Operational Reforms

This section provides a review of different techno-policy solutions that can address a suite of different technological, business, and managerial challenges that discoms face today and will continue to face in the future. Experimentations, piloting, and policy de-risking through financial and non-financial means are crucial to enabling these solutions.

4.1 POWER PROCUREMENT COST OPTIMISATION

Power procurement accounts for almost 80 percent of the expense of the discoms. Discoms have oversubscribed to expensive and long-term thermal PPAs based on incorrect estimates of power demand. The fixed costs of the excess capacity must be paid, even when no power is generated. This has led to a high cost of power, insufficient investment in infrastructure, and payment delays to generators.[75] The Forum of Regulators has calculated in a study of 12 states that they are paying ₹ 17,442 crore annually as the fixed cost for surplus energy.[76]

One way to reduce the cost of power is to use power markets. Over the last decade, transactions in the short-term power market have witnessed an annual growth rate (CAGR) of 8 percent, even though the power generation growth rate reduced to 6 percent during the same period. Electricity traded through power exchange has witnessed a rapid growth of 23 percent annually and is primarily responsible for the growth of the short-term power market. The robust growth of DAM and RTM indicates discoms' preference to move towards short-term power procurement contracts instead of the traditional long-term PPAs.[77]

Box 5: The evolution of the wholesale power market[78, 79]

While power procurement is still largely tied to long-term bilateral PPAs (88%), there has been a slow but healthy growth in the wholesale markets. Short-term power purchase through power exchanges increased from 0.4% in 2009 to 4% in 2019. To strengthen the wholesale market, India recently launched the real-time electricity market (RTM) on June 1, 2020 at the India Energy Exchange Limited (IEX) and the Power Exchange India Limited (PXIL) wholesale market platforms. This is in addition to the existing products: Day-Ahead Market (DAM), Term-Ahead Market (TAM) and Renewable Energy Certificates (REC).

The RTM is designed as a half-hourly market with 48 auction sessions of 15-minute duration. By narrowing the trading window, RTM promised to provide buyers and sellers an opportunity to correct any mismatch of demand and supply closer to delivery, thereby enabling discoms to manage demand variation more efficiently. For generation companies, RTM provides the ability to optimise and sell power surplus better while improving the ability to manage renewable intermittency. RTM even permits generators with long-term PPAs to participate allowing them to sell any unanticipated surplus generation. RE generators can also obtain RECs from any unanticipated surplus generations.

The introduction of Green Term Ahead Market (GTAM) on September 1, 2020, which allows RE developers to sell green power in the open market without the need for long-term PPAs, has already seen a significant uptake by discoms. Electricity scheduled through the GTAM also contributes to the RPO compliance of the buyer.

An important intervention by the Centre around power procurement for states is taking shape in the form of market-based economic dispatch of electricity (MBED),[80] where all power transactions, including the purchase and sale of power through fixed long-term PPAs, would be routed through the power exchange. This can reduce the variable cost of power (though the fixed costs would continue to be payable) and reduce the requirement of PPAs in the future (see Table 5). Andhra Pradesh saved ₹2342 crore by optimising the procurement of power (including purchasing power from the open market) in the two years 2019–21.[81]

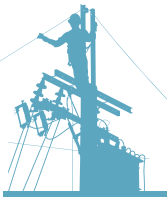


Table 5: Summary of Short-term Power Markets

Solution Option	Technical Issues Addressed	Business Issues Addressed	Managerial Issues Addressed
Real-time market, ancillary markets, DER participation	• Grid stability • RE integration	High APPC	RE purchase obligation
Benefits to Discoms			
• Increase in low-cost flexible supply and demand management through fast responding distributed energy resource management. • Opportunity and incentive to optimise generation and supply-side dispatch of a wide range of available resources that are currently underutilised (e.g., BTM solar, storage, EVs, etc.) • Customer participation.			
How to make it work?			
• **CERC:** Develop and implement wholesale products for ancillary services that are inclusive of DERs and aggregated resources. • **Discoms, GoI, Generators:** Implement a plan to fairly and effectively transition from long-term bilateral PPAs to increased use of power markets and creation of a liquid market. • Build consensus across the Centre and states to create common roadmap among Centre, state, and system operators.			

