CEA: Draft Guidelines for Resource Adequacy Planning Framework for India

CEA notified a draft on "Guidelines for Resource Adequacy Planning Framework for India" on 23rd September, 2022. The key highlights of the draft are given below:

Objective: The sole objective of Resource Adequacy framework is the reliable fulfilment of the peak demand with the help of adequate supply of generation and demand response.

The Resource Adequacy framework will cover the following important aspects:

a) Availability of adequate generation capacities to reliably serve demand under multiple scenarios.
b) Optimal capacity mix based on minimization of overall system cost.
c) Time horizon for the implementation of the framework should be 5 – 10 years.
d) Energy storage, other flexible resources, and short-term sale/purchase under bilateral contracts will be incorporated into the resource adequacy framework.

Important Definitions:

1) **Loss of Load Probability**: Measure of probability that a system's load will exceed the generation and firm power contracts available to meet that load in a year.
2) **Expected Energy Not Served**: Expected amount of load (MWh) that may not be served for each year within the planning period.
3) **Net Energy Not Served**: Total expected load shed due to supply shortages (MWh) as a percent (%) of the total system energy.
4) **Planning Reserve Margin**: It is expressed as a certain percentage of peak load forecast of the system.

Procedure to determine Resource Adequacy targets:

- **Step1**: Initialization of nominal value of Planning Reserve Margin.
- **Step 2**: Determination of generation capacities at nominal Planning Reserve Margin.
- **Step 3**: To meet the demand reliably for multiple future scenarios by calculating Loss of Load Probability and Energy Not Served.
- **Step 4**: The whole process above will iterated again and again until the value of Loss of Load Probability and Energy Not Served does not converge to a minimum standard value.
- **Step 5**: To estimate the value of the Planning Reserve Margin based on the evaluation of the optimized marginal cost of reducing load shed.

The document can be accessed here.

CER Opinion

1. **Necessity of resource adequacy framework**: The ongoing challenge of catering to the peak demand reliably is currently being faced by the utilities in India. Sufficient amount of power supply coupled with demand response framework and sharing of inter-state and inter-region power should be adopted to meet the peak demand reliably. The overall objective of Resource Adequacy (RA) framework is to avoid demand-supply mismatch, ensure system security and reliability at the national level.

   Power procurement cost is a major part of the RA study. Power procurement plans and contracts typically have a long-term horizon and, hence, need to be worked out well in advance, based on reliable and dependable forecast. CER, IIT Kanpur carried out a research on the importance of these aspects and published a book on "*Regulatory Framework for Long-term Demand Forecasting and Power Procurement Planning*"[1], highlighting the need for a regulatory framework for the same. CER and EAL

[1] Singh et al. (2019), *Regulatory Framework for Long-term Demand Forecasting and Power Procurement Planning*,

IITK have also worked on numerous similar assignments and have provided their opinion on "*Power Purchase and Procurement Process Regulations*"[2], and "*Terms and Conditions for short-term procurement/sale of power Regulation, 2021*"[3].

Given the experience of CER and EAL in carrying out Long-term Demand Forecasting and Power Procurement Planning for the states of Uttar Pradesh and Chhattisgarh, we reinforce the need for a robust regulatory framework for the same. **From these studies, it was inferred that significant economic benefits in terms of reduced private and social costs is possible through RA.**

2. **Resource adequacy vs generation adequacy:** Draft Clause No. 2 (1) (1) states "*A key aspect of Resource adequacy planning is to ensure that adequate generation capacities are available, round-the-clock, to reliably serve demand, under various scenarios. This naturally translates into the need for ensuring adequate reserve margin, which could cater to varying levels of demand and supply conditions in the grid. In the wake of high RE generation, it is important to understand demand-supply situation in the grid in more granularity.*" while Clause No. 2 (1) (2) states "*It is necessary to develop a resource adequacy framework to suggest the optimal capacity mix required to minimize the total system cost in meeting the projected demand for the future. This should include determining new generation capacities to meet future demand growth.*" and Clause No. 2 (1) (3) states "*The resource adequacy framework should holistically look at a 5 – 10 year time horizon. This is critical, considering the longer gestation period required for planning and constructing most generation technologies".*

   It's important to point out that role of generation, additional generation capacity is emphasized again and again in the document, whereas the similar association of demand response with RA have not been provided. This undermines the role of demand response in RA.
   Demand response helps in ensuring to address expected demand supply gap in the short run, thus avoiding addition of expensive capacities to meet the peak demand for few hours of the year and hence will avoid the potential burden of the additional costs on the shoulders of the consumer. Thus, demand response should be incorporated properly.

