RAP
REGULATORY
ASSISTANCE PROJECT

May 2024

# Insights on distributed energy resources (DERs) policy support in India

By Ajit Pandit, Rajiv Shukla & Aditya Marathe

**Prepared by:**

Idam Infrastructure Advisory Pvt. Ltd.
An ISO 9001:2015 Certified Company

RAP
REGULATORY
ASSISTANCE PROJECT

## Contents



# Acknowledgements

This policy brief on *Insights on distributed energy resources (DERs) policy support in India* has been jointly prepared by the Regulatory Assistance Project (RAP) and Idam Infrastructure Advisory Private Limited. It would not have been possible to present this work in its current form without insightful review and excellent contribution from the agencies and peers — all of which are sincerely appreciated.

We would like to express our sincere gratitude to RAP for ideation and guidance during the study, with special thanks to Mr. Alejandro Hernandez, Program Director, RAP and Ms. Shravya Reddy, Deputy Chief, RAP. We also take this opportunity to thank Mr. Kamlesh Dilliwar (Director Technical, CSERC), Ms. Deepti Mathur (Executive Engineer - DSM, JVVNL), Mrs. Rajeshwari K. (Asst. General Manager – DSM, BESCOM), Dr. Nilesh Rohankar (Additional Executive Engineer, MSEDCL), Mr. Ashwin Gambhir (Fellow, Prayas Energy Group) for sharing their valuable insights as panellists during the webinar. We also thank the senior officials of the state government agencies (DISCOMs, SNAs, SERCs) of more than 10 states for their active participation in the consultation process and sharing their experiences and challenges within the DER sector.

Finally, we would like to thank the readers of the policy paper for taking the time to study the findings and conclusions. We hope that this policy paper will provide valuable information and insights that will be useful in seeding required reforms to scale the DER sector in India.

**Authors:**

Mr. Ajit Pandit, Founding Director & CEO, Idam Infrastructure Advisory

Mr. Rajiv Shukla, Executive Director, Idam Infrastructure Advisory

Mr. Aditya Marathe, Manager, Idam Infrastructure Advisory

**Reviewers:**

Dr. Alejandro Hernandez, Program Director, RAP

Dr. Rajendra Addepalli, Senior Advisor, RAP

Mr. Dominic Scott, Senior Advisor, RAP

Ms. Shravya Reddy, Senior Advisor, RAP

# Disclaimer

# 1 Executive summary

The objectives of this policy brief are to draw a brief picture of the current penetration of distributed energy resources (DERs) in India and provide policy recommendations to enable smooth penetration of DERs into the distribution grid.

An evolution of DERs in India is discussed by detailing schemes for the grid-connected solar rooftop photovoltaic (PV) programme, central financial assistance (CFA) for rooftop solar (RTS) projects, *Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan* (PM-KUSUM, a Ministry of New and Renewable Energy (MNRE) scheme to increase solar capacity), electric vehicles (EVs) and charging stations, battery energy storage systems (BESS) and demand response.

Then the current regulatory landscape is presented through briefly touching on model regulations for distributed renewable energy sources (drafted by Forum of Regulators (FOR)) and technical standards for connectivity of distributed generation resources by Central Electricity Authority (CEA). Discussion on CEA regulations on ancillary services and FOR model regulations on demand side management also brings out an important facet of demand response.

Current challenges in India faced by DERs revolve around the frequent policy changes, non-uniform regulations across states, concerns of distribution companies (DISCOMs) over revenue loss, levy of network charges and grid support charges, varying power demand due to the intermittent nature of DERs, nuisance tripping of protection devices and capacity building and training of DISCOM officials.

Based on the above background, the following policy recommendations are suggested:

- **State electricity regulatory commission (SERC) to set targets for DER installations for each DISCOM.**
    - Providing reasonable targets to DISCOMs for power consumption from DERs would create a roadmap for stable increase in DERs.
- **Develop cost benefit analysis framework for DERs.**
    - Clearly laying out the actual financial impact of DERs on DISCOMs would enable them to make better decisions.
- **Design, develop and implement pilot projects.**
    - Pilot assignments on current and innovative business models would help DISCOMs and SERCs explore avenues to reach a symbiotic solution for all stakeholders, maintaining grid stability.

- **Adopt new approaches towards system operation, electricity market and energy policy.**
    - Developing regulations and policies would promote DERs as well as provide business opportunities for DISCOMs.
- **Develop regulatory framework for demand response (DR).**
    - To ensure large scale adoption of DR, there is a need to develop a model regulatory framework and associated guidelines such as cost effectiveness assessment and evaluation, measurement and verification of DR programmes.
- **Develop a DER aggregator framework.**
    - Aggregation of small DER resources (such as RTS, demand response, EV charging stations, etc.) and controlling them in real time, creates a virtual power plant which can provide services to the state and regional load management centres. Hence there is a need to develop a DER Aggregator framework and conceptualization of a few pilot projects using said framework,
- **Develop tools for hosting capacity assessment.**
    - Better understanding of the feasibility of DER installation is required to precisely assess the impact of DERs. A tool for hosting capacity assessment would provide grid operators comprehensive information for planning DER capacity installations.

# 2 Background

India's economic growth has led to increased electric power consumption.[1] This consumption is not limited to industrial or commercial consumers; increased spending capacity of residential consumers has also led to growth of power demand from small individual consumers. In 2022-23 the domestic consumer category saw the highest electrical energy sales in India, compared to all other consumer categories (like industrial, commercial, agriculture, etc.).[2] This has implications for achieving India's nationally determined contributions to the United Nations framework convention on climate change. Power distribution systems have traditionally seen unidirectional flow of electrical energy, from large scale power generators towards the consumers. Rapid growth of distributed energy resources (DERs) has led to bi-directional flow of energy through the distribution grid. Consumers of DISCOMs now generate their own power and feed it to the grid.

The electricity sector is at the forefront of decarbonization initiatives and DERs are expected to play a key role in enabling the country to eventually transition away from fossil fuel power generation (especially coal). DERs are assets that are located near demand centres across

[1] India Brand Equity Foundation (IBEF). (2024, February). *Indian power sector analysis*. https://www.ibef.org/industry/indian-power-industry-analysis-presentation

[2] NITI Aayog. (n.d.). *India climate and energy dashboard (ICED)*. https://iced.niti.gov.in/energy/electricity/distribution/consumer

the distribution grid and can provide value to the DISCOMS, power system and customers. Deploying DERs at scale provides an opportunity to improve electric system efficiency, reduce consumer costs and combat emissions. DERs include benefits such as energy efficiency, demand response, storage resources, distributed generation closer to load such as rooftop solar and more. DERs are not just resources behind the meter but also include community-based resources connected to the distribution segment, as well as emerging applications such as managed electric vehicle charging.