Even with the growth of renewable energy, thermal power plants will continue to supply base load, and ways to reduce the cost of thermal power need to be considered. The National Institute for Advanced Studies (NIAS) has suggested a transition plan under which older and inefficient thermal plants can be progressively retired. Their output can be replaced with newer high-efficiency low-emissions (HELE) thermal plants and nuclear plants that are in an advanced stage of construction. This will reduce the idling charges that discoms pay for these underutilised new power plants while reducing energy charges as well.[82]

In a report by Daljit Singh and Ashwini Swain, it was suggested that the discourse needs to move from just power procurement to resource planning. It is a broader process that can be used by discoms to meet the forecasted peak demand and total energy requirements of all their customers over a long-term horizon, typically 10–20 years.

The output of a resource planning exercise is an Action Plan that lists all the actions that need to be taken over the plan period such as capacity additions that need to be made; power purchases that need to be made; and other actions such as programmes to be initiated to improve energy efficiency of consumers.[83]

4.2 METERING AND BILLING

Currently, the billing efficiency at the national level is 83 percent. Smart and prepaid meters can be an important component of the solution to billing and collection challenges. Smart meters increase the efficiency of the billing and collection process by reducing human intervention and consequently empowering both consumers and discoms.

The National Smart Grid Mission (NSGM) has helped build confidence in the technology through pilots on: the impact of smart metering on AT&C losses; communication standards; consumer acceptance and regulatory hurdles. Services such as billing using Advanced Metering Infrastructure (AMI),[ix] peak load management, power quality management and outage management were also piloted. AT&C loss reduction met targets and went as high as 17 percent.[84]

MoP's Smart Meter National Programme (SMNP) aims to replace the country's 25 crore conventional meters with AMIs. SMNP has been conceived as a build-own-operate-transfer (BOOT) model, with Energy Efficiency Services Limited (EESL) as the implementing organisation. By November 2020, EESL had already installed 14.5 lakh smart meters.[85] So far, most smart meters have been installed in the states of UP, Madhya Pradesh, and Manipur. Manipur has effectively used prepaid meters to curb the usage of electricity illegally.[86] The prepaid smart meter is a major component of the revamped discom reform scheme proposed in the 2021–22 Budget.[87]

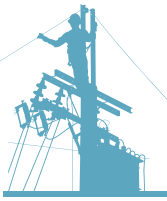
Smart meters also hold other benefits for the system. They are the first step to implement a *smart grid*—an electrical grid with automation, communication, and IT systems that can monitor and control power flows in real time.[88] Such a revamped distribution system—with smart meters, DMS, and other IT/OT components, including SCADA—creates data transparency, improved analytics, better and more granular tariff design, and more control of demand management. These benefits can substantiate the higher expenditure of the new metering infrastructure. But to extract these benefits, discoms also need a new operational and regulatory environment as well as human resources training and capacity building (see Table 6).

It should be noted that smart meters and smart grids cannot be a panacea for the problems of discoms. Deeper structural and managerial issues cannot be solved solely through technological solutions. Also, smart meters may not be suitable for all environments—it may be difficult to justify smart meters for few consumers or in areas where billing efficiencies are already high. The case for smart meters is easier to make in areas where the billing efficiency is low, or in the case of high-tension consumers (where time-of-day (ToD) tariff can make a significant difference).

Table 6: Summary of AMI

Solution Option	Technical Issues Addressed	Business Issues Addressed	Managerial Issues Addressed
Advanced metering infrastructure and billing	◆ Peak demand management ◆ Load forecasting ◆ Network management and data transparency	◆ Provisional billing ◆ Inefficient billing and collection	◆ Anti-theft enforcement ◆ Performance -linked incentives

ix AMI is an integrated system of smart meters, communications networks, and data management systems that enables two-way communication between utilities and customers (Source: US Department of Energy, https://www.energy.gov/sites/prod/files/2019/02/f59/Smart%20Grid%20System%20Report%20November%202018_1.pdf).



