the framework of commercial mechanism with respect to the frequency control ancillary services.

**1.11.** The Commission, vide its notification dated 14th March 2022, notified the Central Electricity Regulatory Commission (Deviation Settlement Mechanism and Related Matters) Regulations, 2022 wherein any deviation of schedule shall be dealt according to the provisions of the regulations.

**1.12.** Subsequently, the Commission on 7th June 2022, notified the Central Electricity Regulatory Commission (Connectivity and General Network Access to the inter-State Transmission System) Regulations, 2022 (hereinafter referred to as 'GNA Regulations') which dealt with provisions related to Connectivity and Access to the Grid.

**1.13.** The consequential changes required in 2010 Grid Code keeping in view above stated changes in Regulations has been duly captured in the draft Grid Code. Accordingly, as per the developments considered above, the Central Electricity Regulatory hereby proposes the draft Commission (Indian Electricity Grid Code) Regulations 2022 ('hereinafter referred to as draft Grid Code).

**1.14.** The draft Grid proposes inclusion of three new chapters viz Protection Code, Cyber Security Code and Monitoring & Compliance Code in addition to specifying the framework for reserves. The salient features of different codes of the draft Grid Code are as follows:

(a) *Resource Planning Code:* The Planning Code has been proposed to be renamed as Resource Planning Code. A bottom up planning approach has been suggested which shall include demand forecasting, generation resource adequacy planning and transmission resource adequacy assessment required for secure grid operation. The resource adequacy planning shall be on a rolling basis of five years to ensure adequacy of generation resources and adequate planning reserve margin.

(b) *Connection Code:* It has been proposed that NLDC shall prepare a detailed procedure for first time energization and integration of new or modified power system elements and SLDC shall prepare the same at intra-State level. NLDC, RLDC or SLDC as the case may be shall carry out joint system study prior to the first time energization of a power system element.

(c) *Protection Code:* Considering the importance of protection protocol and protection audit post 2012 Grid Disturbance, a new code has been introduced in the draft Grid Code covering protection protocol, protection settings and protection audit plan of electrical systems.

(d) *Commissioning and Commercial Operation Code:* In addition to provisions related to trial run and declaration of commercial operation for thermal generating stations, hydro generating stations, transmission system and communication system, provisions related to trial run and declaration of commercial operation of wind, solar, hybrid, pumped storage and ESS stations have been proposed in the draft grid code. Further specific test reports and documents have been specified which shall be submitted prior to declaration of commercial operation by generating stations and transmission licensee.

(e) *Operating Code:* The framework for reserves comprising of primary, secondary and tertiary reserves, Voltage Control Reserves and Black Start Reserves has been proposed in the draft Grid Code. The national reference frequency has been proposed at 50 Hz while allowable frequency band has been proposed to be tightened to 49.95 Hz to 50.05 Hz. The default UFR settings have also been proposed to be amended with an increase of 0.2 Hz

at all stages in the existing settings. The compensation for reactive power service and black start service have been proposed in the draft Grid Code.

(f) *Scheduling and Despatch Code:* The scheduling procedure has been modified to align with the GNA regulations. The mechanism for Security Constrained Unit Commitment has also been proposed to ensure adequacy of reserves.

(g) *Cyber Security Code:* A new code has been proposed wherein all users shall conduct Cyber Security Audit as per the guidelines mentioned in the CEA (Cyber Security in Power Sector) Guidelines, 2021 and any such regulations issued by an appropriate authority, so as to support reliable operation of the grid.

(h) *Monitoring and Compliance Code:* Two methodologies have been followed to ensure compliance: self-audit and compliance audit. The monitoring agency for users shall be the concerned RLDC or SLDC on the basis of their respective control area. The monitoring agency for RLDC, NLDC, CTU and RPC shall be the Commission, and for STUs and SLDCs, shall be the concerned SERC.

## 2. Definitions

**2.1.** The following terms have been proposed in the definition of the draft Grid Code:

(a) 'Alert State', 'Emergency State', 'Normal State' and 'Restorative State' have been introduced in the draft Grid Code. These are system states on the basis of which power system has been proposed to be categorized in real time as per the Regulation 35. Further, definition of 'System State' and 'Blackout State' has also been introduced in the draft Grid Code.