DERs empower customers in many ways:

- To modify their electric usage in a way that would save them money.
- To offer products to load dispatch centres and DISCOMs to increase system reliability and efficiency.
- To help reduce emissions.

The promotion of DERs, however, requires affirmative action by utility regulators and policymakers.

# 3 Evolution of DER support policies in India

The current capacity of renewable energy (RE) systems connected to the Indian grid is 31%, which includes solar, wind, small hydro and bio generation.[3] Rooftop solar, which is the predominant DER in India, is only around 2.5% of the total installed power generation capacity in India.[4] However, with the increasing deployment of DERs and changes in demand, power sector dynamics are bound to change in India. DERs improve the efficiency and sustainability of the power sector, and they also help with meeting the country's electricity demand from local sources in a reliable manner, especially in unelectrified rural areas. There are various distributed technologies with different degrees of maturity that are currently being deployed in India. These include solar, wind, small hydro, waste-to-energy, geothermal, as well as demand response, fuel cell, storage (including EV batteries) and micro- and mini-grids. Among these, solar power, batteries, demand response (including energy efficiency), electric vehicles and micro- and mini-grids are solutions that are expected to grow significantly in the coming years due to a range of policy and market-driven incentives. At the national level, incentives for investments in DERs — including administrative targets and available grant support through Central Financial Assistance — are guided by nation-wide initiatives such as National Solar Mission (NSM), National Energy Storage Mission (NESM), National Smart Grid Mission (NSGM), National Electric Mobility Mission Plan (NEMMP), Faster Adoption of Mobility through Electric Vehicles Phase 2 (FAME-II), and finally National Mission for Enhanced Energy Efficiency (NMEEE). This

[3] Ministry of Power (MOP). (2023, 12 June). *Power sector at a glance all India*. https://powermin.gov.in/en/content/power-sector-glance-all-India

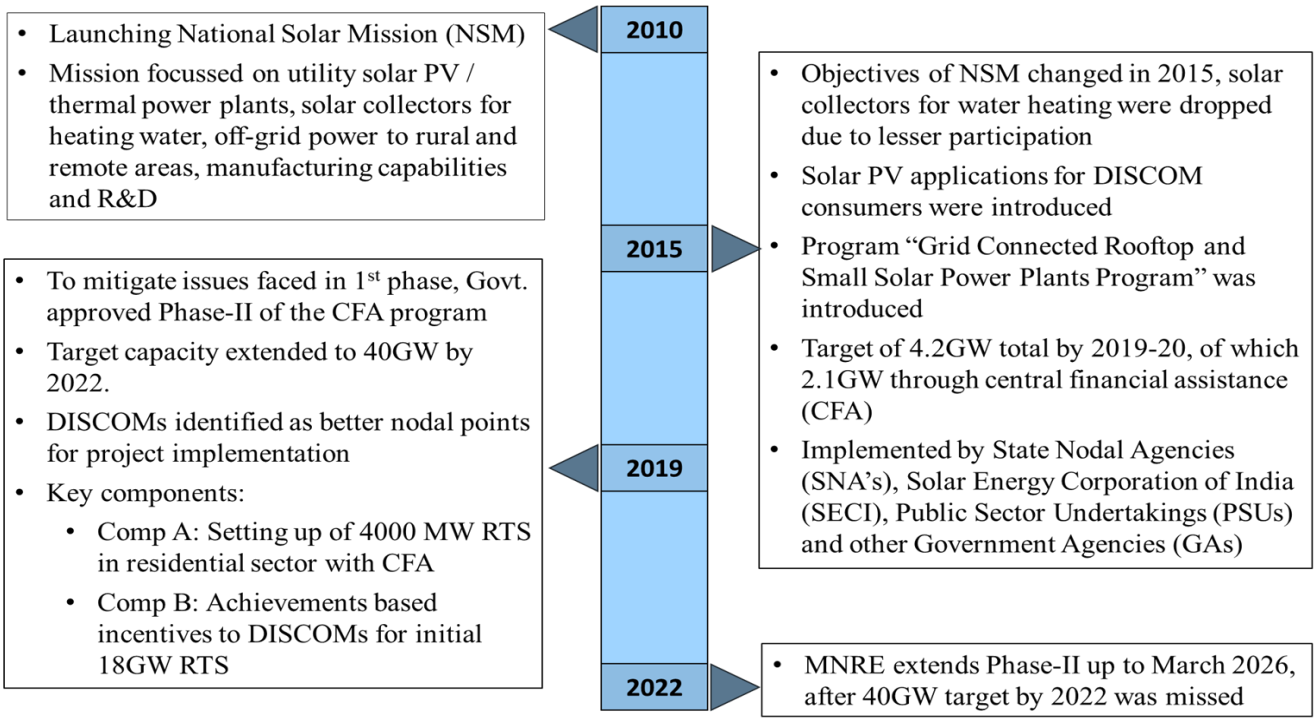
[4] Ministry of New and Renewable Energy (MNRE). (2024, 31 March). *Physical achievements*. https://mnre.gov.in/physical-progress/

section will review the evolution of solar PV, batteries, electric vehicles (EVs) and demand response in India.

# 3.1 Grid connected rooftop PV programme

The grid connected rooftop solar (RTS) PV programme is a subset of India's National Solar Mission (NSM).[5] NSM itself evolved since the time of its inception and the focus on RTS PV came only after 2015, after introduction of RTS PV applications for retail consumers of DISCOMs. A flow chart of the key decisions taken with respect to NSM, with focus on RTS PV is displayed in Figure 1.[6]

**Figure 1. Key national solar mission decisions**




Source: India Science, Technology & Innovation Portal. (n.d.). *Jawaharlal Nehru National Solar Mission (JNNSM)*.

[5] India Science, Technology & Innovation Portal. (n.d.). *Jawaharlal Nehru national solar mission (JNNSM)*. https://www.indiascienceandtechnology.gov.in/st-visions/national-mission/jawaharlal-nehru-national-solar-mission-jnnsm

[6] India Science, Technology & Innovation Portal, n.d.