3. **Information of generation capacities at CEA and URS:** Draft Clause No. 1 (1) (b) states "*Presently, states do their power procurement planning and contracting by considering all the possible options available to them. However, sometimes **details of all generation capacity** available at regional or National level **may not be available with states**. Such a situation necessitates designing of a mechanism to ensure adequacy of resources through sharing of reserves and prevent a potential surplus/ deficit situation, in an optimal way.*" (emphasis added)

   The Clause indicates that the states do not have any information regarding the generation capacities at regional and national level. Hence, there may be a time when there is excess generation taking place at some region, while the other region is suffering from demand deficit and due to the lack of knowledge of capacities available in other region, the power cannot be provided to demand deficit region from surplus generation region. However, the required information regarding the generation capacity is available on Central Electricity Authority (CEA) and Un-Requisitioned Surplus (URS).

4. **Long-term power procurement mechanism to ensure adequacy of supply:** Draft Clause No. 1 (1) (f) states "*Currently, there is no mechanism to enforce and monitor whether adequacy of supply is being*

CER Monograph, *Book ISBN:978-93-5321-969-7*, https://cer.iitk.ac.in/assets/downloads/CER_Monograph.pdf

[2] *Draft Detailed Procedure for Madhya Pradesh Electricity Regulatory Commission (Power Purchase and Procurement Process) Regulations*, Revision-II, 2022 (RG-19(2) of 2022), https://cer.iitk.ac.in/odf_assets/upload_files/blog/Revision_2_2022_Power_Procurement_Draft_Regulation.pdf

[3] *APERC (Terms and Conditions for short-term procurement/sale of power) Regulation,* 2021, https://cer.iitk.ac.in/odf_assets/upload_files/Draft_APERC_Terms_and_Conditions_for_short_term_procurement_sale_of_power_Regulation_2021.pdf

met by state utilities by carefully integrating availability of resources in other states and regions. Hence, situations like overhang of capacity or demand deficits have been common in the recent past."

The Clause suggests that currently there is no operating mechanism to ensure that the adequacy of supply but states utilities sign long-term power procurement agreement with generators anywhere in the country to ensure the same. Thus, there is certainly a need to improve the existing mechanism, but it is incorrect to indicate the non-existence of such mechanism.

5. **Resource adequacy is a combination of adequate generation and demand response:** The definition of resource adequacy have been provided under the Clause No. 1 (2). It suggests that the RA should ensure either adequate generation capacity or demand responsive resources such that peak load can be met reliably. Ideally, the RA should be implemented in such a way to integrate the adequate generation capacity with demand responsive measures.

6. **Optimal reserve margin study on regional level:** The optimal reserve margin study can be undertaken by the utilities on the state level as per the Clause No. 3 (8). The major disadvantage of conducting the study on state level is that the state level planning reserve margin (PRM) will always be higher than the national or regional level PRM which can lead to the problem of surplus generation. Hence, the study should be conducted on national level or more preferably on regional level, since there are institutional frameworks on regional level for sharing of planning reserves. A mechanism can be made to deploy the resources.

7. **Block-wise data for RA Planning amidst growing VRE:** According to Clause No. 4 (5) (b) and Clause No. 4 (6) states, hourly data of demand will be used to prepare the RA plan. In order to capture the variability and uncertainty associated with demand as well as VRE generation, 15-minute time block data will be much more capable of capturing these aspects as compared to hourly granularity for planning for RA. Hence, EAL recommends to use 15-minute time block data and planning thereof.

8. **Guideline for Methodology:** The methodology for modelling have been adequately discussed in Clause No. 4 (5) to Clause No. 4 (8). While the suggested approach seems suitable at the moment, flexibility in developing the methodological approach further should be incorporated in the document. The suggested approach would serve as a broad guideline, with flexibility to account for local aspects including unavailability of appropriate data.

