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How can India Scale Up Electricity Demand-side Management?

Insights from a Multi-state Assessment of DSM Regulations and Discom Action

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Report | March 2024

Suggested citation: Aggarwal, Dhruvak, Muskaan Malhotra, and Shalu Agrawal. 2024. *How can India Scale Up Electricity Demand-side Management? Insights from a Multi-state Assessment of DSM Regulations and Discom Action. New Delhi: Council on Energy*, Environment and Water.

Cover image: iStock.

Peer reviewers: Dr Mahesh Patankar, Founder and Managing Director, MP Ensystems Advisory; Pramod Kumar Singh, Senior Director, Alliance for an Energy Efficient Economy; Prateek Aggarwal, Programme Lead, CEEW; and Harsha V. Rao, Consultant, CEEW.

Publication team: Kartikeya Jain (CEEW); Alina Sen (CEEW); The Clean Copy; Madre Designing, and FRIENDS Digital Colour Solutions.

Acknowledgment: We would like to thank Rushabh Soni for his valuable contributions to earlier drafts of this document and Chanmeet Singh Syal for his guidance on India's distribution sector regulatory framework. We owe a debt of gratitude to the various stakeholders who generously shared insights about the long history and the exciting future of electricity demand-side management.

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Shifting load from peak demand hours to solar hours can help increase solar energy's utilisation, making it more cost-effective.

Image: Alamy

Executive summary

India's installed variable renewable energy (VRE) capacity is expected to increase by over three times between 2024 and 2030, from about 118 GW (28 per cent of the installed capacity) to 392 GW (~50 per cent) (CEA 2023c). Maintaining supply reliability while managing VRE's intermittency is a growing priority for policymakers, system operators, and power distribution companies (discoms). In this respect, policy efforts so far have largely focused on supply-side measures, such as supporting the flexible operation of thermal power plants, enhancing the transmission infrastructure, and supporting grid-scale energy storage.

However, there is growing evidence that using electricity demand as a resource rather than a constraint can be an equally cost-effective strategy. While energy efficiency (EE) can help optimise supply-side investments by mitigating demand growth, shifting loads from non-solar to solar hours can help increase renewable energy (RE) utilisation and make it more cost-effective (Abhyankar, Deorah, and Phadke 2021). Making loads more supply-responsive can help integrate more RE sooner, leading to lower system costs and cumulative emissions (Anjo et al. 2018). Therefore, designing a clean and cost-effective power system requires a portfolio of interventions that can influence electricity demand in diverse ways. This is collectively known as demand-side management (DSM) (McKenna et al. 2021).

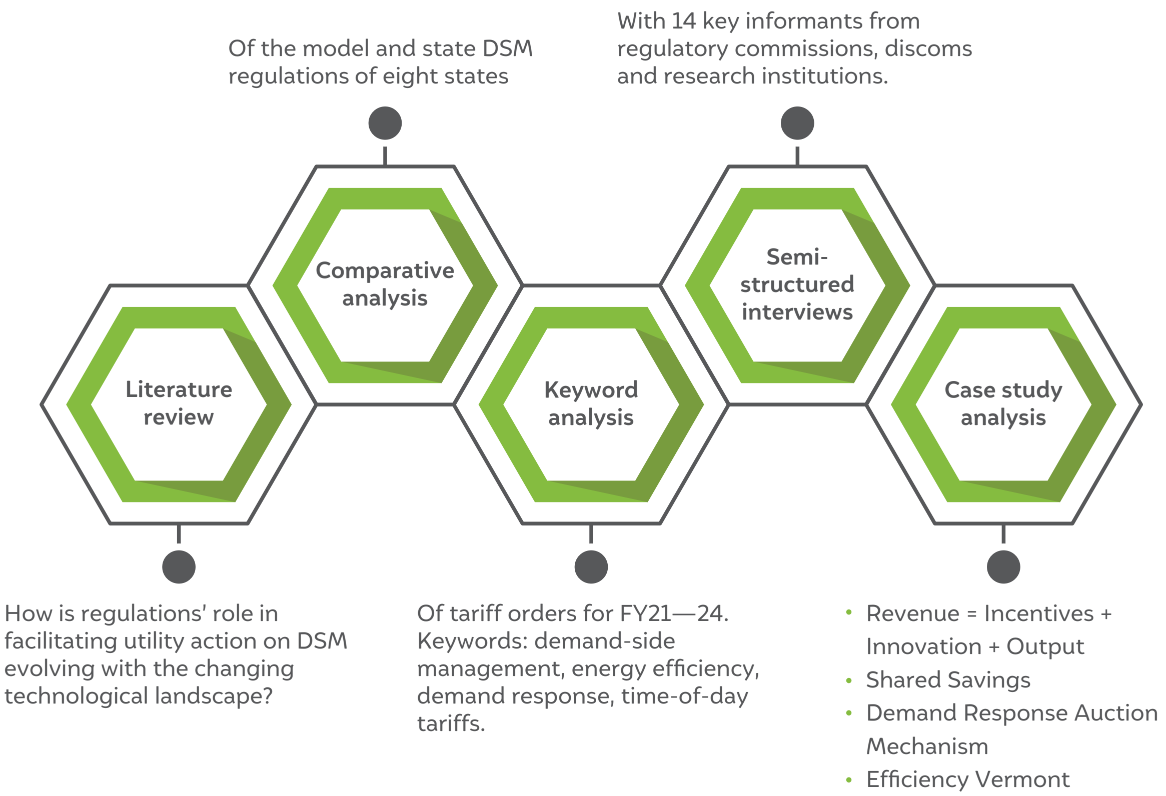
In India, the DSM Regulations (henceforth, "the Regulations") are one of the primary regulations governing demand-side measures in the power distribution sector. First notified by the state of Maharashtra in 2010, and floated by the Forum of Regulators (FoR) as Model Regulations in the same year, 30 Indian states and union territories (UTs) have notified DSM Regulations by 2024. Despite this, progress on DSM has not kept pace with the needs of the Indian power system (Chunekar, Kelkar, and Dixit 2014; Sasidharan et al. 2021; Josey et al. 2023).

Our study takes a critical look at the DSM Regulations and seeks to answer three questions:

- How effective have the Regulations been in aligning discom operations with DSM objectives thus far?
- What are the challenges that limit DSM implementation by discoms?
- How can regulators and policymakers strengthen the regulatory framework to stimulate action on DSM?

Figure ES1 depicts the methodology we used to answer the research questions.

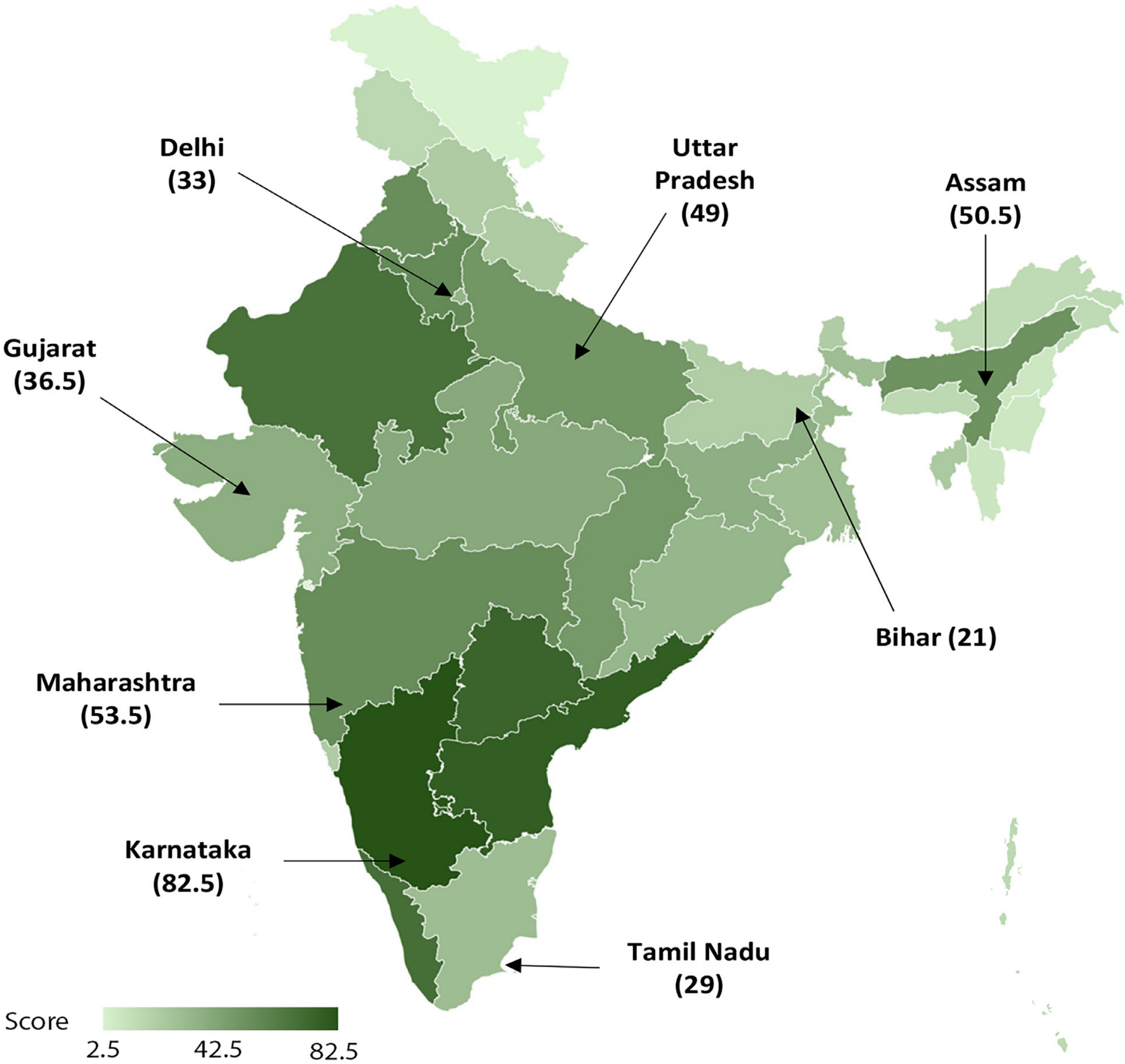
Figure ES1 **Our five-step methodology to answer the research questions**



Source: Authors' compilation

The sampled states span all five grid regions in India, show varied progress on DSM as per the State Energy Efficiency Index (SEEI) 2021–22 (BEE and Alliance for an Energy Efficient Economy 2023), and together constituted half of the all-India electricity requirement in FY22 (CEA 2022a) (Figure ES2).

Figure ES2 **The sample contains eight states with varying progress on DSM**



Source: Authors' compilation based on BEE and Alliance for an Energy Efficient Economy. 2023. State Energy Efficiency Index 2021–22. New Delhi: Bureau of Energy Efficiency and Alliance for an Energy Efficient Economy.

Note: SEEI categories (score range) Aspirant (<30), Contender (30-49.5), Achiever (50-60), Front Runner (>60)

A. How effective have DSM regulations been?

Our review shows that the Model Regulations reflect the context they were drafted in and comprehensively define the roles of DSM, discoms, and state electricity regulatory commissions (SERCs) in assessing its technical potential, setting performance targets, implementing and monitoring programmes, and recovering costs. A comparison across the eight states shows that state regulations largely follow the Model Regulations,[1] with some progressive modifications (Table ES1).

We conducted stakeholder interviews and keyword analysis of tariff orders and found the following:

- **Demand-side management is gaining more attention across states, with a focus on time-of-day (ToD) tariffs and EE.** While ToD tariff design and applicability have been widely discussed, we did not find any reported expenses for enhancing their effectiveness. Energy Efficiency interventions primarily comprise appliance replacement or distribution, which may be driven by Government of India entities such as the Bureau of Energy Efficiency (BEE) and Energy Efficiency Services Limited (EESL). Discussions on other DSM interventions, such as load shifting and demand response (DR), are largely absent.
- **Discoms report including DSM measures in energy sales projections, but impact quantification is limited.** All state orders, except those for the public discoms in Maharashtra, Tamil Nadu, and Gujarat, mention that DSM measures have been incorporated in sales projections, but there is no description of how the measures were integrated or quantification of their impacts. Barring occasional reporting by Delhi, Karnataka, and private discoms in Maharashtra, none of the state orders fulfil reporting criteria.
- **There is a lack of transparency regarding methodologies, performance targets, programme design, and impact assessment.** The DSM Regulations require discoms to design and implement programmes based on the SERC's guidelines on load and market research, cost-effectiveness, implementation, and monitoring. However, Maharashtra is the only state in the sample to have publicly available cost-effectiveness guidelines. Programme design and monitoring details are not available for any state.
- **Funding DSM through retail tariffs is allowed, but there are bottlenecks in actual cost pass-through.** For instance, Delhi's SERC prospectively allowed tariff-based recovery of a DSM programme based on a cost–benefit analysis in 2018, but in FY21 it disallowed pass-through because there was no detailed break-up of actual implementation costs. The SERCs in Maharashtra, Karnataka, and Gujarat allocated a prospective budget for DSM, but the discoms did not claim expenses under it.

Our findings suggest that thus far, DSM Regulations have played a limited role in aligning discoms' operations with the power system's evolving needs. Private discoms show clearer evidence of taking DSM initiatives than public discoms, perhaps due to their governance structure, a favourable consumer mix, limitations on infrastructure expansion in their service areas, and a proactive approach to innovation.

