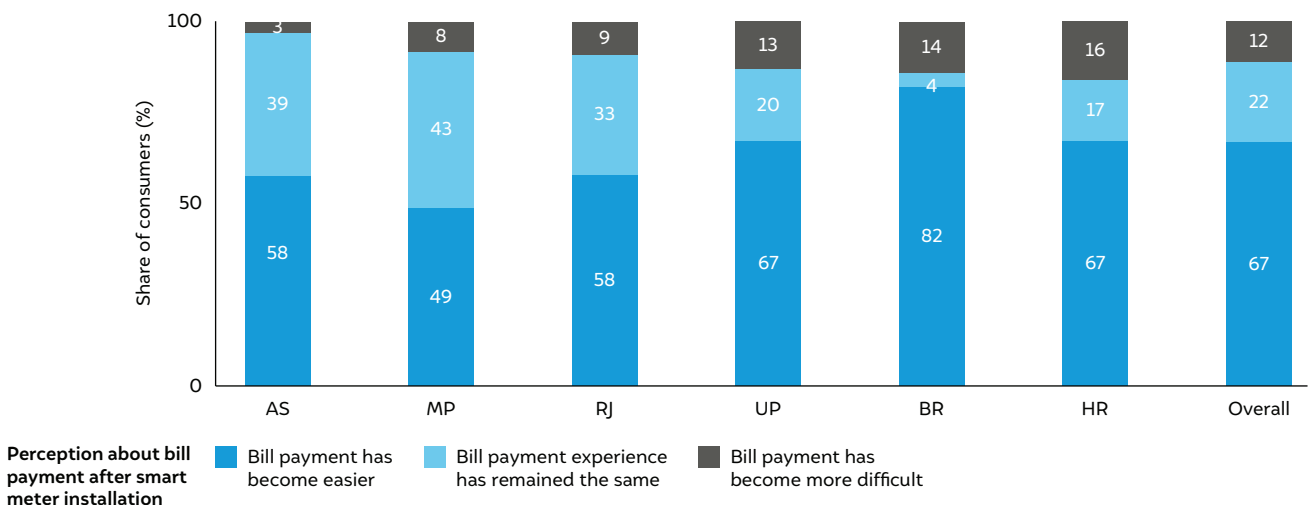
The stage after installation and billing that can affect consumers' perceptions of smart meters is the bill payment experience. In our survey, two-thirds of smart meter consumers report that paying bills is easier since switching to smart meters, mainly due to their use of digital payment modes and smart meter apps.¹⁴ Among households that find bill payments difficult (12 per cent), primary reasons include fear of missing the due date (and getting disconnected), a lack of regular cash flow, and low digital literacy.

It is important to note that the share of consumers reporting positive payment experiences is higher among prepaid users (80 per cent). Consumers attribute this to flexibility to make the payment in varying amounts and ease of payment using smart meter app. Next, we dive into the recharge and disconnection experiences of prepaid consumers.

Recharge experience for prepaid consumers

Of the surveyed consumers using smart prepaid meters, 58 per cent recharge their meters once a month; the remaining recharge at lower or higher frequency (Figure 9). Nearly 30–40 per cent of prepaid users in UP and Bihar recharge their meters more than once a month. This is an important benefit for users – they can recharge at their convenience and when they have cash available.

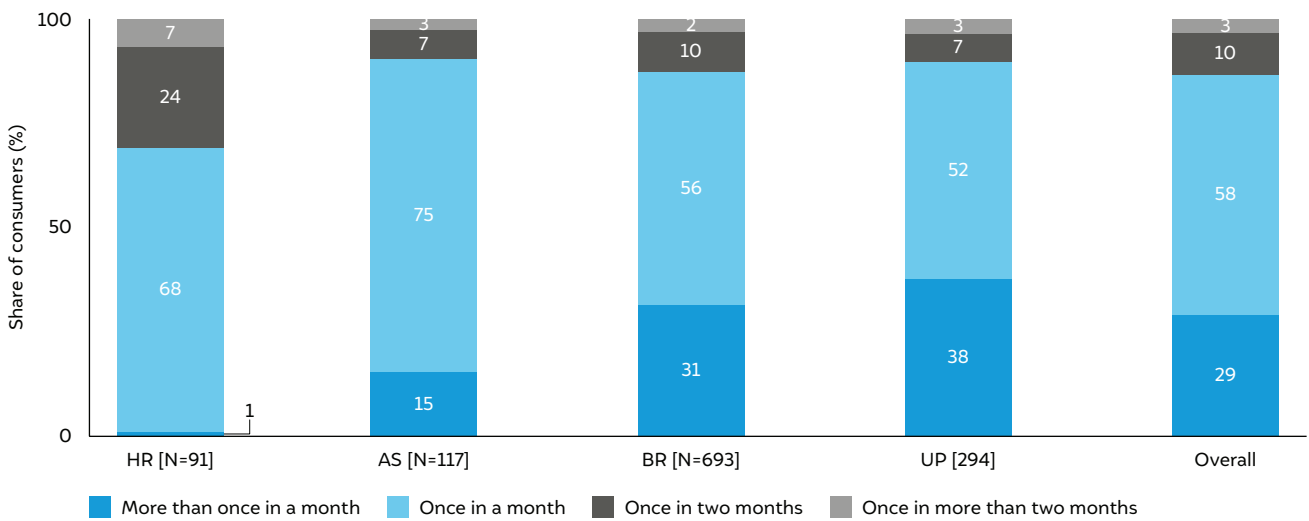
Figure 8 Bill payments have become easier and more flexible since shifting to smart meters



Source: Authors' analysis

¹⁴ In our survey, 72 per cent of consumers report using digital means to pay bills.

Figure 9 Nearly 30 per cent of prepaid users recharge their meters more than once a month



Source: Authors' analysis

We find that the median recharge value decreases on moving down the socio-economic ladder, from INR 1,625 for SEC A1 category consumers to INR 500 for SEC C1 consumers and below. Multiple states define minimum recharge values for prepaid recharges in their regulatory orders. For instance, Haryana have fixed the minimum recharge value at INR 500 while Uttarakhand has fixed it at INR 100. Given that many consumers in the C1 category and below prefer to recharge with smaller amounts, states must consider lowering minimum recharge values.

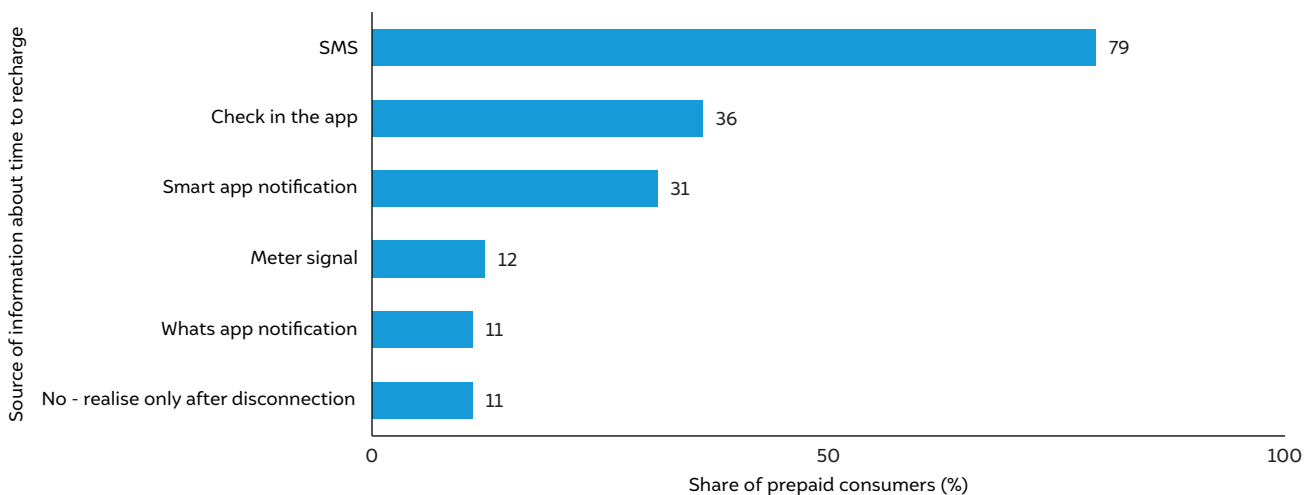
Disconnection and reconnection experiences of prepaid smart meter consumers

Prepaid consumers face automatic disconnection (remotely) when the balance in their account drops

to zero; the electricity gets reconnected only after a successful recharge. However, discoms specify no disconnection and buffer hours to avoid disconnections at times when recharging may be difficult.

