



## Executive Summary

India has transitioned from an era of chronic power shortages to reasonable adequacy over the past few years. In addition, the country has demonstrated commitment towards making renewable energy (RE) the mainstay of its energy mix by 2030. While it undergoes this massive energy transition, it is widely accepted that there is a need to undertake a range of enabling operational and electricity market developments to operate under a new energy order.

The energy transition has also outlined the urgent need for fundamental changes in electricity market operations, particularly in areas which require scientific mechanisms for forecasting and planning, incentivizing flexibility, exploiting the inherent diversity of a large and synchronous grid, introducing time-sequential market options and introducing well-developed ancillary services to improve grid reliability.

To address the above issues and chart out a roadmap for Indian power market, Ministry of Power constituted a **Group for “Development of Electricity Market in India”**. The Group, after extensive consultations and deliberations, identified the main areas of interventions and recommended a range of interventions with associated timeframes and requirements to enable efficient, optimal and reliable market operations.

The key issues to be addressed in the redesign of the Electricity Markets were identified to be the following:

- a) **Dominance of inflexible<sup>1</sup>, longer duration contracts with the Discoms:** Discoms have traditionally depended on inflexible, longer duration contracts for meeting their energy requirements. Power exchanges have only accounted for 5%-6% of day-ahead requirements. This lack of depth in power exchanges is not only an efficiency concern but has long-term implications on integrating renewables into the market.
- b) **Need for sufficient granularity in Resource Adequacy<sup>2</sup> (RA) planning in Centre and States across seasons:** Current planning practices of Discoms are inadequate for energy systems with higher levels of variable renewable energy. Scientific Resource Adequacy planning is required to ensure an optimal resource mix is developed and forms the basis for capacity contracting in the future. RA is also the foundational basis for deeper energy market operations and the introduction of measures such as market based economic dispatch (MBED) and renewables integrated through the market.

<sup>1</sup> Inflexibility of contracts in the Indian context refers to aspects such as i) take-or-pay constraints for paying fixed charges in existing long-term PPAs, ii) right-to-revision of schedules by beneficiaries till 7/8 time blocks prior to despatch, iii) lack of ability to participate in the market by generating sources, despite being available and un-requisitioned, etc.

<sup>2</sup> Resource Adequacy is defined as the ability of a system to supply sufficient electric power and energy to reliably meet the requirements of consumers, considering scheduled and unscheduled outages of system components.

- c) **High Reliance on Self-Scheduling<sup>3</sup> and lower operational efficiency:** The current practice of fragmented control areas with Discoms resorting to self-scheduling creates sub-optimal dispatch with cheaper plants in the national merit order not being scheduled to their full available capacity. The right to revision of Discoms also creates system inefficiencies, which are avoidable.
- d) **Increasing share of RE in the overall energy mix and importance of electricity markets to integrate RE:** Renewable energy currently in India is mostly contracted through long-term contractual means. It is also treated as a must run resource, requiring Discoms to plan for procurement after netting off RE from their demand. There is an emerging need for transiting RE to market based dispatches.
- e) **Firmness in Ancillary Reserves (AS):** For a power system of India's size, with increasing levels of variable renewable energy, it is necessary to ensure firmness of reserves. The current framework of accessing Ancillary Reserves is inadequate. Although w.e.f Dec 5, 2022, procurement of secondary reserves have been separated from tertiary reserves, both are largely served through un-requisitioned surplus from inter-state generating stations (ISGS).

The Group recognized that several actions have already been undertaken to address one or more of the issues highlighted above. These were assessed in detail by the Group. International best practices of advanced electricity markets such as United States, European Union, United Kingdom, Australia, etc. were also studied in this regard. Options for specific interventions were then analysed to address each of the issues highlighted above. These have been covered in separate chapters along the following lines.

- a) **Resource Adequacy Planning and Capacity Contracting:** This would entail setting up of a mechanism to enforce and monitor whether adequacy of supply is being met by state utilities. This would be carried out, considering availability of resources in other states and regions. Such a mechanism would ensure that situations like surplus or deficits do not arise in the future.
- b) **Enhancing the efficacy of the Day-ahead Market:** This would require gradual transitioning to a market-based dispatch of electricity from the existing practice of self-scheduling. This would lead to a system cost optimization through creation of a single merit order of generation plants.
- c) **Participation of Renewable Energy in the Day-ahead Market:** This would involve mandating RE resources to participate in the market and competing with conventional sources. RE developers could be offered some sort of revenue protection to manage the spot price volatility. Such protection would be transitional and would remain till the time there is adequate investor confidence.

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<sup>3</sup> Self-scheduling in Indian context refers to the scheduling of the generating stations by the distribution companies as per their contract(s), outside of organized markets

- d) **Market-based mechanism for secondary reserves:** This would involve introduction of a market for secondary frequency response. The framework would provide adequate incentives and compensation to resources which can provide faster response than conventional sources.
- e) **Demand Response and Aggregation:** Demand response would enable reduction in reserve requirements and lowering the cost of electricity. This can be carried out through tariff-based incentives or direct load control by utilities. Aggregation of distributed energy resources would allow such resources to provide energy and ancillary services at transmission and distribution level.
- f) **Market Monitoring and surveillance:** This would involve strengthening of market-monitoring and surveillance activities in the wake of increasing participation of entities in spot markets which could lead to volume and price volatility
- g) **5-minutes based metering, scheduling, dispatch and settlement:** This would lead to better management of ramping requirements, reduction in forecasting errors and lesser reserve requirements. This would enable managing the intermittency and variability caused by large scale RE integration.
- h) **Regional level balancing framework for deviation management:** This would result in reduction in deviation penalties for states at the ISTS level and consequently lesser reserve requirements.
- i) **Financial products for electricity:** This would involve introduction of products for hedging of price volatility in spot markets