> **Time-of-day tariffs and energy efficiency have received growing attention as DSM strategies across states in recent years.**

1 This holds for those states whose DSM Regulations were notified after the FoR drafted the Model DSM Regulations – that is, all states except Maharashtra.

Table ES1 **Many states have added progressive measures in their DSM regulations**

Parameter	Features
DSM definition and objectives	**Model regulations (MR):** Utilities' behind-the-meter actions to increase, decrease, shift, or manage demand to reduce utility costs, mitigate power shortage, reduce seasonal peaks, save energy, reduce electricity costs, reduce greenhouse gas emissions, etc. **State regulations (SR):** Additional objectives include avoiding/reducing/postponing capacity additions and power purchases and deferring capital expenditure.
Methodologies	**MR:** Discoms will conduct technical potential studies per BEE's methodology; SERCs must provide guidelines for other activities (load and market research, implementation, cost-effectiveness assessments, etc.) **SR:** Maharashtra is the only state from the sampled states for which cost-effectiveness guidelines are publicly available; Karnataka's regulations require discoms to devise their methodologies.
Performance targets	**MR:** SERCs may scrutinise the studies conducted by discoms and set targets in percentage load growth reductions or kilowatt savings terms. **SR:** Provisions are identical to the MR.
Compliances and timelines	**MR:** Technical potential studies, perspective and annual DSM plans, programme documents, progress reports, and completion reports are tied to the tariff determination process under Multi-year tariff regulations. **SR:** Additionally, the Regulations of Maharashtra, Karnataka, and Tamil Nadu define the frequency of submission of progress reports on the DSM plan, while the latter two also specify the frequency of submission for monitoring and programme completion reports.
Cost recovery mechanism	**MR:** Discoms can propose a methodology for the recovery of net incremental costs through tariffs or other means. For programmes that may not be cost-effective but may be 'beneficial for society', the SERC can make resources available. **SR:** The Regulations of Maharashtra and Tamil Nadu allow for a public benefit charge that is complementary to tariffs in recovering DSM costs. All other state regulations have provisions identical to the MR.
Consumer incentives	**MR:** May be provided for achieving or exceeding the targets. **SR:** The Regulations of Uttar Pradesh, Maharashtra, and Tamil Nadu allow for incentives to be paid to consumers for DSM promotion. The Tamil Nadu Regulations include specific incentives such as extending time-of-day metering to low-tension consumers.
Institutional design	**MR:** A dedicated DSM cell to be set up within the discoms with the 'necessary authority and resources' to perform DSM-related functions. **SR:** The Regulations of Tamil Nadu and Maharashtra provide for a DSM advisory/consultation committee in addition to the DSM cell to advise discoms on all DSM functions. Tamil Nadu requires discoms to set up DSM sub-cells at the regional level.

Source: Authors' analysis

B. What is limiting discom-led DSM in India?

A combination of the following factors explains the limited effectiveness of the DSM Regulations:

- **Gaps in the regulatory framework design:** While enhancing supply reliability is not considered an objective of DSM, the poor enforcement of reliability standards diminishes discoms' incentives to implement DSM, and they use load shedding as the alternative. Additionally, DSM cost recovery is ambiguous due to the absence of impact evaluation guidelines.
- **Disconnect between the DSM Regulations and discoms' resource planning:** The cost-plus tariff regulatory framework does not sufficiently incentivise discoms to consider DSM in their planning. Discoms and SERCs treat DSM as a programmatic and subsidiary activity during the budget allocation and progress reporting processes, leading to limited resource allocation for DSM. As a result, DSM has not been institutionalised in discoms.
- **Lack of monitoring and enforcement by SERCs:** There is minimal information in the public domain on how SERCs hold discoms accountable for compliance with DSM Regulations. Poor enforcement leads to a lack of trust among stakeholders such as technology service providers and financiers.
- **Lack of expertise and resources in discoms:** Due to discoms' perception of DSM as a subsidiary activity as well as poor regulatory enforcement, the staff assigned to DSM cells may lack the necessary expertise to conduct/supervise technical potential and load research studies, cost-effectiveness tests, and so on. DSM cells are often inactive and contain staff for whom DSM is an ad hoc responsibility.

C. Roadmap to reform DSM

Given the factors hindering systematic DSM implementation by discoms, we recommend five steps to strengthen the regulatory framework.

- **SERCs must update the DSM Regulations.** DSM's definition and objectives must be updated to reflect its potential to enhance supply reliability cost-effectively, facilitating the entry of new technologies and business models into the power system. In this regard, progressive measures seen in select state regulations can provide helpful examples for other states (Table ES1).
- **SERCs must adopt performance-based regulations and incorporate DSM in resource adequacy and integrated resource planning (IRP).** SERCs must provide supply reliability–based incentives to discoms as laid out in the National Tariff Policy (MoP 2016). Gujarat's Draft Multi-Year Tariff (MYT) Regulations, 2023, are a case in point (GERC 2023b). SERCs must limit discoms' incentives to use load shedding as a DSM strategy by strictly enforcing standards of performance regulations. Under their guidance, discoms must adopt resource adequacy (CEA 2022b) and IRP and include DSM in both exercises.
- **The FoR and SERCs must draft standardised methodologies and reporting formats and commission studies that assist programme design.** The FoR should consider drafting standardised methodologies for load research and cost-effectiveness tests based on various states' experiences and available scientific standards. SERCs must enhance these methodologies with support through public consultations and update the MYT formats for discoms to report DSM-related data. Drawing from the experience of the California Energy Commission, regulators must independently commission studies on energy end-use.
- **Governments must create a funding pool for technological and business model innovation to help create a pipeline of projects.** Such a pool can be created through centrally sponsored schemes, such as the *Revamped Distribution Sector Scheme*, or by expanding the remit of state-designated agency (SDA) activities, drawing from the case of Efficiency Vermont in the USA. Tax funding for DSM should be contingent on publicly reported load research and impact evaluation studies, to help accelerate learning across discoms.
- **Governments must mandate DSM and facilitate market creation for its monetisation.** Market-based instruments, such as the *Perform, Achieve, and Trade* (PAT) mechanism, can help discoms monetise DSM measures through alternate revenue streams. California's demand response auction mechanism (DRAM) provides a useful example, where utilities are mandated to procure DR services while allowing service providers to participate in the wholesale market.

India's power system has evolved from a scarcity-ridden yet predictable grid to one facing swings in supply from surplus to scarce as well as growing demand uncertainty. Given the increase in VRE share in generation capacity, India must tap demand as a resource. Enhancing policy ambition and reforming regulations could empower discoms to experiment with technologies and business models, fail fast, and move quickly to large-scale deployment.

1. Introduction

India's electricity sector is entering its third major growth phase this century. **The first phase was defined by the passage of the** ***Electricity Act*** **in 2003,** doubling the power generation capacity[2] (CEA 2021) and achieving a nationally synchronised grid by 2013. However, per capita electricity demand grew by nearly 60 per cent in this phase, albeit from a low base, leading to a consistent national energy deficit of around 8 per cent (ibid). The **second phase saw household electrification increase from 67 per cent to 97.3 per cent between 2010 and 2020** (Agrawal et al. 2020), bringing swathes of new consumers to the grid. However, a slowing down of per capita electricity demand growth, together with a rapid expansion in generation capacity, including a tripling of renewable energy capacity, caused the energy deficit to fall from 8 per cent to 0.5 per cent by 2020 at the cost of thermal power plant utilisation (CEA 2021).

In the third phase, electricity demand is galloping again, albeit with more uncertainty. In this scenario, ambitions for increasing the share of variable renewable energy (VRE) present us with a choice. We can either over-design the system based on optimistic expectations of annual peak demand growth[3] and continue with rigid contracts between generators, discoms, and consumers, or we can utilise the diversity of various energy sources that new technologies offer and design a more cost-effective power system.

India aims to integrate at least 500 GW of non-fossil power generation capacity by 2030, of which about 400 GW will be VRE, which is equivalent to about half of the installed capacity and a third of the energy generation (CEA 2023c). With installed VRE capacity accounting for 27.5 per cent and VRE generation accounting for 11.5 per cent in 2022 (CEA 2023a), the grid already required increased flexibility for reliable operation (CEA 2023b). Most of the policy focus for enhancing power system flexibility so far has been on the supply side – namely, flexibly operating thermal power plants (ibid), commissioning hybrid and round-the-clock renewable energy (RE) plants (Shah et al. 2022), enhancing transmission infrastructure (CEA 2022c), and supporting energy storage systems (MoP 2023).

Global experience and modelling studies show that demand-side management (DSM) will be critical for VRE integration. For instance, Abhyankar, Deorah, and Phadke (2021) find that the least-cost system to integrate 465 GW of RE in the Indian system by 2030 would require 60 GW of load to be shifted from non-solar to solar hours. A modelling study on the Portuguese power system showed that demand response (DR) can help integrate more RE sooner, and, consequently, will result in lower system costs and cumulative emissions (Anjo et al. 2018). A power system that is clean yet reliable and affordable requires demand to be treated as a resource rather than as a hard constraint.

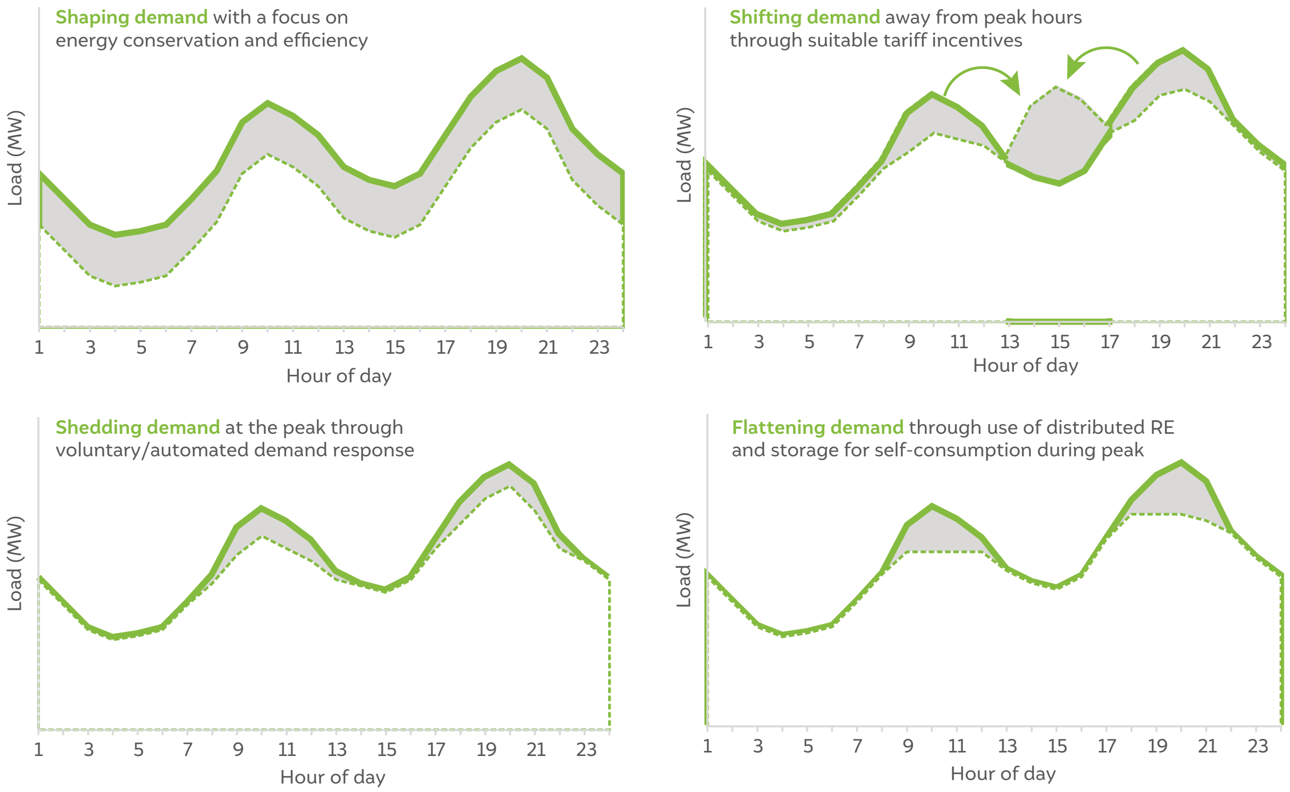
Treating demand as a resource is a deliberate process rather than an organic transition. It requires an expanded definition of DSM beyond energy efficiency (EE) and energy conservation. DSM should be viewed as a portfolio of interventions that can influence aggregate electricity demand and demand profile in diverse ways (McKenna et al. 2021) (Figure 1). While EE and decentralised RE systems can help lower the load curve across hours, other measures such as load shifting, behavioural changes, and DR can help match supply and load profiles and reduce peak demand. Thus, DSM is also about leveraging other 'behind-the-meter' technologies like distributed generation, storage, and electric vehicles (EVs).

> **Demand-side management is a portfolio of interventions that treats demand as a resource for supply reliability and clean energy integration.**

2 Including renewable energy sources, excluding captive generation capacity.

3 Annual peak demand is typically seen for less than five per cent of the hours in a year.

Figure 1 DSM includes different interventions that help modulate the demand profile



Source: Authors' illustration

As entities that procure resources to serve demand, power distribution companies (discoms) are critical in transitioning to a clean grid that continuously and cost-effectively balances variable demand and supply. Since discoms are regulated monopolies, the regulations governing their operations are central to charting the transition pathway and equipping them with the relevant tools.