A brief overview of the CFA provided by MNRE for RTS installed by residential consumers is provided in Table 1.[7]

**Table 1. Overview of central financial assistance for rooftop solar**

| Plant capacity | Applicable Subsidy |
|---|---|
| **Up to 3 kW** | Rs. 14588/- per kW |
| **Above 3 kW and up to 10 kW** | Rs. 14588/- per kW for first 3 kW and thereafter Rs. 7294/- per kW |
| **Above 10 kW** | Rs. 94822/- fixed |

Source: MNRE. (2023, January). *Grid connected rooftop solar programme*.

The rooftop solar in India has seen gradual growth and has recently reached a total of 11GW (as of Aug. 2023). Since the initial target of 40GW capacity by end of 2022 was missed, MNRE has extended the Phase-II period up to March 2026.

## 3.2 *Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan* (PM–KUSUM)

The Cabinet Committee on Economic Affairs approved PM-KUSUM scheme in its meeting held on 19 February, 2019. Subsequently, expansion of the scheme was announced in the budget for 2020-21, which was later approved by the Ministry of Finance. PM-KUSUM consists of three components:

- Component-A: 10,000 MW of decentralized ground mounted grid connected solar power plants.
- Component-B: Installation of 20 lakh standalone solar powered agriculture pumps.
- Component-C: Solarisation of 15 lakh existing grid-connected agriculture pumps.

The scheme was expanded during financial year 2020-21 with an increase targeted solar capacity addition of 30.8 GW and recently granted an extension till 31 March, 2026. The total central financial support provided under the scheme is Rs. 34,422 crore, including service charges of 2% on eligible CFA to implementing agencies. Status of deployment under the said scheme is provided in Table 2 on the next page.[8]

[7] MNRE. (2023, January). *Grid connected rooftop solar programme*. https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2023/01/2023011760.pdf

[8] MNRE. (n.d.). *Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyan*. https://pmkusum.mnre.gov.in/landing.html

**Table 2. Status of DER deployment under PM-KUSUM**

| Component | Sanctioned capacity | Total installed | Total installed (% of sanctioned) |
|---|---|---|---|
| **Component A** | 4766 MW | 138 MW | 3% |
| **Component B** | 946471 nos. | 262873 nos. | 28% |
| **Component C (Individual pump solar)** | 122930 nos. | 1787 nos. | 1% |
| **Component C (Feeder level solar)** | 2912466 nos. | 2615 nos. | <1% |

Source: MNRE. (n.d.). *Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyan.*

Details of the financial assistance available to beneficiaries under the PM-KUSUM scheme are listed in Table 3 on the next page.[9]

[9] MNRE. (2022, September). *PM-KUSUM FAQs*. https://pmkusum.mnre.gov.in/KnowledgeCenter_PMKUSUM.html

**Table 3. PM-KUSUM financial assistance**

| Component | Financial assistance |
|---|---|
| Component A | **Self financed** |
| Component B | **Category A:** Applicable for all over India except Category B regions<br>▪ **Central CFA — 30% and state assistance of at least 30%**<br>▪ **CFA of 30%**<br>**Category B:** Only applicable for North-eastern States, Himachal Pradesh, Uttarakhand, Jammu and Kashmir/Ladakh, Lakshadweep and A&N Islands<br>▪ **Central CFA — 50% and state assistance of at least 30%** |
| Component C (Individual pump solar) | CFA of 30% of benchmark cost or tender cost, whichever is lower, and state assistance of at least 30% |
| Component C (Feeder level solar) | **Category A:** Applicable for all over India except Category B regions<br>▪ **Central CFA — 30%**<br>**Category B:** Only applicable for North-eastern States, Himachal Pradesh, Uttarakhand, Jammu and Kashmir/Ladakh, Lakshadweep and A&N Islands<br>▪ **Central CFA — 50%** |

Source: MNRE. (2022, September). *PM-KUSUM FAQs*.

## 3.3 Electrical vehicles (EVs)

Faster Adoption and Manufacturing of (hybrid and) Electric Vehicles (FAME), is currently India's flagship scheme for promoting electric mobility. Currently in its second phase of implementation, FAME-II was initially being implemented for a period of three years, beginning April 2019, with a budget allocation of 10,000 Cr. The scheme was extended up to March 2024. The incentives offered in the scheme are seen in Table 4 on the next page.[10]

[10] e-AMRIT. (n.d.). *Electric vehicle incentives*. https://e-amrit.niti.gov.in/electric-vehicle-incentives

**Table 4. FAME-II incentives**

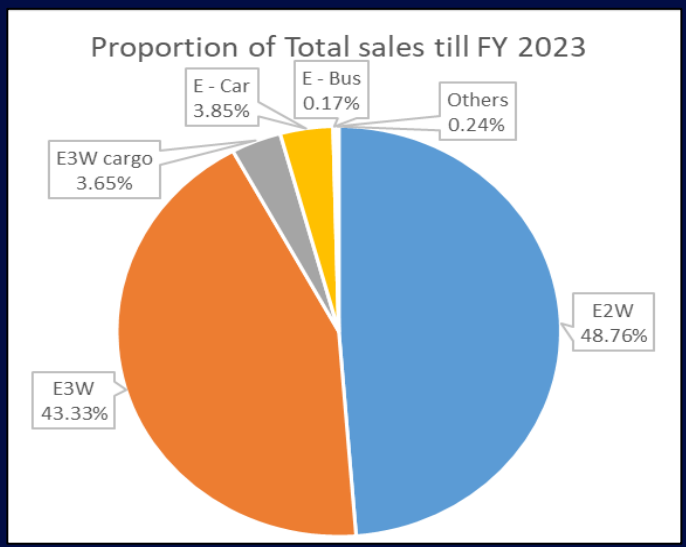
| Vehicle type | Incentive |
|---|---|
| **Two Wheelers** | INR 15,000/- per kWh battery, up to 40% of vehicle cost |
| **Three Wheelers** | INR 10,000/- per kWh battery |
| **Four Wheelers** | INR 10,000/- per kWh battery |
| **E buses** | INR 20,000/- per kWh battery |

Source: e-AMRIT. (n.d.). *Electric vehicle incentives.*

Twenty-nine Indian states have already notified state EV policies along with incentives to promote EVs and charging stations in their respective states.[11] Table 5 shows the take up of EVs of different segments till financial year 2023.[12]

