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PUBLIC NOTICE

Subject: Draft "Guidelines for Medium and Long Term Power Demand Forecast"

There was a long felt need by power sector Utilities to have a set of guidelines in place to have a uniform approach for carrying out their demand forecast. Accordingly, Central Electricity Authority (CEA) has prepared a document titled **"Guidelines for Medium and Long Term Power Demand Forecast"** for the utilities of Indian Power Sector.

2. The draft guidelines aims to serve as a guiding document for power utilities in order to bring uniformity in their power demand forecast approach. It is hoped that this document will fulfill their requirement.

3. All the Stakeholders and members of the public are requested to send their comments/ suggestions on aforementioned draft guidelines preferably through e-mail (pslf-div@gov.in) or at the following address latest by 11th May, 2023.

11/04/2023

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Guidelines for Medium and Long Term Power Demand Forecast

Central Electricity Authority
Ministry of Power

A. General (Term, Periodicity, Scenarios, Methods of the forecast):

A.1 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).

A.2 The long term forecast should at least be for the next 10 years.

A.3 The forecast should be reviewed on yearly basis and updated, if required.

A.4 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.

A.5 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).

Note - If the data for T-2 year is showing some abnormal trends due to various factors such as extreme weather conditions, pandemic etc., then the last normal year till which some definite trends were observable should be considered as the base year.

A.6 The base year for the forecast should subsequently be changed to T-1 after testing the performance of forecasting model.

A.7 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.

A.8 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.

Note – These guidelines are focussed more on working out year-wise forecast for a Discom/State. However, the concept delineated in these guidelines could be extended for more granular (in terms of "Time" as well as "Spatial") forecasting exercises also.

A.9 The forecast should be carried out for at least three scenarios – Optimistic scenario, Business As Usual (BAU) scenario & Pessimistic scenario.

Note – More scenarios could also be built up particularly considering different permutations and combinations of extreme (favourable or harsh) weather conditions. Some typical such scenarios could be – (i) hottest temperature scenario only (ii) coldest temperature scenario only (iii) highest rainfall scenario only (iv) lowest rainfall scenario only (v) hottest temperature and lowest rainfall scenario. The optimistic scenario should consider hottest temperature and lowest rainfall scenario whereas the pessimistic scenarios should factor in lowest temperature and highest rainfall conditions. Since forecasting under BAU scenario should be based on normal past trends, the weather parameters need not required to be considered additionally in this case.

A.10 The power demand forecast should be done under the unrestricted scenario which essentially is reflective of the case when all the unserved demand currently not served by the utilities due to various supply side barriers such as generation & network constraints (resulting in planned load shedding and unplanned outages) is also included.

A.11 The method adopted for forecasting should aim at analysing past consumption data of each consumption category separately and factoring in impacts of emerging aspects to arrive at appropriate future growth trends. Central Electricity Authority traditionally adopts Partial

End Use Method (PEUM) for carrying out Electric Power Survey (EPS) exercises which is explained in **Part C** below.

A.12 In addition to past growth trends, the medium-term forecast should be based on the assessment of impact of specific government policies, developmental plans and other emerging aspects in the definite quantum of electrical energy.

*Note – One way to assess impact of emerging effects could be to take into account the expected additional load and multiply it with average specific energy consumption of the relevant consumer category. The guidelines for factoring in impact of emerging aspects on power demand forecast are available in **part D** below.*

A.13 The long-term forecast should be based on further extrapolation of the growth trends estimated under medium-term horizon.

Box A.1: The main aim of the forecast should be to cover electricity demand projection for the utility system. In addition, forecast of the entire power consumption including demand meeting from distributed power sources such as CPPs, solar roof top should also be carried out so that a holistic picture of power sector could emerge.

A.14 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.

B. Input Data:

B.1 The category-wise consumption data should serve as the basic input for power demand forecasting.