In the Indian electricity sector, the DSM Regulations (henceforth, "the Regulations") are the key mechanism that affects demand-side planning. Although 29 states and union territories (UTs) have notified the Regulations since 2010,[4] the belief that DSM is peripheral to discoms' core function of supplying electricity, and the lack of a clear framework for large-scale programme implementation, have led to limited progress (Chunekar, Kelkar, and Dixit 2014; Sasidharan et al. 2021). Where implemented, most programmes have focused largely on EE (FoR 2017). While sample estimates show that promoting EE may be cheaper than procuring more energy (PwC, Utility CEO, and Shakti Foundation 2014), impact assessments of implemented programmes are not publicly available. Furthermore, schemes like the *Pradhan Mantri Kisan Urja Suraksha Evam Utthan Mahabhiyan* (PM KUSUM), which shape the load profile through load shifting, are not included in discoms' DSM plans.

Given the power system's changing needs, this study aims to reassess the relevance of the Regulations by delving into three critical questions:

- **How effective have the Regulations been so far?**
- **What are the challenges faced by discoms that lead to limited implementation of DSM?**
- **What measures can help strengthen the regulatory framework and its enforcement?**

This study adds to the discourse by reviewing the key features of the Regulations and analysing their relationship with the larger regulatory framework rather than only assessing their implementation.

4 As per Sasidharan et al. (2021), Uttarakhand has notified DSM regulations but a public copy of these could not be located, and, hence, the state is not included in the states/UTs that have notified the regulations.

2. Methodology

To assess the effectiveness of the DSM Regulations, we followed a five-step process as described below:

- A detailed review of the literature to assess regulations' evolving objectives in stimulating utility-led DSM amid a changing technological and policy landscape (discussed in Section 3).
- A comparative analysis of the Model DSM Regulations notified by the FoR in 2010 and the Regulations notified by the state electricity regulatory commissions (SERCs) of select states. We used purposive sampling to select eight states based on two criteria:
  - **Geography:** We selected at least one state from each of the five regions of the Indian electricity grid to ensure geographical representation.
  - **Score on the State Energy Efficiency Index (SEEI)**: The SEEI 2021–22 (BEE and Alliance for an Energy Efficient Economy 2023) provides a comparative evaluation of all states/UTs based on their performance on EE indicators across seven sectors.[5] We selected states with diverse levels of progress on DSM across consumption segments as indicated by their overall scores on the index.[6]

The Regulations in the selected states have been applicable for 7 to 13 years. The selected states accounted for half of the all-India electricity requirement in FY22 (CEA 2022a). Table 1 shows their key characteristics.

- An analysis of the states' distribution tariff determination orders, issued by their respective SERCs, for four consecutive years (FY21–FY24) to determine how the annual planning and tariff determination process align with the Regulations. We developed and used a Python-based text analysis tool to determine the frequency and context of occurrence of the following keywords: 'demand-side management', 'energy efficiency', 'demand response', and 'time-of-day'.[7] We designed the tool to highlight the context in which the keywords were used by extracting two sentences before and after their occurrence. The tool helped us gather information about the nature of DSM interventions reported and discussed in the tariff determination proceedings. However, a shortcoming of the tool was that we could not use it on scanned documents.
- To characterise the challenges in implementing DSM measures, we conducted 14 semi-structured interviews over the telephone and in person, spanning SERCs, discoms, civil society organisations, and market participants that provide technologies for DSM measures (Table 2). Each interview lasted 30 to 45 minutes.

Table 1 States were selected to reflect varied levels of progress on DSM using the SEEI score as a proxy

S. no.	State	Grid region	Year of notification of the DSM Regulations	SEEI score on discom indicators (max. 10)	SEEI overall score (max. 100)
1.	Bihar	Eastern	2014	6.0	21.0
2.	Assam	North-eastern	2012	6.5	50.5
3.	Delhi	Northern	2014	7.0	33.0
4.	Uttar Pradesh	Northern	2014	6.5	49.0
5.	Karnataka	Southern	2015	6.5	82.5
6.	Tamil Nadu	Southern	2013	7.0	29.0
7.	Gujarat	Western	2012	5.5	36.5
8.	Maharashtra	Western	2010	8.0	53.5

Source: Authors' compilation

5 The seven sectors are buildings, industries, transport, municipal services, agriculture, discoms, and cross-sectoral indicators. The score on discom-related indicators has a correlation of 0.73 with the overall score.

6 In subsequent iterations of the SEEI, a distinction between Government of India–supported and discom-driven DSM programmes would serve to better judge the state of DSM implementation in discoms.

7 We did not use 'DSM' as a keyword because (1) DSM is also used to refer to the 'deviation settlement mechanism' in tariff orders, which leads to an inflated number of occurrences of the acronym, and (2) in most cases where DSM refers to demand-side management, the orders use the expanded form alongside the acronym.

Table 2 The stakeholder interviews helped form a rounded view of DSM implementation challenges

Stakeholder category	Name of the organisation
State electricity regulatory commissions (SERCs)	Maharashtra SERC
	Uttar Pradesh SERC
	Delhi SERC
	Karnataka SERC
	Bihar SERC
Discoms	Maharashtra State Electricity Distribution Company Limited
	Uttar Pradesh Power Corporation Limited
	BSES Yamuna Power Limited (Delhi)
	Tata Power Delhi Distribution Limited
Civil society organisations	Prayas Energy Group
	Alliance for an Energy Efficient Economy
	MP Ensystems Advisory
Technology service providers (TSPs)	TSP 1: Provided the technology platform to implement DR pilots in multiple discoms.
	TSP 2: EV charging system operator running a vehicle-to-grid pilot project with a discom.

Source: Authors' compilation

- Finally, we combined the results of the Regulations analysis and stakeholder interviews with information obtained from four case studies on regulatory frameworks and policy instruments. We identified the cases using an inductive approach. These cases are practical examples of how regulations and policies can guide utilities' performance to meet evolving expectations. They also allow us to identify learnings for India's power sector and identify how the Indian regulatory framework could be updated for more effective DSM.

3. The evolving role of demand-side regulations

Demand-side interventions suffer from market failures and barriers[8] that lead to underinvestment in DSM by utilities, making regulation necessary to obtain the desired investment levels. In addition to addressing the traditional market barriers and failures, the regulatory framework should also evolve to meet changing grid requirements and expectations from utilities in the context of the evolving nature of grid operations due to technologies such as weather-dependent and decentralised generation and digital devices (Meeus et al. 2010; Haley et al. 2020). This section reviews the rationale for regulating utilities' actions on the demand side in a transitioning technology landscape.

3.1. Realigning utilities' incentives

In traditional cost-plus or cost-of-service regulation, utilities are allowed to recover all costs plus a return on equity on capital investment, implying that they can recover higher revenue when more energy is sold using their wires or, if they sell the electricity themselves, when they incur higher power purchase costs. Such a regulatory structure does not incentivise utilities to help consumers reduce their energy consumption since energy conserved represents lost revenue (Eldridge et al. 2006). Furthermore, where utilities are allowed a fixed return on their assets, they may be inclined to substitute operating expenditure ('opex') with capital expenditure ('capex') (Brunekreeft and Rammerstorfer 2021). A bias towards capex could lead to lower than desired investments in opex-based measures that can help meet system reliability objectives, such as fee-based models for procuring grid services (Sarkar et al. 2016).

Regulations can diminish utilities' incentive to sell more electricity by decoupling revenue from sales while allowing recovery of efficient costs (Cross-Call et al. 2018).

8 Market barriers refer to obstacles that limit an entity's entry into the market. Market failure refers to the failure of market institutions to avoid 'undesirable' activities, where desirability is relative to an explicit economic welfare maximisation problem (Bator 1958).

Such revenue decoupling fixes utilities' revenue upfront and adjusts electricity prices according to the allowed revenue instead of the other way around – in traditional cost-plus regulation (Lazar et al. 2016). Revenue decoupling lets utilities focus on meeting other system-level objectives rather than focusing solely on electricity sales. India's National Tariff Policy (MoP 2016) also mentions that SERCs may use such 'price cap regulation'.

However, decoupling forms only the first layer of regulatory reform and requires complementary measures to be effective. In developing countries with growing electricity demand, such as India, fixing an efficient revenue level would be challenging: a high threshold could lead to inflated electricity prices, while a low threshold could reduce supply reliability (Brennan 2010). While setting a per-consumer revenue cap instead of an aggregate revenue cap could help (von Loessl and Wetzel 2022), enforcing supply reliability standards is critical. Accompanying regulatory mandates for integrated resource planning (IRP) that require utilities to consider DSM as an alternative to supply augmentation would provide it a strong impetus (Singh and Swain 2018). Furthermore, resorting to higher prices to maintain utilities' revenue could put consumers who are unable to reduce consumption at an elevated price risk (von Loessl and Wetzel 2022). In such a scenario, ensuring lower effective electricity prices would require other revenue streams for utilities and consumers.

Regulatory cost treatment approaches to determine a utility's efficient revenue level are also evolving to address the capex bias. Section 5.1 looks at a practical example of total expenditure ('totex')–based cost treatment as a remedy to the capex bias as well as a method to decouple utility revenues from energy sales.

3.2. Guiding programme design

Loughran and Kulick (2004) discuss how DSM participants can often be free riders – that is, programmes may target consumers who invest in EE due to market dynamics regardless of DSM interventions by the utilities. Disregarding the free-riding consumers and market-driven technologies could lead to overestimating the impact of utility-led DSM programmes.[9] For example, the efficiency improvements in the Indian AC stock are almost entirely due to AC manufacturing regulations by the Bureau of Energy Efficiency (BEE) rather than discom-driven DSM programmes. Therefore, DSM programmes should be used to: (1) avoid selection bias in targeting beneficiaries[10] and (2) accelerate investment in technologies that would be useful in meeting policy objectives but whose market may not be fully mature.

In the Indian electricity sector, consumers who are charged time-invariable and subsidised (non–cost-reflective) power tariffs have the least incentive to invest in EE (Aggarwal and Agrawal 2022) or participate in DR programmes. These are also the consumer segments where losses are high and supplying electricity is costlier (Pachouri, Raparthi, and Sharma 2020). However, in consumer segments where losses are lower, discoms have a lower incentive to reduce demand. Thus, in India's landscape of publicly owned utilities, supporting the adoption of new technologies among high- and low-income consumers requires prescribed targets for discoms.

Furthermore, regulations must also set the processes for gathering and reporting data, maintaining programme transparency, and monitoring achievement against approved targets. The frequency and timeline of targets must fulfil two criteria: one, they should provide policy certainty to the utilities, consumers, and other stakeholders in the short to medium term, and two, they should limit the regulated entities' ability to exploit information asymmetries to underperform (Haley et al. 2020). Sections 5.2 and 5.3 demonstrate the importance of measurement standards and transparency.

3.3. Evaluating cost-effectiveness

DSM investments can vary in their cost-effectiveness for various reasons. For example, Hadley and Hirst (1995) found that the average estimate of the cost-effectiveness of DSM conceals variations between USD 0.004/kWh and USD 0.133/kWh. Larger programmes for commercial and industrial consumers may be more cost-effective than smaller programmes, such as those for residential consumers (Eto et al. 2000). The lack of standard methodologies and non-reporting of some costs can prevent accurate estimation of cost-effectiveness and the comparability of investments between and within utilities (Joskow and Marron 1992; Sarkar et al. 2016). Technical assessments may overestimate savings due to the interplay between multiple DSM options. For instance, EE measures can reduce the load available for DR (Woychik and Martinez 2012).

9 Loughran and Kulick (2004) do not consider the externalities of DSM programmes and provide a conservative estimate of their impacts. The externalities associated with DSM are discussed in Section 3.4.

10 Selection bias in this context refers to choosing free-riding consumers whose derived benefits are not representative of the impact of a DSM programme.

In developing countries, where electricity consumption may be unsaturated and would be expected to grow (Fowlie and Meeks 2021), estimating the baseline to measure programme effectiveness is challenging. Gauging DSM's value requires extensive data on costs and benefits and needs to go beyond techno-economic evaluations to establish the impact on overall welfare. The lack of consistent metrics to evaluate DSM benefits increases the uncertainty in whether regulators would allow cost recovery through tariffs (Potter, Stuart, and Cappers 2018). The regulatory framework must provide the tools that enable utilities to conduct robust evaluation, measurement, and verification (EMV) of DSM interventions and allow independent assessments of their social impacts. This would also facilitate the development of appropriate markets and financing avenues through an accurate and transparent estimation of the risks of DSM programmes (D'Ettorre et al. 2022). The framework should also ensure equitable participant selection by the utility (see Section 5.2 for an example).

3.4. Accounting for externalities

DSM suffers externalities such as hidden costs and public good characteristics, which increase the true costs of implementing DSM and underestimate its benefits. Hidden costs could be in the form of transaction costs like search costs for buying new technologies, training operators, equipment maintenance, etc. Hidden costs could also arise from the failure of technical potential studies to fully capture the costs and benefits of interventions. For example, the lower utility derived from compact fluorescent lamps (CFLs) as a result of their light quality being worse than that of incandescent bulbs may not be captured in cost estimations.