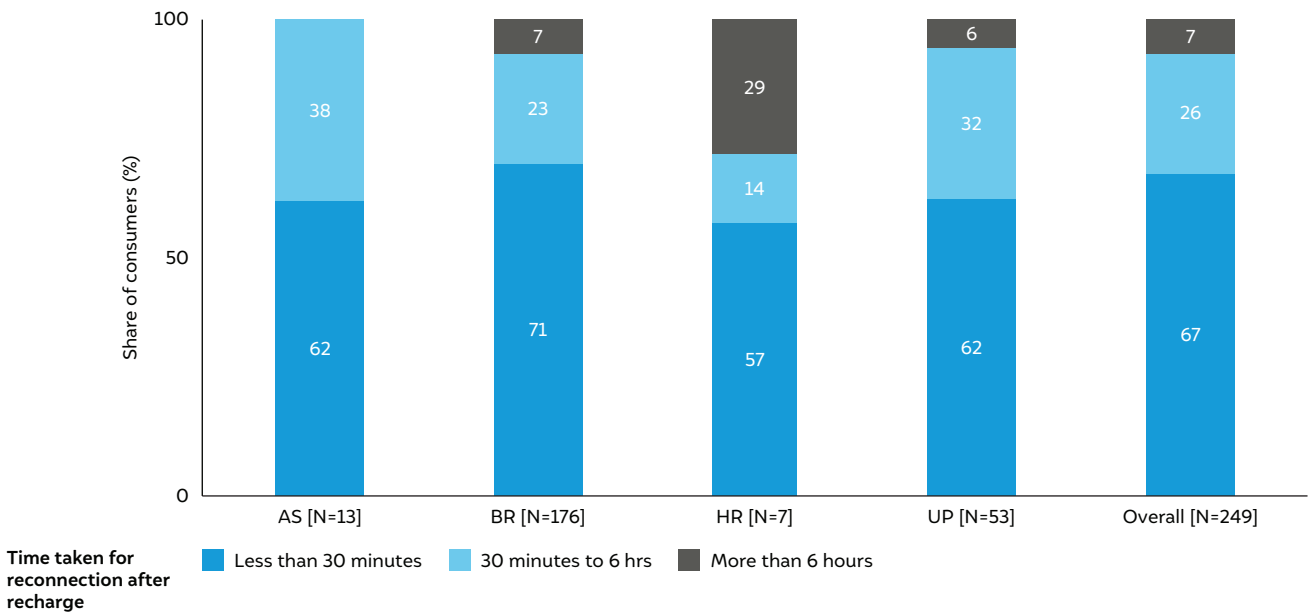
Given the change in payment behaviour that smart prepaid meter users need to undergo, it is important to provide timely notifications to prepaid consumers about recharge levels, especially closer to the exhaustion of their balances. Most consumers report that they get to know when to recharge via SMS (79 per cent) or through the smart meter app (67 per cent). However, 11 per cent of prepaid consumers get this information only after the disconnection comes into effect; this is certainly not a pleasant experience for them (Figure 10).

Figure 10 Most consumers get notifications via SMS or the smart meter mobile app when their balance is about to get over



Source: Authors' analysis

Note: The sum is greater than 100 per cent as respondents selected multiple options.

Figure 11 Two-thirds of consumers experienced reconnection within 30 minutes of recharging their prepaid meters

Source: Author's analysis

In case prepaid consumers get disconnected, reconnection (after recharge) should be immediate to ensure a smooth experience. However, for around one-third of the consumers who got disconnected in the past, it took more than 30 minutes to be reconnected after the recharge (Figure 11). Of the consumers who got disconnected, 16 per cent had to call their discom for reconnection support.¹⁵

Discom officials, when interviewed, cite the presence of black spots or no-network areas where, due to network issues, reconnection sometimes takes longer. The standard REC Limited bidding document – which has been adopted by most discoms as a template for contracts with smart meter service providers – states that 90 per cent of reconnections must happen within 15 minutes. In case discoms are unable to meet this requirement, they may incur penalties.¹⁶ Therefore, in order to ensure timely reconnection, discoms should enforce these contracts and levy strict fines.

To sum up, most consumers in our survey express positive experiences with smart meter installation, billing, and payments. But consumers also face challenges that need attention. For instance, the ground staff of the smart meter service provider need to be regularly trained to avoid making errors or causing delays during installation.

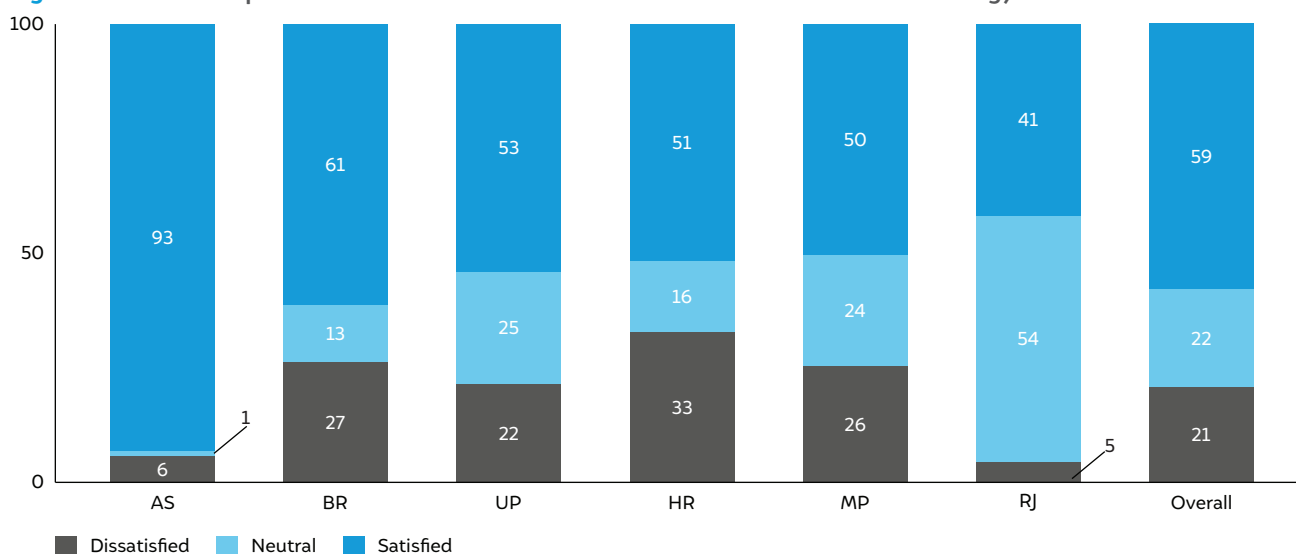
Although smart meters can help improve billing efficiency and frequency, their inability to access detailed bills can impact consumers' trust in the service. Hence, discoms should continue providing paper bills with an opt-out option, while also making efforts to enhance the uptake of the smart meter app. Finally, discoms should link minimum recharge value with billing trends to enable prepaid consumers to take advantage of the benefits of flexible payments. These steps will ensure that consumers are able to avail the benefits of the technology and have a smooth experience overall.

4. Consumer satisfaction and its drivers

The last chapter highlighted consumers' experience with the installation, billing, and payments of smart meters. All of these experiences are strongly linked to consumers' overall satisfaction. In this chapter, we dive deeper into understanding the satisfaction level of consumers with smart meter technology and its determinants thereof. We will also assess the implications of their satisfaction levels on the willingness to recommend the technology adoption to other consumers.

¹⁵ Disconnection happens during the day (usually between 10 am and 3 pm), and a buffer period (of about 24 hours) is provided for consumers to recharge.

¹⁶ The standard bidding document states that if 90 per cent of meters are not reconnected within 15 minutes of the recharge, 0.5 per cent of the provider's service charge will be deducted for every 0.5 per cent (or part thereof) of meters not reconnected; this penalty is capped at a 2 per cent.

Figure 12 Around 60 per cent of smart meter consumers are satisfied with the technology

Source: Authors' analysis

4.1 How satisfied are smart meter consumers?

Our survey suggests moderate satisfaction levels. Of all the surveyed consumers, 59 per cent are satisfied with the smart (prepaid) meters, 21 per cent are dissatisfied, and the remaining 22 per cent have neutral views. We also observe a higher satisfaction level among consumers with smart prepaid technology (63 per cent) as compared to postpaid users (55 per cent).

At the state level, Assam has the highest satisfaction rate (93 per cent) compared to only 41 per cent in Rajasthan (Figure 12). Interestingly, Rajasthan has the lowest share of dissatisfied consumers (5 per cent), but more than half of the consumers in the state have a neutral opinion about the technology. This predominant indifference in the state reflects that many consumers in Rajasthan haven't perceived any significant change in services due to smart meters. Apart from Assam and Rajasthan, the other four states have comparable (dis)satisfaction levels among their consumers. Haryana and Bihar have the highest share of dissatisfied consumers, closely followed by MP and UP.

The most important reason for consumer dissatisfaction is the perceived increase in electricity bills post-smart meter installation. Other reasons cited for dissatisfaction included the continuous running of meters even when

not in use,¹⁷ additional charges, and difficulty in making bill payments, which reflects the awareness gap among consumers. Some prepaid consumers are also dissatisfied due to the prepaid functionality itself, and this share is higher in Bihar.

4.2 What drives consumer satisfaction with smart meters?

In order to better contextualise consumer satisfaction and understand the state-level differences in satisfaction levels, it is important to identify its key drivers. It will help the discoms in effectively designing their consumer engagement strategy to improve consumer satisfaction levels, thereby creating a positive perception among both existing and upcoming adopters of smart meters.

We assessed the factors linked to consumer satisfaction using ordered logistic regression on our survey data (Annexure 2). Figure 13 summarises the results for five factors that emerge as significant and positively associated with satisfaction levels.¹⁸ We find that the probability of consumers being satisfied is higher if:

- Consumers have fewer issues during the smart meter installation process.
- Consumers are able to access their detailed bills (the most important determinant).

¹⁷ Most consumers are unaware of how bills are computed and the process of daily deductions. For instance, even if consumers are not using the appliances, there is a fixed charge component that gets deducted daily.

