Procedure for Resource Adequacy Assessment

(To be Part of NLDC Operating Procedure)

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Need for Resource Planning

- To ensure sufficient electricity to power the growing economy of country.
- Generation and transmission capacity is to be added timely at a pace matching the growth in demand and in fact slightly ahead of the demand; so that the shortage of electricity does not slow down growth.
- Optimal capacity mix to meet the projected demand at minimum cost.

Background

- Clause 16.4 of the Electricity (Amendment) Rules, 2022 notified by Government of India, Ministry of Power:

  "The National Load Dispatch Centre and the Regional Load Dispatch Centres shall carry out assessments of resource adequacy, for operational planning, at the national and regional levels, respectively, on an annual basis, in accordance with the guidelines issued by the Central Government"

- Clause 5.3 of the Indian Electricity Grid Code, 2023 notified by the Central Electricity Regulatory Commission:

  "NLDC shall carry out a simulation, to assist the States in drawing their optimal generation resource adequacy plan. While carrying out the simulation, NLDC shall also take into consideration the information related to demand estimation, generation planning and related matters as available with CEA"

- Clause 3.2 of Section-3 of CEA Guidelines for Resource Adequacy:

  "NLDC shall annually publish a one-year look-ahead Short-term National Resource Adequacy Plan…"

Procedure	Uploaded on	Comments invited by	Stakeholder Consultation held on
Resource Adequacy Assessment	11th September 2023	20th September 2023	18th September 2023

Stakeholder suggestions/feedback on this draft procedure are invited at operatingprocedure@grid-india.in by **20th September 2023.**

Link of the procedure: https://posoco.in/wp-content/uploads/2023/09/Draft-Procedure-Resource-Adequacy-and-Operational-Planning.pdf

Objective

The objective of this procedure is to describe the methodology adopted by NLDC for national level simulation for assessing generation resource adequacy and one year look ahead operational planning

Roles of NLDC, RLDC and SLDCs

NLDC in consultation with RLDCs shall annually publish a one-year look-ahead Short-term National Resource Adequacy Plan (ST-NRAP) for the subsequent financial year to assist the States in drawing their optimal generation resource adequacy plan

STUs/SLDCs, ISTS connected Bulk Consumers or such other agency as may be designated by the State Commission shall furnish data in the stipulated formats to the RLDC/NLDC for preparing the Short-term National Resource Adequacy Plan

The STUs/SLDCs, ISTS connected Bulk Consumers or such other agency as may be designated by the State Commission shall submit the details of their contracted capacities to the respective RLDC for the ensuing year for meeting Resource Adequacy Requirement for national peak as assessed by NLDC.

The RLDCs shall aggregate the capacities assessed at the regional level and submit the information to the NLDC. NLDC shall aggregate the capacities at the national level and check compliance with ST-NRAP and identify shortfall for the ensuing financial year, if any.

Submission of Technical data

The data described in further slides shall need to be submitted by

i. STUs/SLDCs or such other agency as may be designated by the State Commission

ii. Inter-state Transmission Licensees

iii. Regional Entity Generating Stations or ISTS Connected Bulk Consumers, as applicable, by 30th April for the ensuing financial year.

(**Illustration**: For operational analysis for ensuing year, i.e. FY 2024-25, the responsible agency shall submit the specified data by 30th April 2023)

Submission of Technical data … (1)

Electricity Demand Data (as per format RA-1)

i. Forecasted hourly demand (MW) for the ensuing year .

ii. Estimated month wise instantaneous peak demand (MW) for both solar & non-solar hours.

iii. Monthly energy consumption (MU) of the control area for the ensuing year.

(Illustrations: If operational analysis is to be done for year 2024-25, then SLDCs have to submit data of load forecast for year 2024-25)

If the forecast data is not furnished by concerned agencies, then RLDC in consultation with SLDC shall estimate the demand of states using historical data available at NLDC/RLDC and submit the data to implementing committee at NLDC.

Submission of Technical data … (2)

Reserve Requirement (as per format RA-2)

Reserve requirement of each hour (in MW) for each state to be considered for the ensuing year

State	Year (2024-25)	Reserve Name	Type [spinning, non-spinning]	Requirement (MW)

Submission of Technical data … (3)

Tie Line Details (as per format RA-3)

i. Existing interstate tie lines between states and external systems with the capacities.

ii. Planned tie lines: The planned interstate tie lines between states and external systems anticipated to be commissioned in the in the ensuing year with design capacity.

iii. Annual outage plan of the existing transmission lines for the ensuing year.

Submission of Technical data … (4)

Transfer Capability (as per format RA-4)

The available transfer capability of the respective states for each month of the ensuing year.