Public goods characteristics of an investment imply that their costs/benefits are not fully internalised by the investors (Ostrom and Ostrom 1979). For example, the improved reliability of electricity supply to consumers beyond just the adopters of energy-efficient technologies makes EE a public good (Carranza and Meeks 2021). Similarly, participants of DR programmes can help improve overall supply reliability, preventing failure and outages even for non-participants. Information about the effectiveness of new technologies is also a public good, as it can flow from consumers or utilities that invested in it to those that did not. However, adequate provision of public goods, in this case DSM, requires regulation.

The positive aspects of public goods can also be leveraged by regulations to drive wider uptake. For example, information from a DSM programme in one utility, even if unsuccessful, can be used in future programmes or by other utilities. Creating public goods in this manner can accelerate learning, lower costs, and increase the adoption of DSM, especially in developing countries (Boyle 1996).

Thus, regulations governing monopolies must adapt to the evolving technology landscape and help direct their operations and investments towards desired policy objectives. In the following chapter, we unpack the existing DSM Regulations in India and discuss how they measure up to this task.

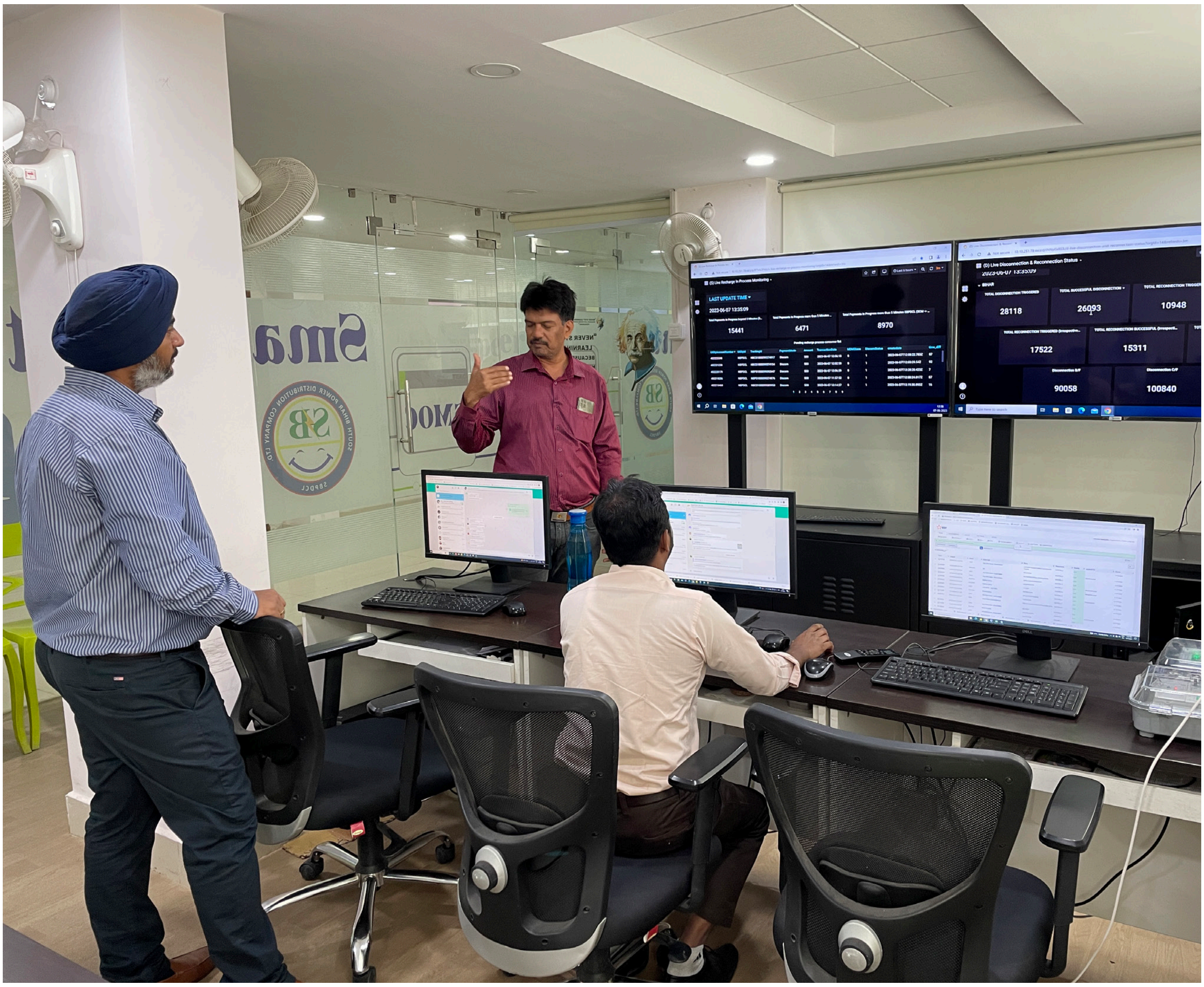
> **Regulations are necessary to correct the market failures and barriers that hinder utility-led investments in DSM.**

4. Effectiveness of the Regulations in India

Although the Regulations have been notified in 29 states/UTs since 2010, their effectiveness in stimulating discom action remains unclear (Chunekar, Kelkar, and Dixit 2014; Sasidharan et al. 2021). This chapter describes the key provisions in the Regulations, analyses the extent to which they are a part of discoms' annual planning and tariff determination process in select states, and discusses the challenges faced by various stakeholders in following the Regulations.

4.1. Key features of the Model and state DSM Regulations

The *Energy Conservation Act, 2001*, set up the institutional structure for economy-wide energy conservation activities by establishing the BEE and state-designated agencies (SDAs). However, the Act's focus was on transforming EE product markets rather than stimulating utility DSM (FoR 2010a). Under the Act, while discoms are 'designated consumers', their obligation is limited to improving the efficiency of their operations rather than end-use consumption. *The Electricity Act, 2003* – the main legislation governing the Indian electricity sector – also promotes the sector's efficient operation but does not mandate any institution to carry out DSM functions (ibid).



With the growing penetration of smart meters, discoms can employ opex-based business models for DSM.

Image: CEEW

Table 3 Key features of the *Model DSM Regulations, 2010*

Parameter	Feature
DSM definition and objectives	**Definition:** "the actions of a Distribution Licensee, beyond the customer's meter, with the objective of altering the end-use of electricity – whether it is to increase demand, decrease it, shift it between high and low peak periods, or manage it when there are intermittent load demands – in the overall interests of reducing Distribution Licensee costs." **Objectives:** "power shortage mitigation, seasonal peak reduction, cost-effective energy savings, lowering the cost of electricity, reduction in emissions of greenhouse gases, etc."
Methodologies	Discoms must conduct the technical potential study guided by the methodology developed by the BEE. SERCs will provide the guidelines for all other activities, such as load and market research, programme implementation, cost-effectiveness assessment, EMV, and monitoring and reporting (M&R).
Performance targets	SERCs may scrutinise the studies conducted by discoms and set targets in percentage load growth reduction, kilowatt or kilowatt-hour savings terms, or savings as a percentage of total resources to meet the load.
Compliances and timelines	**Technical potential study:** To be conducted one year before the start of the next MYT control period (three to five years). **Perspective plan for activities over the control period**: At least six months before the start of the control period. **Annual plans:** To be submitted to the SERC with the annual performance review, which, as per the MYT Regulations, must be submitted by 30 November of each year for tariff to be enforced starting April of the following year. **Programme document:** To be submitted to the SERC for approval before implementation of any programme. **Progress reports on the perspective plan:** Every six months. **Programme completion reports:** Within one month of programme completion.
Cost recovery mechanism	Discoms can propose a methodology for recovering **net incremental costs** through tariffs or other means. The SERC can make resources available for programmes that may not be cost-effective but could be "beneficial for the society".
Incentives	May be provided to the discom for achieving or exceeding targets.
Institutional design	A dedicated DSM cell is to be set up within the discoms with the "necessary authority and resources" to perform the DSM-related functions.

Source: Authors' compilation based on the Model DSM Regulations (FoR 2010a)

In May 2010, the FoR drafted the *Model DSM Regulations* to fill the institutional gap in DSM. Table 3 summarises the key features of the Model DSM Regulations. Since crucial DSM compliance aspects and timelines are tied to the Multi-Year Tariff (MYT) Regulations (FoR, 2011), Annexure I provides a brief overview of these regulations.

SERCs could modify the Model Regulations' clauses to suit the state's context. Our review shows that state DSM regulations largely follow the Model Regulations in structure and provisions. However, some innovative features stand out, such as capex deferral as an explicit objective of DSM, adherence to cost-effectiveness metrics for project evaluation, creation of a public benefit charge for funding DSM, setting up DSM consultative committees and sub-cells for monitoring, and additional transparency requirements. Table 4 summarises these noteworthy modifications that could help explain the differences in DSM implementation observed across the selected states.

Table 4 SERCs have introduced additional innovative clauses in state DSM Regulations

Parameter	Feature
DSM definition and objectives	• Delhi's Regulations have two additions to DSM objectives: (1) amending the consumer's load profile in terms of level and timing of consumption and (2) complementing supply-side strategies to help the utilities avoid, reduce, or postpone costly capacity (generation, transmission, and distribution network) additions and power purchases. • Tamil Nadu's Regulations mention capex deferral as an objective of DSM.
Methodologies	• Maharashtra is the only state in the sample where the SERC has provided cost-effectiveness assessment guidelines for DSM programmes, prescribing three tests to measure cost-effectiveness. The programmes are screened based on their net present value. Additional factors in programme selection are the potential for peak load reduction/shifting, the creation of new energy-efficient equipment stock, the period over which electricity savings are available, and carbon dioxide reduction potential. However, the EMV guidelines under Maharashtra's Regulations are not publicly available. • In Delhi, the discoms must also calculate the cost-effectiveness index for DSM projects, but the method used to calculate the index is not publicly available. • Karnataka is the only state in the sample that requires discoms to develop a methodology for cost-effectiveness, which may be less desirable due to discoms' capacity constraints and a conflict of interests.
Compliances and timelines	• All the reviewed Regulations tie the submission of technical potential studies, perspective DSM plans, and annual plans with the MYT process as in the Model Regulations. Bihar is the exception since its MYT regulations came into force in 2018, four years after the DSM Regulations were notified. Consequently, rather than following the MYT control period, Bihar's Regulations require DSM plans to be designed annually. • Only three of the reviewed state regulations define the frequency of submission of monitoring reports. For example, Maharashtra's discoms must submit monthly and quarterly monitoring reports for all pilot-phase and large-scale DSM programmes conducted in a year and submit progress reports on the control period's DSM plan quarterly and annually. • Karnataka's Regulations specify that the discoms must report progress on the DSM plan every six months and provide reports on completion, expenses, achievements, lessons learnt, and the way forward within a month of programme completion. • Tamil Nadu's discoms are required to submit only a quarterly progress report on the DSM plan.
Cost recovery mechanism	• Maharashtra's and Tamil Nadu's regulations allow for a public benefit charge as complementary to tariffs to recover DSM costs.
Incentives	• Uttar Pradesh's, Maharashtra's, and Tamil Nadu's regulations allow discoms to incentivise consumers to promote DSM. In contrast, Karnataka's Regulations do not provide incentives for the discoms or the consumers. • Tamil Nadu's Regulations also specify the nature of incentives that could be used, such as extending time-of-day metering to low-tension consumers, load management, rebates for EE buildings/appliances, etc.
Institutional design	• Regulations in Bihar, Tamil Nadu, and Maharashtra provide for a DSM advisory or a consultation committee to be created by the SERC in addition to the DSM cell within the discoms. These committees must advise the SERC and discoms on all DSM functions specified within the Regulations. Maharashtra's committee is also responsible for developing and maintaining databases on innovations and technologies relevant to DSM and information on past programmes. This consultation committee also acts as a platform to connect financiers with discoms. Tamil Nadu's committee is entrusted with evaluating the terms for DSM funding. • Gujarat's and Tamil Nadu's regulations prescribe the constitution of the DSM cell by specifying the required number and rank of officials. • The Tamil Nadu Regulations require discoms to set up additional DSM sub-cells at the regional level to offer consultation to consumers to carry out DSM-related activities in their homes/industries/establishments, etc. • Delhi is an exception since its Regulations do not prescribe any cell or committee dedicated to DSM.
Transparency	• Maharashtra's Regulations explicitly mention that documentation on DSM plans and programmes must be uploaded on the discoms' websites for wider dissemination. The consultation committee must also consult various stakeholders while designing DSM programmes. None of the other regulations, including the Model Regulations, have these provisions.

Source: Authors' analysis based on the DSM Regulations of selected states

Based on this review and in the backdrop of the evolving role of regulations discussed in Chapter 3, we make the following observations.