Box B.1: Electricity consumption of Open Access consumers should be attributed to the respective Discom due to the following reasons:

a) Open access consumers use the network of the Discom for supply of electricity in most cases.

b) The source of electricity may change but the location of load will remain the same.

c) Although Discoms need not have to consider the demand of open access consumers for power procurement, however, the same should have to be considered for augmentation of power network by the Discoms/States/UTs.

d) It will give a better picture for planning/augmenting the transmission/sub-transmission/distribution network for sourcing power to the open access consumer in the Discom/State.

B.2 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.

B.3 The input data should be collected for the past 10 years at least. An indicative format for collecting year-wise input data is given in **Annexure-I**.

Note – More granular data could also be collected in similar formats.

B.4 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.

B.5 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.

B.6 The weather parameters (such as rainfall, temperature) should also be collected for arriving at the forecast range.

> **Box B.2:** There should be proper up-keeping of data so that the data for any forecasting exercise should be readily available and not suffer from any inconsistency.

C. Forecast Methodology (Partial End Use Method):

C.1 The annual growth rate in the past for each energy consumption category should be analysed. Two of the simplest and appropriate statistical methods for such purposes are "Least Square Method" and "Weighted Average Method" which are explained with illustrative examples in **Annexure II**. Other advanced statistical tools may also be used to analyse growth rates.

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.

Box C.1: The three components of T&D losses viz. Distribution losses, Intra-state transmission losses and Inter-State transmission losses should be analysed separately as each component normally follows separate and disjoint trajectories. The transmission loss trajectories are normally found to be flatter in comparison to a steeper distribution loss trajectory. Also, the quantum of Inter-State transmission losses depends more on net energy import of the Discom/State whereas intrastate transmission losses depends more on technical losses.

C.2 The past growth trends for T&D losses (in energy terms) should also be analysed separately for estimating future growth trends. For this purpose, the three components of T&D losses (viz. Distribution losses, Intra-state transmission losses and Inter-State transmission losses) should be analysed separately.

Box C.2: In cases where Discoms/States are hopeful of reducing T&D drastically over a shorter period of time due to some planned measures such as extensive meter installations, reduction in losses should not be considered in complete isolation as some of the unmetered load then, would be expected to come up under metered load of different consumer categories. Accordingly, adjustments should be made by taking appropriate assumptions.

C.3 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 as explained in **Part D**.

Note - The impact of ongoing government policies/schemes, technological advances should not be factored in additionally if they are already in vogue for quite some time in the past and expected to follow similar trajectories in future as such impacts are already captured intrinsically in the past time series data.

C.4 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. However, if some major changes on account of energy efficiency are expected in future due to various factors such as some major technological breakthroughs or implementation of some major government policies, then the impact should be factored in additionally. In such cases, the impact in a definite quantum of electric energy should be assessed.

C.5 The methodology adopted should be assessed on the criterion of out-of-sample validation (pls refer **para A.5** above). For doing this, the forecast for the first year immediately after the base year should be compared with actual data recorded for the year.

Note - In case of deviations, necessary course correction in the growth rates adopted should be done after detailed examination. Some of such correction measures could be filtering the outline data from the input data, changing the base year, changing the assigned weights etc.

C.6 The energy requirement of a Discom/State should be arrived at by adding T&D losses to their total energy consumption. The concepts of accounting T&D losses to arrive at energy requirement figures at Discom and State levels are explained in **Part E** and **Part F** respectively.

C.7 The energy requirement of a state incident upon the Ex-Bus of the generators should also be estimated (refer **Part F)**.

C.8 The peak demand forecast of a Discom/State should be derived from the energy requirement figure by applying appropriate load factor as explained in **Part G**.

C.9 The forecast under BAU scenario should be derived first and based on that, forecasting under other scenarios should be done. A broad list of the parameters which may be considered for creating different forecasting scenarios is given in **Annexure III**.

C.10 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.

