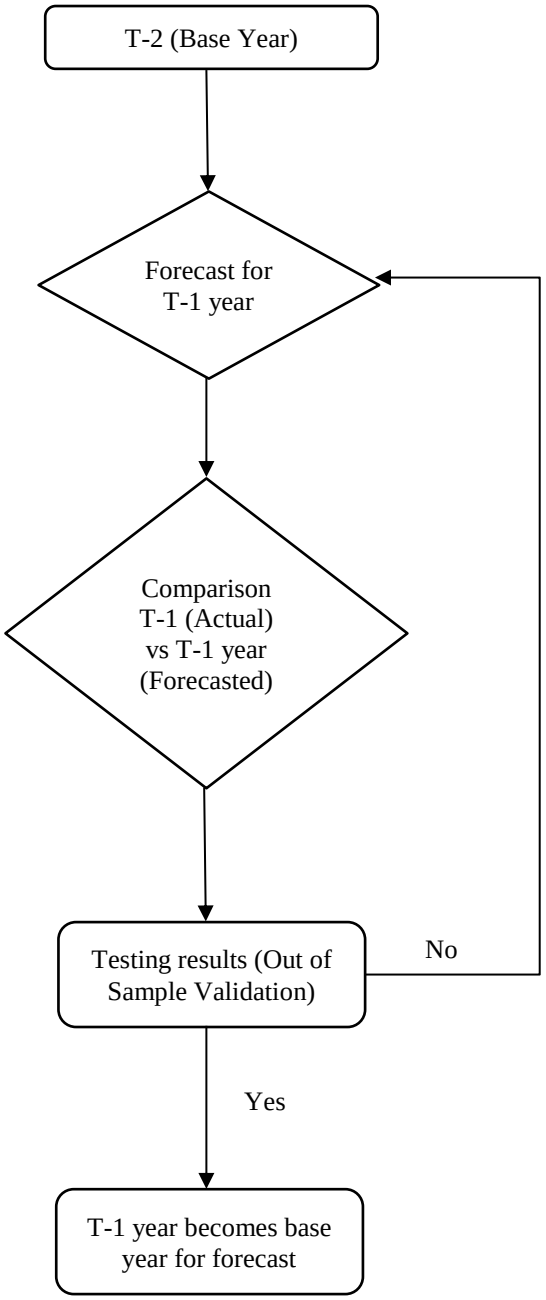
CEA: Draft Guidelines for Medium and Long Term Power Demand Forecast

CEA notified a draft on "Guidelines for Medium and Long Term Power Demand Forecast" on 11th April, 2023. The key highlights of the draft are given below:

Objective: To standardize the forecasting methodology for the discoms across the country.

As per the draft, the medium term forecast should be prepared more than 1 year and up to 5 years while long term forecast should be at least for the 5 years and at least for next 10 years. The draft document suggested that the forecast should be prepared in consultation with all stakeholders, including industrial, agricultural, municipal corporations, drinking water departments, captive power plant owners and other departments involved in planning and implementing electrical schemes.

CEA suggested forecasting methodology as follows:



According to draft document, the demand projection should be done for utility level. The foremost step proposed is analysing historical consumption data for each consumption category independently and take into account the effects of new factors to determine the best future development tendencies. In addition to this, impact of specific government policies, developmental plans and other emerging aspects should also be considered for medium-term forecast. The growth trends estimated under medium-term forecast is extrapolated further to estimate long-term forecast. The forecasting results obtained should be validated through at least one different method.

Input Data that should be considered:

1. Category-wise consumption data including Domestic, Commercial, Public Lighting, Public Water Works, Irrigation, LT Industries, HT Industries, Railways, Bulk Supply & Others.
2. Electricity consumption of Open Access consumers should be added if DISCOMs had not accounted for such energy.
3. The input data should be collected for the past 10 years at least.
4. The unserved demand should be added category-wise as per the consumer mix profile of the concerned geographical areas.
5. The weather parameters (such as rainfall, temperature) should also be collected.
6. The past growth trends for T&D losses (in energy terms) should be considered separately.

CEA has considered PEUM for forecasting electricity demand. Two statistical method is considered least square method and weighted average method. The document also suggested to estimate energy requirement of a state incident upon the ex-bus of the generators. After that peak demand should also be forecasted by applying monthly/ yearly load factor.
In addition to this weather parameters are also considered separately which impact electricity demand. Advanced statistical tools like Multivariate Regression Analysis should be used for this purpose

The guidelines suggests granularity based on spatial and time. The forecasts should be prepared at the discom/ state level at least, but more granular forecasts should be attempted at the zonal, circle, district, sub-station, and feeder/ transformer levels if adequate granular level data is available. More granularity based on time should be work out.

