

Resource Adequacy Framework

By: Central Electricity Authority

Policy Framework

- ✓ MoP has notified Electricity (Amendment) Rules, 2022 on 29.12.2022

Rule 16:

- ***Resource Adequacy Guidelines*** for assessment of resource adequacy during the generation planning stage (one year or beyond) as well as during the operational planning stage (up to one year) shall be issued by the Central Government in consultation with the Authority, within six months from the date of commencement of these rules. - **Final Guidelines issued on 28th June 2023.**
- State Commission shall ***frame regulations*** on resource adequacy, in accordance with the ***guidelines*** issued by the Central Government, the ***distribution licensees*** shall formulate the ***resource adequacy plan*** in accordance with these Regulations and ***seek approval of the Commission***
- The ***National Load Dispatch Centre and the Regional Load Dispatch Centers*** shall carry out assessments of resource adequacy, for ***operational planning, at the national and regional levels***, respectively, on an annual basis

Policy Framework

- The **State Commission** may determine **non-compliance charges** for failure to comply with the resource adequacy target approved by the Commission.
- The **State Load Dispatch Centre** shall carry out assessments of resource adequacy, for **operational planning, at the state level**, in consultation with all the concerned stakeholders on an annual basis ,in accordance with the guidelines issued by the Central Government and the directions of the State Commission.
- The State Load Dispatch Centre **shall review** the **operational resource adequacy** on a daily, monthly and quarterly basis

Role of CEA

- Publish Long Term National Resource Adequacy Plan (LT-NRAP) for 10 years containing the following:
 - National Level PRM and reliability indices
 - Share of State in National Peak Demand
 - Capacity credit of all generation technologies
 - Optimal Generation Mix at national level
- LT-NRAP shall be revised annually
- Vetting of state specific LT-DRAP for all states

Role of NLDC

- To Publish **Short Term** National Resource Adequacy Plan (ST-NRAP) for one year considering the following :-
 - **Reserves** (Primary, Secondary and Tertiary) in the Grid for grid security
 - **Planned maintenance schedules** of existing stations
 - Station-wise historic **forced outage** rates
 - Resource Availability based on **new projects**
 - Decommissioning plans, if any.

Role of Distribution Utility

- Long-term Distribution licensee Resource Adequacy Plan (LT-DRAP) (on annual rolling basis) for 10 year for:
 - Meet the *peak demand and energy requirement* of the Discoms along with the RPO Obligations
 - Meeting *contribution towards national peak* with PRM
 - Adhering Reliability norms
- LT-DRAP shall be vetted by CEA and submitted to State Commission for approval
- Demonstrate 100% tie-up for the first year and min 90% tie-up for the second year to meet their contribution towards national peak.
- To submit the details of contracted capacities to the respective STU/SLDC after the approval of State Commission.

Role of STU/SLDC

- To provide the following inputs for formulation of LT-NRAP:-
 - Hourly demand (15 minute time block wise)
 - Hourly demand forecasts for the next 10 years
 - Availability from the existing/contracted generation resources
 - Any other inputs required for national RA plan
- Aggregate the total contracted capacities at the state level and submit the information to the respective RLDC.
- RLDCs shall aggregate the capacities at Regional Level and submit to NLDC
- SLDC shall carry out assessments of resource adequacy, for operational planning, at the state level
- Review the ST-DRAP on a daily, monthly and quarterly basis based on actual availability of generation resources.

Role of and SERCs

- SERCs to timely approve the LT-DRAP and contracted capacities of DISCOMs
- Monitoring of RA by SERCs

Judicious mix of Long, Medium and Short-Term Contracts

Type of Contract	Meeting Distribution Licensee Contribution in national Peak	Distribution licensee own peak and electricity requirement
Long-Term	75-80%	>75%
Medium-Term	10-20%	10-20%
Short-Term	0-15*%	0-15%

* Power procurement through the power exchanges, such as the Day-Ahead Market segment, shall not be considered

Timely Procurement of Resources

- The distribution licensee must ensure that procurement process for the projected demand is undertaken and completed sufficiently in advance to ensure its availability for meeting the demand.

Resource	Long Term	Medium Term
Coal/Lignite Based Capacity	7	2
Hydro	9	2
Solar	2	1
Wind	3	1
PSP	5	3
Other Storage	2	1
Nuclear	9	3

