

Demand Response : Tool to Optimise Electricity Tariff

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INTRODUCTION

India, as a tropical country, experiences intense summers and recurring heat waves, with several northern cities recording temperatures above 50°C¹. Climate projections suggest that average temperatures in India could increase by 1.1°C–4.1°C over the 1986–2005 baseline, with the rate of warming dependent on the 21st century emissions pathway.²

Simultaneously, India's economic growth is driving appliance ownership and electricity use. Government projections indicate a significant rise in electricity consumption as India moves toward the Viksit Bharat 2047 vision. The Draft National Electricity Policy (2026)³ projects per-capita electricity consumption increasing from about 1,460 kWh in 2025 to over 4,000 kWh by 2047, implying a near-threefold expansion in reliable electricity supply.

At the same time, decarbonisation strategies are accelerating the electrification of end-use such as transport, cooking, and industrial processes. In parallel, structural demand drivers such as rising penetration of Air Conditioners, expansion of electricity-intensive Data Centres supporting the digital economy, and increasing charging load from Electric Vehicles are expected to significantly influence peak load.

Together, these factors are likely to drive peak electricity demand to unprecedented levels, even as the generation mix shifts increasingly toward variable renewable energy.

This dual transition of rapid demand growth alongside increasing renewable energy penetration poses a serious challenge to the reliability of the distribution infrastructure. Distribution networks often operate beyond their design thermal limits during peak demand hours, leading to voltage deterioration, transformer overloading, and outages, thereby impacting the technical health and operational efficiency of the system.

The issue is compounded by the highly variable nature of electricity demand across hours, seasons, and states, making peak management a central concern for system planning and operations. Such stress conditions often lead to outages and forced load shedding, which in turn adversely impact the revenue and financial stability of Distribution Companies (DISCOMs).

The operational stress is already visible in system-level indicators. India recorded a national peak demand of around 250 GW in 2025-26, compared to about 184 GW in

¹ <https://www.indiatoday.in/cities/story/delhi-areas-temperature-nearly-50-degrees-celsius-heatwave-sweeps-india-2544931-2024-05-28>

² World Bank Climate Risk Profile [15503-WB_India_Country_Profile-WEB.pdf](#)

³ <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2216661®=3&lang=2>

2019-20⁴, reflecting a sharp structural increase in peak loads within five to six years. During extreme summer conditions, several states have faced localized shortages and price spikes in short-term markets, forcing DISCOMs to procure power at elevated rates. For instance, on 30th May 2024, when temperatures surged and peak demand touched 250 GW, the average price in Real Time Market at Indian Energy Exchange was about Rs. 6.20/kWh, with the market price hitting the ceiling of Rs. 10.00/kWh for 4 hours.

At the utility level, the financial impact of such procurement patterns is evident. In its True-up Petition for FY 2024–25, Jaipur Vidyut Vitran Nigam Limited (JVVNL)⁵ reported procuring 4,129 MU, nearly 10% of its total power purchase, from short-term sources including exchanges and bilateral contracts. Power procured from exchanges was at an average rate of Rs. 5.18 per kWh, while bilateral purchases were at Rs. 6.91 per kWh, significantly higher than typical long-term contracted power.

Recent grid disturbances in advanced power systems have underscored the growing importance of flexibility. The large-scale blackout that affected Spain and Portugal in 2025 was not caused by a single failure, but by a combination of generation loss, inadequate reserves, and insufficient real-time balancing capability. In systems with high shares of renewable energy, fast-acting flexibility resources—such as storage, flexible

generation, and demand response—play a crucial role in preventing failures. While demand response alone cannot eliminate blackout risks, it can provide rapid load relief during periods of system stress, thereby reducing the probability and severity of such events. The Iberian incident thus underscores the need for a diversified flexibility portfolio, within which **Demand Response (DR)** forms an important, though complementary, component.

These trends highlight the growing cost and reliability risks associated with unmanaged peak demand, underscoring the need for demand-side flexibility, improved distribution planning, and mechanisms to smooth load profiles. Against this backdrop, DR is increasingly promoted as a low-cost alternative to supply-side investments. It is frequently cited as a solution for peak management, cost reduction, and renewable integration. DR is increasingly finding space in policy debates and regulatory frameworks, yet important questions remain. ***What exactly is demand response? How far has India progressed in its implementation? More importantly, is DR being overestimated in a fast-growing economy like India? And could excessive reliance on DR lead to power shortages in the long run and stunt growth in India?***

This article examines these questions and argues for a calibrated, context-sensitive approach to demand response in India.