Benefit to Discoms
◆ Increased temporal and special granularity of electricity consumption allows discoms to pinpoint areas of inefficient system operation and predict future system upgrade requirement better. ◆ States with smart meters have demonstrated an increase in billing efficiency of 25 percent. ◆ With energy consumption data being collected at a 15-minute interval—compared to a month or two with manual meters—the discom can make use of ToD electricity tariffs that send price signals to the customer to shift their consumption to periods of lower cost. ◆ Having real-time information of energy consumption and flow across the network gives discoms very valuable information to aid in system planning for load growth.
How to make it work?
◆ **Discoms**: Develop a clear understanding and articulation of smart grid technology applicability considering geography, consumer mix and net value to the discom concerned. ◆ **National Smart Grid Mission**: Develop a common and scalable architecture for discoms to deploy smart meters, collect and use data, and optimise operations around improved data transparency. ◆ **GoI**: Support discoms in availing funding support for smart meter rollout, provide capacity building, create customer awareness around the benefits of smart meters and AMR meters.

4.3 IMPROVING COLLECTION EFFICIENCY

Even though the unauthorised use of electricity is a cognisable offence under EA2003, the theft of electricity continues to be rampant in many parts of the country[89] Discoms require the support of government machinery, in the form of police and courts, to settle legal and administrative disputes. In states such as Maharashtra, Odisha, and Manipur, such support from the government resulted in a drastic decrease in loss due to pilferage.

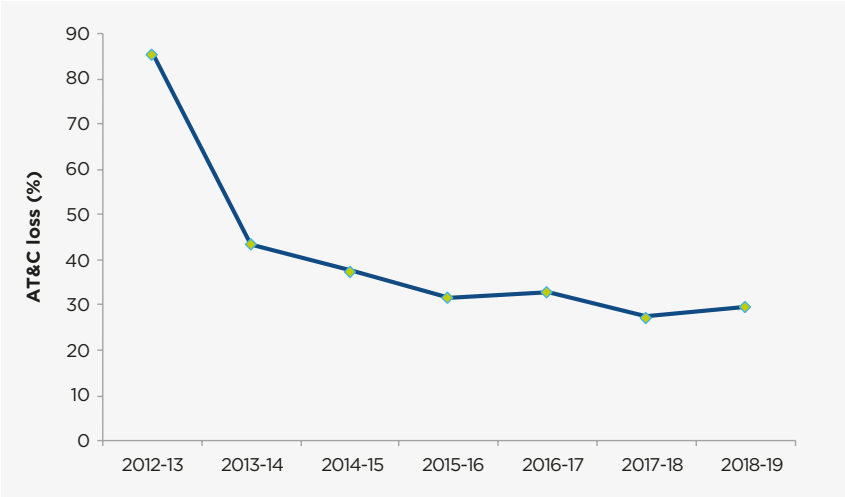
In Haryana, the officers of Dakshin Haryana Bijli Vitran Nigam sanctioned cash rewards to people providing information on electricity theft, pilferage of material, and corruption.[90] In Gujarat, thefts have been reduced by conducting frequent crackdowns, and by setting up special police stations and courts to deal exclusively with power theft.[91]

Some states have also implemented prepaid metering coupled with tamper-proof techniques to tackle illegal connections. The basic premise of prepaid metering is to eliminate issues around theft, non-payment, billing, collection, and discrepancies in meter reading while at the same time improving access to customers. It also reduces the working capital requirements of discoms.