State	Month	Import ATC (MW)	Export ATC (MW)

Submission of Technical data … (5)

Generation Data (as per format RA-5)

i. Technical parameters of present conventional generation plants viz. Name of plant, location (State/Region), Maximum Continuous Rating (MW), Auxiliary Consumption (% of MCR), Maximum and Minimum Generation Limits (MW), Ramp Up and Ramp Down Rate (% of IC/min), Minimum up and down time, etc.

ii. Fixed costs, variable costs, start up and shut down Cost of generators, etc.

iii. Historical forced outage rates of generators/units for conventional stations

iv. Planned maintenance rates of generators/units for conventional station

v. Hydro generation technical parameters viz. Capacity (MW), Efficiency, Upper and lower storage volume, or limits, pumping load (MW), Pumping Efficiency etc.

vi. Capacities and hourly generation profile of renewable and hydro generation.

vii. New generation capacity expected to be commissioned and generation capacity expected to retire for the concerned year under study.

Methodology of Short-term National Resource Adequacy Plan (ST-NRAP)

- The input data as mentioned in previous slides shall be collated at the regional and national level. NLDC shall also take into consideration the information related to demand estimation, generation planning and related matters as available with CEA for carrying out simulations for resource adequacy assessment.
- The forecasted hourly demand shall be used as input into the model. It shall be endeavored that the resource adequacy model is capable of simulating all 8760 hours in a year.
- After establishment of demand profile for the future year, the model would stack the available generation resources for meeting the forecasted demand and operating reserve requirement in all study periods.
- This exercise shall be repeated for multiple scenarios so as to capture the uncertainty in demand forecast, RE Generation and forced outages of generating units. A suitable approach shall be adopted to generate probable demand profiles, RE profiles, and forced outage patterns, which would then be fed into the model.

Constraints … (1)

- **Portfolio balance constraints**: The portfolio balance constraints ensure that the total generation within a region/state and the import of power to the region/state is equal to the sum of the demand, the exports from the region/state, any energy not served and curtailment, for each hour.
- **Transfer Capability**: The power flow between states or regions is limited by the available transfer capability of the respective states or regions.
- **Storage constraints:** Storage charge and discharge at any instant are constrained by the storage level or the state of charge (SoC) of the storage resource, and the maximum charge / discharge limit.
- **Operating Reserve constraints:** Operating reserve constraints ensure that enough resources are in the system and kept online or on standby each hour to account for load forecast errors, intermittency of renewables or meeting contingencies in the real time.
- **Renewable/Storage purchase obligation:** Fulfilment of Renewable/Storage purchase obligation should be considered as one of the constraints of Resource Adequacy studies.

Constraints … (2)

- **Generation constraints**:
  - The thermal resources are bound by constraints such maximum and minimum generation limits, ramp rates, spinning reserve offers and plant availability etc.
  - The hydro based resources are bound by the generation limits, storage capacity etc.
  - The dispatch (energy offer) plus the reserve offer (specified through regulations) for each generator is constrained to be within the maximum and minimum generation limits.
  - Generation between two consecutive time blocks also must be within the ramping capabilities of the resources.
  - Unit commitment decisions, such as start-up/shut-down, minimum up and down times, etc.,
  - Generation units will have periods of outages which will need to be captured by using an availability factor.
  - The capacity for each year needs to be tracked by a constraint which ensures that the capacity available on a particular day in a year is equal to the capacity available on previous day plus any new capacity investment minus any capacity retirement.

Output

- The periods where the available All India generation is inadequate to meet the All-India demand (including operating reserves) shall be identified along with the quantum of shortfall.
- Based on the resource adequacy study outcome across different possible scenarios, the model shall compute the following parameters:
  - Loss of Load Probability (LOLP)
  - Loss of Load Expectation (LOLE)
  - Expected Energy Not Served (EENS)
  - Normalised Energy Not Served (NENS)

Compliance Monitoring

- The SLDCs shall submit the details of the contracted capacities for the ensuing financial year for meeting Resource Adequacy Requirement (RAR) of the national peak to the respective RLDC by 15th February.
- The RLDCs shall aggregate the capacities at the regional level and submit the information to the NLDC by 28th February.
- NLDC shall aggregate the capacities at the national level and check compliance with ST-NRAP by 15th March and identify shortfall for the ensuing financial year, if any.

Information Dissemination

- NLDC shall annually publish a one-year look-ahead Short-term National Resource Adequacy Plan (ST-NRAP) on its website by 31st July for the ensuing financial year.
- NLDC shall publish the details of any short fall in capacities based on contracted capacities received from SLDCs on its website by 15th March.