**Table 5. EV sales by segment and state**

| State | Total sales till FY2023 | Sales in % of total |
|---|---|---|
| Uttar Pradesh | 482514 | 20.64% |
| Maharashtra | 237283 | 10.15% |
| Delhi | 206892 | 8.85% |
| Karnataka | 199645 | 8.54% |
| Rajasthan | 149617 | 6.40% |
| Bihar | 134187 | 5.74% |
| Tamil Nadu | 130681 | 5.59% |
| Telangana | 106836 | 4.57% |
| Others | 690107 | 29.52% |




Source: JMK Research & Analytics. (2023). *Annual India EV report card: FY2023.*

[11] Bureau of Energy Efficiency. (n.d.). *Public charging stations*. https://evyatra.beeindia.gov.in/public-charge-stations/

[12] JMK Research & Analytics. (2023). *Annual India EV report card: FY2023*. https://jmkresearch.com/annual-india-ev-report-card-fy2023/

## 3.4 EV charging stations

The Ministry of Power (MoP) published the *Revised consolidated guidelines & standards for charging infrastructure for electric vehicles (EV)* in January 2022. The guidelines include provisions for individual owners of electric vehicles and for public charging stations (PCS). Some salient features of the guidelines are discussed below:[13]

- Owners may charge their electric vehicles at their residence/offices using their existing electricity connections.
- Any individual/entity is free to set up public charging stations without the requirement of a license.
- Technology agnostic charging standards.
- Land at promotional rates for installation of PCS through a revenue sharing model, along with a model revenue sharing agreement provided in the Guidelines.
- Timelines for the infrastructure provider to provide connectivity for the installation of PCS have been prescribed.
- Tariff for supply of electricity to public EV charging stations shall be a single part tariff and shall not exceed the 'Average Cost of Supply' till March 2025.
- At least one charging station shall be available in a grid of 3 Km x 3 Km; one charging station shall be set up at every 25 Km on both sides of highways/roads.

[13] Press Information Bureau (India). (2022, 15 January). *Revised consolidated guidelines & standards for charging infrastructure for electric vehicles (EV) promulgated by Ministry of Power.* https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=1790136

EV chargers specified under these guidelines are as follows in Table 6.[14]

**Table 6. EV charger types**

| Charger type | S. No. | Charger connectors | Rated output voltage | No. of connector guns (CG) | Charging vehicle type (W=wheeler) |
|---|---|---|---|---|---|
| **Fast** | 1 | Combined Charging System (CCS) (min 50 kW) | 200-750 or higher | 1 CG | 4W |
| | 2 | CHArgedeMOve (CHAdeMO) (min 50 kW) | 200-500 or higher | 1 CG | 4W |
| | 3 | Type-2 AC (min 22 kW) | 380-415 | 1 CG | 4W, 3W, 2W |
| **Slow/ Moderate** | 1 | Bharat DC-001 (15 kW) | 48 | 1 CG | 4W, 3W, 2W |
| | 2 | Bharat DC-001 (15 kW) | 72 or higher | 1 CG | 4W |
| | 3 | Bharat AC-001 (10 kW) | 230 | 3 CG of 3.3 kW each | 4W, 3W, 2W |

Source: MoP. (2022, 14 January). *Charging infrastructure for electric vehicles – the revised consolidated guidelines & standards.*

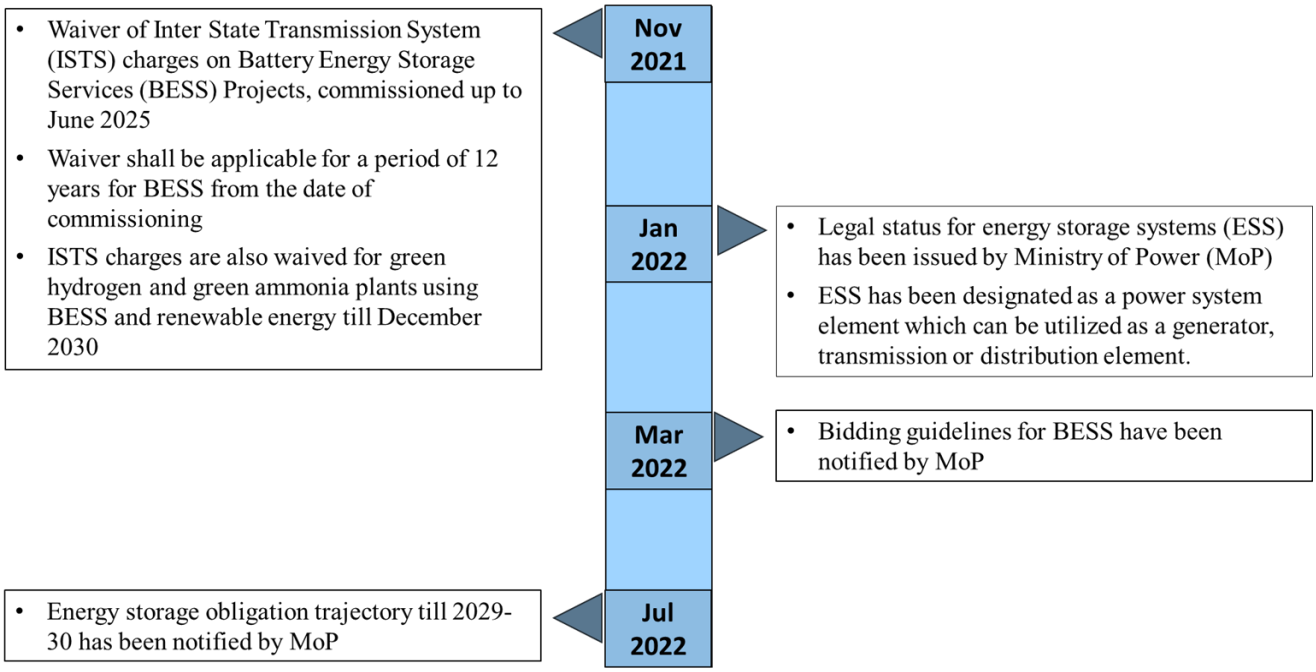
# 3.5 Battery energy storage systems

Battery energy storage systems (BESS) are likely to be vital in achieving decarbonization and electrification objectives. Battery storage has the advantage of charging during solar output hours (typically afternoon) and discharging during the evening period to better meet demand. Batteries paired with solar PV are also a cost-efficient way of providing affordable electricity to isolated communities. Electric vehicles are expected to be the main form of behind-the-meter battery storage in India but the key challenge is large-scale grid connected energy storage (front-of-the-meter). The Government of India (GoI) estimates that the country will require 27 GW of grid-connected battery storage by 2030. Some of the initiatives undertaken by GoI are seen in Figure 2 (next page).[15]