- **Enhancing supply reliability is not an objective of the Regulations.** The Model Regulations focus primarily on power shortage mitigation through EE and energy conservation. In 2010–11, when the Model Regulations were drafted, India's annual electrical energy deficit was 8.50 per cent, and the supply deficit to meet the peak demand was 9.84 per cent (CEA 2021). Closing the deficit by mitigating demand growth was a policy objective enshrined in the Model Regulations. However, by 2020–21, the energy and peak deficits had fallen to 0.38 per cent and 0.42 per cent, respectively (ibid). Now, with the share of VRE increasing, cost-effective and reliable grid operation has become a larger concern. 'Behind-the-meter' technologies can help discoms tap DSM to meet these objectives (Carranza and Meeks 2021; Dranka, Ferreira, and Vaz 2022)we estimate the impact of compact fluorescent lamps (CFLs, and the Regulations must facilitate this.
- **The provisions concerning DSM financial incentives and funding are inadequate.** The cost-plus regulatory structure with a provision to pass power purchase cost variations due to sales fluctuations to retail tariff does not rectify the discoms' incentive to sell more energy. Their capex bias was also noted while drafting the MYT Regulations, but the remedy, that is, scrutiny by the SERC based on norms,[11] may not be adequate due to information asymmetry between the discoms and the SERC (Brunekreeft and Rammerstorfer 2021). The regulatory framework falls short of making discoms agnostic between capex and opex to meet operational goals. Furthermore, since DSM costs are to be recovered through tariffs, uncertainty in future benefits could make discoms wary of upfront investment (Hassett and Metcalf 1993).[12]
- **DSM is treated as a programmatic activity rather than a core function.** The requirement of drafting and submitting 'programme documents' before implementing any DSM activity and frequent submission of progress reports reinforces a programmatic approach to DSM, where costs are scrutinised and budgets approved on a project-to-project basis. Utilising demand as a resource may warrant an approach where discoms are mandated to plan for DSM more regularly (Potter, Stuart, and Cappers 2018; Dranka, Ferreira, and Vaz 2022). Regulatory mandates for IRP that require utilities to consider DSM as an alternative to supply augmentation would provide a solid impetus for its mainstreaming (Singh and Swain 2018), supplemented by the adoption of CEA's recent resource adequacy guidelines (CEA 2022b).

While the Regulations are designed to address concerns about cost-effectiveness and transparent reporting on DSM programmes, they do not achieve two fundamental objectives: realigning utilities' incentives to invest in DSM and providing detailed guidance on programme design.

4.2. Effectiveness of the Regulations

To assess effectiveness, we investigate the extent to which discoms and SERCs adhere to the Regulations' provisions in the annual distribution tariff preparation. To do so, we analyse the SERCs' distribution tariff orders in the selected states.[13] We searched tariff orders from the last four financial years to determine the number of occurrences of DSM-related keywords and the context of their discussion. We used the following keywords: 'demand-side management', 'energy efficiency', 'demand response', and 'time-of-day'. We complemented the results with additional publicly available information and stakeholder consultations. We discuss the key observations below, and Table 5 summarises the state-wise findings.

> **The DSM Regulations currently do not align discoms' incentives to invest in DSM with their core operational objectives adequately.**

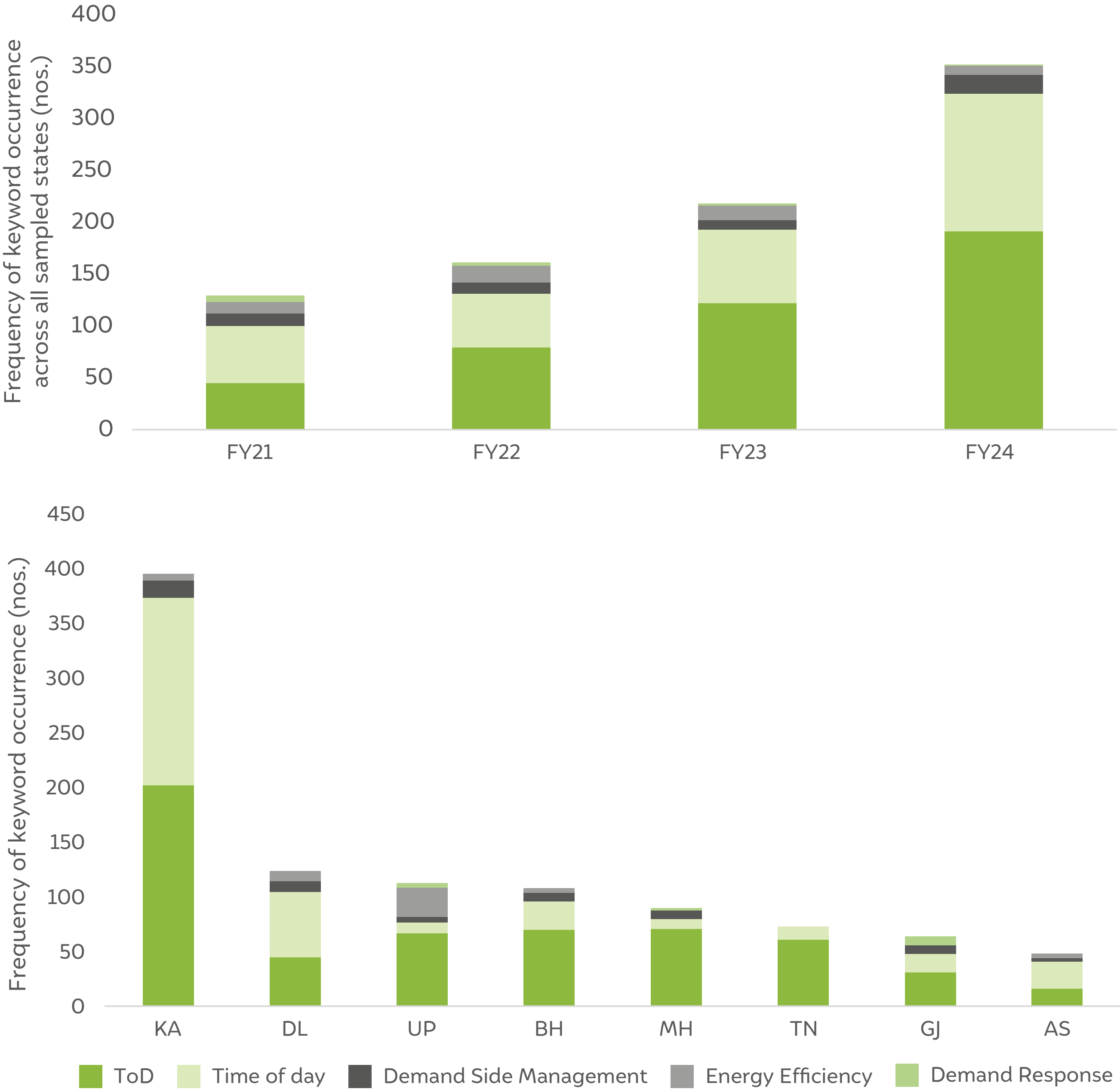
11 Early-stage deliberations on the MYT framework noted that discoms may have a tendency to overstate their capex, and SERCs should scrutinise it based on norms defined at the beginning of each control period (FoR 2008).

12 Indian discoms had a net debt of nearly INR 6,17,928 crore (~USD 75 billion) by the end of FY22 (PFC 2023). High indebtedness and poor financial health lead to increased cost of capital for discoms, which leads to a higher discount rate – that is, a higher weightage is given to revenue now than gains in the future.

13 The tariff orders consist of SERCs' scrutiny of the information submitted by discoms on their aggregate revenue requirement (ARR) based on their expected costs for the subsequent year including costs related to power procurement, based on which the distribution tariff for consumers is determined. They also include scrutiny of costs incurred in past years via true-ups and annual performance reviews. Since DSM Regulations require DSM-related expenses to be considered as part of discoms' ARR, the tariff orders should contain discoms' submissions of such costs and the past and future impact of DSM on sales and power purchase expenses. Meta-data of the analysed documents is given in Annexure II.

- **DSM measures are gaining more attention in tariff orders across states, but the focus is mainly on time-of-day (ToD) tariffs and EE.** ToD tariffs are the most frequently discussed DSM measure across years and states, along with EE, which is mentioned to have been incorporated in future energy sales projections (Figure 2). Nearly all ToD occurrences are in the context of their design (see Box 1).[14] However, despite ToD tariffs being considered a DSM measure, we did not find any reporting related to expenses on enhancing their adoption or effectiveness. The tariff orders from Delhi, Gujarat, and Uttar Pradesh also mention DR in the context of recent pilots done in the discoms' service areas.

Figure 2 Time-of-day tariffs receive the maximum attention as a DSM measure across discoms



Source: Authors' analysis; a list of the analysed tariff orders is given in Annexure II

Note: The results should not be interpreted as comparative across states as the number of documents analysed for each state is different due to differences in availability and state-specific factors (number of discoms, frequency of orders, etc.).

14 Only those occurrences of 'ToD' were counted that appear in the discussion. The ones mentioned in tariff schedules/tables have been excluded to avoid repetitive counting.

- **Most discoms acknowledge DSM measures in their petitions, but prospective impact quantification is nearly absent.** All states' orders, except those for the public discoms in Maharashtra, Tamil Nadu, and Gujarat, mention that DSM measures have been incorporated in the sales projections for the aggregate revenue requirement (ARR) year or the control period. Delhi's discoms used the most recent two years' compounded annual growth rate (CAGR) to project the subsequent year's sales to account for DSM measures rather than the three to five years' CAGR, as is usually done. Reporting the impact of past programmes is more common. One of Maharashtra's private discoms reported savings of 24 million units (MUs) due to DSM programmes in FY20–22 in its ARR petition for FY24–25, and another reported savings of 28.5 MUs in FY21 from DSM measures in the same year's petition. In the FY23 order, a Karnataka discom reported a sales reduction of 207 MUs in one consumer segment due to past DSM measures.
- **Methodologies and programme design information are not available in the public domain.** Information regarding technical potential, load research and market research studies, and EMV and M&R guidelines and reports are not available in the public domain for any of the analysed states. Where DSM programmes are mentioned, the tariff orders contain limited references to reports submitted by discoms or third parties to the SERCs or of regulatory scrutiny of such reports, as required by the Regulations. For example, Tamil Nadu's tariff order for FY23 (TNERC 2022) mentions a study to investigate potential improvements to the state's ToD tariff structure conducted by discoms and submitted to the Tamil Nadu Electricity Regulatory Commission (TNERC).
- **DSM performance targets are missing, but energy-conservation targets are notified via state policies.** Maharashtra and Karnataka have specified a target for energy savings via the State Energy Conservation Policy, 2017 (Government of Maharashtra 2017), and the Energy Conservation and Energy Efficiency Policy, 2022–27 (Government of Karnataka 2022), respectively. Although performance targets are mandated to be set under the Regulations, they are not referenced or monitored in any of the analysed tariff orders.
- **There are various bottlenecks in DSM funding and cost recovery.** For example, in 2018, Delhi's SERC allowed a discom to recover an AC replacement programme's administrative and rebate costs through tariffs based on its cost–benefit analysis, though it was not based on a cost-effectiveness index as required by the state's Regulations (DERC 2018). However, the DERC disallowed actual cost recovery in FY21 without a detailed implementation cost break-up (DERC 2020b). In Maharashtra, the SERC had approved an annual DSM budget of INR 0.68 crore for FY20–22 for a private discom and approved actual expenses that fell within the total sum for the three years (MERC 2023b), while the public discom did not claim any DSM expenses (MERC 2023a). Karnataka's and Gujarat's SERCs prospectively allocated capex for DSM, but the discoms did not utilise it (KERC 2023; GERC 2023a), indicating an absence of funding-ready DSM projects.

Our analysis suggests that while the Regulations may have prompted discoms to consider DSM measures while projecting sales and preparing revenue recovery plans, they do not consider DSM as a resource for cost-effective system operation. Although the tariff orders acknowledge ToD tariffs and EE as DSM measures, there is little focus on using DSM to monitor and manage demand actively. There is also limited progress on evidence-informed programme design and impact evaluation. Some discoms – mostly private discoms in Delhi and Maharashtra – have been proactive in devising DSM initiatives. This could be a result of their governance structure, consumer mix (high share of moderate to large consumers), or geography (dense urban areas with constraints on infrastructure expansion to serve a growing load). The following section discusses the possible reasons for the poor focus on DSM across discoms.

> **Our analysis of the tariff orders suggests that discoms do not consider DSM as a necessary activity for system planning.**

Table 5 State-wise progress on their respective Regulations as per the last four years' tariff orders and stakeholder consultations

Parameters	Maharashtra	Delhi	Karnataka	Gujarat	Tamil Nadu	Uttar Pradesh	Bihar	Assam
Performance targets					Energy saving targets are notified under the Maharashtra Energy Conservation Policy 2017 and Karnataka Energy Conservation and Energy Efficiency Policy, 2022, respectively.			
Programme design study methodologies	Only state in the sample to have notified cost-effectiveness guidelines.				No methodologies or studies in the public domain.			
Compliances (load research studies, DSM plans)	All states have conducted load research studies and created DSM action plans either independently or with BEE's support.					Only Karnataka and Tamil Nadu have published action plans.		
Evaluation and monitoring reports	Maharashtra has published guidelines for M&R but not EMV. Delhi and Karnataka provide some quantitative impact of DSM but not the methodology.							
Funding and cost recovery	DSM expenses/budgets accounted for in the tariff orders.							
Performance incentives for discoms	Most state regulations allow for performance incentives for discoms for meeting/surpassing approved DSM targets. However, in the absence of target-setting and detailed M&R reports, none of states have allowed incentives.							

Source: Authors' analysis; a list of the analysed tariff orders is given in Annexure II

Note: Colour coding: dark green: provision present/implemented; light green: provision present/partially implemented; orange: provisions not implemented/adequate details are not available in the public domain.

Image: iStock

Time-of-day tariffs can be an effective DSM strategy but would require investments in consumer engagement and readiness.