⁴ PFI Dashboard
<https://www.powerfoundation.org.in/demand.php>

⁵<https://www.powerfoundation.org.in/assets/downloads/63.pdf>

DEMAND RESPONSE

Demand Side Management (DSM) is a broad framework through which DISCOMs encourage consumers to optimise their electricity consumption patterns. It includes programmes that promote energy efficiency, conservation, & load management, thereby reducing overall system costs and optimising investments across electricity value chain.

Within this framework, DR refers to a narrower, operational intervention. It involves short-term, time-specific changes in electricity consumption by consumers in response to price signals, incentives, or system needs. The objective is to flatten the load curve by reducing electricity consumption during peak demand periods, thereby reducing reliance on costly short-term power purchases and avoiding additional network costs. The cost of power purchase constitutes over 80% of the Tariff charged from the consumers.

As demand rises, DISCOMs and the State Transmission Utilities are also required to upgrade their networks to handle higher peak loads, which leads to a significant CAPEX for strengthening both upstream and downstream infrastructure. Analysis in PFI's report on "Incidence of Electric Bus Charging on DISCOMs' Network and Scope for Optimal Power Purchase" indicates that the levelized tariff impact of

network cost is around Rs. 61.45 Crore for peak load of 30 MW in network upgrades, highlighting the importance of managing peak demand through flexible resources like DR (Refer Annexure 1).

Unlike energy efficiency measures, which reduce overall electricity consumption over the long term, DR focuses on time-specific adjustments in electricity use during periods of system stress. It is therefore a flexibility tool rather than a conservation tool. In effect, it treats electricity demand as a dispatchable system resource, capable of providing peak shaving, load shifting, congestion relief, and short-term reliability support—functions traditionally delivered served by generation or network assets, which typically need high capital expenditure.

DR mechanisms can be classified as be Price-based (wherein consumers adjust consumption in response to dynamic tariffs such as Time-of-Day tariffs), Incentive-based (wherein consumers are compensated for reducing or shifting load during specific system stress events). DR can be Manual (Load reduction is carried out through consumer action based on signals or instructions) or Automated (enabled by Digital controls, smart meters, and communication systems for near real-time response at appliance or facility level).

IMPLEMENTATION STATUS OF DR IN INDIA

India's experience with DR remains nascent and institutionally fragmented. The Electricity Act of 2003, which consolidates the laws governing the electricity sector in India, as well as its latest amendment of 2025, does not explicitly mention DSM/DR, nor do they

assign clear responsibilities to DISCOMs in implementing such initiatives. Similarly, the Energy Conservation Act of 2001, the foundational legislative framework for energy conservation and efficiency initiatives, does not contain any specific provisions for DR initiatives. The Forum of

Regulators issued model DSM Regulations in 2010, which were subsequently adopted by several states. However, these regulations were largely focussed toward energy efficiency and conservation, with limited emphasis on time-bound load shifting or DR.

More recently, DR has begun to find recognition in central regulations. The Central Electricity Regulatory Commission (CERC) Ancillary Services Regulations, 2022, and the Indian Electricity Grid Code, 2023, define Demand Response. At the state level, regulatory momentum is also building. Maharashtra has notified dedicated Demand Flexibility and DSM Regulations in 2024, while states of Assam, Rajasthan, and Karnataka have issued Draft Demand

Flexibility (DF) or Demand Response Regulations. These specifically include peak demand reduction targets, program design, communication standards, and monitoring of DR programs. To institutionalize implementation, these regulations mandate every DISCOM to establish a dedicated DF/DSM Cell. Notably, Maharashtra, Rajasthan, and Karnataka have also introduced Demand Flexibility Portfolio Obligations (DFPO), as a percentage of peak demand experienced in the previous Financial Year, with targets till FY 2029-30 (*Refer Table 1*).⁶ Maharashtra, Rajasthan, and Karnataka also provide Distribution Licensee an incentive of Rs 0.20 Crores for every MW achieved in excess of DFPO, and a disincentive of Rs 0.20 Crores for every MW underachievement of DFPO.