(b) The definition of 'Ancillary Services' has been modified in the draft Grid Code. The Commission, vide 2022 Ancillary Services Regulations, had notified Primary Reserve Ancillary Services (PRAS), Secondary Reserve Ancillary Services (SRAS) and Tertiary Reserve Ancillary Services (TRAS) as the ancillary services through which the frequency shall be maintained close to 50 Hz. Accordingly, the same has been modified in the draft Grid Code.

(c) 'Area Control Error' has been introduced in the draft Grid Code since it is the metric for measuring the generation and load imbalance for activating secondary reserve ancillary services.

(d) 'Automatic Generation Control' has been introduced in the draft Grid Code since it is the control system for activating the SRAS and may require modifications on account of proposed regulations.

(e) 'Declared Capacity', 'Cold Start', 'Warm Start', 'Hot Start', 'On-Bar Installed Capacity', 'On-Bar Declared Capacity', 'Off-Bar Declared Capability': The Commission, vide its order dated 5$^{th}$ May 2017 in order No. L-1/219/2017-CERC had notified the aforementioned definitions. As details of these capabilities are proposed to be submitted to RLDC under the draft Grid Code, these definitions have been included in the draft Grid Code.

(f) 'Control Centres' at NLDC, RLDC, REMC, SLDC, Area LDC, Sub-LDC and DISCOM LDC have been included in the draft Grid Code as the control centres are critical for grid operations.

(g) 'Energy Storage System': The Commission has already notified the definition of 'Energy Storage' in the Ancillary Services regulations. The provisions of declaration of COD of ESS has been included in the draft Grid Code.

(h) 'Flat frequency control', 'Flat tie-line control' and 'Tie-line bias control' are three AGC operation modes available to the system operator. Through

these modes, the system operator shall be able to deploy SRAS to manage the grid as per the draft Grid Code.

(i) 'Flow-gate' are a group of transmission lines whose cascade tripping can lead to loss of generation and load. Due to the critical nature of such corridors, they have a critical role while determining the ATC or while planning the protection schemes. Accordingly, the definition of flow-gate has been included in the draft Grid Code.

(j) 'Frequency Response Characteristics', 'Frequency Response Obligation', 'Frequency Response Performance', 'Frequency Stability', 'Inertia', 'Nadir Frequency', 'Rate of Change of Frequency' and 'Reference contingency' have been introduced in view of the frequency control mechanism as defined in the draft Grid Code.

(k) 'Gate Closure': In IEGC (Sixth Amendment) Regulations, 2019 Gate Closure was termed as "before the window for trade closes for a specified duration". The Gate Closure is defined in the draft Grid Code to bring clarity and considering its relevance in the scheduling of transaction in Real-time market.

(l) 'Generating unit': The definition of generating unit has been expanded in the draft Grid Code and proposed to cover solar, wind and hybrid generation in addition to the turbo-generator.

(m) 'GNA Regulations' and 'GNA Grantee' have been introduced in the draft regulations to align with the GNA regulations notified by the Commission.

(n) 'Grid-forming Capability': Generally the RE based plants are grid following in nature and require voltage reference and rely on a strong grid for synchronizing and thus follow the grid behavior by responding to the measured quantities. The Commission has defined this term and emphasized its importance in system restoration procedure because of unique capability which do not rely on external grid voltage to generate

power and can operate without, or with very few, synchronous machines electrically nearby.

(o) 'Infirm Power': The treatment of 'Infirm Power' was earlier in accordance with the Central Electricity Regulatory Commission (Grant of Connectivity, Long-term Access and Medium-term Open Access in inter-State Transmission and related matters) Regulations, 2009. As the Central Electricity Regulatory Commission (Grant of Connectivity, Long-term Access and Medium-term Open Access in inter-State Transmission and related matters) Regulations, 2009 ('2009 Connectivity Regulations') are proposed to be repealed after the GNA regulations come in force, the treatment of infirm power has been dealt in the Grid Code and accordingly, the definition is included the draft Grid Code.

(p) 'Merit Order': The term has also been used in the existing Grid Code. In order to have better clarity, the term has been proposed in the draft Grid Code for deciding despatch instruction to the generating stations including SCED.