   Based on its experience, EAL suggests that simulation scenarios may also be based on top-3/top-5 days of each month to ensure that the available resources would be able to cater to higher demand scenario for most of the critical days across months.[4]

9. **Demand response as important component of RAR calculation:** The Clause No. 4 (8) (a) is very important in the perspective of RA as it elaborates on calculation for Planning Reserve Margin (PRM)/ Resource Adequacy Requirement (RAR). The formulation provides adequate importance to supply side aspects with separate term for each such contributing factor, while demand side gets hyphenated with other factors and seem to lose its visibility and its importance. EAL suggests to incorporate demand response as a distinct component in the calculations so that it gets addressed in planning as well.

10. **Coincidental forced outage and calculation of peak demand:** The Clause No. 4 (8) (a) contains a formula to calculate supply side RAR, which assumes that forced outage rates of different type of generators will occur at the same time or coincidentally. The coincidence of forced outage rate to calculate the capacity credits may need to be reconsidered, as the forced outages of the plants are not likely to be in practice. .

[4] *Long-term Demand Forecasting and Power Procurement Planning for CSERC*, EAL (Report Submitted)

The same Clause also discusses the estimation of **contribution to coincidental peak demand** to calculate demand side RAR. The current methodology in the document is based on the estimation of the peak demand using diversity factor. Unless demand profile for respective states are forecasted, the relative contribution of state level demand to national peak demand could not be arrived at. A method incorporating the philosophy has been used by EAL, for undertaking the forecast of demand for three states[1,4].

11. **Incorporating captive, rooftop and behind the meter generation in the study:** With the growing capacity of captive generation (459.15 GW capacity of 1 MW & above as on 31 March 2021)[5], significant amount of power may be available for sale through open access. Furthermore, there is increasing adoption of rooftop solar or behind the meter generation, which is being witnessed for institutional, non-domestic, industrial as well as domestic consumers. Due to their recent emergence, the historical data does not capture this, and thus needs to be appropriately modelled in forecasting..

12. **Demand response in IRP and the associated capacity credit:** Draft Clause No. 4 (8) (g) states "*Potential for demand side management such as shifting of load or demand response **can** be considered while undertaking the IRP. Constraints such as periods when load shifting can occur, the maximum quantum in an hour and the maximum quantum of load which can be shifted would need to be included*." (emphasis added)

    Consideration of demand response should be (rather than can be) considered in an IRP exercise. It is recommended to make demand response an integral part of the IRP modelling. At the same time, adequate regulatory framework should be provided by the regulator and institutional mechanism be placed by the respective DISCOM.

    Capacity credit mechanism for the expected demand response should be considered in the IRP as well as PRM for the respective utility.

13. **Month-on-month optimal generation:** Draft Clause No. 4 (9) states "*The output of the model would be the **quantum and type of resources** required in the portfolio of a utility to meet the demand in an optimal (least cost and secure) manner. The model shall give the **year-on-year optimal generation** (conventional + Renewable) and **storage capacities required to meet the system demand** and the **planning reserve margin** condition securely and at least cost.*" (emphasis added)

    The output of the overall study will be year-on-year optimal generation. It is recommended to report monthly optimum generation plan to ensure RA uniformly throughout the year.

14. **Alignment of forecasts used by CEA & POSOCO with DISCOMS projections:** Draft Clause No. 5 (3) states "*The hourly demand forecasts used by CEA and POSOCO / NLDC should be aligned with the projections as per the individual Distribution Licensees...*"

    The meaning of "*aligned*" in the Clause is not clear. The meaning and the modality for aligning the hourly demand forecasts by CEA & POSOCO and Distribution Licensees shall be provided.

15. **The process after LT-DRAP (Long-term DISCOM resource adequacy planning):**
    Draft Clause No. 5 (6) states "…*The distribution licensees shall demonstrate to the SERC **100% tie-up** for the first year and a minimum 90% **tie-up** for the second year to meet the requirement of their contribution towards meeting coincident national peak. Only resources with long / medium / short-term **contracts** will be considered to contribute to the PRM. Power procurement through the power exchanges, such as the Day-Ahead Market segment, will not be considered.*
    *For subsequent three years, the distribution licensee shall submit a plan for 100% **capacity tie-ups** to*

[5] Source: Economic Survey 2021-22

meet estimated requirement of their contribution towards meeting coincident national peak for SERC's approval."