According to draft document forecasting should be carried out for at least three scenarios – Optimistic scenario, Business As Usual (BAU) scenario & Pessimistic scenario.

The document can be accessed here.

CER Opinion

1. **Harmonised Regulatory Framework for Electricity Demand Forecasting:** A publication by the Centre for Energy Regulation (CER), IIT Kanpur on "Regulatory Framework for Long-Term Demand Forecasting and Power Procurement Planning", (Singh et al., 2019)[1] emphasised the need for introducing/updating applicable regulations for demand forecasting and power procurement planning. It was found that regulatory framework for the same differs across states

[1] Singh et al. (2019), "Regulatory Framework for Long-Term Demand Forecasting and Power Procurement Planning", 2019. Centre for Energy Regulation, Indian Institute of Technology Kanpur. ISBN: 978-93-5321-969-7 https://cer.iitk.ac.in/assets/downloads/CER_Monograph.pdf

with marked differences in terms of scope, horizon, methodological approach, responsible agency, periodicity etc. The proposed guidelines by CEA would help in bring about a harmonized regulatory framework to help coordinate this exercise in a bottom up manner enabling coordination and consolidation of the forecast for state, regional and national level.

2. **Overlapping Long-term and medium-term forecasts:** Draft Clause No. A.1 states, "*The forecast should be prepared for medium-term (more than 1 year and **up to 5 years**) as well as for long-term **(more than 5 years)**.*" (emphasis added)

   The methodological approach to medium- and the long-term forecast may differ. To ensure that the two methodologies are able to reproduce the respective forecast, the guidelines should ensure that there is a common overlapping year for which both medium-term as well as long-term forecast would be undertaken. Depending on the approach to forecast for the two types of horizon, the energy/ peak demand/ demand profile from the two forecasts can be compared for the common year and thus be calibrated accordingly. The long-term forecast can thus cover a period of 5 years and above.

3. **Consultation with State Planning Department:** Draft Clause No. A.4 states, "*The forecast should be prepared/reviewed/updated in consultation with all stakeholders such as industrial department, agricultural department, municipal corporation, drinking water department, captive power plant owners, state nodal agencies for renewable energies and any other department entrusted with planning and implementing any electrical energy intensive plan/scheme.*"

   While undertaking the electricity demand forecasting at the discom and the state-level, it is important to have the perspective of necessary targets or plans set up by the state planning department of the respective states. Accordingly, consultation process should also include the state planning department.

4. **Flexibility to choose base year test of model performance:** Draft Clause No. A.5 states, "*The base year for the forecast should ideally be taken as the two-year (T-2) preceding the year during which forecast exercise is being carried out. For example, if forecasting exercise is being done in 2022-23, then the base year for the forecast should be 2020-21. This is to be done to test the performance of the forecasting model by comparing the forecast results obtained for 2021-22 with actual available data (termed as Out of Sample Validation).*"

   The guidelines propose the base year for developing the forecasting model shall be T-2, if the exercise is being carried out during the year T. Since the exercise will be carried out at the discom level, which are in large number and are situated in diverse regions of the country, some discoms are likely to have insufficient amount of data available up to the year T-2. Thus one year flexibility to use data up to T-3 year for carrying out the exercise for the first time may be provided for as a one-time exception.

5. **Change of base year:** Draft Clause No. A.6 states, "*The base year for the forecast should subsequently be changed to T-1 after testing the performance of forecasting model.*"

   While the performance of the forecasting model will be tested using T-2 as the base year, the forecasting exercise for later years will be carried out by using T-1 as the base year. Since the original forecast will continue to be anchored to year T-2, change of base-year later to T-1

would be only a cosmetic and redundant exercise. It is suggested to retain T-2 as a base year to correctly reflect the underlying approach.

6. **Consideration of discom's ownership:** Draft Clause No. A.7 states, "*Spatial Granularity - The forecasts should be prepared at the Discom/State level at least. In addition, forecast at more granular levels i.e. Zonal level, Circle level, District level, Sub-Station Level, Feeder/Transformer level should also be carried out in case of availability of adequate granular level data. Such granular forecasts would be more useful in power infrastructure planning. It would also help in generating more revenues as the potential customers would be fascinated to set up their base in the areas where their power requirements are expected to be fulfilled and are already a part of the planning process.*"

   Discoms within a state may be under ownership of public/ private entities. It is noted that across most of the states, multiple discoms are owned by the respective state government[2]. It is also observed that most of the planning/forecasting for power procurement is undertaken in a consolidated manner for all the discoms under public ownership (often by the holding/trading company). Such disoms should be required to undertake exercise at the discom level to provide better visibility and enable further planning by the discoms.