[14] MOP. (2022, 14 January). *Charging infrastructure for electric vehicles – the revised consolidated guidelines & standards.* https://powermin.gov.in/sites/default/files/Final_Consolidated_EVCI_Guidelines_January_2022_with_ANNEXURES.pdf

[15] Press Information Bureau (GoI). (2022, 8 December). *Energy storage technology*. https://pib.gov.in/Pressreleaseshare.aspx?PRID=1881940

**Figure 2. Government of India battery storage initiatives**




Source: Press Information Bureau (GoI). (2022, 8 December). *Energy storage technology*.

# Demand response

Demand response (DR) is still in its nascent stages in India. The rapid growth of energy consumption, non-remunerated grid supply disruptions and penetration of renewables, however, could accelerate demand response programmes in the country. Over the last ten years some pilot demand response initiatives have taken place (Table 7[16,17] on the next page) with a focus on large customers mainly from commercial and industrial segments.

[16] Chunekar, A., Kelkar, M., Dixit, S. (2014, September). *Demand side management in India: An overview of state level initiatives.* Prayas Energy Group. https://energy.prayaspune.org/images/pdf/dsm_state_review_peg_sept14.pdf

[17] Bureau of Energy Efficiency (BEE). (2023, March). *Compendium on DSM measures by Distribution Companies (DISCOMs).* https://beeindia.gov.in/sites/default/files/publications/files/Compendium_on_DSM_measures_by_DISCOMs_BEE.pdf

**Table 7. Pilot DR initiatives**

| Utility | Consumer Category | Objectives | Capacity MW | Type of DR | DR Events |
|---|---|---|---|---|---|
| BRPL (2018) | Residential (2 lakhs) | Establish a model for utility-led consumer focused behavioural EE programme | 2.8 Million Units (MUs) at DISCOM Periphery | Behavioural EE | N/A |
| BYPL, Delhi (2017-18 & 2018-19) | C&I | Load balancing | 17 MW (FY18) 32.5 MW (FY19) | Manual | 8 |
| TPC-D Mumbai, Maharashtra (2012) | Mumbai airport, Commercial private offices, IT parks, and local municipality. | Peak demand management | 15 | Aggregator Based | 21 |
| TPC-D Mumbai, Maharashtra (2012) | Hotel | Peak demand management | 0.6 | Auto DR | N/A |
| TPC-D Delhi (2014) | | Demonstrate peak demand and grid stress management | 7.2 | Auto DR | 17 |

Data sources: Chunekar, A., Kelkar, M., Dixit, S. (2014, September). *Demand side management in India: An overview of state level initiatives.*

Bureau of Energy Efficiency (BEE). (2023, March). *Compendium on DSM measures by Distribution Companies (DISCOMs).*

Analysis shows that most of these DR programmes are pilot in nature and implemented by private DISCOMs. Flexibility from the demand side expands the capability of traditional DR programmes, which only target peak management. When aggregated, flexible demand builds capability in responding to changing operating conditions to provide ancillary services to local grids and the bulk power system. *CERC (Ancillary services) regulations, 2022* allows entities capable of providing DR to qualify as ancillary service providers. Thus, DR is not limited to DISCOMs but grid operators at state level can also procure DR.

# 4 Current regulatory landscape for DERs in India

Prior to discussing policy and regulatory recommendations, it is important to understand the current DER regulatory landscape in India and efforts made by several agencies to provide clarity on DER related assets and operations through guidelines. The DER landscape in India is evolving rapidly. The thought process behind creating initial regulations had to evolve to encompass developments in the sector and challenges surfacing due to increasing penetration of DERs. Thus, newer regulations provided greater clarity with more specifications related to the technical and commercial aspects of DERs.

## 4.1 *Central Electricity Authority Technical standards for connectivity of the distributed generation resources regulations, 2013*

Central Electricity Authority (CEA) published *Technical standards for connectivity of the distributed generation resources regulations* in 2013.[18] These standards were intended for all generating companies or persons owning distributed generation resources, which are connected to or seeking connectivity with the electricity system. These are also applicable to distributed generation resources owned by licensee. In 2019, CEA amended the regulation and introduced the concept of the 'prosumer', as well as increasing its applicability to charging stations. These regulations are specific to electricity systems below 33kV. The regulations provide clarity on various standards which the distributed energy resource needs to comply with in order to maintain power quality and safety of the power distribution grid.

## 4.2 Forum of Regulators — *Model regulation for grid interactive distributed renewable energy sources*

Forum of Regulators (FOR) issued draft *Model regulation for rooftop solar grid interactive systems based on net metering* in 2013.[19] The model regulations were proposed to be applicable to distribution licensees and consumers of electricity of the licensee and were intended to be used by State Electricity Regulatory Commissions (SERCs) as a guiding document to draft their own regulations on RTS systems.

[18] Central Electricity Authority (CEA). (2013, 7 October). *Technical standards for connectivity of the distributed generation resources, 2013*. https://cea.nic.in/regulations-category/connectivity-of-distributed-generation-resources/?lang=en

[19] Forum of Regulators (FOR). (2013). *Model regulation for rooftop solar grid interactive systems based on net metering*. https://forumofregulators.gov.in/Data/Working_Groups/Net.pdf

The draft model regulations discussed several important facets to be included as a part of the regulations:

- Capacity targets.
- Eligible consumer and individual project capacity.
- Interconnection with the grid.
- Energy accounting and settlement.
- Clarity on renewable purchase obligation.
- Applicability of other charges.
- Clarity on renewable energy certificate mechanism.
- Metering arrangement.
- Penalty or compensation.
- Power to give direction, relaxation and amendment.