Summary of Timeline

- Timeline for the ST-NRAP implementation for year 2024 - 25 is shown as below:
  - 30th April 23: Submission of data by STUs/SLDCs/Bulk Consumers or such other agency as may be designated by the State Commission in format RA-1, RA-2, RA-3, RA-4 & RA-5.
  - 31st July 23: NLDC would publish a Short-term National Resource Adequacy Plan
  - 15th February 24: SLDCs shall submit the details of the contracted capacities for meeting RAR of national peak to the respective RLDC
  - 28th February 24: RLDCs shall aggregate the capacities at the regional level and submit the information to the NLDC
  - 15th March 24: NLDC shall publish the details of any short fall in capacities based on contracted capacities received from SLDCs

Thank you !!

Format RA-1:
Load forecast during Horizon of analysis

State	Year(2024-25)	Energy [GWh]	Peak [MW]
State A	April 2024	.....	.....
State A	May 2024	.....	.....
.....	.....	.....	.....

State	Date & Time	Load (MW)
State A	01-04-2024 00:00	.....
State A	01-04-2024 01:00	.....
State A	01-04-2024 02:00	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....
State A	31-03-2025 23:00	.....
State A	31-03-2025 24:00	.....

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Format RA-3:

1. **Existing Tie Transmission Lines:**

State From	State To	Capacity (MW)	Voltage level [kV]	Resistance (pu)	Reactance (pu)	Thermal Loading Limit

Format RA-3:

2. Tie Transmission Lines expected to be commissioned in the period under study

State From	State To	Capacity (MW)	Voltage level [kV]	Resistance (pu)	Reactance (pu)	Commissioning Date

Format RA-3:

3. Annual Outage Plan of existing transmission lines

State From	State To	Outage Start Date	Outage end Date

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Format RA-5:

1. **Existing and Planned conventional generators Parameters:**

Production													
State	Plant Name	Unit No	Max Capacity (MW)	Aux consumption (% of IC)	Min Stable Level (MW) - min level for continuous operation	Heat Rate (kcal/kWh)	Fuel Type (e.g. coal, oil, gas, nuclear, biomass etc.)	Variable Charge (Rs/ MWh)	Fixed Charge (Rs/MW/year)	Max Ramp Up Rate (% of IC/min)	Max Ramp Down Rate (% of IC/min)	Run Up Rate [MW/ min]	Run Down Rate [MW/ min]

Production								Expansion		
Start Cost/ Shut down cost (Rs) (for Hot, Warm and Cold Start)	Min Up time (hrs)	Min Down time (hrs)	Planned Maintenance rate [%]	Forced Outage Rate [%]	Mean Time to Repair (hrs)	Details of GT and ST Combinations (for gas based units)	Dispatchable/Non-Dispatchable	Commissioning Date (planned)	Decommissioning Date (for both existing unit and planned unit)	Fixed Charge (Rs/kW/year) (If applicable)

Format RA-5:

2. **Existing and Planned Hydro (DAM, Run of river, and Pump Storage) Generator Parameters**

Production													
State	Station Name	Unit No	Type [Storage/RUN OF RIVER/PUMP STORAGE]	Upper Reservoir Name	Lower Reservoir Name (For Pump Storage only)	Max Capacity (MW)	Efficiency	Upper Reservoir Max Volume (GWh)	Lower Reservoir Max Volume (GWh) (For Pump storage only)	Upper Reservoir Min Volume (GWh)	Lower Reservoir Min Volume (GWh) (For Pump storage only)	Pump load (MW) (For Pump storage only)	Pump Efficiency (For Pump storage only)

Production			Expansion		
Variable Charge (Rs/MWh)	Dispatchable/ Non-Dispatchable	Energy Limits (Yearly, Monthly, Weekly, Daily – as applicable)	Fixed Charge (Rs/MW/year) (If applicable)	Commissioning Date	Decommissioning Date (for both existing unit and planned unit)

Format RA-5:

Historic Generation Profile of Hydro Plants for last 5 years

Plant Name	Date & Time	Generation (MW)
Plant B	01-04-2018 00:00	.....
Plant B	01-04-2018 01:00	.....
Plant B	01-04-2018 02:00	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....
Plant B	31-03-2023 22:00	.....
Plant B	31-03-2023 23:00	.....

Format RA-5:

3. **Existing and Planned Renewable Plants:**

Production					Expansion	
State	Renewable Plant Name	Type [PV/Wind/Hybrid]	Max Capacity (MW)	Fixed Charge (Rs/MW/year) (If applicable)	Commissioning Date	Decommissioning Date (for both existing unit and planned unit)

Renewable historic generation profiles for last five years

Name	Datetime	Available Capacity (MW)	PV/ Wind Generation profile (MW)	Curtailed quantum (MW)
	01-01-2018 00:00			
	01-01-2018 01:00			
	01-01-2018 02:00			
	01-01-2018 03:00			
	.....			
	.....			
	31-03-2023 23:00			
	31-03-2023 24:00			

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