C.11 The basic concept and a simple approach for factoring in weather parameters are discussed in **Annexure-IV** which could be adopted in forecasting power demand. Advanced statistical tools like Multivariate Regression Analysis should also be used for this purpose.

Box C.3: For arriving at power demand inclusive of CPPs, as the energy exported by CPPs to grid is already accounted for in respective Discom/State consumptions, the growth trend of self-consumption of CPPs (i.e. Net Generation – Energy Exported to the grid) only should be analysed and added separately.

D: Impact of Emerging Aspects:

D.1 The impact of emerging aspects should be quantified in sync with the targets set by the government. In case of non-availability of any target, suitable assumptions should be taken that should be spelled out clearly.

D.2 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.

Box D.1: 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. Estimating expected monthly/daily/hourly/time-block wise impact profile due to an emerging aspect could be one way to achieve this purpose. For example, solar roof top impact profile could be similar to any solar power generation project profile of the concerned geographical area. Another example is the impact of green hydrogen production which could have a straight line profile throughout the year.

D.3 As far as possible, the impact of the emerging effects should be apportioned to the corresponding pre-defined consumption categories only (For example, Electric Vehicle penetration could impact domestic and commercial consumptions, Green Hydrogen production could impact Industrial consumption, Solar pump penetration could impact irrigational consumption). In absence of any such suitable category, a new category could be created if the impact is substantial. Otherwise, it could be clubbed in "Others" category.

(Note: The methodology adopted during 20th EPS for assessing impact of electric vehicles on energy demand is given in **Annexure-V** for reference).

E. Electrical Energy Requirement of a Discom:

E.1 The total electrical energy requirement of a Discom should be worked out by adding its Distribution losses & Intra-State Transmission losses attributed to that particular Discom to its total category wise electrical energy consumption.

Box E.1: 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.

E.2 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.

E.3 Intra State Transmission losses for the whole state should be apportioned to each Discom in the ratio of their respective energy requirement (i.e. Energy Consumption + Distribution losses) if more than one Discom is present in any state.

Box E.2: For the purpose of calculating % T&D losses, the open access consumption and unserved demand should be subtracted from the Discom's consumption. Afterward, based on % losses, the T&D losses in energy terms should be calculated on the total consumption including open access consumption.

F. Electrical Energy Requirement of a State:

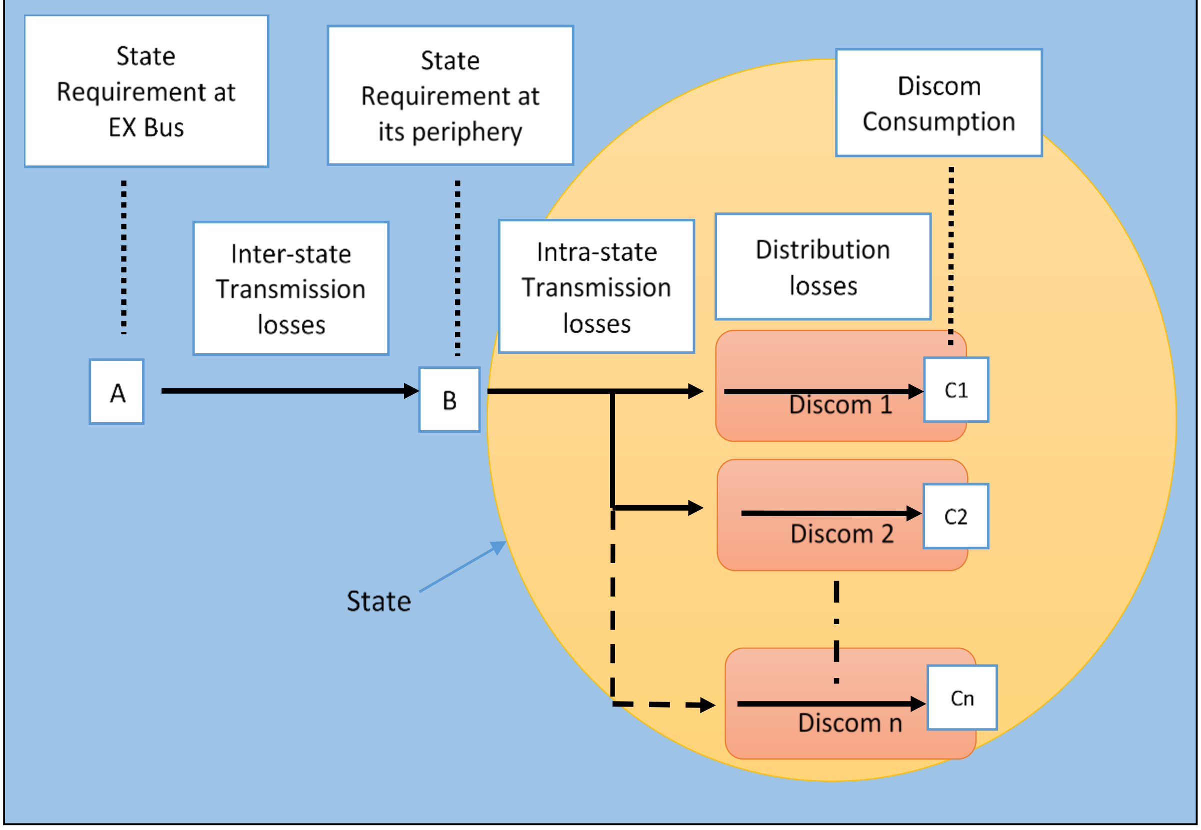
F.1 Electrical energy requirement of a State at its periphery should be worked out by summing up the T&D losses of its each Discom and adding it to the electrical energy consumption of the state.