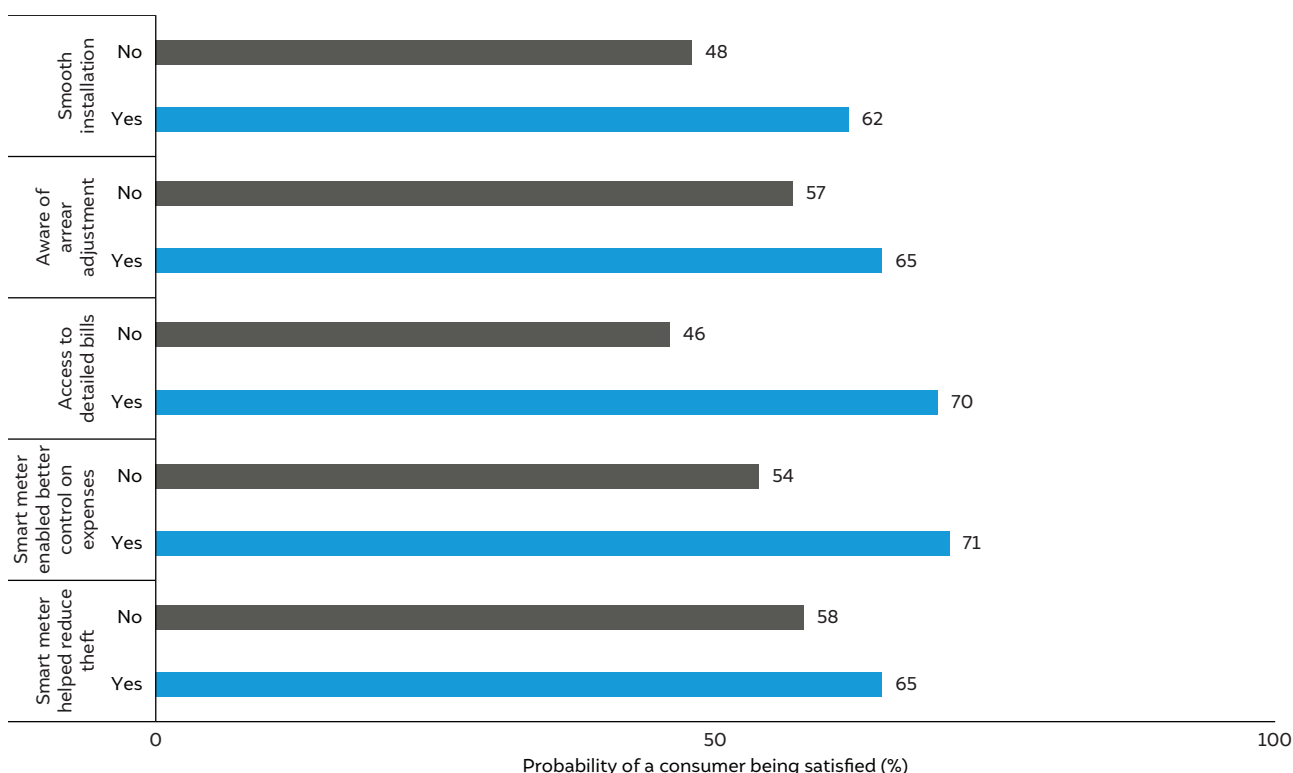
¹⁸ Ordered logistic regression models are non-linear in nature, and hence, their results (including the coefficients and odds ratios) are difficult to understand and often prone to misinterpretation. Therefore, in order to make the results easily interpretable, we have converted the odds ratios presented in Table A2 (Annexure 3) into probabilities and show the results in Figure 13. We arrive at these probabilities after estimating marginal effects, and we do this only for five factors that significantly determine consumer satisfaction.

- Consumers are aware of how past pending arrears are adjusted in their present/future bills.
- Consumers perceive that smart meters give them better control over their electricity expenses.
- Consumers perceive that smart meters have helped reduce electricity theft in their locality.

Thus, installation experience, awareness about bill composition, and perceived benefits (see spotlight 1 for

details) together determine consumers' satisfaction and outlook toward smart meters. This also helps explain the state-level differences. Assam, which has the highest share of satisfied consumers, scores the highest on all the key determinants of consumer satisfaction (Table 2). On the other hand, Rajasthan – the state with the lowest share of satisfied consumers – features the poorest on three of the five key factors. For instance, only 8 per cent of consumers in Rajasthan experience any reduction in their electricity bills post-smart meters.

Figure 13 Consumers who experienced a reduction in their electricity bills are most likely to be satisfied with smart meters



Source: Authors' analysis

Table 2 Assam is the best-performing state in each of the factors driving consumer satisfaction

	Determinants of satisfaction among smart meter consumers	State					
		Assam	Bihar	Uttar Pradesh	Haryana	Madhya Pradesh	Rajasthan
1	Share of satisfied consumers (%)	93	61	53	51	50	41
2	Share of consumers with positive responses on key determinants of satisfaction:						
	a. Smooth smart meter installation process	96	86	88	94	91	95
	b. Access to details bills (paper or digital)	81	56	41	50	79	47
	c. Aware of arrear adjustment in the current bill	93	33	43	61	56	12
	d. Feel that smart meters enable better control on electricity expenses	68	45	44	22	30	8
	e. Feel that smart meters help reduce electricity theft in their locality	60	26	41	48	53	2
3.	Simple average of the above five factors	79.6	49.2	51.4	55	61.8	32.8

Source: Authors' analysis

Note: For each of the five factors, we highlight the best and worst performing states in blue and grey, respectively.

Spotlight 1 – Perceived co-benefits of smart meters

When asked about the benefits of smart (prepaid) meters, many of the surveyed consumers responded positively to three key benefits. For instance, 37 per cent of the consumers reported that smart meters led to a reduction in electricity theft in their locality, and an almost similar share reported improved quality of power supply quality (41 per cent), and reduced electricity bills (38 per cent). The variation in prepaid and postpaid consumers in reporting the co-benefits is provided in Figure 14. We see that more prepaid consumers are reporting better control of electricity expenditure as well as improved quality of supply while more postpaid consumers are reporting a reduction in theft as a co-benefit.

When asked about the benefits of smart (prepaid) meters, many of the surveyed consumers responded positively to three key benefits.

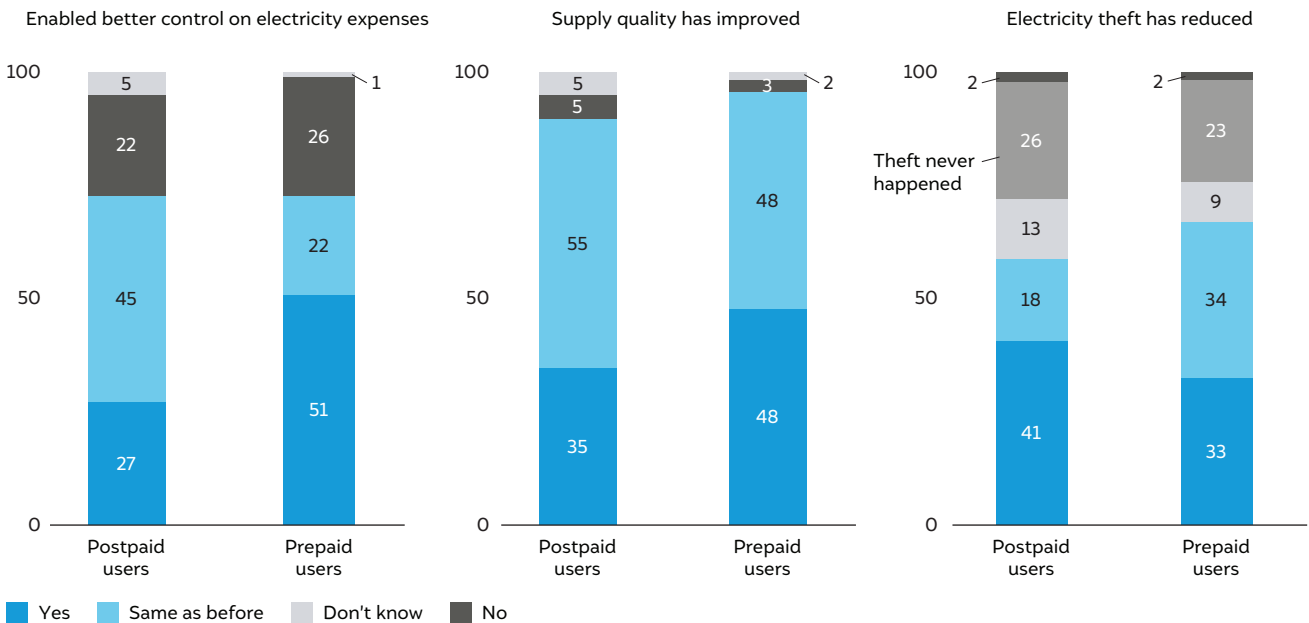
- *Smart meters enable better control of electricity expenses:* 51 per cent of prepaid users and 27 per cent of postpaid users reported this benefit, providing evidence that smart meters can empower consumers in managing their electricity budgets. However, nearly a fourth of the users disagree and feel their bills have increased after a switch to smart meters. Most of these consumers are from Bihar and Haryana and belong to higher socio-economic categories.
- *Quality of supply has improved in areas with smart meters:* Around 48 per cent of prepaid and 35 per cent of postpaid users reported this benefit, providing evidence that smart meters can improve the quality of power supply.

cent of postpaid consumers reported that quality of supply has improved in their areas. This perception could be attributed to the infrastructure upgrades being undertaken along with smart metering drives. For instance, the replacement of old cables with insulated cables reduces the incidences of tripping (often due to loose wiring, wind, and even disturbances by monkeys).