Box 1 **Spotlight on time-of-day tariffs**

Across the sampled states, ToD tariffs are primarily applicable to high-tension (HT) industrial consumers. Few states have extended ToD tariffs to commercial consumers, and only Delhi offers them to domestic users with three-phase connections (Table 6). No state applies ToD tariffs to agricultural consumers.

Table 6 The applicability of ToD tariffs across consumer segments in the sampled states varies

	Domestic	Commercial		Industrial		LT others	HT/EHT others
		LT	HT	LT	HT/EHT		
Uttar Pradesh					✓		✓
Delhi	✓ (orange cell)	✓	✓	✓	✓	✓	✓
Maharashtra		✓	✓	✓	✓	✓	✓
Gujarat			✓		✓	✓	✓
Karnataka			✓	✓ (orange cell)	✓		✓
Tamil Nadu						✓	✓
Bihar				✓ (orange cell)	✓		✓
Assam					✓		✓

Source: Authors' analysis

Note: (1) Orange cells indicate optional ToD tariff; (2) LT: low tension; EHT: extra HT; (3) 'LT others' primarily includes public water works, EV charging stations, and sewerage pumping stations/treatment plants. 'HT/EHT others' primarily includes public water works and EV charging stations. In Assam, it also includes tea/rubber production units and coal/oil sector units.

The considerations for implementing ToD tariffs vary across states. The Bihar SERC (BERC) introduced optional ToD tariffs for public water works and LT industrial consumers in FY21 to flatten the load curve (BERC 2020). Delhi SERC's additional objective includes avoiding high-cost electricity purchases during peak hours (DERC 2020a). The Maharashtra SERC emphasises implementing dynamic and seasonal ToD tariffs instead of a single structure for the whole year, keeping up with the market and technological developments (MERC 2023a). In the RE-rich states of Karnataka and Tamil Nadu, the SERCs acknowledged the role of ToD tariffs in cost-effective load management during low-RE and high-demand and high–market price periods (TNERC 2022; KERC 2023).

The tariff orders also demonstrate the need to balance system management and cost recovery concerns with consumers' interests while implementing ToD tariffs. The TNERC directed discoms to charge 20 per cent of LT consumers' daily consumption at a 25 per cent surcharge in the absence of ToD meters (TNERC 2022). However, it allowed consumers to request ToD-programmed meters if they feel that their peak-hour consumption is lower than this stipulated share (ibid). Uttar Pradesh's discoms suggest that LT consumers have a low potential to shift demand, and extending ToD tariffs to the cross-subsidised domestic consumers, constituting about 80 per cent of the consumer base, may be financially unjustifiable and work against the state's tariff philosophy (UPERC 2022), although the rationale for this argument is unclear. In 2013, the Delhi SERC applied ToD tariffs only to industrial consumers who could bear the additional cost of peak charges (DERC 2020a). However, they were subsequently extended to all consumers with a sanctioned load/contracted demand of 10 kW/11 KVA and above (ibid).

Overall, while all the sampled states apply ToD tariffs to at least one consumer category, only a few states refer to detailed load research studies as the basis for designing them (TNERC 2022; GERC 2023a; MERC 2023a). While some SERCs direct the discoms to conduct load research to inform ToD tariff design (AERC 2023; KERC 2023; UPERC 2023), there is a dearth of assessments and proposals to implement ToD tariffs for a wider consumer base (KERC 2023; UPERC 2023). Detailed and publicly available assessments of the impact of ToD tariffs on consumers and discoms could help in the design of more effective ToD rates.

4.3. Operational barriers to implementation

Beyond regulation design, DSM also requires proactive implementation by discoms and monitoring by SERCs. For example, discoms must conduct or commission technical potential and load research studies in time so that they can be submitted to the SERC along with the tariff petitions. In case of non-compliance, SERCs must hold the discoms accountable. Based on our interactions with stakeholders (see Section 2 for details), we find the following implementation barriers to DSM.

- **Lack of capacity, expertise, and resources in discoms:** While the Regulations require discoms to set up specialised cells to carry out DSM-related functions, this is often treated as an additional responsibility. As a result, the DSM cell staff may lack the expertise to supervise/conduct technical potential and load research studies, cost-effectiveness tests, etc. Thus, over time, DSM cells in most discoms have become inactive. While the need to enhance discoms' capacity is well known (FoR 2010b), and BEE regularly provides technical support to discoms through training and financial, technical, and human resources (BEE 2021), DSM has not been successfully institutionalised within discoms.

  The limited role of DSM in discom operations as defined under the Regulations, the weak financial incentive to invest in DSM, and poor enforcement of performance reliability may be reasons for a lack of institutional focus on DSM (see Section 4.1). Other impediments could include the dependence on BEE to provide the resources to conduct DSM-related activities and on EESL to implement EE programmes (Aggarwal and Agrawal 2022).

- **DSM's perception as a cost centre:** Although the Model Regulations and many state Regulations allow recovery of net incremental costs through tariffs, the cost and benefit accounting methodologies are unclear – for example, do 'net incremental costs' include lost revenue due to reduced sales? For these reasons, discoms may perceive DSM planning, design, and scrutiny as external to their core functions – namely, electricity supply, billing, and collection. Based on our conversation with discom officials, this perception is reinforced in the absence of regulator-assigned performance targets. In the absence of detailed guidance on programme design and targeting, interventions that reduce energy demand from consumers paying higher than the average cost of supply can further deteriorate the discoms' financial health (Aggarwal and Agrawal 2022).

  As seen in Sections 4.1 and 4.2, the Regulations require SERCs to notify the necessary methodologies, but most SERCs have not done so. The absence of high-quality load research and impact evaluation studies in the public domain also restricts the learning process across discoms.

- **Lack of monitoring and enforcement by SERCs:** The analysis in Section 4.2 suggests that most discoms mention DSM in their sales projection submissions to SERCs, and this seems to suffice as compliance with the Regulations. However, DSM planning, such as formulating targets, identifying the interventions and target consumer segments, designing appropriate consumer incentives, and so on, is predicated on load research studies. Very few such studies are available in the public domain, and based on our interactions, discoms do not conduct them regularly. In cases where discoms do not comply with the Regulations' provisions, SERCs can hold them accountable and impose fiduciary penalties under the Electricity Act, 2003. However, we did not find any instances of the SERC penalising discoms for inaction on DSM.

  As noted in Section 4.1, the lack of an integrated approach to evaluating and utilising DSM may be a reason for poor monitoring of DSM. Frequent submission of programmatic documents requires extensive capacity within SERCs to scrutinise them, which may be lacking. Furthermore, poor enforcement of performance reliability standards also contributes to the lack of focus on DSM. While the costs of failing to meet the reliability standards are not recovered through tariffs (see Annexure I), poor enforcement of the performance standards leads to frequent load shedding (Mandal et al. 2019) as a form of DSM. For instance, a 2020 survey across 21 Indian states reported that 40 per cent of urban and 64 per cent of rural households face daily power outages (Agrawal et al. 2020).

> **Lack of expertise in discoms and regulatory enforcement by SERCs pose operational barriers to wider DSM implementation.**

- **Lack of transparency:** Discoms' research studies and programme design details have not been made public. For example, while DSM action plans have been created for 30 discoms (BEE 2021), most are not publicly available. Maharashtra's Regulations specify that all DSM plans and programmes must be disclosed on the discom's website, but this guideline was not being followed at the time this study was conducted. Such a lack of transparency can result in an erosion of trust among consumers and other stakeholders. For instance, in the absence of impact assessment guidelines, evaluating the cost-effectiveness of DSM programmes and facilitating their recovery through tariffs is difficult.

Therefore, the existing regulatory framework for DSM, while robust in some respect, must be updated to adapt to the power system's evolving needs and strengthened, so that there are stronger incentives for discoms to utilise DSM. In the following chapter, we discuss the initiatives that regulators and policymakers, globally, are taking in this respect.

5. Learnings from international case studies

As electricity grid investments become increasingly guided by policy objectives, regulators are experimenting with mechanisms to align utility performance with policy goals. This chapter discusses four such approaches and potential learnings for the Indian regulatory framework. The cases were selected through an inductive approach and discuss ways to make utilities performance-oriented, decoupling utility revenue from electricity sales, enabling new power markets, and strengthening the governance of DSM.

> **Global models of performance-based regulation and enabling new market creation provide useful lessons for stimulating action on DSM.**

5.1. Revenue = Incentives + Innovation + Outputs (RIIO): Great Britain

RIIO is the regulatory framework governing Britain's energy utility businesses, including electricity and gas transmission and distribution, administered by the Office of Gas and Electricity Markets (Ofgem 2017), which is the gas and electricity market regulator. The framework – implemented for electricity distribution utilities for the first time in 2014 – caps the revenue a utility can earn over a multi-year control period,[15] with a provision for annual adjustments. The allowed annual revenue consists of three components: (1) the **base revenue** required by the utility to recover an efficient level of costs, (2) **adjustments** for uncertain cost elements that could not be fixed at the beginning of the control period, and (3) **incentives and penalties** that are based on the utility's performance on a pre-defined set of outputs, including reliability and availability, customer service, social obligations, safety, and so on. Ofgem determines the efficient level of costs to deliver on these outputs based on justifications provided by the utilities and benchmarking across utilities. In addition, utilities can propose drawing on a separate pool of funds earmarked to test innovative network technologies.

The following are RIIO's key features:

- **Output and incentive-based regulation**: The framework puts utility performance and efficiency at the centre of the regulation by determining the revenue required based on pre-defined outputs, including innovation. The mechanism incentivises utilities to cost-efficiently deliver on outputs and penalises them for underperformance using revenue pass-through and other mechanisms.[16] The overall approach incentivises utilities to consider cost-effective demand-side resources in their planning. In the Indian regulatory framework, in the absence of the stringent implementation of the Standards of Performance regulations (Mandal et al. 2019), loss reduction is the main performance metric used to determine the allowed revenue for discoms (see Annexure I), leading to the neglect of other key service areas.

15 RIIO-ED1, the first price control period for electricity distributors, spanned eight years from 1 April 2015 to 31 March 2023. The current control period – RIIO-ED2 – is for the five years from 1 April 2023 to 31 March 2028.

16 For example, if a utility's business plans are deemed to be of high quality, with evidence of a robust stakeholder engagement process and clear justifications, Ofgem fast-tracks their scrutiny.

- **Totex approach to correct for the capex bias:** Along with benchmarking utility costs to determine their efficiency, Ofgem uses a fixed capitalisation rate to divide the total expenditure (totex) into capex and opex. The totex approach makes utilities indifferent between opex and capex when planning to improve the network (see Section 3.1). In India's MYT framework, the opex (for pass-through) and capex (for determining the rate of return as reported by utilities) are scrutinised by SERCs based on historical trends, making the cost treatment relatively rigid. Combined with a narrow definition of DSM and its objectives, discoms have limited flexibility in terms of using new demand-side technologies and business models, such as fee-based service procurement, to enhance the network.
- **Accounting for externalities:** Ofgem explicitly recognises that utilities may have to adopt new technologies whose commercial benefits are uncertain or whose benefits may not directly accrue to a single utility. Utilities can draw on funds earmarked for innovation to test such technologies conditional on them undertaking at least 10 per cent of the project's cost and the project generating learnings for all utilities (Ofgem 2010). Along with treating innovation as an output of regulatory performance, conditional and time-bound funding ensures the creation of public goods through innovation. In India's case, although the regulations of Tamil Nadu and Maharashtra provide for a public benefit charge to create a funding pool for DSM, we could not find public documentation showing that discoms have utilised it.

Although RIIO is a comprehensive framework that addresses many structural barriers to DSM, it may increase the administrative burden on the regulator to benchmark costs, determine the efficient capitalisation rate, monitor outputs, determine incentives, and so on. SERCs must significantly enhance their technical and institutional capacities if they are to incorporate some of RIIO's features.

5.2. Shared savings: the United States of America

The shared savings mechanism for utility-driven programmes originated in the 1970s. In this system, energy service companies (ESCOs) which retain a part of bill savings due to their energy-saving services (Eto, Destribats, and Schultz 1992). For utilities, the mechanism is based on the principle that the regulator can independently apportion the risk and reward associated with DSM among various entities (ibid). Under the mechanism, utilities retain a fixed part of the net benefits of deploying demand-side programmes as an alternative to investing in supply-side infrastructure and share the other part with the consumers (ibid). The net benefits are calculated through the following formula (ibid):

$$NRV = (LR \times AC) - PC$$

where NRV is the net resource value in USD, LR is the load reductions in kW or kWh, AC is supply costs avoided by the utility in USD/kW or USD/kWh, and PC is the programme costs in USD, including administrative costs, rebates, etc.

Benefits are passed on to participating consumers through lower bills in the near term and to other consumers through mitigated tariff increases in the longer term (Eto, Destribats, and Schultz 1992). While the mechanism originated to incentivise EE investments by utilities (Nowak et al. 2015), recent iterations have included DR and distributed energy resources (AEE Institute, RMI, and America's Power Plan 2018).