FOR had subsequently in 2019 issued *Model regulation for grid interactive distributed renewable energy sources*.[20] In this version instead of focusing solely on solar, they expanded the scope of the model regulations to distributed renewable energy (DRE) resources, which means energy fed into the electric system at voltage below 33kV. The 2019 draft model regulations additionally introduced options like Renewable Energy Service Company (RESCO), as well as adding metering mechanisms (like net-billing). At present, most of the SERCs as well as Joint Electricity Regulatory Commission (JERC) have issued their state specific regulations with respect to either RTS projects or DERs in general connected to DISCOM grids. Depending on how it is designed, while net metering can increase penetration of RTS, it may not be the most efficient approach. The value of DERs is an emerging alternative to improve pricing for DERs that is more efficient and equitable.

## 4.3 *Central Electricity Regulatory Commission (Ancillary services) regulations, 2022*

The *Central Electricity Regulatory Commission (Ancillary services) regulations, 2022* were issued by CERC[21] with the objective to provide for procurement of adequate reserves through administered and market-based mechanisms, deployment and payment of ancillary services at the regional and national level and maintaining the grid frequency close to 50 Hz. These regulations enable grid operators to restore the grid frequency within the allowable band as specified in the Grid Code and relieve congestion in the transmission network, to ensure

[20] FOR. (2019). *Model regulation for grid interactive distributed renewable energy sources*. https://forumofregulators.gov.in/Data/Reports/DMR-for-GIDRES-08-05-19.pdf

[21] CEA. (2022, 31 January). *Central Electricity Regulatory Commission (Ancillary services) regulations, 2022*. https://cercind.gov.in/regulations/Ancillary-Service-Regulations-2022.pdf

smooth operation of the power system and safety and security for the grid. Ancillary services are defined as the service necessary to support grid operation in maintaining power quality, reliability and security of the grid and includes Primary Reserve Ancillary Service, Secondary Reserve Ancillary Service, Tertiary Reserve Ancillary Service, active power support for load following, reactive power support, black start, and such other services as defined in the Grid Code. These regulations are applicable to regional entities (including entities having energy storage resources and entities capable of providing demand response qualified to provide ancillary services) and other entities as provided in these regulations.

## 4.4 Forum of Regulators — *Model demand side management regulations, 2010*

FOR issued *Model demand side management regulations* in 2010[22] incorporating demand side management (DSM) objectives such as power shortage mitigation, seasonal peak reduction, cost effective energy savings, lowering the cost of electricity, reduction in emissions of greenhouse gases, etc. The draft model regulations discussed several important facets suggested to be included as a part of the regulations by the SERCs:

- Assessment of technical potential for DSM.
- DSM targets.
- Guidelines on DSM process.
- Constitution of DSM cell, its roles and responsibilities.
- Load and market research and development of baseline data.
- Formulation of DSM plan.
- DSM programme document.
- Process for implementation of DSM programmes.
- Mechanism for cost recovery.
- Monitoring and reporting of DSM programmes.

Around 22 States and seven Union Territories (UTs) notified their state specific DSM regulations in accordance with model DSM regulations issued by FOR.

[22] FOR. (2010, May). *Model demand side management regulations [draft]*. https://forumofregulators.gov.in/Data/study/Model%20DSM%20Regulations.pdf

## 4.5 *Guidelines for procurement and utilization of battery energy storage systems as part of generation, transmission and distribution assets, along with ancillary services*

The Ministry of Power (MoP) issued *Guidelines for procurement and utilization of battery energy storage systems as part of generation, transmission, and distribution assets, along with ancillary services* in 2022. The objectives of the guidelines were laid out as follows:

- Facilitate procurement of Battery Energy Storage Systems (BESS) for addressing the variability, firming power supply, increasing energy output, extending the time of supply from an individual RE project or a portfolio of RE projects, and augmentation of existing RE projects.
- Provide ancillary, grid support and flexibility services for the grid.
- Optimal utilization of transmission and distribution network.
- Ensure transparency and fairness in procurement processes and provide a framework for an intermediary procurer as an aggregator, trading licensees, and implementing agency for the inter-state and intra-state sale-purchase of power.
- Enable risk sharing frameworks for all stakeholders involved in the energy storage and storage capacity procurement.

Several business cases are proposed under these guidelines like supply of RE power with BESS, storage for ancillary services and flexible operations, and strengthening DISCOM operations to manage peak load and grid resilience. Since these guidelines are applicable for intra-state projects of minimum individual project size of power rating of 1MW and above, the implication of these guidelines on DER evolution is significant.

In addition to the above, MoP has also published consolidated guidelines and standards for EV charging stations which is already discussed above (3.4).

# 5 Challenges associated with DERs in India

To further investigate the challenges faced by DERs, and to know more about the underlying concerns of stakeholders, RAP and Idam conducted an online survey and a webinar on *Market dialogue on DER policy support in India*. The objective of the webinar was to bring important stakeholders in the power sector community on one platform to identify the most immediate challenges in DERs in India and discuss solutions which could be effective in dealing with those challenges. The webinar was attended by more than 40 stakeholders (State Nodal Agencies, Distribution Companies (DISCOMs), State Electricity Regulatory Commissions (SERCs)) from the states like Maharashtra, Goa, Gujarat, Rajasthan,

Karnataka, Chhattisgarh, Tamil Nadu, Punjab, Haryana, Assam, etc. The webinar also hosted panellists from SERCs, DISCOMs and private think tanks. Several challenges were identified which are restricting the growth of deployment of DERs in India:

- **Frequent policy changes —** Both central and state governments have issued policies for accelerating deployment of DERs in India. These policies, however, are subject to regular revisions. These revisions resulted in lots of ambiguity among the stakeholders due to varying interpretations and implications.
- **Non-uniform regulations across states —** In order to harmonise regulatory framework across states, FOR has formulated model Grid Interactive Distributed Renewable Energy Regulations. It is expected that SERCs will refer model regulations while developing/amending their state specific regulations. However, electricity regulatory commissions of various states outline different conditions for interconnections, applicability of metering mechanisms, eligible consumer categories, hosting capacity, energy accounting and settlement, etc. in their regulations that would lead to regulatory complexity specifically for the developers working in multiple states across the country.
- **Concerns of DISCOMs over revenue loss —** Certain consumer categories like residential, agriculture, etc. are provided subsidized electrical power in India. To compensate for the loss, DISCOMs charge other consumers from commercial or industrial categories an additional cross subsidy surcharge. When consumers from commercial or industrial categories install RTS or other DER systems, DISCOMs see it as a revenue loss since the number of agriculture consumers who are supplied with subsidized power remains the same. The installation of DERs like RTS eats into the energy sales and revenues of the DISCOMs.
- **Levy of network charges / grid support charges by DISCOMs —** Under the net metering framework, consumer savings equal the applicable energy charges for every unit generated from the RTS system. On the other side, there is revenue loss to the DISCOM as they are still required to pay fixed charges for already committed power purchase agreements (PPAs), and have additional costs towards balancing, banking and wheeling of exported energy. To safeguard the non-RTS consumer interest, several states have moved ahead and either removed or disallowed net metering provisions for certain consumer categories or levy network / grid support charges.
- **Varying power demand due to the intermittent nature of DERs (especially solar PV generators) —** It is known that one of the biggest drawbacks of DERs is their intermittent nature. Although solar PV generators are quite popular in the market, EVs and their inconsistent charging schedules are expected to add more complexity in the demand and supply estimation.