- *Reduction in electricity theft in areas with smart meters:* 33 per cent of the prepaid and 41 per cent of postpaid consumers reported having perceived a reduction in electricity theft in their areas. This perception can be attributed to many factors. One, infrastructure upgrades accompanying smart metering drives such as insulated cables make direct hooking (commonly used for stealing electricity) difficult. Two, discoms have started using smart meter data to identify consumers that are bypassing meters (by tracking anomalous load profiles) and conduct targeted disconnection drives. For instance, in the Mhow division near Indore, MP, the sub-division officers informed of how they have set up a data analytics cell to monitor consumption and identify theft. Due to these trends, there seems to be a perception among consumers that, due to smart meters, it is easier for discoms to catch theft and so low-risk taking consumers would avoid such indulgence.

Future communications campaigns on smart meters must use these co-benefits as anchor points to engage with consumers and build acceptance among them of the smart-metering technology.

Figure 14 40 per cent of smart meter consumers report multiple co-benefits of using the technology



Source: Authors' analysis

Table 3 Assam has the highest share of consumers reporting multiple co-benefits of smart meters

	Sample composition	Can exercise better control on expenses (%)	Supply quality has improved (%)	Electricity theft in the locality has reduced (%)
Assam	70% postpaid, 30% prepaid	68	66	60
Bihar	Smart prepaid	45	41	26
Haryana	82% postpaid, 18% prepaid	22	37	48
Madhya Pradesh	Smart postpaid	30	35	53
Rajasthan	Smart postpaid	8	13	2
UP	45% postpaid, 55% prepaid	44	45	41
Overall	Smart prepaid	51	48	33
	Smart postpaid	27	35	41
	All consumers	38	41	37

Source: Authors' analysis

We also observe a variation in perceived benefits across states. For instance, Assam has the highest share of consumers reporting all three co-benefits, which also explains the highest satisfaction levels in the state. Bihar, with more than 90 per cent of all smart prepaid meter installations in the country, has the highest awareness and uptake of the smart meter app, partly linked to the intensive consumer engagement efforts by the discoms, and the fact that consumers are more conscious of their deductions in prepaid mode. More than half of the smart meter users in MP report that electricity theft has reduced in their neighbourhood. This can be attributed to active efforts by the discoms in the state to leverage smart meter data to direct vigilance activities and curb theft.

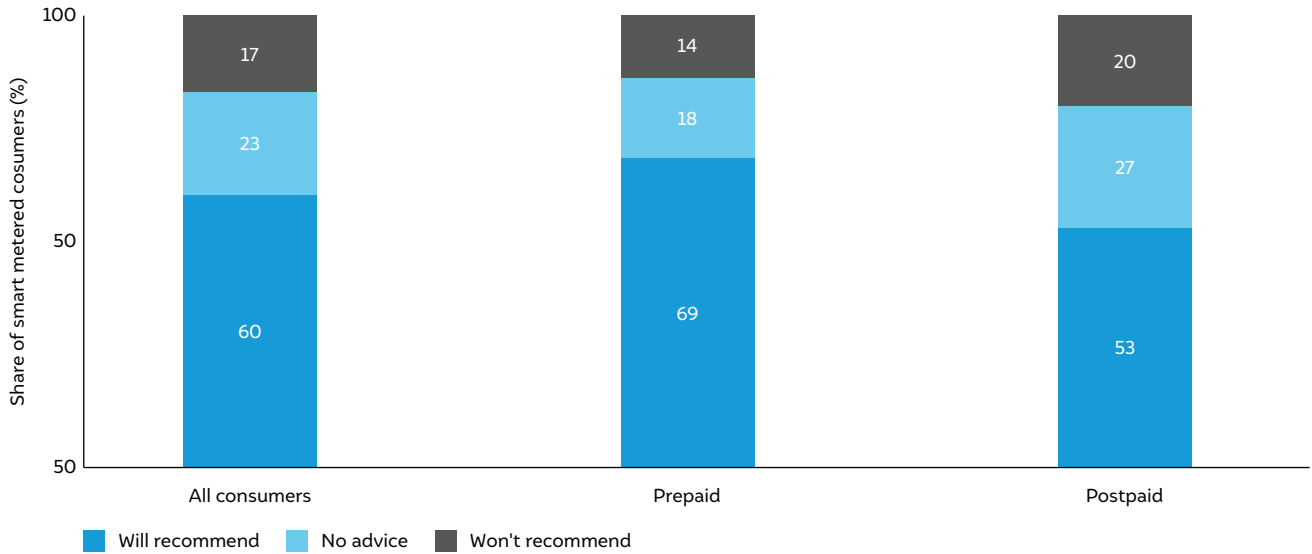
4.3 Would smart meter consumers recommend others to adopt the technology?

Around 60 per cent of smart meter consumers reported that they are willing to recommend smart meter adoption to their friends and relatives. Consumer

satisfaction levels seem to strongly influence the recommendation type. We also find that a higher share of prepaid consumers was satisfied (63 per cent) and willing to recommend (69 per cent) the technology to others (Figure 15). This difference can be attributed to the higher usage of smart meter apps by prepaid consumers to check their bills and consumption along with the flexibility to make payments. At the state level, Rajasthan and Haryana had the highest share of consumers not willing to recommend smart meter adoption to other consumers (23 per cent and 20 per cent, respectively) due to their lower share of satisfied consumers (as presented in Table 2).

MP seems to be an exception here, with a lower satisfaction rate but the highest recommendation rate (72 per cent). On closer examination, we find that around 80 per cent of smart meter consumers in MP have access to detailed electricity bills, which is the most important determinant of consumer satisfaction. Haryana is the only curious case with around half of the smart meter consumers having no advice for potential smart meter consumers, a point that needs to be researched further.

Figure 15 Around 60% of smart meter consumers are willing to recommend smart meter adoption to friends and family



Source: Authors' analysis

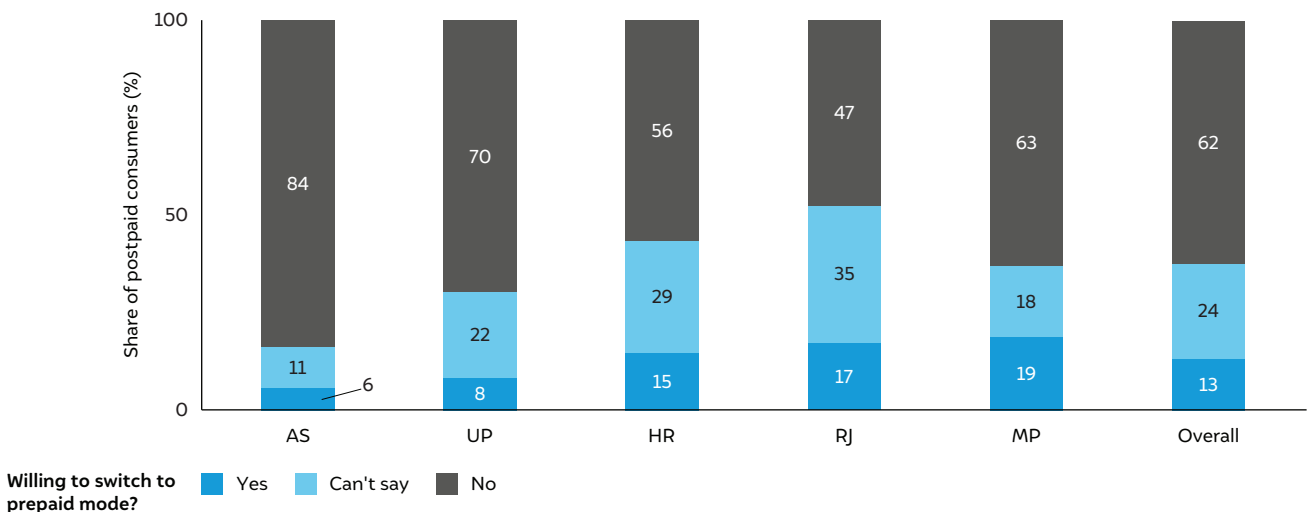
Spotlight 2 – Are postpaid consumers willing to shift to the prepaid mode?

Although most smart meters have so far been installed in postpaid mode, the Government of India envisions all meters to be smart prepaid by 2025–26 under the RDS scheme. This is because the prepaid functionality could help discoms improve revenue collection efficiency by requiring consumers to pay before consumption and thus avoid non-payment and accumulating arrears. In addition, the prepaid mode also allows consumers to plan their electricity usage as per their own needs and resources. Therefore, it is important to assess the

awareness levels of postpaid meter consumers about the prepaid mode, and their willingness to transition to it. We found that only 25 per cent of postpaid smart meter consumers were aware of the prepaid functionality and only 13 per cent were willing to switch to the prepaid mode (Figure 16).

The most important reason for this high resistance was the postpaid consumers' inertia (contentment with the status quo), which suggests the need to provide rebates or other incentives to generate interest to switch to prepaid mode. Other reasons for resistance included a lack of awareness about prepaid technology and fear of disconnection, highlighting the need to educate consumers and dispel the fear of disconnection.