(q) 'Minimum Turndown Level': 'Technical Minimum' was defined under 2010 Grid Code to indicate the minimum loading required by generating station for safe operations. It has been proposed to rename it as 'Minimum Turndown Level'.

(r) 'Primary Reserve', 'Secondary Reserve' and 'Tertiary Reserve': The Commission vide CERC (Ancillary Services) Regulations 2022 had notified the framework for ancillary services wherein PRAS, SRAS and TRAS were proposed to be deployed to manage any frequency incursion. Accordingly, the 'Primary Reserve', 'Secondary Reserve', 'Secondary Reserve Ancillary Service', 'Secondary Reserve Ancillary Service Provider' and 'Tertiary Reserve' have been defined in the draft Grid Code.

(s) Pooling Station has been introduced in definitions since the power generated from all RE generators shall be pooled in at the pooling station.

Further, all scheduling activities of QCA shall also be carried out at the pooling station.

(t) 'Qualified Coordinating Agency': The definition of 'Qualified Coordinating Agency' has been introduced in view of their role envisaged in the scheduling and despatch process of generators in the draft Grid Code.

(u) 'Ramp Rate': The Ramping Capability is essential for maintaining grid stability especially in high RE Scenario. Further, the Commission has also provided incentive for generators having ramping capability greater than 1% in the Tariff Regulations. Accordingly, 'Ramp Rate' has been defined in the draft Grid Code to cater to the commercial and operational implications arising out of ramping capabilities of generators.

(v) 'Security Constrained Economic Despatch: The Commission vide its suo motu Order dated 31st January 2019 in Petition No. 02/SM/2019, directed Power System Operation Corporation (POSOCO) to implement a pilot on Security Constrained Economic Despatch (SCED) w.e.f. 01.04.2019. The same involves scheduling of power covered under the Grid Code. The framework has been formalized in the draft Grid Code. Accordingly, the definition is included in the draft Grid Code.

(w) 'Security Constrained Unit Commitment' has been proposed to address the shortage of reserves under 2022 Ancillary Service Regulations, if any. Accordingly, the same has been introduced in the draft Grid Code.

(x) 'Settlement Nodal Agency': The Commission has defined Settlement Nodal Agency in CERC (Cross Border Trade of Electricity) Regulations, 2019. Since SNAs are also envisaged to coordinate grid operations in case of cross border transactions, the definition of SNA has been included in the draft Grid Code.

(y) 'System Constraint' has been introduced in the definitions on account of their impact on grid operations.

(z) ‘User’: The definition of ‘User’ has been expanded to include energy storage system, solar park developer, wind park developer and wind-solar photo voltaic hybrid system.

## 3. Resource Planning Code

**3.1.** The provisions related to Integrated Resource Planning have been covered under the Chapter 2 of the draft Grid Code. Integrated Resource planning ensures optimal harnessing of available resources in economical and sustainable manner and is essential for secure grid operation with high reliability, high resilience and more flexibility.

**3.2.** The objective of the Planning Code is to set out principles for planning of generation and transmission resources for reliably meeting the projected demand in compliance with the specified reliability standards for serving the load with optimum generation mix, and to create framework for integration of environmentally benign technologies for electricity generation. It factors large scale absorption of renewable energy in accordance with national policy taking into account measures, including flexible resources, storage systems for energy shift and demand response measures for managing the intermittency and variability of renewable energy sources.

**3.3.** In the 2010 Grid Code, the scope in the Planning Code was limited to transmission planning and it basically reiterated salient aspects of CEA Transmission Planning Criteria. However, the draft Planning Code comprehensively covers the required details, process and attributes to be captured and to be followed for demand forecasting, generation resource adequacy planning and transmission resource adequacy assessment.

**3.4.** The Expert Group, in its report in January 2020, had also noted that there was a need for an institutional mechanism for long-term and short-term demand

forecasting by each control area as well as ensuring adequacy of transmission and generation resources.

**3.5.** Stakeholders had also highlighted the requirement of resource adequacy and pointed out that determination of resource adequacy guidelines for each region is important including LoLP (Loss of Load Probability), VoLL (Value of Lost Load) and Optimal Reserve Margin when the Commission had sought comments on the draft CERC (Ancillary Services) Regulations, 2022. The Commission, in its Statement of reasons dated 26th April 2022, observed that since Resource Adequacy is outside the purview of the Ancillary Service regulations, it shall be considered while reviewing the existing Grid Code.