A good example of this is Manipur. The government first tested prepaid metering in parts of the capital city, Imphal, in 2011. As installation, replacement, and customer service can be done more easily in urban areas than in rural or challenging terrains, post-paid and single-point metering were continued in the hilly and rural parts of the state. Prepaid metering was supplemented with the use of tamper-proof techniques such as aerial bunched cables and sealed meters to curb illegal tapping of wires and improve the power supply (from 6–8 hours to 16–20 hours). Improved supply also encouraged consumers to pay. Monthly revenues from electricity sales increased from ₹ 5.5 crore to ₹ 10.5 crore.

This also resulted in an overall fall in AT&C losses by over 50 percent (see exhibit 10).[92]

***Exhibit 10:AT&C** losses in Manipur and impact of prepaid meters (Source, PFC)*



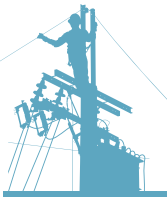
Improving collection efficiency also requires many state government departments to clear their past dues to discoms.[93]

4.4 DEMAND-SIDE FLEXIBILITY AND THE ROLE OF DYNAMIC TARIFF

The use of AMI goes beyond billing, collection and distribution automation. The granular and almost real-time data from AMI can be combined with controllable devices and dynamic tariff to increase demand flexibility. This can cater to not just load management and energy efficiency requirements, but also help in reducing peaking power needs and better management of renewables and distributed energy assets. As consumption grows, particularly with rising industrial and cooling needs, the scope for demand flexibility expands over time.

So far, in India, automated demand response (ADR) pilots have been conducted by Tata Power in Delhi and Mumbai, focusing on a limited number of commercial and industrial customers.[94] If the share of renewable energy is low, then demand flexibility can also be achieved using simple heuristics to shift elastic loads. For instance, in Karnataka, the utility BESCOM decided to energise irrigation pump sets during daytime in a manner that broadly tracks solar generation patterns. This enables them to serve the morning and evening peak loads better.[95]

Demand flexibility can also be achieved through behavioural approaches. Behavioural Energy Efficiency (BEE) programmes work under the principle that consumers can reduce or shift their usage to flatten the load curve when supplied with relevant, eye-catching, and actionable information about their use patterns.[96] BEE projects are being piloted by Jaipur Vidyut Vitran Nigam Limited (JVVNL) and BSES (see Box 6 for BSES' ongoing pilot in Delhi).



Box 6: BSES Home Energy Report Pilot[97]

Distribution utilities are looking at employing demand-side measures (DSM) as a cost-effective response to rising electricity demand. Internationally, distribution utilities have been able to achieve 1–3% energy savings per household by sending them home energy reports (HERs) which were compiled using data analytics and behavioural science.

BSES Rajdhani Power Limited (BRPL) is implementing such a BEE pilot programme in South and West Delhi. This project aims to induce residential energy savings by promoting domestic energy literacy and encouraging participation in DSM programmes. It uses a customer engagement software to study residential energy consumption habits and accordingly provides customised insights in the form of HERs. The ongoing pilot has at least 2,00,000 enrolled customers and will enable comparison between household energy use patterns using a randomised controlled trial to inform decisions about system expansion/upgrades.

ToD tariffs and real-time pricing (RTP) are electricity tariffs that change with time to reflect system conditions and provide customers a price signal that reflects the current conditions. The time-varying price signals can provide economic incentives to customers to increase or decrease energy consumption at a given time. This gives discoms another tool to lower the cost to procure and distribute electricity to their customers. Demand flexibility and dynamic tariffs hold significant benefits for discoms. But they require closer coordination between the state and the SERC coupled with support from the central government nodal agencies for their successful deployment (see Table 7).

Table 7: Summary of Demand-side Flexibility

Solution Option	Technical Issues Addressed	Business Issues Addressed	Managerial Issues Addressed
Demand-side flexibility and dynamic tariff	◆ Local and system peak management ◆ Load predictability ◆ System ramping	◆ Revenue realisation ◆ Customer engagement and choice	
Benefits to Discoms			
◆ Demand-side flexibility helps in lowering the average cost of supply. ◆ Dynamic tariff encourages movement towards cost-reflective tariff, thereby improving revenue.			
How to make it work?			
◆ **State Government and SERC**s: Empower discoms to develop more granular and cost-reflective tariffs that are approved in a timely manner and revisited frequently. ◆ **MoP**: Develop a common 'plug and play' education and awareness campaign for discoms to educate customers on financial benefits of the programmes and increase participation.			