Table 1: Summary of DFPO in various states

Year	Maharashtra	Rajasthan [^]	Karnataka [^]
FY 2025-26	1.5%		
FY 2026-27	1.5%	0.25%	0.5%
FY 2027-28	2.0%	1.0%	1.0%
FY 2028-29	2.5%	1.5%	1.5%
FY 2029-30	3.5%	2.0%	2.0%

DFPO as percentage of Peak Demand experienced in previous Financial Year

[^]As per Draft Regulations; Source: Respective States' Demand Flexibility and DSM Regulations⁶

India has also conducted several pilot projects using manual or automated approaches. Early pilots focused on commercial and industrial (C&I) consumers, as they offered large, controllable loads, clear financial incentives, and easier aggregation. For example, in 2012, a Tata Power Mumbai DR pilot achieved about 15 MW of

curtailable capacity across 21 events using voluntary participation by large C&I consumers⁷. Similar results have been observed in Delhi, where BSES Yamuna Power Limited (BYPL) had implemented multiple DR pilot initiatives across consumer segments. In 2017-18 and 2018-19, BYPL undertook two manual demand response pilots targeting C&I

⁶ merc.rajasthan.gov.in/;
https://kerc.karnataka.gov.in/uploads/media_to_upload1760767578.pdf;
https://merc.gov.in/regulation_type/current-

[regulations-demand-side-management/](https://aerc.gov.in/regulations/1722836861.pdf);
<https://aerc.gov.in/regulations/1722836861.pdf>
⁷ <https://bridgetoindia.com/backend/wp-content/uploads/2020/03/Shekhar-Khadilkar-Tata-Power-20032020.pdf>

consumers, achieving an estimated load reduction of around 50 MW. In 2020-21, BYPL also implemented an Automated DR pilot within its office wherein temperature setting of ACs was controlled/changed at specific intervals. Further residential Automated DR was carried out in FY 2023–24, with participation of approximately 50 residential consumers. In this individual loads were controlled through Auto DR based operation of smart switches. Continuing this progress, BYPL again undertook manual DR project in FY 2025–26 for C&I consumers, saving 14 MW; and an Automated DR pilot focused on electric rickshaw charging stations, saving 23 MW [Source: BYPL].

These pilots revealed two distinct models. C&I DR can deliver large load reductions quickly, often without significant technology investments, but its scalability is limited. Residential automated DR, by contrast, delivers smaller absolute reductions but can be scaled across millions of households, particularly for cooling loads, with minimal impact on comfort, but is dependent on smart meters and automation infrastructure. However, current pilots operate in the kilowatt to small-megawatt range, far below system-level requirements. Some of the key DR pilots in India are as follows:

Table 2: Overview of Demand Response Projects in India

Sr. No.	Type	Consumer	Year	State
1.	Aggregator-based automated DR – for peak demand management (Tata Power Company Ltd)	C&I	2012	Mumbai, Maharashtra
2.	Manual – for managing deviation from the schedule (JVNL)	C&I	2013-14	Jaipur, Rajasthan
3.	Automated – for peak demand management (TPDDL)	C&I	2014	Delhi
4.	Manual – for managing C&I load (BYPL)	C&I	2017-18; 2018-19	Delhi
5.	Manual – for peak demand management (UPPCL)	C&I	2019	Uttar Pradesh
6.	Automated – BYPL internal AC load	BYPL Office	2020-21	Delhi
7.	Automated - 0.3 kW per consumer per event saving (BYPL)	Residential	2023-24	Delhi
8.	Manual -14 MW cumulative saving (BYPL)	C&I	2025-26	Delhi
9.	Automated - 23 MW saved with 29,000 events for 102 points (BYPL)	E Rickshaw charging stations	2025-26	Delhi

Source: AEEE⁸, BYPL

⁸ <https://aeef.in/wp-content/uploads/2022/06/Roadmap-for-Demand-Flexibility-in-India.pdf>

Despite these developments, DR is not yet systematically integrated into Resource Adequacy planning, Distribution planning,

and Procurement decisions. As a result, DR remains largely experimental rather than institutionalized.

IS DR OVERRATED IN A GROWING ECONOMY?

In a growing economy like India, much of the peak demand is met through short-term market purchases from peaking merchant power plants, or to some extent through various gas based plants. Such plants are built primarily to meet short-duration peak demand. These plants typically operate for a limited number of hours in a year, have low utilisation factors, and recover costs through higher tariffs during peak periods. As peak demand rises, systems face the choice of investing in such peaking resources or managing the peak through flexible demand.