**3.6.** It has been proposed to adopt the following bottom-up methodology to ensure resource adequacy at control area level as well as national level:

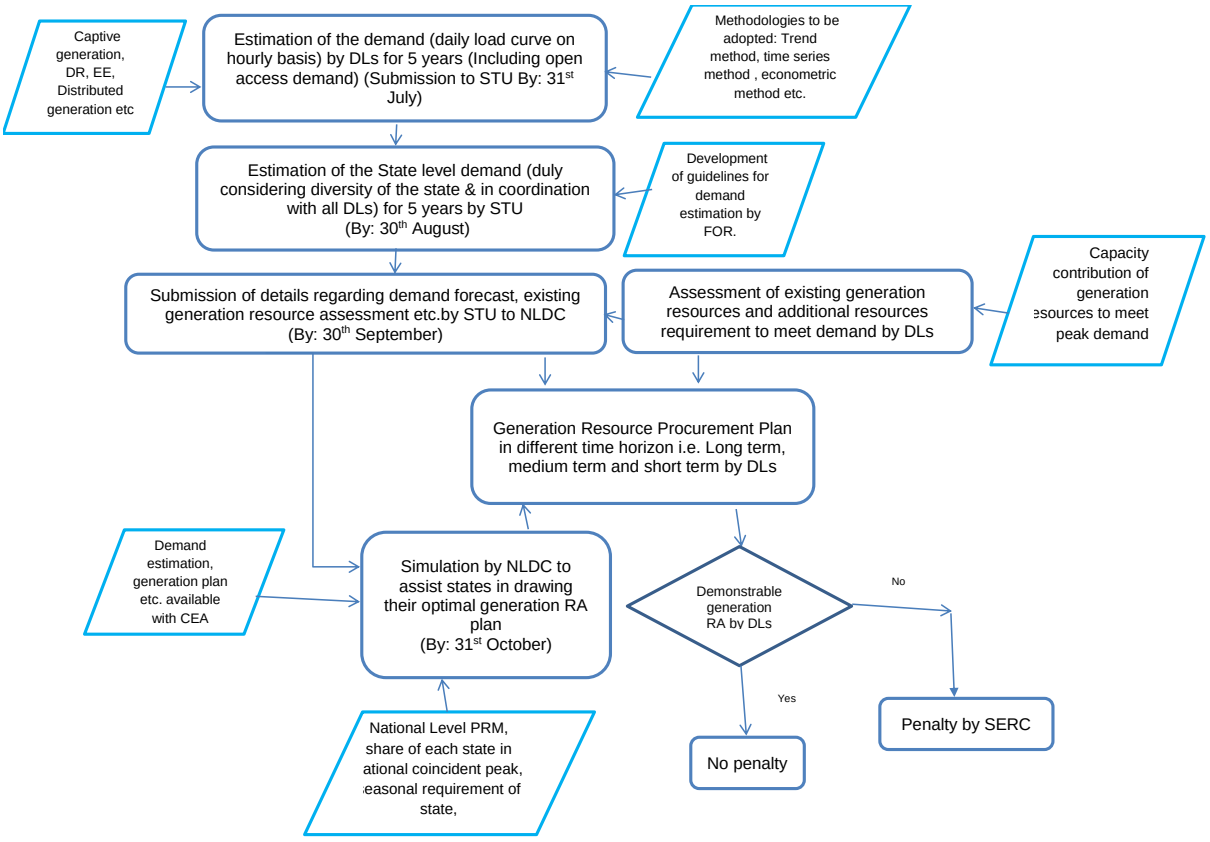


*Figure 1: Resource Adequacy flowchart*

## 3.7. Demand Forecasting

The first important requirement *for* ensuring resource adequacy is to have proper demand forecasting over different time horizons. Demand estimation/forecasting is crucial for integrated resource planning because other aspects of planning are dependent on it. Distribution licensees are the major stakeholders which are on the demand side and serve the load. In this Planning Code, the distribution licensees have been assigned the responsibility to estimate the demand in their control areas including the demand of open access consumers and factoring in captive generating plants, energy efficiency measures, distributed generation and demand response. The distribution licensees shall do this demand estimation for