   Furthermore, forecasting at more granular level (zonal/circle/district/sub-station etc.) may only be feasible if sufficient and reliable data with similar granularity is available. A predefined timeline, say 3 years, may be set for the discoms to begin the exercise at more granular level. The intervening period should be utilized to setup necessary database for the same.

7. **Time granularity for medium-term and long-term forecast:** Draft Clause No. A.8 states, "*Time Granularity - The forecast should be worked out year-wise at least. In addition, month-wise/day-wise/hour-wise/time-block wise forecasts should also be done if adequate granular level data is available.*"

   The guidelines have been made to carry out year-wise forecast at least on time granularity level for both medium-term and long-term. Depending on the methodological approach adopted for the long-term/medium-term forecast, the level of granularity may differ. For example, there could be annualized year-wise energy forecast with peak load forecast for the long-term (may be with variation for peak/ off peak months), whereas there may be time block based forecast for the medium-term. Such a flexibility in choice of granularity may be desirable and be incorporated in the guidelines.

8. **Common reference Optimistic, Business As Usual (BAU) and Pessimistic scenario:** Draft Clause No. A.9 states, "*Time Granularity - The forecast should be worked out year-wise at least. In addition, month-wise/day-wise/hour-wise/time-block wise forecasts should also be done if adequate granular level data is available.*"

   To enable consolidation of the discom/state-level forecasts across different scenarios, a common framework to choose a set of assumptions for the Optimistic, Business As Usual (BAU) and Pessimistic scenarios may be adopted. Although it may not be feasible to suggest similar/same numerical values, but relative scale difference across key assumptions may help develop a national level forecast for the three scenario to some extent.

[2] For example, in the case of Uttar Pradesh, there are five government owned discoms, whereas one is privately owned.

9. **Flexibility to choose the methodology for forecasting:** Draft Clause No. A.13 states, "*The long-term forecast should be based on further extrapolation of the growth trends estimated under medium-term horizon.*" while A.14 states, "*The forecasting results obtained should be validated through at least one different method. Econometric Method should preferably be one of the methods adopted for forecasting*". Also, Section C of the document is titled as 'Forecast Methodology (Partial End Use Method)'. Draft Clause C.8 states, "*The peak demand forecast of a Discom/State should be derived from the energy requirement figure by applying appropriate load factor…*"

   It is important to point out that at multiple places, the guidelines has emphasized application of Partial End Use Method (PEUM) as the primary method for forecasting. While the aim of the document seems to set the standards for forecasting at the discom/state level, restriction of choosing the forecasting methodology should be avoided. In fact, availability of alternate forecast methodologies would help the states/dicoms to learn from them and make an informed choice in later cycle of forecasts. The discom should thus be given the flexibility to adopt the approach for undertaking the medium-term and long-term forecast. In this context, the proposal for 'extrapolation of the growth trends' applied to the medium-term forecast to arrive at the long-term forecast is also not advisable.

   Depending on the availability of data, respective experience and merit of the methodology, the states/discoms may be allowed flexibility to choose one methodology as a primary one (e.g. econometric forecast) and use the other one (e.g. PEUM) for validation.

10. **Inclusion of banking:** Draft Clause B.2 states, "*The consumption categories should be identified as per the tariff structure prevailing in the respective Discoms. The broad categories are Domestic, Commercial, Public Lighting, Public Water Works, Irrigation, LT Industries, HT Industries, Railways, Bulk Supply, Open Access & Others.*"

    Banking of power may cross over from one financial year to the other. Energy accounting towards the same should be considered and adjusted while finalizing historical data for demand forecasting.

11. **Exclusion of 'sale outside the state':** Draft Clause B.4 states that *"The "Other" category should generally include energy consumption not fitting into any of the standard categories such as temporary connections consumptions, State Centre Category (as in Jammu & Kashmir) consumption etc."*

    There guidelines do not refer to an important 'consumption' category, identified separately in some states, called 'sale outside the state'. It is important to highlight that data for such sales should be excluded from analysis as it pertains to 'consumption' in other states/discoms. Otherwise, it would result in double counting and affect the forecast of energy 'to be consumed' in a state/discom, and would also influence the estimation of overall network losses as such sales would only account towards inter-/intra-state transmission losses.