- **Nuisance tripping of protection devices at distribution substations due to unbalanced loading —** Several DER systems are installed in single phase connections. The power being transmitted at distribution substations, however, should ideally be a three phased balanced power. In a conventional distribution grid, electrical loads at load centres are divided on each phase equally to a large extent. However, the addition of DERs on single phase has led to unbalanced loading being reflected at distribution substations. Hence, even though no fault has occurred in the distribution network, this unbalance is detected by the relays which leads to circuit breakers tripping.
- **Capacity building and training of DISCOM officials —** In a broader context the central and state governments in India are quite active in promoting DERs. But the updates in policies, regulations and guidelines may not always reach each DISCOM official, especially the ones directly involved with consumers. This may mean that despite the regulations and policy measures in plans, suitable action may not be taken at the grass root level. One of the reasons for such instances could be that enough capacity building and training sessions for DISCOM officials are not being conducted.

Addressing these challenges with an enabling policy and regulatory framework supports development of new and innovative business models that can facilitate the large-scale penetration of DERs to complement large-scale renewable resource growth. It also offers a pathway towards a sustainable, reliable and inclusive energy system. By proactively addressing regulatory challenges, promoting market mechanisms and ensuring fair competition, regulators can facilitate the integration of DERs and drive the transition to a cleaner and more resilient energy future.

# 6 Policy recommendations

Growth of DERs should be seen by all stakeholders as a symbiotic solution. Several initiatives for the consumers have already been proposed by the central and state governments, and so the focus now could shift to present solutions and policy recommendations that could benefit DISCOMs or address distortions that harm the financial viability of DISCOMs, along with the consumers. During the interaction with power sector stakeholders, it was evident that RTS was the most talked about DER currently in the India power sector. It is also the DER with considerable penetration in DISCOM grids and has the significant focus of the governments. More work on policy and regulations related to RTS is imminent. All facets of DERs, however, should be looked at thoroughly, as each one of them can be utilized to fulfil the nation's renewable energy and climate targets.

## 6.1 State Electricity Regulatory Commission (SERC) to set target for DER installation for each DISCOM

SERCs may set the target for each DISCOM in the State in such a manner that 3-4% of total electricity is generated from DER projects. Further, SERCs can bifurcate the overall DER capacity addition target into different consumer categories such as Residential, Commercial, Industrial, Institutional, etc. It is also suggested to define a separate target for the subsidized

consumer categories (such as Residential, Agricultural, and Micro, Small and Medium Enterprises (MSME)) so that SERCs can direct DISCOMs to develop a suitable programme for them to promote RTS deployment. Forum of Regulators in *Model regulations for grid interactive distributed renewable energy source, 2019* specified that DISCOMs shall purchase a certain percentage of their total energy requirements from distributed renewable energy sources. None of the SERCs, however, have specified such targets while issuing/amending their state specific regulations. Ministry of New and Renewable Energy may support SERCs in amending their state specific regulations to provide long term regulatory certainty.

At a recent meeting where the topic of access and public participation was being discussed, one utility commissioner described her agency as “imposing,” and further characterized it as “just the opposite of accessible.” That one unvarnished observation captures the challenge facing state agencies that want to be more open and welcoming to the public.

## 6.2 Development of cost benefit analysis framework for DERs

DISCOMs may be understandably reluctant to promote DERs given the potential negative impacts they could suffer (such as reduction in sales, loss of revenue, etc.). In addition, some DISCOMs may not be fully aware and appreciate other benefits that DERs bring to the system and the environment. To address these challenges, a benefit/cost analysis framework is needed to determine the value of DERs to help decide whether they are worth implementing. A systematic evaluation would lead to more efficient deployment of DERs. The benefits would include reduction in marginal power purchase costs, renewable purchase obligation (RPO) compliance, reduction in distribution losses, deferred investment in distribution infrastructure, generation and transmission, operation and maintenance costs, environmental externalities, etc. Costs include the costs of developing and deploying DER products, services and administrative costs, accommodating DER intermittency and faults due to nuisance tripping, among others.

## 6.3 Design, development and implementation of pilot DER projects

Traditional business models such as capital expenditure (CAPEX) and operating expenses (OPEX), have not been able to scale up DER (specifically RTS) in India. At the same time, DISCOMs can play a significant role in accelerating the deployment of DERs. Many DISCOMs, however, may not be fully aware of the potential benefits that DERs can bring to the system. Instituting pilot and demonstration projects would be an effective way to share experience, work through the mechanics of DER programmes and increase knowledge. It is imperative that DISCOMs are mandated to adopt business models, prepare medium-term deployment targets and adopt innovative measures to boost deployment and address financing, operational and technical challenges faced by the DER segment. It is suggested that SERC shall engage with DISCOMs in devising tailor-made business models for DER

deployment and define overall timelines for the entire process of regulatory approval and adoption of business models. Pilot projects should be well defined to test one or more value streams and should produce results in a meaningful timeframe to evaluate whether they can be rolled out on a larger scale. Business models should also include third party private players to take a major role in promoting DERs.