F.2 Electrical energy consumption of a State should be worked out by summing up electrical energy consumption of all its Discoms.

Box F.1: Open Access consumptions should be added at state level consumption additionally if Discoms had not accounted for such energy at their level. In such case, the state transmission losses applicable on quantum of open access consumption should also be added additionally to arrive at total T&D loss figure of the state.

F.3 The energy requirement of a state incident upon the Ex-Bus of the generators should be arrived at by adding the inter-state transmission losses to the electrical energy requirement of the state at its periphery.

Box F.2: Concept of factoring in T&D losses in Energy Requirement



F.4 The inter-state transmission losses should be calculated by multiplying such losses in % term calculated by GRID-INDIA at the national level with the electrical energy the states are expected to import from the national grid which in turn should be based on the ratio of the energy the states had imported against their energy requirement in past.

G. Peak Demand:

G.1 The peak demand forecast of a Discom/State should be derived from the energy requirement by applying appropriate load factor.

G.2 The Load Factor is calculated by dividing total electrical energy requirement for a given period of time by the product of maximum demand and that specific period of time. The formulae for calculating load factor on monthly and yearly basis are:

*Monthly Load Factor (in %) = (Energy Requirement in MU *100) / (Peak Demand in MW * No. of days in the Month * No. of hours in a day).*

*Yearly Load Factor (in %) = (Energy Requirement in MU *100) / (Peak Demand in MW * No. of days in the year * No. of hours in a day).*

G.3 The appropriate load factors in the upcoming years should be estimated on its past trend. However, any expected change in specific consumer mix should also be accounted for. For example, in case of increase in industrial consumption share, an increase in load factor could be expected.

G.4 If the pattern of specific consumer mix is expected to differ from the past, the expected load factor should be derived by examining load factors of other Discoms with similar consumer mix.

G.5 If the pattern of specific consumer mix is not expected to differ appreciably from the past, then it should be assumed that the load factor trend observed in the past may continue.

G.6 Peak electricity demand of the state should be estimated by applying suitable diversity factor, as per the past trends, to the sum of peak electricity demand of its all Discoms. The diversity factor within a state for peak demand should be calculated as -

Diversity factor = Sum of Peak Demand of Individual Discoms in a State/ Peak demand of State.