Figure 16 Only 13% of the postpaid consumers are willing to transition to the prepaid mode



Source: Authors' analysis

To sum up, a majority of the surveyed consumers were satisfied with smart meters, but a fifth of them was dissatisfied. The most important reason for their dissatisfaction is linked to their perception that electricity bills have increased post-smart meters. Utilities need to establish sustained communication with the consumers to improve transparency around bill computation. Some consumers also face difficulties in making (online) payments. Utilities can take inspiration from (or partner with) fintech companies to make the online payment interface easier and more inclusive. All these efforts will go a long way in creating a positive atmosphere around smart meter technology among consumers.

5. Consumer engagement: effective communication channels

As discussed in Chapter 3, a large majority of consumers do not use the smart meter mobile application and are hence unable to access the services offered by the app. Moreover, we have seen that consumers are more likely to use smart meter apps once they have received detailed information through various channels of mass and social media. In this chapter, we explore the smart meter consumers'

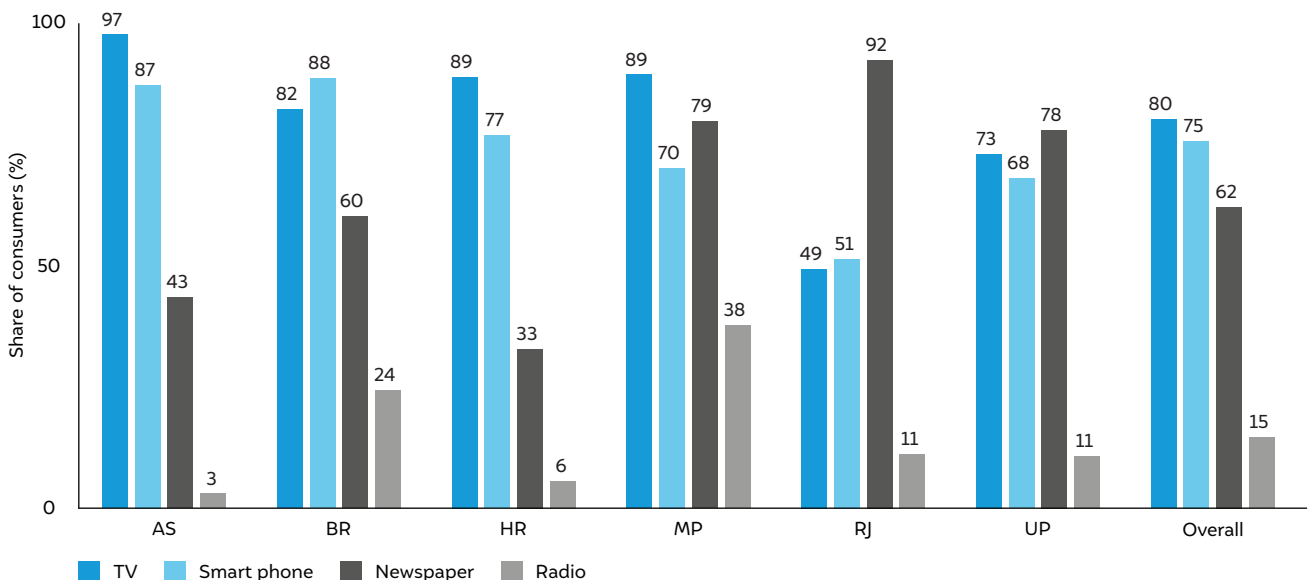
preferred modes of communication that they use to receive information about the world in general and matters related to electricity in particular. Utilities can use these insights to figure out the right mix of communication channels to engage with their consumers about the technology.

5.1 Consumers' media consumption patterns

We find that most consumers use televisions (TVs), smartphones, and newspapers to receive information about the world (Figure 17a). There is marginal state-wise variation; for example, consumers in Rajasthan prefer newspapers over TV and smartphones. In comparison, radio is preferred by a very small share of the sample (15 per cent), except in Madhya Pradesh and Bihar where 38 and 24 per cent of consumers respectively listen to the radio.

Among consumers who watch TV, channels providing regional entertainment and news are the most popular choice (Figure 17b). In a similar vein, among consumers who read newspapers, 60 per cent prefer to read them in their regional languages. For respondents who consume information through smartphones, YouTube, WhatsApp, and Facebook are the three most preferred applications (Figure 18).

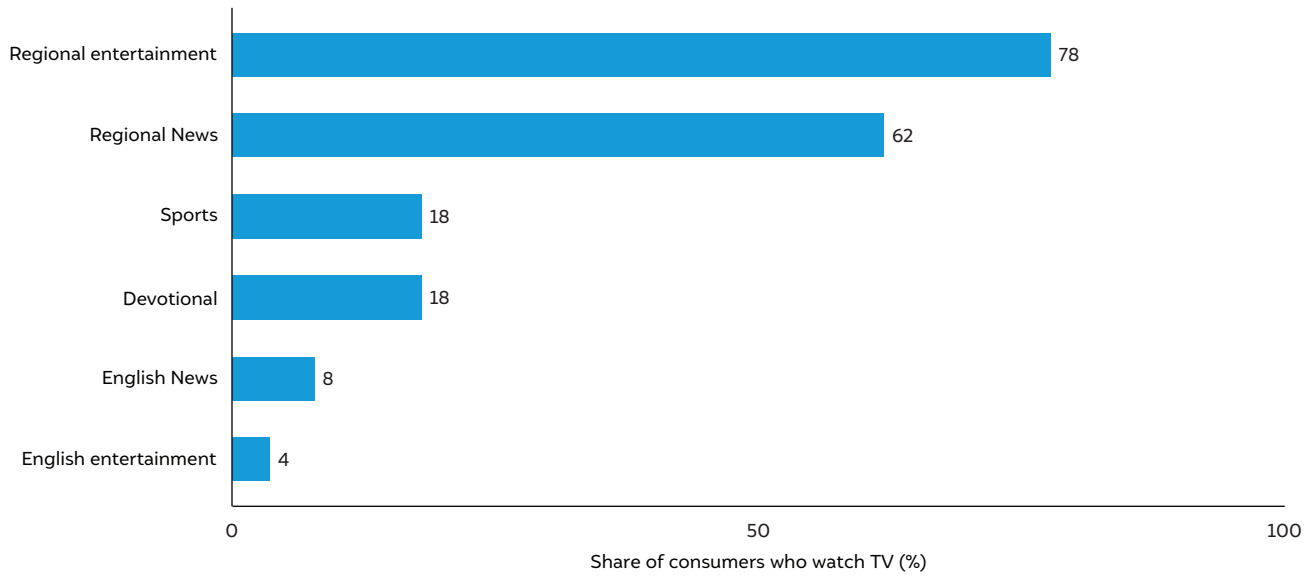
Figure 17a TV, smartphones, and newspapers are the most popular sources of infotainment



Source: Authors' analysis

Note: The sum is greater than 100 per cent as respondents selected multiple options.

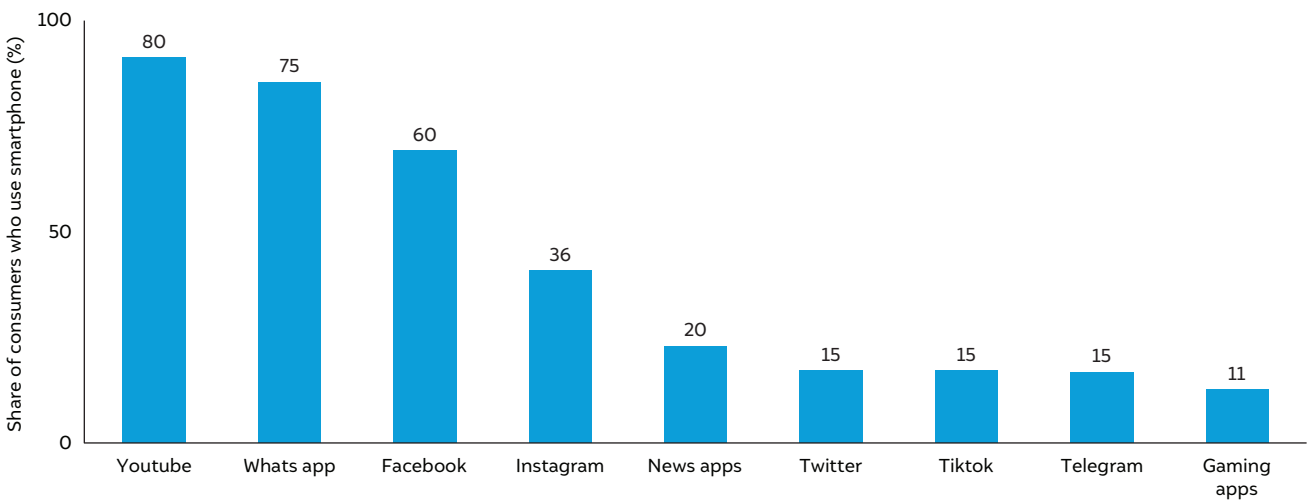
Figure 17b Majority of consumers prefer to watch regional channels on TV



Source: Authors' analysis

Note: The sum is greater than 100 per cent as respondents selected multiple options.