The following comments may be noted in the above context,

- **The LT-DRAP process emphasises capacity tie-ups to achieve the Planning Reserve Margin (PRM), while demand response seems to be sidelined.** Capacity tie-ups (through contracts) are only eligible to demonstrate PRM. Apart from demand response, role of short-term market (through power exchanges) also need to be highlighted. **Capacity tie-up should be replaced with resource tie-up (which would include demand response as well) at all relevant instances.**

- The level of 'capacity' tie-up should keep into mind the gestation period for setting up new capacity, especially for the first few years of its implementation. Many discom **may not be able to demonstrate 100% capacity tie up in the very first year of obligation** under the RA requirements. **This further highlights the importance of demand response, which would have relatively much shorter gestation period**. Figure outlines the need for 'capacity' tie-up over a five-year horizon, wherein demand may have been under- or over-projected. It is proposed that the rollout of the RA plan should have sufficient time for the utilities to ensure compliance for the first year of implementation, to the least.

- Furthermore, short-term contracts are not decided significantly in advance and, also depend on the market conditions. While their role would be important, **certainty of capacity credits across states may not be ensured for all discoms during the period of shortages.** The IRP and the RPM should appropriately incorporate capacity credits for the same.

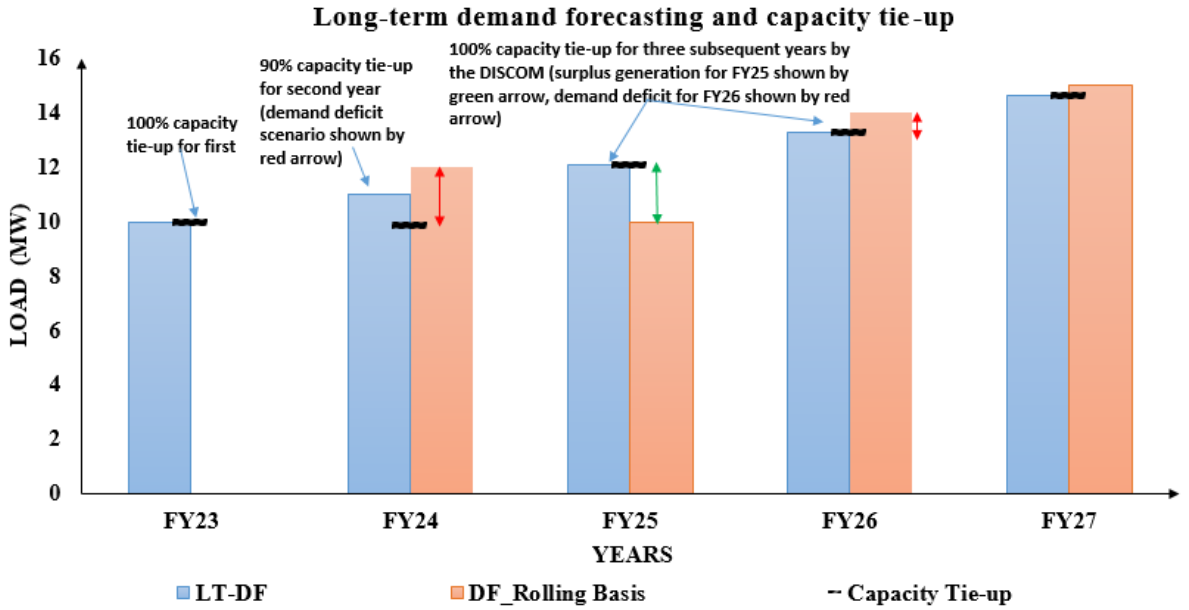

Figure 1: Case demonstration to understand the impact of capacity tie-up

As per the Clause, the capacity tie-up by the DISCOM is indicated in the figure. The figure indicates that there may be a potential occurrence demand deficits during the 2nd year due to low tie-up capacity (90%) as compared to 1st year (100%). A scenario of surplus capacity can also take place in the 3rd year of 100% of capacity tie-up. Thus, the above tie-up process can be implemented in a more effective way.

EAL suggests the following rollout plan for resource adequacy planning:

a. DISCOM shall demonstrate 85-90% tie-up of resources for the 1st year and 2nd year. (immediately after rollout of RA plan)
b. DISCOM shall demonstrate 95% tie-up resources for the 3rd year.
c. DISCOM shall demonstrate 100% tie-up resources for the 4th year onwards.
d. The tie-up resources now can be brought down for the subsequent years.