- **Discoms**: Implementation of a robust communication network and data processing approach that allow discoms to understand where flexibility exists and provide the correct price signal to the right customer at the right time.
- **Discoms**: Smart meter rollout with high temporal granularity to enable effective ToD programmes.

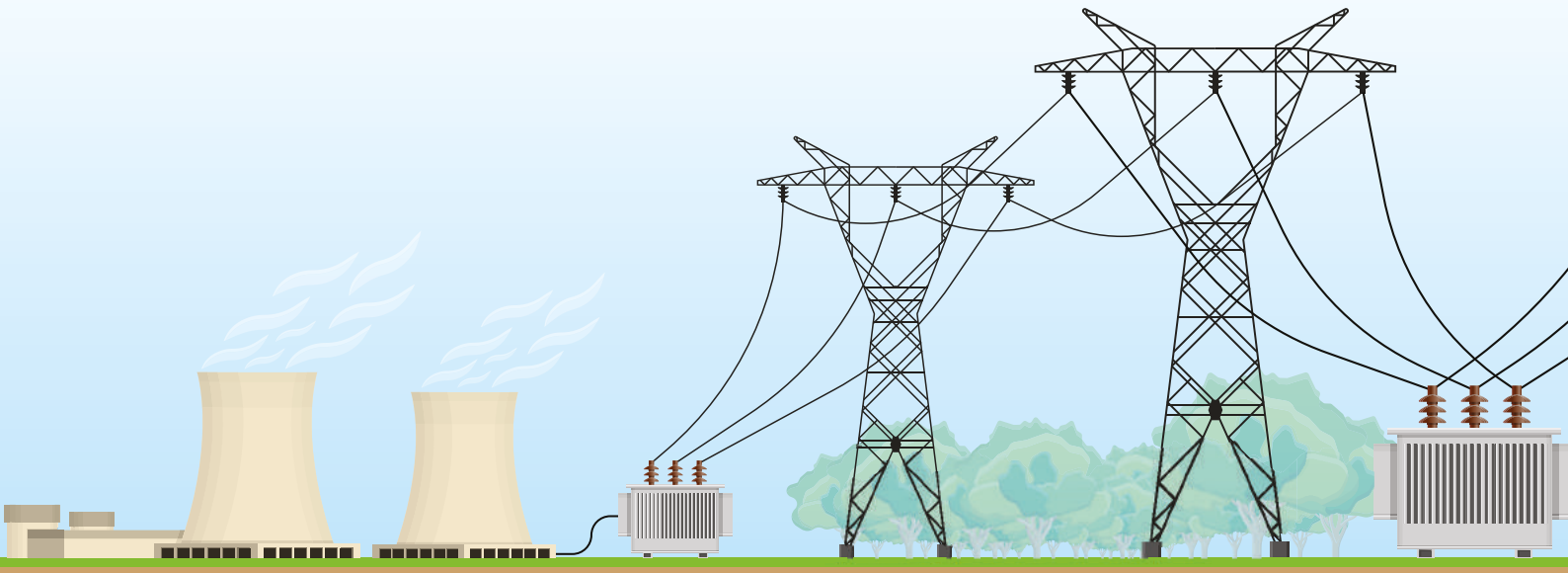
4.5 UPGRADING DISTRIBUTION INFRASTRUCTURE

Many loss-making discoms are unable to invest in the upgradation and maintenance of their equipment due to lack of resources. Old and dilapidated conductors, poorly-sized transformers and low-quality equipment can lead to high technical losses as well as unreliable power. For instance, a recent study found that 70 percent of household customers reported one or more power cuts in the past week, and 75 percent of them had no prior notification of upcoming power cuts.[98] This is a vicious cycle, since poor grid quality leads to low revenue realisation.