Some common features of the mechanism used across states are as follows:

- **Continuous programme assessment and rigorous measurement standards:** Establishing a baseline, ascertaining programme impacts, and accounting for factors such as decay in savings over time and free riding (see Section 3.2) require continuous assessment and revisions. Assessment outcomes inform the benefits accruable to utilities and consumers and future programmes. The use of transparent and standardised methodologies for assessment allows comparability of performance across programmes and discoms.
- **Ensuring equity of DSM benefits across consumer segments:** Some states used a variation of the mechanism that featured an additional incentive for implementing cost-ineffective programmes or those that did not accrue a significantly positive NRV (Eto, Destribats, and Schultz 1992). Higher incentives for such programmes coupled with higher penalties for underperformance ensure that utilities include diverse consumer segments in DSM programmes. In India's case, the regulations of Delhi, Uttar Pradesh, Tamil Nadu, and Gujarat also allow for SERCs to approve programmes that may be cost-ineffective but 'beneficial to society'. However, the definitions and methodologies to make such an evaluation are absent.

- **Regulatory certainty on cost recovery:** Under shared savings, the utility's incentive recovery is front-loaded and recovered annually or distributed over the initial three years before the programme's useful life lapses (Eto, Destribats, and Schultz 1992). In some cases, revenue lost from reduced sales can be recovered via a separate adjustment mechanism (ibid). The additional features help mitigate risks associated with regulatory changes, provide certainty of tariffs, and simplify the accounting of programmes with differing life cycles.

The risks associated with the shared savings mechanism include difficulties in establishing a robust baseline to measure programme impacts and the fact that incentives need to be shared between the utility and consumers. Baselines may be especially difficult to compute in areas where electricity demand is growing rapidly. A lack of transparency may also lead to disputes over the programme's financial aspects, such as over the incentives and consumers' benefits (Cross-Call et al. 2018), potentially leading to uncertainty in payments to third-party service providers.

5.3. The demand response auction mechanism (DRAM): California, the USA

DRAM is a mechanism to allow third-party DR providers to offer grid services, such as demand reduction, against a price, thus opening up a new market in the electricity supply chain. DRAM is a pay-as-bid auction mechanism through which DR providers bid services into the California Independent Service Operator's (CAISO's) wholesale day-ahead or real-time markets and provide capacity offers for resource adequacy (CPUC 2019). Each resource must be 100 kW or above, and each seller must bid a price per kW for their demand reduction.

DRAM has been functional as a pilot for eight years and has successfully supported innovation and enabled DR providers to enter the market. An evaluation of the contracts of 2015–17 (for service delivery in 2018 and 2019) showed that amongst the companies that participated in the auctions, almost 70 per cent were new to the Californian market (ibid), indicating a healthy market for DR services. However, DRAM has also witnessed a decline in the number of participating service providers in recent years.

The following are DRAM's notable features:

- **A market-based approach to stimulating demand-side services:** DRAM allows distribution-level service providers to bid their services into the wholesale energy and capacity markets. Unlike an administered approach, this provides market signals on the value of demand-side services. In the Indian regulatory framework, while the CERC (Ancillary Services) Regulations (2022) define DR and allow aggregators to provide grid services, the lack of a mechanism to foster these services at the distribution level makes it difficult to operationalise.
- **Inclusion of DR in resource adequacy:** The CPUC, the state's electricity regulator for private utilities, obligates utilities to procure adequate resources to serve load (CEC 2022). It allows utilities to reduce the resource adequacy obligation to the extent of DR resources procured (ibid). For example, in August 2020, utilities under the CPUC's jurisdiction were allowed to reduce their resource adequacy obligations by 1,482 MW because of DR resources (ibid). Including DR in utilities' planning encourages them to foster these services if they are more cost-effective than procuring additional supplies.
- **Active market monitoring and transparency:** Starting with DRAM's early stages, the CPUC continuously engages an independent evaluator to monitor utilities' solicitation bids, stakeholder engagements, valuation methodologies, and selection processes and deter market collusion or manipulation (CPUC 2019). Having an independent evaluator reporting to the regulator adds to the pilot's credibility, provides confidence to market participants, and reduces the regulator's administrative burden. The CPUC also made the evaluation process of the programme's market potential and institutional design transparent, enabling incremental design improvements (CPUC 2014). For example, CAISO found that CPUC may be over-counting DR credits, leading to their lower-than-expected availability (CAISO 2022), which allowed CPUC to carry out subsequent correctional proceedings (CEC 2022).

> **Mandating procurement of demand-side resources and creating ways to monetise DSM can help create a market for such services.**

While DRAM is not a perfect mechanism, it is an important example of the incremental approach regulators can take towards fostering new grid services on the demand side, resulting in a larger set of stakeholders, including independent actors and private service providers in the process.

5.4. Efficiency Vermont: The USA

Efficiency Vermont is a regulated utility dedicated to EE activities. It was formed in 1999 by the Vermont Legislature and the Vermont Public Utility Commission to fulfil the need for state-wide action on EE after a review of distribution utility–led programmes. Participants in Efficiency Vermont's programmes have saved over USD 2 in lifetime savings for every dollar spent (White 2018). Efficiency Vermont became a model for other states that also established efficiency utilities, such as Efficiency Maine, Energy Trust of Oregon, and Mass Save in Massachusetts. The following are its notable features:

- **A regulated utility dedicated to EE:** Efficiency Vermont provides several EE services to consumers as an ESCO, including technical guidance, financing options, and training. However, as a regulated entity, its targets and budget are regulated by Vermont's Public Utilities Commission. The Commission had authorised an additional charge on the electricity bill's variable component in the state, thereby socialising EE costs. In India, SDAs operate at the state level to implement the BEE's programmes. However, their mandate to work with ESCOs and the discoms is limited. The Indian private ESCO market is also fraught with regulatory, financial, and technological challenges (Kumar et al. 2017), leading to an under-saturated ESCO market.
- **Bidding EE into the capacity markets as a resource:** Efficiency Vermont cannot use the revenue from the additional charges on electricity for non-electricity programmes, for example, to improve the thermal efficiency of buildings. The utility was allowed to bid energy savings on the regional power grid in the forward capacity market as a revenue source. The saved energy is rigorously verified using a standardised methodology to ensure that it is treated as a resource comparable to traditional supply sources.

Image: CEEW

Battery swapping stations for two- and three-wheeler electric vehicles can provide localised peak demand shaving services.

- **Collaboration and partnerships resulting in market transformations:** Efficiency Vermont has successfully partnered with manufacturers, contractors, electricians, and architects to drive market transformation for new technologies by training service providers, employing marketing resources and special offers, and helping consumers make efficient choices. Partnerships with food, housing, and nutrition organisations that have expertise in serving low-income consumers ensure that their services are accessible to consumers from diverse socio-economic backgrounds (Efficiency Vermont 2021).

Although largely successful, the company's revenue from capacity markets has rapidly declined recently. While the market acts as a one-time fundraising avenue, the EE's benefits are derived throughout the equipment's lifetime. Therefore, the capacity market does not provide full compensation for EE. However, Efficiency Vermont is a useful example of reimagining EE implementation by reducing utilities' involvement and using a dedicated administrator.

The next chapter discusses recommendations to strengthen DSM in India based on the analysis presented so far.

6. Roadmap to reform DSM

Based on the analyses presented in the previous chapters, this chapter offers suggestions to strengthen the Indian regulatory framework and its enforcement to stimulate action on DSM.

6.1. SERCs must update the Regulations to expand the definition and objectives of DSM

- The definition and objectives of DSM under the Regulations must be updated to reflect its potential to enhance supply reliability cost-effectively.
- The updated definitions should align the Regulations with clean energy transition goals and facilitate the entry of new technologies and business models into the power system.

The overall framework that governs distribution sector planning and discom revenues focuses on loss reduction. While the Regulations provide an impetus for discoms to include DSM in system planning, most discoms thus far have tended to focus solely on ToD tariffs, EE, and energy conservation. This can partly be attributed to the energy- and power-deficit context in which the Model DSM Regulations were drafted. Combined with a lack of incentives and resource constraints, a narrow view of DSM leads to limited resource allocation during the planning process for the implementation of DSM.

The regulations of Delhi and Tamil Nadu provide examples of an expanded view of DSM, where deferred investments in supply-side infrastructure are explicit objectives of DSM. Delhi's Regulations further include changes in electricity consumption levels and time of use as DSM objectives. Updated Regulations incorporating these suggestions would provide a stronger legal footing for discoms and SERCs to pursue novel DSM methods.

6.2. To mainstream DSM, SERCs and discoms must adopt performance-based regulations and resource adequacy guidelines

- SERCs must update the MYT regulations to provide incentives based on supply reliability to discoms as per the principles of performance-based regulation laid out in the National Tariff Policy.
- SERCs must enhance independent monitoring of supply reliability through standards of performance regulations.
- Under the guidance of SERCs, discoms must adopt the IRP's and the CEA's guidelines on resource adequacy and include demand-side measures as resources in both exercises.

While the Regulations in most states allow for DSM performance-based incentives or penalties, we did not find any evidence of disbursement of incentives or any discussion on their adequacy. Their enforcement is also contingent on the discoms providing the requisite evidence, which, per our analysis, does not always happen as per stipulated timelines. SERCs should consider providing additional incentives to discoms to aid higher performance on reliability, beyond allowing cost pass-through for maintaining reliability by considering it as a controllable factor of expenditure. The GERC draft MYT regulations for the control period 2024–29 provide a good example of this approach, wherein the SERC had proposed allowing an additional return on equity to discoms on achieving certain performance objectives (GERC 2023b). To do this effectively, SERCs must enhance their independent monitoring and enforcement of discom performance, in the absence of which discoms may continue treating load shedding as the cheapest form of DSM. SERCs must enforce automatic credits to consumers for poor supply reliability to nudge discoms to consider well-designed, cost-effective DSM measures (Mandal et al. 2019).

Furthermore, the current practice of scrutinising capex based on norms must be updated to address information asymmetries between the SERCs and discoms such that there is greater flexibility for discoms to adopt new, service contract–based business models. The prevailing programmatic approach to DSM places a higher administrative burden on discoms and SERCs to design programmes and report and scrutinise costs but with no clarity on its benefits. SERCs and discoms must adopt IRP and resource adequacy processes to institutionalise DSM in planning, such as through regular load research studies.

6.3. The FoR and SERCs must notify standard methodologies, update data-reporting formats under MYT regulations, and commission studies that enable DSM programme design

- The FoR should consider drafting standard methodologies based on various states' experiences and available scientific standards.
- SERCs must notify and enhance these methodologies with support from independent experts, DSM consultative committees, and public consultations to ensure that the needs of various consumer segments are considered while designing DSM interventions.
- SERCs must update the formats available under MYT for discoms to report data on DSM measures and their impacts.
- SERCs must also commission independent studies, such as energy end-use surveys, that can help discoms design effective DSM programmes.

While the Regulations mention that the BEE and SERCs must notify the methodologies and guidelines for technical potential, market assessment, load research studies, EMV, M&R, etc., they are either not notified or unavailable in the public domain. While tariff orders mention that discoms have incorporated DSM in sales projections, only some discoms quantify the impact (Delhi and Karnataka among the sampled states), while none of the states disclose the methods, assumptions, and programme specifications.

Without robust impact assessments, discoms and SERCs would be unable to justify expenditure on DSM or determine performance-based incentives/penalties for discoms. Having transparent methodologies in place would mitigate the regulatory risk of cost disallowance, maintain comparability of programmes within and across discoms, foster confidence in private service providers, and help incrementally improve programme design. SERCs' guidance should also enable discoms to design programmes that help avoid selection bias and target the most beneficial technologies. Furthermore, appropriate training and capacity-building exercises should be provided to discom officials, which can aid in effectively implementing the DSM measures.

Regulators must also commission independent studies to assist in DSM programme design. The California Energy Commission's comprehensive residential energy end-use surveys in 2003, 2009, and 2019 provide an interesting example (CEC 2024). The 2019 survey collected data from nearly 40,000 households on their appliances, equipment, and general consumption patterns, including EV charging, and the penetration of DRE systems, such as solar photovoltaic systems and energy-efficient appliances (Palmgren et al. 2021). Such information can provide valuable metrics to design and implement robust DSM initiatives.

6.4. Governments must create a funding pool for innovation and enforce transparency to help create a pipeline of projects

- The Ministry of Power, Government of India, should create a pool to fund DSM projects across discoms through its agencies such as the BEE.
- The funds should be contingent on transparent load research and impact evaluation studies to help accelerate learning across discoms.

> **Providing incentives for cost-effective enhancement in supply reliability is essential to institutionalise DSM in discom planning.**

Due to DSM's dispersed and uncertain benefits (Carranza and Meeks 2021), discoms and SERCs may prefer a precautionary approach to innovation to keep electricity tariffs in check. However, continuous learning through experimentation is critical because of the influx of new technologies in the grid. Discoms may require a separate funding provision to promote innovation without adversely affecting their costs and consumer tariffs.

There are many examples of non-tariff funding sources available to discoms for various purposes – for example, the State Energy Conservation Fund (BEE n.d.b), the Power System Development Fund (CERC 2014), and centrally sponsored schemes, such as the *Revamped Distribution Sector Scheme*, as part of which REC Limited supported innovation and private-sector collaboration (REC, MoP, and SINE 2022). Our stakeholder interviews suggest that while the MoP has previously offered funding for DSM projects, discoms could not avail of the opportunity due to their inability to submit funding-ready proposals. While the BEE seeks to provide the necessary support to discoms (BEE n.d.a), ensuring that studies conducted through tax funding are publicly available can help create public goods, prevent duplication of efforts across discoms, and accelerate learning (Boyle 1996), thereby helping to create a pipeline of funding-ready projects. Furthermore, SERCs can also help optimise innovation costs, as is done in the RIIO framework. While the Regulations in some states allow for a public benefit charge for DSM, we could not find documentation or evidence on how discoms have utilised them.