In this context, DR functions as a non-generation alternative to peaking capacity. Instead of building generation assets that run only a few hours annually, the system can incentivize consumers with flexible loads to shift or curtail demand during peak periods. This approach reduces the need for high-cost peaking plants, lowers short-term market procurement costs, and improves system reliability.

Most DR pilots in India operate at kilowatt or small megawatt scales. By contrast, projected evening deficits in some scenarios run into tens of gigawatts, driven by the mismatch between solar generation and peak demand. DR is

therefore best understood as a tool for managing the timing of demand so that the system can rely less on expensive peaking or merchant plants, not for reducing how much electricity a growing economy requires.

Concerns about DR constraining growth or creating shortages are not entirely misplaced, but they arise only when it is poorly designed. If treated as a substitute for firm capacity, DR could lead to peak-hour rationing, discourage industrial activity, or delay necessary investments in generation and networks. However, these outcomes are not inherent to DR itself; they are the result of misaligned expectations.

When designed properly, DR should be voluntary, compensated, and targeted at flexible, non-critical loads. It should operate during limited peak windows and complement investments in generation, storage, and networks. In this form, DR does not suppress growth. Instead, it acts as a cost-effective alternative to merchant or peaking power plants, improving reliability and reducing overall system costs. For DISCOMs, it leads to flattening of load curve and optimisation of power purchase cost.

WAY FORWARD

Demand Response is neither inherently overrated nor a panacea for India's power sector challenges; rather, its perceived overstatement often stems from misaligned expectations about its role. It is a useful instrument whose value depends entirely on how it is designed and deployed. India's power system must expand, decarbonise, and remain affordable at the same time. In such a context, DR should function as a supporting flexibility resource. Evidence from pilot projects suggests that DR performs well within specific operational niches, particularly for peak shaving and short-duration system stress.

Over-reliance on DR as a substitute for supply-side adequacy could increase the risk of shortages, especially during prolonged or coincident peak demand events. DR is fundamentally a temporal balancing tool, capable of deferring or reshaping demand over minutes or hours, but not of meeting sustained energy requirements. Treating DR as a replacement for firm generation, storage, or network, rather than as a complementary flexibility resource, would therefore be inappropriate and potentially destabilising.

India's development trajectory—reflected in the Viksit Bharat 2047 vision and NITI Aayog's manufacturing roadmap—envisages a significant increase in electricity-intensive economic activity, including raising manufacturing's share of GDP from approximately 16–17% today to around 25% by 2047.⁹ Consistent with this, the Draft National Electricity Policy projects that per-capita electricity

consumption must triple by 2047, implying a multi-fold increase in reliable electricity supply.¹⁰ DR does not reduce aggregate electricity consumption or suppress productive demand; instead, it alters the timing of consumption, primarily by shaving short-duration peaks, leading to saving in power purchase cost and network cost, hence, lowers the burden of high Tariff on end-consumers.

When applied to flexible end uses and limited peak windows, DR can lower system costs, defer inefficient infrastructure investments, and improve reliability—outcomes that support, rather than constrain economic growth. Growth risks will arise only if DR is misapplied as a long-term substitute for generation, storage, or network investment.

The policy question, therefore, is not whether to adopt DR, but how to institutionalise it prudently and systematically within India's evolving electricity architecture.

To move beyond pilot-based experimentation, DR must be formally recognised within State Electricity Regulatory frameworks. State Electricity Regulatory Commissions (SERCs) may consider notifying **Demand Response Obligations** for DISCOMs, with phased and realistic targets. Regulatory Commissions of Maharashtra, Rajasthan, and Karnataka have already taken a step towards it. Compliance mechanisms, including reporting standards and penalty provisions for non-fulfilment, may draw parallels from Renewable Purchase Obligation (RPO) frameworks. Annual ARR

⁹ *Reimagining Manufacturing: India's Roadmap to Global Leadership in Advanced Manufacturing* (NITI Aayog)
<https://niti.gov.in/sites/default/files/2025->

[10/Reimagining_Manufacturing_Indias_Roadmap_to_Global_Leadership_in_Advanced_Manufacturing.pdf](#)

¹⁰ *Draft National Electricity Policy (NEP), 2026*

filings should require explicit disclosure of DR procurement, performance, and cost-benefit outcomes. Such measures would provide regulatory certainty and encourage systematic scaling. Regulatory frameworks should allow recovery of DR programme costs through ARR to avoid financial stress on DISCOMs. Standardised Measurement & Verification (M&V) Protocols should be developed to ensure comparability across states, strengthen regulator confidence and reduce disputes.