12. **Category-wise unserved demand:** Draft Clause B.5 states, "*As far as possible, the unserved demand should be added category-wise as per the consumer mix profile of the concerned geographical areas. In case of unavailability of these details, such demand should be added to the "Others" category.*"

The category-wise unserved data is not captured across discoms due to mixed feeders and lack of appropriate metering. In contrast, unserved demand across a discom is usually captured in a structured manner and can be incorporated for the discom level forecast. The guidelines should highlight the need to capture category wise unserved demand as well as load profile, though a larger sampling based approach. Such data should be collected and reported on a block-wise basis across the year. This would help incorporation of such information in electricity demand forecast in the future.

13. **Impact of weather data:** Draft Clause B.6 states, "*The weather parameters (such as rainfall, temperature) should also be collected for arriving at the forecast range.*"

    The PEUM, in its basic form, does not directly use weather data in arriving at a forecast. Econometric methods are more suitable for capturing influence of weather and other such parameters. Further, given spatial diversity of weather across discom, granular forecast (at district, control area, feeder level etc.) would capture this impact in a better manner. Nevertheless, discoms should implement a framework for capturing detailed weather parameters through substation level sensors, possibly implemented through a third party and ensure its operational effectiveness. This data would be useful for more reliable forecasts in future incorporating impact of weather parameters.

14. **Data availability and accessibility in the public domain**: Discoms should be mandated to compile identified data useful for developing demand forecast and make it accessible through its portal so that other independent forecasts can be developed and provide better insights to adoption of a suitable methodology in future.

15. **CEA's Dashboard for consolidating discom/state-level forecasts:** The medium and long-term forecasts shall be submitted to CEA and should be available for further validation by stakeholders including academic institutions. CEA may develop a common dashboard to provide access to individual and consolidated forecasts at state/regional/national level.

16. **'Growth Trend' for granular forecasting?**: Draft Clause B.6 states, "*Note – In case of more granular forecasting exercise, the annual consumption growth rate of each month/ day/ hour/ time-block, as per applicability, could be analysed separately.*"

    While it has been mentioned in the guidelines that granularity of forecast would depend on availability of data (for example, month-wise, day-wise, hour-wise, block-wise data, etc.), it is neither advisable to apply 'trends/growth rate' on daily, hourly or block-wise forecasts as economics trends and seasonalities do not follow calendar with such a granularity.

17. **Provisions for un-metered connections for agricultural loads**: A significant portion of electricity sold by discom was unmetered (particularly for agriculture, lifeline tariff, street lamp etc.). A greater proportion of the same still remains unmetered. The guidelines should specifically provide for treatment of such unmetered consumption. This would make category-wise forecast, for such categories, to be a challenging task.

18. **Time series data for emerging aspects:** Draft Clause C.3 states that, *"The impact of emerging aspects expected in future should be factored in additionally after arriving at the forecast on the growth rates estimated on the past time series data."*

For emerging aspects expected in the future, there will not be any past data, hence there will not be any quantitative trend for the same. It will be complicated to include the impact of emerging aspect on present forecast.

19. **Impact of energy efficiency and incorporating achieved targets for policies**: Draft Clause C.4 states that, "*The impact of energy efficiency should not be considered additionally in most of the cases as such impacts are already captured intrinsically in the past time series data…*".

    It is suggested that Energy efficiency should be considered while forecasting for later years. Even if past time series data does indicate a reduction in energy use, it is important to continue monitoring and evaluating the impact of energy efficiency measures over time, as the effectiveness of these measures may change as technology advances and scope for further improvement is identified.

    In context of impact of major government policies, it is suggested that apart from government policy targets, realistic policy targets may also be adopted and these be fine-tuned with progress thereof. Long-term electricity demand forecasting under taken by EAL, IIT Kanpur for the states of Uttar Pradesh, Rajasthan as well as Chhattisgarh have made such[3,4,5].

20. **Integration of weather parameters with Partial End Use Method:** Draft Clause C.10 states that, *"The electricity demand depends on weather conditions also. In the traditional PEUM, weather parameters are not considered separately as those are assumed to be inherent in the past energy consumption data.*
    However, weather parameters should be considered separately while developing more than one forecasting scenario."