These losses can be brought down in many ways. When new cables are installed in peri-urban areas, they can be laid underground to reduce thefts and increase reliability. HT or LT aerial bunched cables (ABC) can be used to avoid theft through direct hooking, and to reduce fault rates as well. The load profile of transformers can be studied and modified as per the connected load. This will reduce losses of the transformers and improve the voltage profile.

Some states have systematically brought down technical losses through better equipment and by instituting proper maintenance practices. Gujarat was able to reduce technical losses through steps such as the use of HT lines, prepaid/smart meters in government establishments, installation of new substations and specially designed transformers, AMR for feeders, and optimal sizing of conductors and transformers.[99]

Similarly, in Delhi, the AT&C losses in Tata Power-DDL areas have shown a major decline, from 53 percent in July 2002 to 7.79 percent in April 2020. This reduction in losses was



achieved by the implementation of several technologies, including Advanced Distribution Management System (ADMS), Integrated Geographical Information Systems (GIS), AMI, ADR, field force automation, and upgradation of the network. The technical losses were brought down by balancing loads, enforcing technical specifications, and replacing old and inefficient cables, panels, and transformers with high quality equipment. All this requires high capital expenditure.

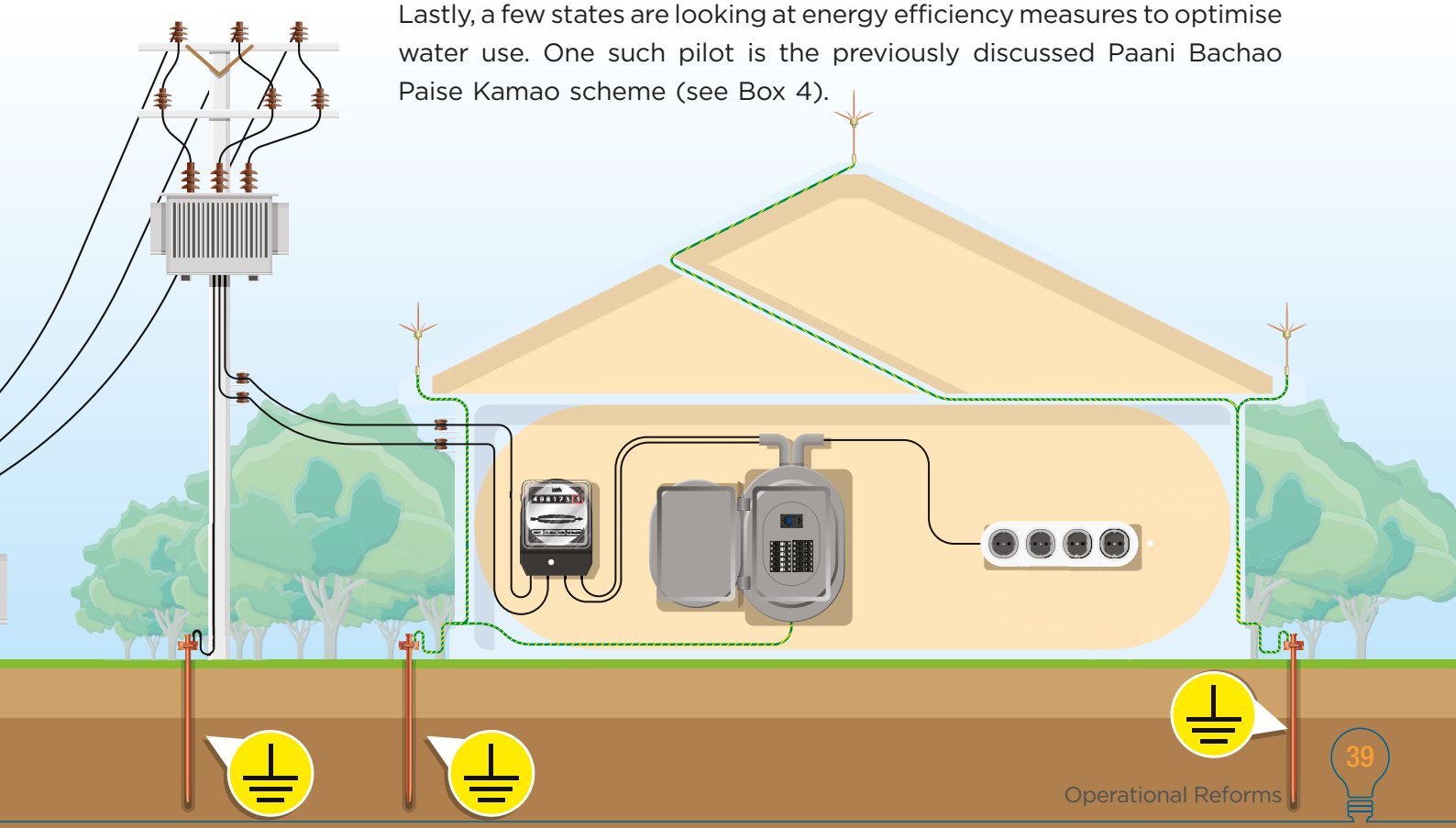
4.6 AGRICULTURAL DEMAND MANAGEMENT

Current pilots on demand flexibility are primarily being driven in urban and industrial regions. But agricultural load management is equally important, given that most discoms have to cater to a large share of not optimised and highly subsidised agricultural demand.

States with a large rural or agricultural consumer base—such as Rajasthan, Andhra Pradesh, Gujarat, Karnataka and Maharashtra—have resorted to separating feeders for agricultural use from non-agricultural use. This measure has been adopted to regulate agricultural consumption and manage peak loads. Investment in feeder separation has been encouraged by the Centre through the DDUGJY.