**Based on the pros and cons of options analysed, the following activities have been suggested to be implemented in near term i.e. within one year from now:**

- a) Two-part tariff-based bidding (fixed charges and variable charges) can be introduced in e-bidding portal. Discoms can also put up their surplus capacity for sale through this portal. Banking transactions may continue as they have no major commercial implications to the Discoms.
- b) Grid Controller of India should initiate security constrained economic dispatch (ED) with unit commitment (UC) on D-1/ D-3, for NTPC thermal fleet.
- c) Pilot Mechanism for RE participation in market through revenue protection needs to be implemented. An initial capacity (~ 1000 MW) can be tendered by the concerned nodal agency as a pilot project under the single price option with a 15-year PPA tenure. Remaining RE capacity addition can meanwhile continue through the current PPA route.
- d) Operationalization of CERC Ancillary Services Regulations should be done within one year.
- e) Demand response should be enabled to participate in Ancillary Services. Voluntary DR programs/ tariff-based incentives should be launched. Aggregation of Demand Response needs to be allowed.

- f) Power Exchange should mandatorily constitute a Market Surveillance Committee (MSC). There should be post-facto audits by CERC on market monitoring activities being carried out by PXs.
- g) On 5-minutes scheduling and dispatch, two taskforces, one on regulatory aspects to be steered by CERC and the other on metering and communication related aspects to be steered by Grid Controller of India Ltd should be formed. The taskforces would finalize the regulatory and operational requirements for the transition. CEA could coordinate the activities of these two taskforces.

**Further, the following activities have been suggested to be implemented in medium-term i.e. within 1-2 years from now:**

- a) Standardized exchange-based capacity contracts can be introduced for short-term trading of power
- b) Grid Controller of India should expand the security constrained economic dispatch (ED) with unit commitment (UC) for all ISGS thermal fleet
- c) Market-based mechanism for procuring secondary frequency regulation services needs to be implemented
- d) Additional RE capacities can be made to participate in market through revenue protection
- e) Aggregation of demand response from lower voltages should be encouraged.
- f) Market monitoring function should be strengthened within CERC to carry out real-time and post-facto audits of Power exchange activities. CERC may appoint Market Monitors for the same
- g) Move to a 5-min based metering, scheduling, dispatch and settlement should be undertaken
- h) Move to a regional level framework for deviation management at ISTS level should be undertaken

**Following activities have been suggested to be implemented in long-term i.e. two years and beyond from now:**

- a) Formation of Distribution System Operators could be contemplated
- b) Long-term capacity markets could be implemented
- c) MBED could be implemented for entire fleet of ISGS thermal plants as well as merchant capacities.
- d) For RE participation in market, instead of a single strike price option, other variants could be introduced. With increased investor confidence and increased market penetration (through MBED), all new RE additions could be treated as dispatchable resources.

## 1. Background

- 1.1. India has transcended from an era of chronic power shortages into one of reasonable adequacy over the past 7-8 years. This has led the distribution utilities to re-think on the need for inflexible longer duration contracts more suited for base-load requirements. In addition, the country is poised to add more Renewable Energy in its overall energy portfolio mix over the future. It has been widely acknowledged by many stakeholders that a high RE system requires a range of operational and electricity market interventions to mitigate its variability on the power system.
- 1.2. In this context, the Ministry of Power felt it necessary to review all issues, identify the required interventions drawing lessons from international best practices and draw up a roadmap for the future. Furthermore, changes in the statutory provisions and key enablers required for such interventions to be implemented also need to be identified along with an institutional and capacity building framework to successfully implement the proposed market interventions.
- 1.3. The Ministry of Power, accordingly, constituted a Group for “**Development of Electricity Market in India**” (office order enclosed in Annexure-1). The Group was comprised of representatives from the Ministry of Power, CEA, CERC, Energy department of Maharashtra, Energy department of Tamil Nadu, Energy department of Madhya Pradesh, Grid Controller of India Limited (Grid-India) and Ministry of New and Renewable Energy (MNRE). M/s Deloitte provided advisory assistance to the Group. Representative from Securities and Exchange Board of India (SEBI) and Multi Commodity Exchange of India Limited (MCX) were also invited to meetings of relevance.
- 1.4. The following key areas were highlighted to be focused by the Group for developing the roadmap for electricity market in India.
  - i. Resource Adequacy Planning
  - ii. Reducing dependence on longer-duration PPAs and the need for optimal mix of long and short-term contracts of varying duration
  - iii. Addressing high reliance on self-scheduling by moving towards security constrained economic dispatch<sup>4</sup> with unit commitment<sup>5</sup> in day ahead horizon
  - iv. Enabling RE integration into power markets
  - v. Developing framework for market-based procurement of ancillary services
  - vi. Additional enablers required for effective implementation of above viz. Demand response, Aggregation, Market monitoring & surveillance, movement to 5-min metering, scheduling,

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<sup>4</sup> Security constrained economic dispatch is an optimization process which enables meeting the electricity demand at the lowest cost subject to operational and reliability limitations of generation fleet and transmission system

<sup>5</sup> Unit Commitment is a process which helps in determining which power generators to run at which times and at what level, in order to satisfy the demand for electricity.