H. General Checks & Balances

i. The Load Factor of a Discom/state should not be more than 1. The Load Factors for the Discoms/States were observed in the range of 40% to 80% in the past.

ii. If the system feeds block industrial loads like aluminium and other process industries etc. having high electric load factor, the overall system load factor should ideally be high.

iii. Diversity factor of the peak demand of a state calculated on the peak demand of its each Discom should be more than 1. Otherwise, it indicates wrong reporting of peak demand by any/all of the Discom or some loads are being missed in overall calculation. The typical range of diversity factors observed in the past is given in the table below. The states are expected to witness lower diversity factors than their respective region.

Northern Region	Western Region	Southern Region	Eastern Region	North Eastern Region	All India
1.13	1.09	1.05	1.07	1.07	1.13

iv. T&D losses of a state (excluding Inter State Transmission Loss component) should be equal to the sum of T&D losses of all its Discoms.

v. Every consumption should be accounted for. Examples of some consumptions observed to be left out by the Discoms/States in their consumptions are –

a) Small Discoms
b) Franchisees
c) Temporary connection category

d) Special categories (ex- Center-State Category in Jammu & Kashmir) etc.

vi. The possibility of double accounting of any energy across the concerned utilities should be checked and rectified. Some examples of double accounting observed in case of –

a) Creation of new States/Discoms
b) Merging of tariff slabs
c) Franchisees reflected in Bulk Supply Category
d) DVC (accounted in West Bengal as well as in Jharkhand).

vii. The consistency of the input data for energy requirement should be cross checked from demand as well as from supply side. For a state, the energy requirement met at its periphery should be equal to total net generation within the state from all sources feeding to the grid plus its net import from outside the state.

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Annexure-I

Input Data Format

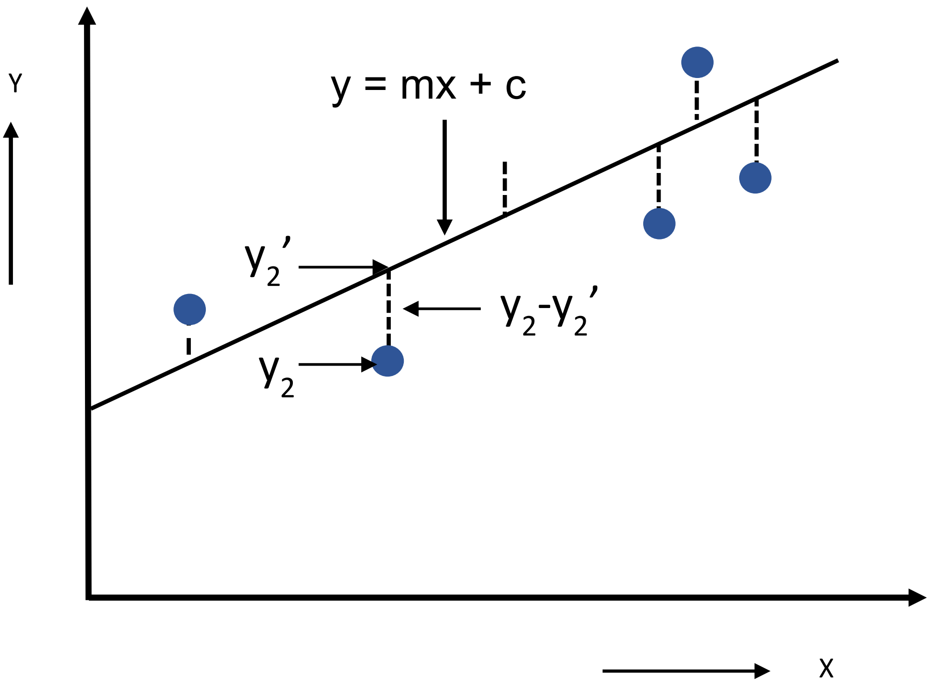
	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Energy Consumption (in MU)											
1. Domestic											
2. Commercial											
3. Public lighting											
4. Public Water Works											
5. Irrigation											
6. LT Industries											
7. HT Industries											
8. Railway Traction											
9. Bulk Supply											
10. Open Access											
11. Others											
Total (Energy Consumption)											
T&D losses -MU											
T&D losses -in %											
Energy Requirement - MU											
Annual Load Factor - %											
Peak Load - MW											