DR should be incorporated into Integrated Resource Planning exercises, Resource Adequacy frameworks, and Distribution

network investment planning. This integration must quantify avoided capacity procurement costs, deferred capital expenditure, and reduced network congestion.

If supported by appropriate reforms, Demand Response can play a critical supporting role in India's electricity transition—reducing peak stress & system costs and deferring inefficient capital expenditure, without constraining energy consumption growth — thereby positioning DR as an enabling instrument for optimisation of electricity tariff and for ensuring affordable and reliable power supply.

Annexure 1

Table : Assumptions for CAPEX requirement for the Network upgradation

Particulars	UoM	FY 26	FY 27	FY 28	FY 29	FY 30
E-bus Charging Capacity that can be avoided	MW	24	10	14	20	28
	MVA	43	18	25	35	49
Capex Requirement for the network upgradation	Rs Cr/MVA	4	4	4	4	4
	Rs Cr	171	70	99	140	197
Capex Deferral	Rs Cr	171	70	99	140	197
Debt: Equity		70:30	70:30	70:30	70:30	70:30
Debt	Rs Cr	120	49	69	98	138
Interest Rate on Debt		12%	12%	12%	12%	12%
Useful life of the network	yrs	25	25	25	25	25
Loan repayment period	yrs	12	12	12	12	12
Equity	Rs Cr	51	21	30	42	59
Rate of RoCE		14%	14%	14%	14%	14%
Salvage value of Assets		10%	10%	10%	10%	10%
Depreciation rate	1st 12 years	5.83%	5.83%	5.83%	5.83%	5.83%
	for next 13 years	1.54%	1.54%	1.54%	1.54%	1.54%
Discount rate		9.71%				

Network Cost Impact

Particulars	UoM	Y-1	Y-2	Y-3	Y-4	Y-5	Y-6	Y-7	Y-8	Y-9	Y-10	Y-11	Y-12	Y-13	Y-14	Y-15	Y-16	Y-17	Y-18	Y-19	Y-20	Y-21	Y-22	Y-23	Y-24	Y-25	
Depreciation	Rs Cr	5	12	17	24	34	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39
Accumulated Dep		5	17	34	58	92	131	171	210	250	289	329	368	378	389	389	410	420	431	441	451	462	472	483	493	502	
Return on Capital Employed (ROCE) Rs Cr																											
Opening Assets		0	171	241	340	480	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677
Addition		171	70	99	140	197	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Decapitalization		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Closing Assets		171	241	340	480	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677
Average Assets for FY		86	206	291	410	578	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	677	600
Regulated Rate Base		0	154	207	282	388	546	506	467	427	388	348	309	298	288	278	267	257	246	236	226	215	205	194	184	175	
Investment capitalised in the year		171	70	99	140	197	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Depreciation during the year		5	12	17	24	34	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	
Depreciation on decapitalised assets		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Net Investment capitalised		166	58	82	116	163	-39	-39	-39	-39	-39	-39	-39	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	-10	
RRBo		166	212	289	398	551	506	467	427	388	348	309	298	288	278	267	257	246	236	226	215	205	194	184	173	163	
RRBI		83	183	248	340	470	526	487	447	408	368	329	289	283	272	262	252	241	231	220	210	199	189	179	169		
WACC		12.67%																									
ROCE		11	23	31	43	60	67	62	57	52	47	42	37	37	36	35	33	32	31	29	28	27	25	24	23	21	
Deferral Cost/yearly	Rs Cr	16	35	48	67	93	106	101	96	91	86	81	76	48	46	45	44	42	41	40	38	37	36	34	33	31	
Discount Factor		1	0.91	0.83	0.76	0.69	0.63	0.57	0.52	0.48	0.43	0.40	0.36	0.33	0.30	0.27	0.25	0.23	0.21	0.19	0.17	0.16	0.14	0.13	0.12	0.11	
Discounted Deferral Cost	Rs Cr	16	32	40	51	64	67	58	50	43	37	32	27	16	14	12	11	10	8	7	6	5	4	4	4	3	
Levelized annual Deferral Cost	Rs Cr	61.45																									