Figure 18 Consumers mostly use YouTube, WhatsApp and Facebook on their smartphones



Source: Authors' analysis

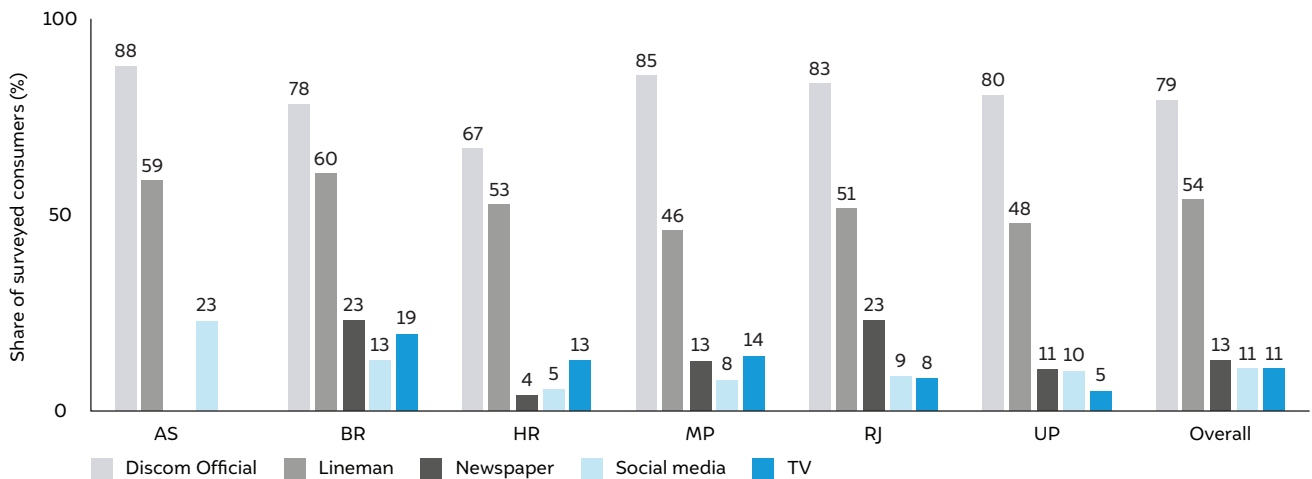
Note: The sum is greater than 100 per cent as respondents selected multiple options.

5.2 What modes of communication do the consumers trust?

We also asked the consumers what modes of communication they trust when receiving any information about electricity. Discom representatives

including officials and linesmen are the most trusted source with 79 per cent and 54 per cent of consumers trusting them, respectively. In comparison, mass media (like newspapers and TV) and social media options were trusted less by consumers. These trends are similar across states, though trust in discom officials is lowest among consumers from Haryana (Figure 19).

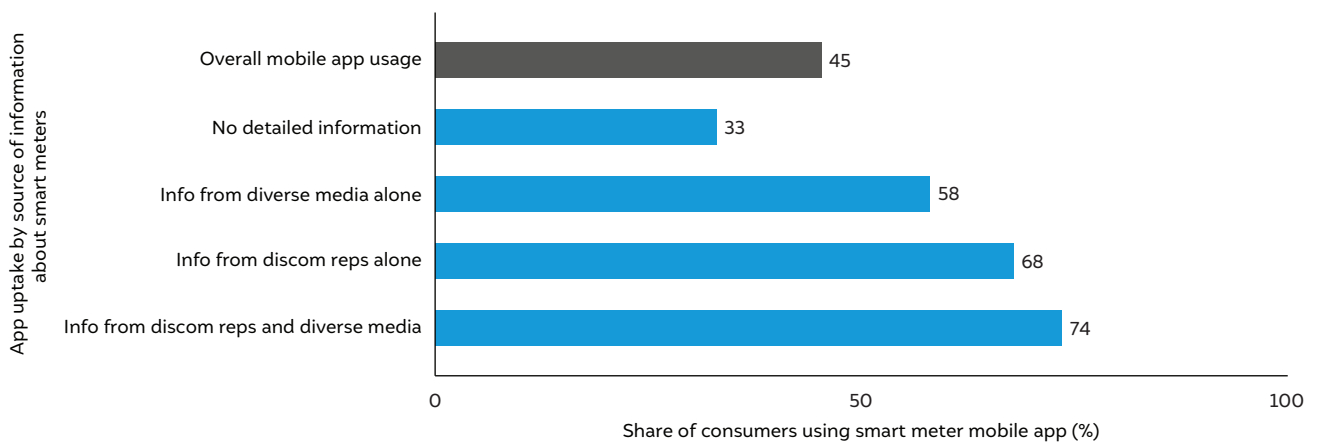
Figure 19 Consumers across states tend to trust discom representatives on general matters related to electricity



Source: Authors' analysis

Note: The sum is greater than 100 per cent as respondents selected multiple options.

Figure 20 Smart meter app uptake increases if consumers are provided with detailed information through various communication channels



Source: Authors' analysis

Note: The sum is greater than 100 per cent as respondents selected multiple options.

The importance of devising an effective consumer engagement strategy comprising the use of the right communication channels, content curation in preferred languages, and the right messenger can also be gauged through an example of smart meter uptake. Even though 45 per cent of surveyed consumers in our survey use smart meter mobile apps, we find that the uptake is significantly lower among consumers who have not received any detailed information about the technology as compared to those who did (Figure 20). We also observe a relatively higher uptake of mobile apps among consumers who received detailed information through both one-on-

one engagements with smart meter vendors (hired by discoms) as well as other media employed by discoms.

A well-targeted, robust communication strategy is key for effective consumer engagement. Utilities are already targeting consumers through various means like holding week-long campaigns at the sub-division office of the discom (Bishnoi, 2021). Moreover, citizens have also started to explain the working of smart meters on social media platforms like YouTube (Zaroori Baatein, 2019). Thus, discoms need to devise a context-specific engagement strategy to reach the consumers through communication channels that they are more likely to use.

6. Conclusion and policy recommendations

As countries chart their clean energy transition journeys, the digitalisation of energy infrastructure would be a key defining pillar in the transition. India's drive towards an AMI is at the core of digitalising the power sector. Even as discoms in India are gathering momentum to deploy smart prepaid meters across 250 million consumers by March 2026, this rapid transition at scale would require a significant behavioural change at the consumers' end, especially concerning bill receipts and payments. Ensuring consumer buy-in becomes very important in the smooth implementation of the scheme.

Our study, based on a survey of ~2,700 smart metered consumers from six Indian states, suggests an overall positive consumer experience with the technology, but there are also several gaps that require the attention of policymakers and discoms. Around 60 per cent of the survey respondents expressed satisfaction with billing and payments after a switch to smart meters, but a fifth was dissatisfied, and the remaining neutral. We find that consumer (dis)satisfaction is linked to factors such as installation experience, access to detailed electricity bills, and realisation of co-benefits associated with smart metering (like improved supply and theft reduction). Many of the surveyed consumers (44 per cent) had limited access to detailed bills, which in turn feeds into the perception of inflated bills due to a switch to smart meters (a concern raised by 17 per cent of consumers). Although bill payments became easier for most respondents, a few (12 per cent) cited difficulties in making digital payments.

That a higher share of prepaid consumers was satisfied than postpaid consumers counters the popular belief that smart prepaid meters may not suit the Indian context. At the same time, only a few postpaid users (13 per cent) were willing to switch to prepaid mode due to status-quoism and perception barriers. This is because many postpaid users harbour the fear of disconnection on failure to recharge on time, delayed reconnection, and a rise in electricity bills, which is linked to the experiences and perceptions of some prepaid users. Proactive grievance redressal and consumer engagement on the issues identified in our study will be integral to building social acceptance for smart prepaid meters.

We propose five recommendations for a consumer-centric transition to smart (prepaid) meters.



Discoms along with REC Limited should undertake a sustained campaign to educate consumers about the benefits of smart prepaid meters, mobile applications, and their features.

Our study suggests that consumer satisfaction is directly linked to perceived benefits of the technology and access to detailed bills, which, in turn, is linked to consumers' awareness and use of smart meter mobile applications. However, less than half of the surveyed consumers use smart meter apps. We also saw that consumers who had received detailed information about the app were more likely to use it for various features like accessing detailed bills, checking consumption, and recharging.

To increase consumer awareness of smart meter benefits and app uptake, we recommend that discoms – in partnership with REC Limited – must run a sustained and integrated communication campaign using diverse channels such as social media, mass media, pamphlets and loudspeakers, and one-on-one interaction with the field staff installing smart meters. Explainer and testimonial videos in regional languages and their dispersion through popular social media platforms like YouTube, WhatsApp, and Facebook should also be considered to spread awareness. Discoms must also ensure that smart meter applications are accessible to consumers through user-friendly interfaces and the option to operate in vernacular languages.



Discoms should continue giving paper bills and withdraw them in a phased manner.

Multiple discoms such as those in Bihar, Haryana, MP, and UP have discontinued the distribution of paper bills to smart metered consumers as the bills are available to download on smart meter apps. However, with the low uptake of smart meter apps, many consumers are unable to access detailed bills and rely on limited information through SMS alone. Limited digital literacy is also a barrier to consumers accessing their bills online; one-fourth of the consumers reported that they find it hard to understand the digital bills. Unsurprisingly, 70 per cent of the surveyed consumers would like to receive paper bills.

Therefore, discoms must continue distributing paper bills to smart metered consumers with an option to opt-out of paper bills for digitally savvy consumers. This would also follow the Electricity (Rights of Consumers) Rules, 2020, which require discoms to intimate all consumers about the “details of the bill amount”. Further, discoms should prepare a strategy to educate and enable all consumers to access digital bills in order to gradually phase out paper bills.



Discoms need to ensure timely alerts and a smooth recharge experience for prepaid consumers.