Annexure-II

Least Square Method & Weighted Average Method

Least Square Method:

The least square method is used to find the best fitted linear curve for a set of data points by minimizing the sum of the squares of the offsets (residual part) of the points from the curve.



$$\text{Least Square Method} = \text{Minimize } \left(\sum_{i=1}^{n}(y_i - y_i')^2\right)$$

The slope (m) and y intercept(c) of the best fitted straight line are estimated in Microsoft Excel through the following formulae:

m = INDEX(LINEST(y_known), 1)

c= INDEX(LINEST(y_known),2)

Where y_known = range of dependent y values

For finding out the yearly energy consumption trend, the y axis may represent the energy consumption (i.e. y_known) whereas x axis may denote years. A calculation example is given below:

	Sl. No.	Year	Energy Requirement (in MU)	slope(m)	Y-Intercept (c)
INPUT	1	2020-21	100		
DATA	2	2021-22	110		
	3	2022-23	122		
	4	2023-24	135		
	5	2024-25	148		
	6	2025-26	160	=INDEX(LINEST(E4:E9),1)	=INDEX(LINEST(E4:E9),2)
FORECAST	7	2026-27	=$F$9*C10+$G$9		
	8	2027-28	=$F$9*C11+$G$9		

Value = 12.2

Value = 86.47

Value = 172

Value = 184

Weighted Average Method:

In the Weighted Average Method, the quantities which are needed to be averaged are assigned weight first as per their importance and then their average is calculated. The formula for weighted average is -

Weighted Average = ∑ (Weights x Quantities)/∑Weights

An example of using weighted average method in Microsoft Excel is given below wherein more weights are assigned to recent year data:

	Year	Energy Requirement (in MU)	Annual Growth Rate (in %)	Weight	Annual Growth Rate x Weight	Weighted Average Growth Rate (in %)
INPUT	2020-21	100				
DATA	2021-22	110	10.00	1	10.00	
	2022-23	122	10.91	2	21.82	
	2023-24	135	10.66	3	31.97	
	2024-25	148	9.63	4	38.52	
	2025-26	160	8.11	5	40.54	
FORECAST	2026-27	175		**15**	**142.84**	**9.52**
	2027-28	192				

Sum of Weights

Sum of Average Growth Rate X Weight

	A	B	C	D	E	F	G	H
1								
2								
3			Year	Energy Requirement (in MU)	Annual Growth Rate (in %)	Weight	Annual Growth Rate x Weight	Weighted Average Growth Rate (in %)
4		INPUT	2020-21	100				
5		DATA	2021-22	110	=((D5/D4)-1)*100	1	=E5*F5	
6			2022-23	122	=((D6/D5)-1)*100	2	=E6*F6	
7			2023-24	135	=((D7/D6)-1)*100	3	=E7*F7	
8			2024-25	148	=((D8/D7)-1)*100	4	=E8*F8	
9			2025-26	160	=((D9/D8)-1)*100	5	=E9*F9	
10		FORECAST	2026-27	=D9*(1+$H$10/100)		=SUM(F5:F9)	=SUM(G5:G9)	=G10/F10
11			2027-28	=D10*(1+$H$10/100)				
12								
13						Sum of Weights	Sum of Average Growth Rate X Weight	
14								

<u>Selection of the method – A hybrid approach:</u>

1. If minor difference is observed in the two aforementioned growth rates for any category of data, the growth rate arrived through least square method should be considered as the future growth rate.
2. In case of appreciable deviations between the two growth rates, causes of deviations in the later year's data should be examined thoroughly.
3. If deviation between the two growth rates is driven by sudden policy/developmental changes (ex – Metro rail) or technological changes (ex. LED in public lighting) in the later years, then also, the future growth rates should be taken as the growth rate arrived through least square method.
4. If causes of deviation between the two growth rates are not identifiable or it appears that such deviation is occurring due to natural development, then the future growth rates should be taken as per the growth rate arrived through the weighted average method.