## 6.4 Adoption of new approaches towards system operation, electricity market and energy policy

It is suggested to harmonize rules for supporting decentralized solar across the country, facilitating open-access power procurement for decentralized solar systems, stimulating the demand for rooftop projects through suited building codes and city-planning procedures, and reducing cross-subsidies in electricity tariffs, while providing incentives to subsidized consumers through other channels. For instance, in California, U.S., the building code mandates new construction homes to have a solar photovoltaic (SPV) system as an electric source.[23] In India, the Ministry of Urban Development (MoUD) has also asked all states to mandate rooftop solar plants on all new buildings. Several states like Haryana, Chhattisgarh, Uttar Pradesh have made RTS mandatory subject to certain conditions. Chhattisgarh mandates all new government and semi-government buildings to install RTS. Haryana mandates 3-5% of connected loads. While Uttar Pradesh mandates RTS on residential and office buildings constructed on an area of more than 5,000 square feet, other avenues like 1-5 MW scale solar plants connected to DISCOM networks and closer to city areas should be explored.

## 6.5 Development of regulatory framework for demand response

DISCOMs in India are experiencing steady growth of 5-6% in peak energy consumption annually. The highest demand occurs for less than 1% of the time, i.e., 70-80 hours of peak load out of 8,760 hours of annual operation. To fulfil peak demand, utilities must invest in generation and transmission infrastructure, which remains underutilized most of the time. A well-executed demand response (DR) programme can help DISCOMs in meeting the peak demand, reducing short term power procurement and optimizing the investment required for upgrading existing infrastructure. Over the last ten years, some pilot DR initiatives have taken place, primarily focusing on large commercial and industrial customers. At present, however, there is no explicit incentive framework to promote demand response across all consumers in the country.

[23] Thoubboron, K. (2023, 27 February.) *California solar mandate: What you need to know*. EnergySage. https://www.energysage.com/blog/an-overview-of-the-california-solar-mandate/

Large scale deployment of DR is facing several challenges, such as:

- The structure of final tariffs is such that there is no obvious benefit for small consumers to change their consumption pattern, as they are primarily on an inclined block tariff.
- DISCOMs might have little incentive to procure demand response from commercial and industrial consumers because of concerns about revenue loss, given the higher tariff that this consumer category pays.
- The role of aggregator and its scope of operation have not yet been defined in India's power sector regulation. The presence of aggregators is important to enable demand response, especially from smaller consumers.
- Furthermore, information and communication technology (ICT) infrastructure does not yet have full coverage in India at the level of small consumers.

To ensure large scale adoption of DR, there is a need to develop a model regulatory framework and associated guidelines, such as cost effectiveness assessment and evaluation and measurement and verification of DR programmes.

## 6.6 Development of DER aggregator framework

Aggregation of small DER resources and controlling them (such as RTS, demand response, EV charging stations, etc.) in real time, creates a virtual power plant which can provide services to the state and regional load management centres. Despite the high potential of DER aggregation and its proven performance in other countries, the experience of India with this business model has so far been limited. India has not gone beyond a few aggregations based pilot DR programmes. The current regulatory framework of India's electricity market has neither a system of defined resource aggregation nor the role of aggregator. Recently, *Central Electricity Regulatory Commission (Ancillary services) regulations, 2022* allows entities capable of providing DR to qualify as ancillary service providers. There is a need to develop a DER aggregator framework and conceptualization of a few pilot projects using this DER aggregator framework.

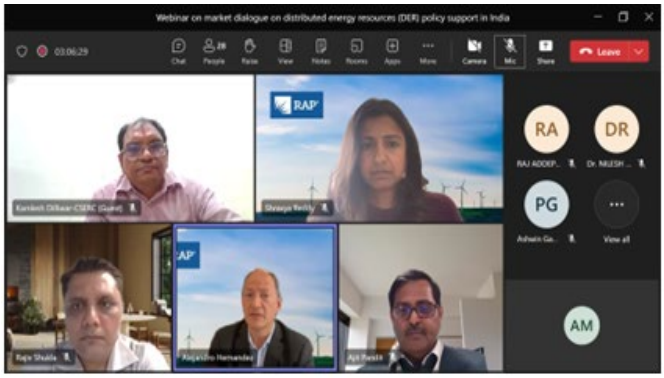
## 6.7 Conceptualize tools for hosting capacity assessment

A Hosting Capacity Analysis (HCA) provides a snapshot in time of the conditions on a utility's distribution grid that reflect the grid's ability to "host" additional DERs at specific locations without upgrades. The information gleaned from this analysis can help regulators, utilities, developers and customers make more proactive, cost-effective and efficient decisions about DER investments. It is important that DISCOMs should assess potential of DER capacity that can be permitted at various circuits in the local grid. This will not only help the utilities estimate Substation (SS), Feeder, and Distribution transformer (DT) permissible capacity of DER penetration, it will also help the consumer to understand the feasibility of installing DER at a specific Feeder or DT to which it is already connected. This helps better planning. In

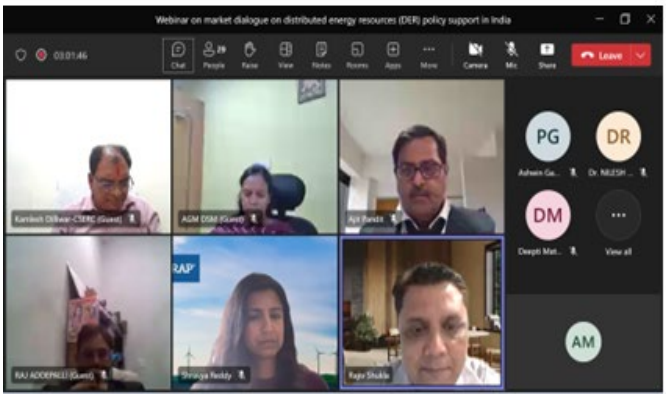
addition, from the insights on the possibility of reverse power flow scenarios in some of the circuit, the utility can plan for installation of protection devices to avoid such a reverse power flow scenario. It is suggested that energy regulatory commissions should come up with analytical frameworks to evaluate the capacity of their distribution systems — "down to the line sector or node level" — to host additional DERs and develop tools for assessing its hosting capacity.

The above recommendations are provided with a holistic viewpoint, where the benefits of DERs to the grid and consumers are achieved with minimal near-term implications on the DISCOMs. The regulatory framework shaping incentives of DISCOMs makes them supportive of DER roll out (where this roll out lowers the cost of the energy system). Thus, they should not be made financially unviable by roll out of DERs.

# 7 Webinar photographs









**Regulatory Assistance Project (RAP)®**
Belgium · China · Germany · India · United States

50 State Street, Suite 3
Montpelier, Vermont 05602
USA

+1 802 223 8199
info@raponline.org
**raponline.org**