A third of the surveyed prepaid users got disconnected at least once upon failure to recharge on time. Of these, a third could reconnect only after 30 minutes of recharge (implying a significantly long power cut). To overcome these issues, discoms need to design their recharge system keeping the consumer at the centre. This will include sending multiple well-timed notifications (on mobile apps) and SMSs to indicate the drawdown of recharge amounts (e.g., alerts scheduled for balance approaching seven days, three days, and one day’s worth of consumption). Discoms should also declare ‘happy hours/days’ when no disconnection takes place to help consumers avoid disconnections on days/hours when recharging could be challenging. For instance, in Bihar, electricity can only be disconnected between 10 AM–1 PM and a buffer time of 24 hours is provided to the consumers to recharge. Consequently, a proactive grievance redressal mechanism to address the issues of delayed recharge

would be of paramount importance, given how integral electricity is to daily life. This would require strict enforcement of contracts with AMI Service Providers (AMISPs) (see Box 2).



Discoms should help consumers tap into payment flexibility feature of prepaid meters.

Nearly 80 per cent of surveyed prepaid users said that bill payments have become easier due to the use of apps and the option for flexible payments. In fact, 30 per cent of the surveyed prepaid users recharge their bills more than once a month, highlighting the demand for payments in small amounts. But some states have high recharge limits (e.g. INR 500 in UP and Haryana) which can restrict low-income households (with low consumption) from making small recharges. Consumers facing difficulty in payments also explicitly attribute these to income constraints and low comfort in making digital payments. To address these challenges, discoms should consider a low minimum-recharge limit and may even link it with consumption levels. Waiving off any additional fee associated with recharge or digital payments and providing rebates on prepaid meters will make the technology attractive to consumers. Finally, given the digital literacy gap, discoms should support offline payment facilities like mobile ATMs, e-wallets operated by women SHGs, neighbourhood shopkeepers, banks, post offices, and kiosks in bus depots, especially in areas with poor network connectivity. Educating consumers about these benefits would be equally important.

Box 2

Enforcing discom-AMISPs contracts for better service delivery

Most discoms in India have chosen to contract out all key activities related to smart meter deployment including equipment procurement, system installation and integration, and operation and maintenance due to the high upfront cost of the AMI. To facilitate robust contracts, REC Limited has released a standard bidding document (SBD) which can be adopted by the discoms while getting into contracts with the AMISP (Ministry of Power, 2022).

The SBD prescribes detailed provisions for service delivery, ranging from timely bill generation and disconnection/reconnection to consumer engagement. For instance, SBD requires AMISPs to prepare and implement a consumer engagement plan in consultation with the discom. Such a plan should span all stages of meter installation and operation, and include engagement activities to be undertaken at utilities’ headquarters at the division and sub-division level along with a media plan. It also contains measures to hold AMISPs accountable. For instance, AMISPs are to ensure remote disconnection or reconnection for 90 per cent of smart meters (for applicable cases) within 15 minutes of service initiation, failing which a deduction of 0.5 per cent of service charges (capped at 2.0 per cent) would be applicable.

Despite such provisions, the issues identified in this study reflect a gap in enforcement. Discoms must leverage the SBD to design robust contracts and strictly enforce the provisions to ensure that AMISPs provide adequate on-ground services for a positive and smooth consumer experience.



State electricity regulators should issue smart (prepaid) meter guidelines to ensure a uniform consumer experience with the technology.

A large-scale switch to smart prepaid meters would imply a shift in the way consumers receive and interpret their bills and make payments. Our study highlights that there is a need to specify provisions concerning the installation, operation, and communications related to smart meters such that this transition for consumers is smooth, particularly for those from low socio-economic backgrounds.

Currently, the provisions for smart meters are scattered across different regulatory orders and directives, which makes it less accessible for all key stakeholders, especially consumers. For instance, in UP, the provisions are dispersed along three documents.¹⁹ In addition, many important provisions concerning disconnection, minimum recharge, meter charge, arrear adjustment, etc. are not specified anywhere in the case of several states. During our field visits, we also observed many consumers being unaware of important provisions such as rebates on switching to prepaid meters or the buffer time for disconnection.

Thus, state electricity regulators must devise, discuss, and notify smart meter guidelines to guide discoms, AMISP, and consumers on all relevant aspects. Such guidelines must cover the following critical elements:

- Information to be shared with consumers during installation (about the technology, its benefits, and the mobile application).
- Rebates, if any, upon switching to the prepaid mode.
- Applicable tariffs and method of bill computation, deductions, and arrear adjustments.
- Frequency, timing, and modes of receiving bills along with options available to consumers (e.g., opting out of paper bills).
- Minimum value for any prepaid recharge for different consumer categories.
- Frequency and number of alerts to nudge consumers for timely recharges.
- Modes of recharge/payment options available and rebates, if any.

- Buffer time and no disconnection hours/days (when electricity cannot disconnect, even with zero balance).
- Maximum time within which reconnection should take place upon recharge.
- Meter charge, if any, that the consumer must pay.
- Parameters to be displayed on meter unit (to assist consumers who do not use the smart meter app).
- Frequency at which discom staff should manually inspect smart meters.

Such guidelines will help ensure a positive and uniform consumer experience within states and across states. Discoms can distribute a simplified version of these guidelines to consumers to apprise them of their rights and set expectations.



REC Limited must facilitate cross-learning and sharing of best practices across discoms.

Both the survey findings and our interactions with discom staff during field visits indicate several opportunities for cross-learning across states. For instance, Assam has the highest share of consumers who found the installation process smooth, was satisfied, and felt that smart (prepaid) meters have enabled better control of electricity expenses. Bihar has the highest awareness and uptake of the smart meter app, partly linked to the intensive consumer engagement efforts by the discoms in the state. More than half of the smart meter users in MP feel electricity theft has reduced; this is partly due to the discoms' efforts to leverage smart meter data for vigilance activities.



End-to-end ownership of the smart meter programme by the discom leadership.

Our study suggests that the success of the smart meter rollout is closely linked to a close involvement of the discom officials across the hierarchy with smart metering service providers and consumers during on-ground implementation. Proactive participation of state governments and end-to-end ownership of the smart meter rollout efforts by discoms' top management would be critical to India's vision to digitalise power distribution infrastructure and pave the way for the clean energy transition.

¹⁹ These include: Tariff order FY21-22, *Order in the matter of Approval of Smart meter roll out plan presented by UPPCL before the commission, 2018 and Petition No. 1015/2015 Order on Fixation of Tariff for Prepaid Metering.*

Annexures

Annexure 1: Socio-economic classification

The socio-classification system used in the study is based on two variables – the education of the chief earner and the number of assets owned. Using this classification, consumers can be grouped into 12 grades, ranging from A1 to E3 where the education

level and asset ownership decline as we move down from A1 (Figure A1).

For example, a household where the chief earner has completed their graduation/post-graduate (general degree) and owns eight durables would be placed in category A2. Similarly, 11 durables are considered to assess asset ownership: an electricity connection, ceiling fan, LPG stove, two-wheeler, colour TV, refrigerator, washing machine, laptop/computer, car/jeep/van, air conditioner, and agricultural land.

Figure A1 Socio-economic categories based on education level and number of durables owned

No of Durables) TRANSFER FROM Q3)	Chief Earner: Education (Q2)						
	Illiterate	Literate but no formal schooling/ School-Upto 4 years	School- 5 to 9 years	SSC / HSC	Some College (incl a Diploma) but not Grad	Graduate/ Post Graduate: General	Graduate/ Post Graduate: Professional
	1	2	3	4	5	6	7
Name	E3	E2	E2	E2	E2	E3	D2
1	E2	E1	E1	E1	D2	D2	D2
2	E1	E1	D2	D2	D1	D1	D1
3	D2	D2	D1	D1	C2	C2	C2
4	D1	C2	C2	C1	C1	B2	B2
5	C2	C1	C1	B2	B1	B1	B1
6	C1	B2	B2	B1	A3	A3	A3
7	C1	B1	B1	A3	A3	A2	A2
8	B1	A3	A3	A3	A2	A2	A2
9 +	B1	A3	A3	A3	A2	A1	A1

Source: Prabhudesai, 2014

Annexure 2: What determines smart meter application usage among consumers?

To analyse the factors associated with smart meter consumers using the application, we constructed a logistic regression model. Consumers' response on whether they use the smart meter application or not is the dependent variable which takes two different values (1 = Yes; 0 = No). We included consumer responses on whether they received detailed information about the smart meters during installation, their socio-economic profile, level of education, and gender of respondent along with their meter type (postpaid or prepaid) as the independent variables. We also include state-fixed effects to control for state-level variations, if any, and the results are presented in Table A1.

Annexure 3: What determines consumer satisfaction with smart meter technology?

To analyse the factors associated with consumer satisfaction with smart meters, we constructed an ordered logistic regression model. The level of consumer satisfaction is the dependent variable which takes three different values (1= Dissatisfied, 2 = Neutral, 3 = Satisfied). We included consumers' responses on various important parameters related to their experiences with smart meters, their socio-economic profile, and the gender of the respondent as the independent variables. Table A2 presents the results for all consumers and those with all consumers, prepaid and postpaid smart meters in the second, third, and fourth columns respectively.