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Annexure-III

Parameters need to be considered for the different forecasting scenarios:

Parameters	**Optimistic Scenario**	**Business As Usual Scenario**	**Pessimistic Scenario**
Partial End Use Method:			
Government Targets	Full Achievement	Realistic Assessment	Pessimistic Assessment
Weather	factoring extreme weather conditions driving power demand upwards such as lesser rainfall.	Normal weather conditions (weather parameters need not required to be factored in separately).	factoring extreme weather conditions driving power demand downwards such as heavy rainfall.
T&D losses trajectory	Liberal	Moderate	Aggressive
Energy Efficiency	Liberal	Moderate	Aggressive
Additional Parameter for Econometric Method:			
Gross Domestic Product (GDP)/Gross State Domestic Product (GSDP)	Maximum GDP/GSDP growth projected by reputed agencies such as Reserve Bank of India.	Average GDP/GSDP growth in the past.	Minimum GDP/GSDP growth projected by reputed agencies such as Reserve Bank of India.

Annexure-IV

Impact of Weather Conditions on Power Demand Forecast

The electricity demand is dependent on weather conditions also. In the traditional Partial End Use Method (PEUM), weather parameters are not considered separately as such factors are assumed inherent in the time series past energy consumption data. However, weather parameters could be considered separately while developing more than one forecasting scenario such as -

a) Business As Usual (BAU) Scenario – Normal weather conditions (weather parameters need not required to be factored in separately).
b) Optimistic scenarios - factoring extreme weather conditions driving power demand upwards such as lesser rainfall.
c) Pessimistic scenarios - factoring extreme weather conditions driving power demand downwards such as heavy rainfall.

Note – More scenarios could also be built up considering different permutations and combinations of extreme (favourable or harsh) weather conditions. Some typical such scenarios could be – (i) extreme hot temperature scenario only (ii) extreme cold temperature scenario only (iii) higher rainfall scenario only (iv) lesser rainfall scenario only (v) extreme hot temperature and lesser rainfall scenario.

The weather conditions could be analysed on two main parameters viz. Temperature and Rainfall. The extreme condition of weather in terms of temperature could be analysed with degree day approach as explained below:

i. Yearly HDDs/CDDs represent the number of days in a year on which the temperature is respectively below/above the threshold cooling /heating point and by how many degrees. The threshold is a point over or under which the heating or cooling appliances are expected to be switched on. HDD, CDD and threshold points are all measured in degree Celsius.

ii. Yearly HDDs/CDDs figures could be arrived at by analysing CDD for each day of summer season and HDD for each day of winter season by using the following formulae:

HDD_d = Heating Degree Day = Max (0, T – T)*
CDD_d = Cooling Degree Day Max (0, Tt – T)

Where,

T = Threshold Temperature of cold and heat. As it could vary from place to place, its appropriate value as per specific geographical areas should be ascertained. The threshold temperature for India was assumed 21°C during 19th EPS based on literature review.*

T = Average Temperature Observed during the day.