- **A dynamic approach to RA**: Let us consider a situation wherein 100% resource tie-up has been ensured for the next 5 years, based on project electricity demand. Since demand forecasting is a dynamic exercise, it is likely that demand forecast is adjusted downward for the 3rd year onwards. In such a case, resource adequacy would likely to be more than 100% for the 3rd year onwards.

- Many DISCOMs in the country have achieved a capacity tie-up of less than 85%. Pushing such DISCOMs to achieve 100% capacity tie-up will lead to signing of PPAs with generators, thus adding to their financial burden of capacity charges. EAL suggests **a gradual approach to implement RA plan so that DISCOMs can work on their demand response program**.

16. **Modified timelines for Annual RA Planning:**
Draft Clause No. 5 (8) states "*…The RLDCs shall aggregate the capacities at the regional level and submit the information to the POSOCO / NLDC by the month of February. POSOCO / NLDC shall aggregate the capacities at the national level and check compliance with ST-NRAP and identify shortfall for the ensuing year, if any. In case of shortfall, POSOCO / NLDC shall either communicate the shortfall to the distribution licensees for compliance or facilitate a national-level auction for the balance capacity with participation from distribution licensees with capacity shortfall. The contracting for the balance capacity shortfall shall be completed by the month of March prior to the start of the delivery year (1st April).*"

The DISCOMs should submit their contracted capacities for the upcoming year to the STU/SLDC by the month of September or October, i.e., before their submission of ARR in the tariff petition to the respective SERC. Also, contracting for the balance capacity shortfall should be completed by the month of January/February instead of March.

17. **Dilemma of multiple future scenarios:**
Annexure A (5) suggests that there will be multiple future scenarios that should be created to account for uncertainty and analysis of the occurrence of the lost load. The question is that result from **which scenario should be considered for the actual implementation of RA framework. How would the knowledge from alternate scenarios be incorporated in the RA plan? Would this allow for RA plan flexibility based on the outcome of the scenarios?**

18. **Inclusion of renewable energy resources included in Round-The-Clock (RTC) power generators**
Draft Clause No. B (4) states "*The Capacity Factor Approximation with Top Net Load Hours can be considered to determine the capacity credits for new resources and the Top Load Hours methodology can be considered to determine the capacity credits for existing resources*…"

RE RTC contracts can demonstrate full capacity credits and need to be considered under 'Top Load Hours' methodology instead of 'Top Net Load Hours'. The later methodology can be applied to individual/hybrid RE resources without assured schedulable capacity. Furthermore, RE/hybrid resources with storage should also be considered as firm contribution to the top load hours.

Annexure B highlights different methods for the calculation of capacity credits for Renewable resources. Since there is an emergence of RE RTC contracts in the Indian power sector, the capacity credit for renewable energy sources included in the tenders should be taken into account.

19. **Impact of Fuel Availability on Capacity Credit under IRP/RA:** Given the existing contract for fuels, full capacity credit need to be considered for such tied up capacity. Uncertainty associated with fuel supply would generally be a short-term phenomenon and be penalized through appropriate mechanisms in the fuel supply agreement.

20. **Graduated Approach and Institutional Capacity:** While discoms are required to undertake load forecast and plan for power procurement while submitting their tariff petition, a lot needs to be achieved in that respect. Given the limited capacity and the learning curve associated with the detailed resource adequacy plan, discoms be allowed a grace period of 2-3 years before implementation of the same. This period should be used to develop draft RA for the intervening years. While this draft RA for the respective discoms may be submitted to the NLDC/POSOCO for review and should also be placed on public domain for comments/inputs. Such preparatory period would allow the discoms to explore the methodology, collect relevant data and put an internal institutional mechanism in place. In the meanwhile, SERCs may amend the respective regulations. An earlier study by EAL may provide inputs for the regulatory framework towards the same[6].

[6] Singh et al. (2019), *Regulatory Framework for Long-term Demand Forecasting and Power Procurement Planning*, CER Monograph, *Book ISBN:978-93-5321-969-7*, https://cer.iitk.ac.in/assets/downloads/CER_Monograph.pdf