Table A1 Logistic regression to understand the factors that determine usage of the smart meter application among consumers

Dependent variable: Smart meter app user (1=Yes; 0=No)	Odds ratio	Std. Error	P-value	95% confidence interval	
Did you receive detailed information about smart meters during its installation? (1=Yes; 0=No)	3.0	0.31	0.00	2.49	3.70
Does the household belong to upper SEC category (A1, A2, A3)? (1=Yes; 0=No)	1.8	0.21	0.00	1.40	2.25
Any graduate member in the family? (1=Yes; 0=No)	2.2	0.25	0.00	1.71	2.71
Is the respondent female? (1=Yes; 0=No)	0.8	0.09	0.04	0.64	0.98
Is the respondent a prepaid meter user? (1=Yes, prepaid; 0=No, postpaid)	4.8	0.68	0.00	3.63	6.35
State fixed effects (Base state - Uttar Pradesh)					
Assam	1.9	0.32	0.00	1.39	2.67
Bihar	3.0	0.46	0.00	2.22	4.06
Haryana	0.7	0.13	0.08	0.53	1.04
Madhya Pradesh	1.1	0.26	0.62	0.71	1.77
Rajasthan	1.6	0.30	0.01	1.15	2.35
Number of observations	2588				
Log likelihood	-1288.95				
Pseudo R²	0.2778				
Prob > Chi²	0.00				

Source: Authors' analysis

Note: The independent variables that have a P-value of less than 0.05 significantly determine the consumers' likelihood of using the smart meter application, and they are highlighted in blue.

Table A2 Logistic regression of consumer satisfaction with smart meters

Dependent variable: Satisfaction (1 = Dissatisfied; 2 = Neutral; 3 = Satisfied)	All consumers	Prepaid consumers	Postpaid consumers
Did you face any issues during installation? (1 = Yes; 0 = No)	0.57*** (0.09)	0.69* (0.14)	0.50*** (0.12)
Did you receive detailed information about smart meters during installation? (1 = Yes; 0 = No)	1.18* (0.11)	1.21 (0.17)	1.22 (0.17)
Are you able to access your detailed electricity bill? (1 = Yes; 0 = No)	2.75*** (0.26)	1.95*** (0.31)	3.39*** (0.43)
Has the smart meter helped you in reducing your electricity bills? (1 = Yes; 0 = No)	2.02*** (0.21)	2.43*** (0.34)	1.57*** (0.26)
Has the smart meter helped you in reducing electricity theft in your locality? (1 = Yes; 0 = No)	1.32*** (0.14)	2.05*** (0.33)	0.90 (0.13)
Are you aware that electricity charges in your bills are estimated slab-wise? (1 = Yes; 0 = No)	0.95 (0.10)	0.75* (0.12)	1.17 (0.17)
Are you aware that previous errors are adjusted in your current bills? (1 = Yes; 0 = No)	1.42*** (0.16)	1.45** (0.25)	1.46** (0.22)
Are you aware of monthly maximum demand charges? (1 = Yes; 0 = No)	1.05 (0.11)	0.98 (0.17)	1.09 (0.16)
How long have you been using the smart meters? (1 = Less than 6 months; 2 = B/w 6 months and 1 year; 3 = More than 1 year)	0.91 (0.07)	0.87 (0.11)	0.98 (0.10)
Does the household belong to the high SEC category (A1, A2, A3)? (1 = Yes; 0 = No)	1.25** (0.11)	1.22 (0.18)	1.25* (0.16)
Is the respondent female? (1 = Yes; 0 = No)	1.02 (0.10)	0.87 (0.13)	1.15 (0.16)
Is the respondent a prepaid meter user? (1 = Yes, prepaid; 0 = No, postpaid)	1.15 (0.17)	-	-
State fixed effects (Base state – Uttar Pradesh)			
Assam	4.92*** (1.34)	3.04*** (1.39)	7.52*** (2.59)
Bihar	0.89 (0.13)	0.98 (0.16)	-
Haryana	0.68*** (0.10)	0.84 (0.23)	0.66** (0.13)
Madhya Pradesh	0.58*** (0.11)	-	0.62** (0.13)
Rajasthan	1.48*** (0.24)	-	1.36* (0.24)
Number of observations	2414	1091	1323
Log-likelihood	-2107.74	-893.17	-1154.03
Pseudo R²	0.11	0.11	0.13
Prob > Chi²	0.00	0.00	0.00

Source: Authors' analysis

Note: The independent variables that have a P-value of less than 0.05 significantly determine consumer satisfaction with smart meters, and they are highlighted in blue. Standard errors are within the parenthesis below the odds ratios, and we also control for state-level variation by including state-fixed effects in the model.

***p < 0.01, **p < 0.05, *p < 0.1.

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Acronyms

AMI	advanced metering infrastructure
AMISP	advanced metering infrastructure service provider
APDCL	Assam Power Distribution Company Ltd.
AT&C	aggregate commercial and technical
COP	Conference of the Parties
DHBNV	Dakshin Haryana Bijli Vitran Nigam
IRES	India Residential Energy Survey
JVVNL	Jaipur Vidyut Vitran Nigam Ltd.
JdVNNL	Jodhpur Vidyut Vitran Nigam Ltd.
KESCO	Kanpur Electricity Supply Company Ltd
MVVNL	Madhyanchal Vidyut Vitaran Nigam Ltd.
MoEFCC	Ministry of Environment, Forest and Climate Change
MPPKVVCL	Madhya Pradesh Poorv Kshetra Vidyut Vitaran Company Ltd.
MRSI	Market Research Society of India
NBPDCL	North Bihar Power Distribution Company Ltd.
NSGM	National Smart Grid Mission
RDSS	Revamped Distribution Sector Scheme
SBPDCL	South Bihar Power Distribution Company Ltd.
SEC	socio-economic classification
SHGs	self-help groups
UDAY	Ujwal DISCOM Assurance Yojana
UHBVNL	Uttar Haryana Bijli Vitran Nigam Ltd.
UPPCL	Uttar Pradesh Power Corporation Ltd.

State acronyms used in the study

AS	Assam
BR	Bihar
RJ	Rajasthan
HR	Haryana
UP	Uttar Pradesh
MP	Madhya Pradesh

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“With prepaid smart meters, both consumers and utilities will enter a new billing and payments regime. Our study suggests that we need a consultative and holistic approach to ensure a smooth transition and derive the most out of a digitalised and smarter distribution grid.”

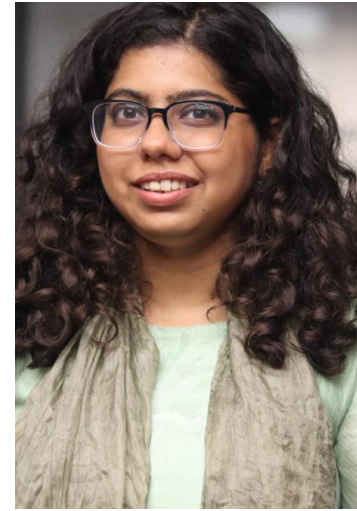


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A Programme Lead at The Council, Sunil's work for the last six years has centred around collecting and using primary data to understand and improve the energy access situation at the household and community level in India. He holds a master's degree in economics from Shiv Nadar University, India.

“India is rolling out one of the world's largest electricity smart metering programmes. The success of this revolution would significantly depend on consumers' engagement, interest, and acceptance of the idea of this transition.”



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Simran works as a Consultant at The Council, and since the past year, has been engaging with issues of smart meter deployment in India. Previously, she worked on issues of revenue recovery and clean energy access in the electricity distribution sector. She has a master's degree in public policy and governance from Azim Premji University, Bangalore.

“Smart meters are necessary to transition to a clean grid. As the scale of deployment increases, focus should be on creating consumer-friendly policies, engaging in consumer-awareness practices, and building discom capacity.”

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“India’s planned smart prepaid meter rollout scale is one of a kind. A consumer-centric deployment of smart prepaid meters will usher in greater transparency in billing and consumer control over their electricity consumption.”

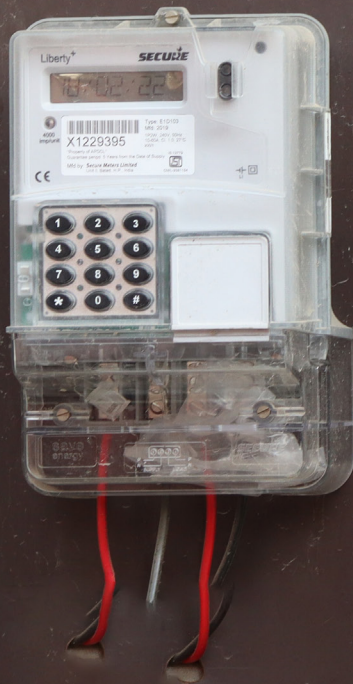
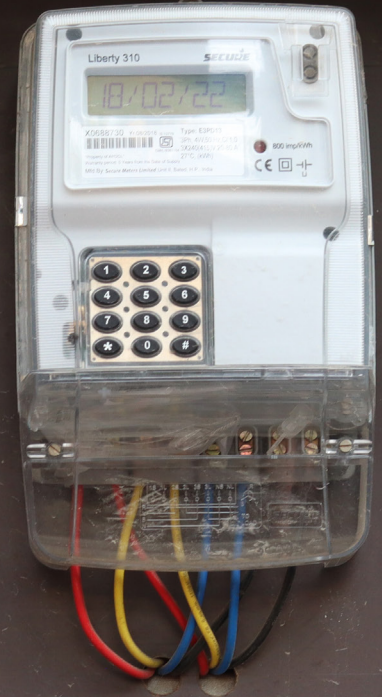
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“Smart meter rollout is aimed at improving discoms’ billing and collection operations and providing reliable service to the consumers. This study offers insights to onboard consumers efficiently and deploy a holistic smart metering ecosystem.”



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