    How is it proposed to consider weather parameters separately in forecasting scenarios while the PEUM itself does not incorporate the weather related aspects in an explicit manner? Unless the methodology itself is modified to take weather parameters into account, creation of such scenarios will not be possible.

21. **Distribution of impact of emerging aspects:** Draft Clause D.2 states that, *"If the targets are not segregated at annual level or no definite trends are anticipated, then an exponential trend with more impact in the later years should be considered."*

    Adoption of 'exponential trend' in the absence of a 'definite trend' would be erroneous as this would lead to over estimation of forecast if the underlying model does not identify the same. The choice of trend should be based on the forecasting model, preferably estimated using an econometric model.

---

[3] Singh et al. (2019), "Regulatory Framework for Long-Term Demand Forecasting and Power Procurement Planning", 2019. Centre for Energy Regulation (CER), Indian Institute of Technology Kanpur. ISBN: 978-93-5321-969-7 https://cer.iitk.ac.in/assets/downloads/CER_Monograph.pdf

[4] Singh, Anoop (2021), Long-term Energy/Load Forecasting and Power Procurement Planning: Case Study of Uttar Pradesh and Chhattisgarh, Centre for Energy Regulation (CER), Indian Institute of Technology Kanpur. https://cer.iitk.ac.in/assets/downloads/FOR_CBP14/presentations/CBP14_PPT_anoops@iitk.ac.in_LTDF.pdf

[5] Singh, Anoop (2022), Project Summary Report on Rajasthan Energy Scenarios for 2030 and 2050, Centre for Energy Regulation (CER), & Energy Analytics Lab (EAL), Indian Institute of Technology Kanpur. https://eal.iitk.ac.in/CER_EAL_IITK_Project_Summary_Report_of_LTDF_for_Rajasthan.pdf

22. **Approach for medium-term forecasting:** Box D.1 states that, *"The approach discussed here for considering impact on power demand due to emerging effects is target based that is normally available on yearly basis. In such cases, the month/day/hour/time-block wise demand impact assessment should be done by arriving at the annual impact assessment first and then spreading it over to each month/day/hour/time-block appropriately."*

    The procedure to spread the annual impact due to emerging aspects to each month/day/hour/time-block shall be clarified. It seems a number will be given for each day of every discom/state. This will not be correct approach to do medium-term forecasting and the above Clause should be modified accordingly.

23. **Exclusion of billing efficiency from distribution losses:** Box E.1 states that, *"If compared with the concept of Aggregate Technical & Commercial (AT&C) Losses, then Distribution Losses for the power demand forecasting exercise should include Technical as well as Billing Efficiency losses but exclude Collection Efficiency Losses."*

    The billing efficiency is not a reflection of consumption pattern but the commercial performance of the discoms. It does not play a role in electricity demand forecasting. Thus in place of AT&C losses, T&D losses should be considered for the forecasting.

24. **Estimation of unmetered consumption:** Draft Clause E.2 states that, *"Distribution losses of a Discom should be calculated by subtracting total electrical energy billed to all consumers from total electrical energy purchased by Discom from all sources."*

    While the distribution losses shall be calculated by subtracting energy billed to all consumers from total electrical energy purchased by the discoms as per the guidelines, it is also important to keep in mind that the agricultural consumption comes under the category of unmetered consumption, which cannot be measured or recorded. CER recommends to add a separate section in order to elaborate on the estimation of unmetered consumption for the forecasting purpose to conduct month-wise/day-wise/hourly/block-wise forecasting.

    This is another reason why the PEUM method should not be used as a primary method for forecasting.

25. **Impact of Rooftop Solar and Solarised Pumps on Network losses:** While rooftop solar and solar pumps have not made significant contribution to the electricity demand in the past, it is expected to play an important role in future. Due consideration should be given to their impact while forecasting electricity demand in future.

26. **Estimation of total peak demand from category-wise peak demand:** It is important to point out that if the peak demand is being calculated category-wise which seems so as per Clause G3, G4 and G5, then it will not be possible to easily arrive at total peak demand unless coincidental nature of peak demand of all consumer categories is ascertained.

27. **Conflicting philosophies for optimistic and pessimistic scenarios:** Annexure III of the document shows a table explaining the philosophies of optimistic, BAU and pessimistic scenarios. In the table, the impact of Government Targets vs impact of rest of the parameters on the demand seems to be conflicting with each other. In the absence of such consistency, the

states shall define the three scenarios based on their own judgement, which will result in inconsistency of forecast-terminology among discoms/states. The philosophy of three scenarios, thus shall be defined clearly to ensure consistency across states.