Solar pump deployment has also received a push through the Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyan (PM-KUSUM) scheme. This scheme is meant to support installation of off-grid solar pumps in areas with poor grid supply, and reduce the dependence on grid power in grid-connected areas. The scheme will help farmers set up standalone solar pumps, and solarise their grid-connected pumps. Farmers can set up solar power generation capacity on fallow and barren lands and sell the power to discoms.[100] Faster implementation of this scheme requires cooperation among the Centre, states, and other stakeholders (including farmers, manufacturers, and integrators).[101]

Lastly, a few states are looking at energy efficiency measures to optimise water use. One such pilot is the previously discussed Paani Bachao Paise Kamao scheme (see Box 4).



5 Solutions for RE Integration

India has set the ambitious target of generating 450 GW of solar and wind power by 2030. If this target is met, renewable energy would account for more than 50 percent of the power generation capacity and more than a quarter of all the electricity produced.

However, the challenge of RE integration and curtailment must be resolved. RE can impose additional costs on the system, and it is important to determine the corresponding full system cost.[102] If not managed well, greater penetration of RE can impact the technical and financial functioning of discoms.[103]

As discussed earlier, contractual inflexibility aside, growth in renewables has compounded the problems of power procurement for discoms. While progress has been made in the regional integration of RE at the transmission end, gaps have remained in the discoms' preparedness with respect to avoidance of curtailment and management of existing long-term PPAs.

As the primary offtaker of RE and given the concentrated generation and localised consumption, discoms remain critical in RE integration. However, there are many potential sources of flexibility in renewables-rich states. These include demand-side flexibility, long-term supply and demand analysis and integrated resource planning (IRP), RE forecasting and scheduling (including weather and load), identification of flexible balancing resource beyond thermal generation, optimal use of power exchanges, and managing growth in RTS and other DER assets.[104]

5.1 REGIONAL INTERCONNECTION AND BALANCING

Power system operators and load dispatch centres balance electricity supply and demand within specified areas, called balancing areas, which include a fixed portfolio of generators.