6.5. Governments must use policies to mandate and monetise DSM and facilitate market creation

- National and sub-national policies can be used to provide stronger mandates for DSM.
- Mandates must be accompanied by fiscal or market-based financial instruments to help discoms monetise DSM measures and provide them with alternate revenue streams.

The growth of RE in India provides many learnings with regard to how policies can spur progress in DSM. The SERCs mandate discoms to procure a defined share of RE through renewable purchase obligations (RPOs), while the trajectory of RPOs is set at the national level (MoP 2022). Such obligations have also been adopted for energy storage (ibid). Global examples of such an approach to DSM exist, such as the energy efficiency resource standards (EERS) in the United States and Europe (Palmer et al. 2013; Steinberg and Zinaman 2014). By 2019, 27 states in the United States had implemented EERS, accounting for 80 per cent of all energy savings reported by utilities (Gold, Gilleo, and Berg 2019). The union or state governments in India can implement similar mandates for DSM, including DR.

However, for policy mandates to succeed, they must be backed by revenue streams that compensate for the incremental or compliance-related costs of obligated entities. DRAM, which mandates utilities to procure DR resources, while allowing aggregators to participate in the wholesale capacity market, is a useful example of services other than EE. Tradable certificates are another market-based instrument that can be used (Palmer et al. 2013; Sarker et al. 2020).

India's *Perform, Achieve and Trade* (PAT) scheme is a good example of such a mechanism, which awards designated consumers, including discoms, tradable energy savings certificates (ESCerts) for achieving energy savings goals. However, the ESCerts market is fraught with design and implementation issues (Patankar et al. 2018; Chunekar and Apte 2023). For instance, discoms are awarded ESCerts for reducing transmission and distribution losses, but the loss-reduction trajectories assigned under PAT are less rigorous than those set by SERCs, implying that the PAT scheme provides no additional incentives (Patankar et al. 2018). Furthermore, the ESCerts market is oversupplied, implying that participants only get the administrative floor price (Chunekar and Apte 2023), which is hardly commensurate with the required investments. The PAT scheme design can be reformed to incentivise discoms to invest in DSM. For DR services, the CERC (Ancillary Services) Regulations (2022) can be operationalised to help create a revenue stream for aggregators.

Enhancing ambition on DSM requires concerted policy and regulatory changes and, therefore, coordinated action by policymakers and regulators. While well-designed statutes are essential, their enforcement by the relevant agencies and implementation by discoms are just as important.

> **Standardized and transparent programme evaluation with dedicated funding can facilitate innovation in DSM.**

7. Conclusion

India's power system has changed significantly over the past decade. From being a scarcity-ridden yet predictable electricity grid, operators are now managing periods of surplus as well as scarce supply, in parallel with growing uncertainty and a surge in demand. Given the growing share of variable RE, most measures to keep the grid balanced have focused on supply-side measures such as enhancing transmission infrastructure, introducing flexible power plant operation, and deploying storage. However, emerging evidence shows that DSM measures will be crucial for cost-effectively managing the grid in a RE-dominant system. New technologies and business models must be developed and deployed at scale to make demand more responsive to grid conditions.

Our review of the evolving role of distribution sector regulations in this context has shown that they are crucial in guiding grid development and creating new power markets. Thus far, Indian discoms, guided by DSM Regulations, have taken a limited view of DSM and focused on EE and implementing ToD tariffs for high-volume consumers.

However, the Regulations must be updated. There is a need to expand the definition of DSM to encompass a wider set of approaches and consumer segments. Accompanied by other regulations governing discoms' operations, utilities' incentives must be realigned to prompt them to critically consider demand-side measures in systems planning. Regulations must be flexible to allow discoms to experiment with emerging technologies and business models, fail fast, and move quickly to generate learnings for deploying solutions at scale. Detailed and publicly available assessments of the impact of the implemented programmes could help in designing more effective solutions, such as ToD tariffs. A flexible and transparent regulatory framework will help create the space for new market players to emerge and participate in system operation. Furthermore, national and state government policies must support this transition within the larger energy transition through policies that address externalities and accelerate market transformation towards a smart power distribution sector.

The crucial ability of stakeholders to work in tandem towards a common set of objectives will determine the cost-effectiveness of the energy transition.

Annexures

Annexure I: Model multi-year tariff (MYT) regulations

The key principles and features of the MYT framework are as follows (FoR 2008; 2011):

- SERCs should set a multi-year trajectory for the discoms' operational efficiency with incentives/penalties for achieving/underachieving the targets. Discoms' annual ARR is set by escalating the costs by the retail price index (RPI) and reducing them by a normative factor 'X', representing cost reductions due to operational efficiency gains.
- Discoms should bear the losses arising from missed efficiency targets of controllable parameters, while gains from (over)achievement should be shared with consumers. Controllable parameters are the cost components that are deemed to be within the discoms' control, including capex overruns, distribution losses, aggregate technical and commercial (AT&C) losses, variations in returns on equity, depreciation, operation and maintenance expenses, normative working capital, and costs related to the failure of meeting the reliability standards specified in the standards of performance regulations.
- All gains and losses due to uncontrollable parameters should be passed on to consumers. Uncontrollable parameters are the cost components deemed to be beyond the discoms' control, including power purchase costs due to variations in sales and fuel costs, expenses due to force majeure conditions, and changes in law and taxes and duties.
- One-third of the cost savings from efficiency gains on AT&C losses should be passed on to consumers as rebates on tariffs, and the rest are to be used by the discom. Two-thirds of AT&C losses should be passed to consumers as extra charges, and the rest should be absorbed by the discom.
- A composite supply and network availability index can be estimated using reliability indices. Incentives/penalties to the extent of ±0.2 per cent of the ARR may be enforced for every percentage point increase/decrease in availability vis-à-vis the target.

This form of regulation is known as price cap or RPI-X regulation[17] and should result in lower tariffs in the subsequent year in real terms as discoms become more efficient.

17 The National Tariff Policy, 2016 (MoP 2016), refers to this as the performance-based cost of service regulation, which applies to natural monopolies in both the transmission and distribution network business.

Annexure II: List of analysed tariff orders

State	Documents
Delhi	Tariff orders for FY21 and FY22 with true-up of expenses up to FY20
Maharashtra	Truing-up of FY20–22, provisional truing-up for FY23, and revised ARR for FY24 and FY25
Karnataka	Annual performance review (APR) for FY21, approval of ARR for FY23–25, and revision of retail supply tariff for FY23 for Mangalore Electricity Supply Company (MESCOM), Bangalore Electricity Supply Company (BESCOM) APR for FY22, approval of revised ARR for FY24, and revision of retail supply tariff for FY24 for all discoms
Bihar	ARR orders for FY21–24 with APRs and true-up of previous years, including ARR for the control period FY23–25
Assam	ARR orders for FY21–24 with APRs and true-up of previous years
Uttar Pradesh	ARR orders for FY22–24 with APRs and true-up of previous years
Tamil Nadu	True-up order for FY17–21 and APR for FY22 ARR order for FY23–27 Generation and distribution tariff determination order for FY22–27 Distribution tariff determination order for FY24
Gujarat	ARR orders for FY22–24 with APRs and true-up of previous years

Source: Authors' compilation

Notes: (1) Delhi: For FY23, the DERC passed interim orders admitting the tariff petitions and instructing that the discoms would have to furnish further clarifications/additional information as and when required by the Commission.

(2) Maharashtra: Following the MERC's MYT order for the control period FY20–25 under Section 62 of the Electricity Act, 2003, and MERC MYT Regulations, 2019, the MERC passed the mid-term review orders, which are included in our review.

(3) Karnataka: The documents mentioned above are the only searchable ones. Other years' orders were scanned copies and could not be analysed using our search code.

4) Tamil Nadu: The annual distribution tariff order for FY24 alone was available for the analysed period.

Acronyms

APR	annual performance review
ARR	aggregate revenue requirement
AT&C	aggregate technical and commercial
BEE	Bureau of Energy Efficiency
BESCOM	Bangalore Electricity Supply Company
CAGR	compounded annual growth rate
CAISO	California Independent System Operator
CEA	Central Electricity Authority
CEC	California Energy Commission
CERC	Central Electricity Regulatory Commission
CFL	compact fluorescent lamp
CPUC	California Public Utilities Commission
DERC	Delhi Electricity Regulatory Commission
DR	demand response
DRAM	demand response auction mechanism
DSM	demand-side management
EE	energy efficiency
EERS	energy efficiency resource standards
EESL	Energy Efficiency Services Limited
EMV	evaluation, measurement, and verification
ESCO	energy service company
FoR	Forum of Regulators
IRP	integrated resource planning
MERC	Maharashtra Electricity Regulatory Commission
MESCOM	Mangalore Electricity Supply Company
MoP	Ministry of Power
MU	million units
MYT	multi-year tariff
M&R	monitoring and reporting
NRV	net resource value
PAT	*Perform, Achieve, and Trade*
PM KUSUM	*Pradhan Mantri Kisan Urja Suraksha Evam Utthan Mahabhiyan*
RIIO	Revenue = Incentives + Innovation + Outputs
RPI	retail price index
RPO	renewable purchase obligation
SDA	State-Designated Agency
SEEI	State Energy Efficiency Index
SERC	state electricity regulatory commission
ToD	time-of-day
UT	union territory
VRE	variable renewable energy

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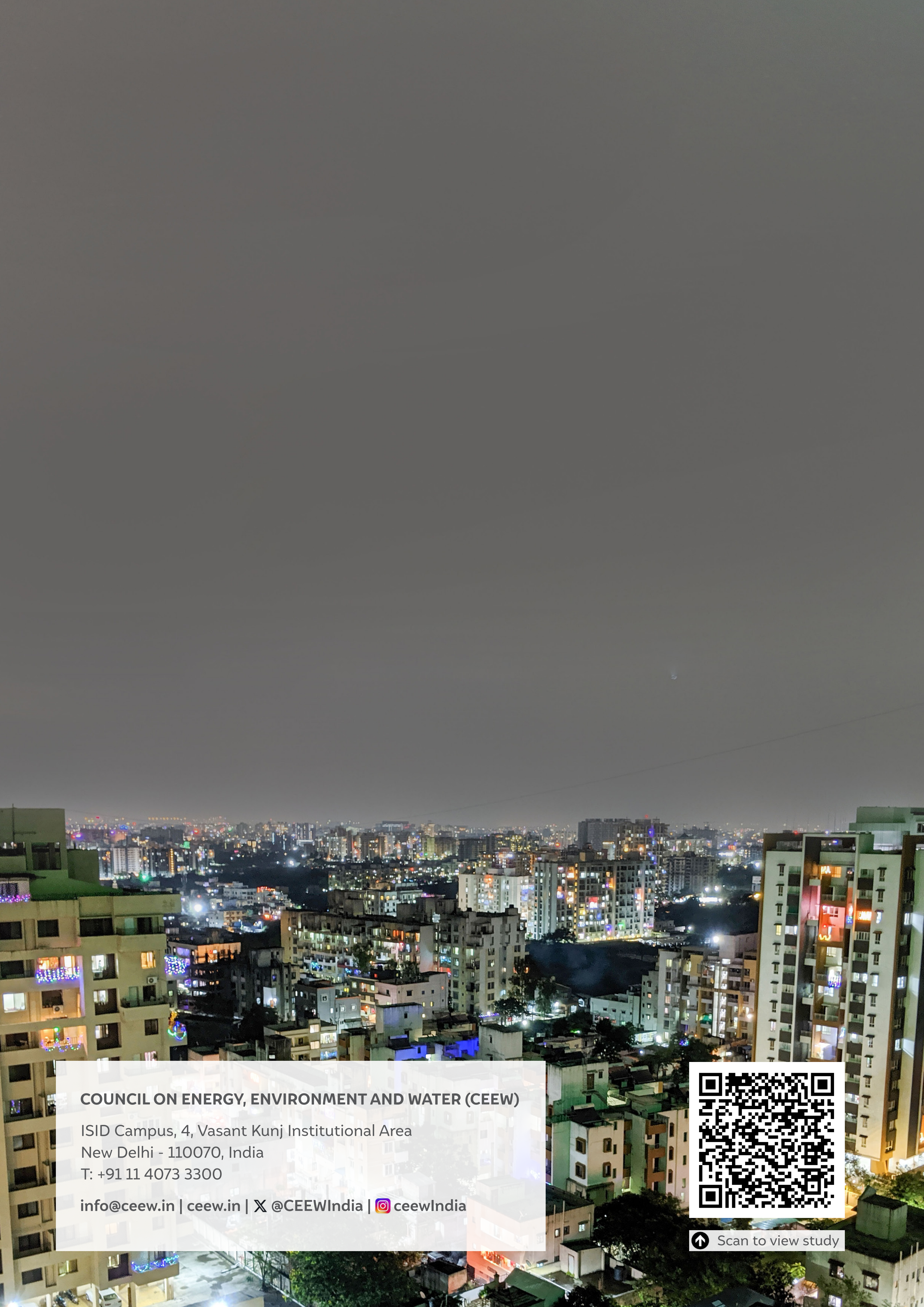

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