Note – Based on the climatic conditions of a specific geographical region, only one of dominant parameters (HDDs or CDDs) could also be analysed leaving out the other non-applicable parameter. For example, power demand is more dependent on CDDs in the most parts of India except for the hilly regions where HDD plays the major role.

iii. HDD and CDD values of each day could be further summed up to arrive at yearly HDD & CDD values respectively.

$$HDD_Y = \sum HDD_d$$
$$CDD_Y = \sum CDD_d$$

iv. The extreme weather year could be identified as:

a. Year with extreme unfavourable weather conditions = Year with maximum values of HDD_Y & CDD_Y.
b. Year with extreme favourable weather conditions = Year with minimum values of HDD_Y & CDD_Y.

v. Once the extreme weather condition year is identified, impact on Power Demand is estimated as:

a. The normal growth rate till the extreme year is calculated and it is applied to the immediate last year data to arrive at notional energy demand during the extreme weather year. This could be the demand likely to be observed in absence of extreme weather conditions in that particular year.

b. The impact of extreme weather conditions on power demand is estimated by calculating % deviation of the notional demand from the actual demand observed during the year.

c. This % deviation is then applied on the Business As Usual energy requirement forecast to arrive at optimistic and pessimistic scenarios.

Similar approach could be adopted to identify other extreme weather conditions (highest and lowest rainfall years) and to assess their impact on power demand. Also, the approach discussed above, although, is for estimating forecasts on yearly basis, the same approach could also be extended at more granular level to analyse the month/day wise impact.

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Annexure-V

Electric Vehicle – Impact on Power Demand

The assumptions and the methodologies adopted for assessing impact of electric vehicles on all India power demand during 20th EPS were as follows:

Assumptions:

i. Weighted Average annual growth of vehicles sold for last 20 years (i.e. 2001-02 to 2020-21) was calculated as 5% and the same growth rate was assumed for future.
ii. Any vehicle sold would be de-registered after 15 years.
iii. By 2030, 30% of total vehicle sales would be BEVs as per the projection made by NITI Aayog.
iv. The vehicles considered in two segments with the following parameters:

Type	Efficiency (in Wh/km)	Avg Km Travel in a Year	Charging Time (in Hrs)	Ratio of Vehicle charged in Night
2 Wheeler	33	12800	4	0.3
4 Wheeler	96.8	12000	8	0.7

Methodology:

i. The total vehicle sales (including EV sales) in 2021-22 were estimated as 1.95 crores.
ii. The total vehicle sale by 2029-30 was estimated by applying 5% annual growth rate on 1.95 crores vehicles sold during 2021-22 and it was assumed that 30% of those would be EVs.
iii. The base value of electric vehicles sold was assumed as total number of registered EVs estimated by 2021-22 i.e. 10.5 lakhs.
iv. Based on the above assumptions, CAGR for EV sales was calculated for the period of 2021-22 to 2029-30.
v. Based on CAGR thus calculated, year wise expected EV sales were estimated for the period of 2021-22 to 2029-30.
vi. Energy Requirement is calculated as (Total number of vehicles on road*Efficiency * Average Km Travel in a Year).
vii. Peak Demand in MW is calculated as ((Energy Requirement in MU * 1000)/ (Charging Time*365)).

Based on the above assumptions and the methodologies adopted, the following results have been obtained:

- For FY 2029-30 -
  - BEV sale – 71 lakhs.
  - Total BEV on Road – 2.9 crores.
  - EV share out of all vehicles – 8.7% of all vehicles.
  - Energy Requirement – 15 BU.
  - Peak Demand - 3 GW.

The following methodologies were adopted for apportioning All India energy requirement to the States & Discoms on account of EVs:

i. The additional energy requirement was apportioned among various states in the ratio of number of vehicles registered in 2018-19.

ii. It is assumed that the additional energy requirement would be incident on two categories viz. Domestic and Commercial, in the ratio of 70:30.

iii. The additional energy requirement for a state was apportioned among various Discoms as –

   a. For each Discom, the ratio of their total energy requirement for domestic and commercial categories out of state's total energy requirement for domestic and commercial categories was calculated.

   b. EV Energy requirement of the state was distributed among Discoms in their respective ratio of total energy requirement for domestic and commercial categories.

   c. Then, EV Energy requirement of a Discom was distributed into domestic and commercial categories in the ratio of 70:30.

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