Key Design Parameters

➤ Reliability Indices

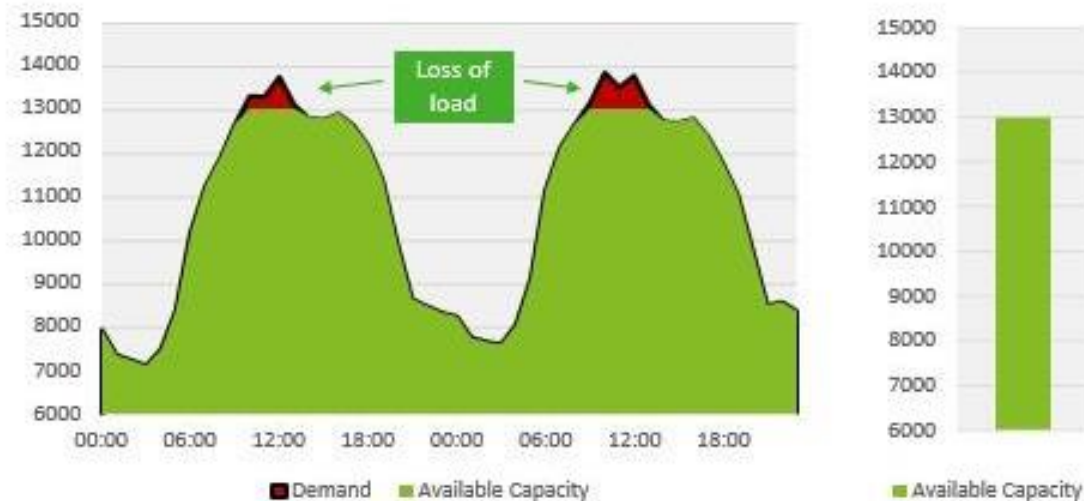
- Loss of Load Probability (LOLP)
- Expected Energy Not Served (EENS) and Normalised ENS (NENS)

➤ Planning Reserve Margin- Sufficient Reserve margins are required for adequately addressing the demand and supply variations to meet reliability criteria.

- PRM is expressed as a certain % of peak load of the system.

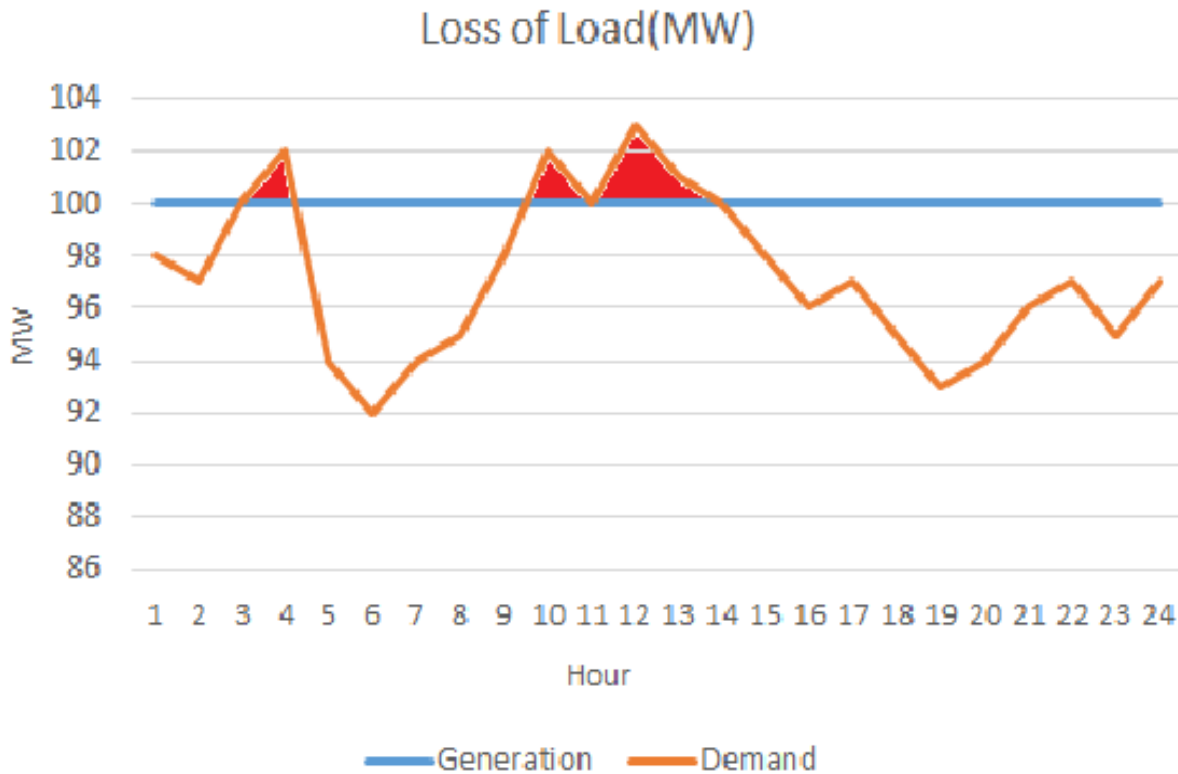
Loss of Load Probability

- Measure of the probability that a system's load may exceed the available generation to meet the load in a year.



- The LOLP value adopted by CEA for the purposes of the National Electricity Plan (NEP) is 0.2%

CALCULATION of LOLP and NENS



Hours of Lost Load (A)	4	LoLP = A / B	LoLP =16.67 %
Hours in a Day (B)	24		
Quantum of Lost Load (MWh) (C)	8	NENS = C/D	NENS= 0.34%
Total Demand (MWh) (D)	2334		

The sample calculation shown is for LoLP and NENS on a daily basis.

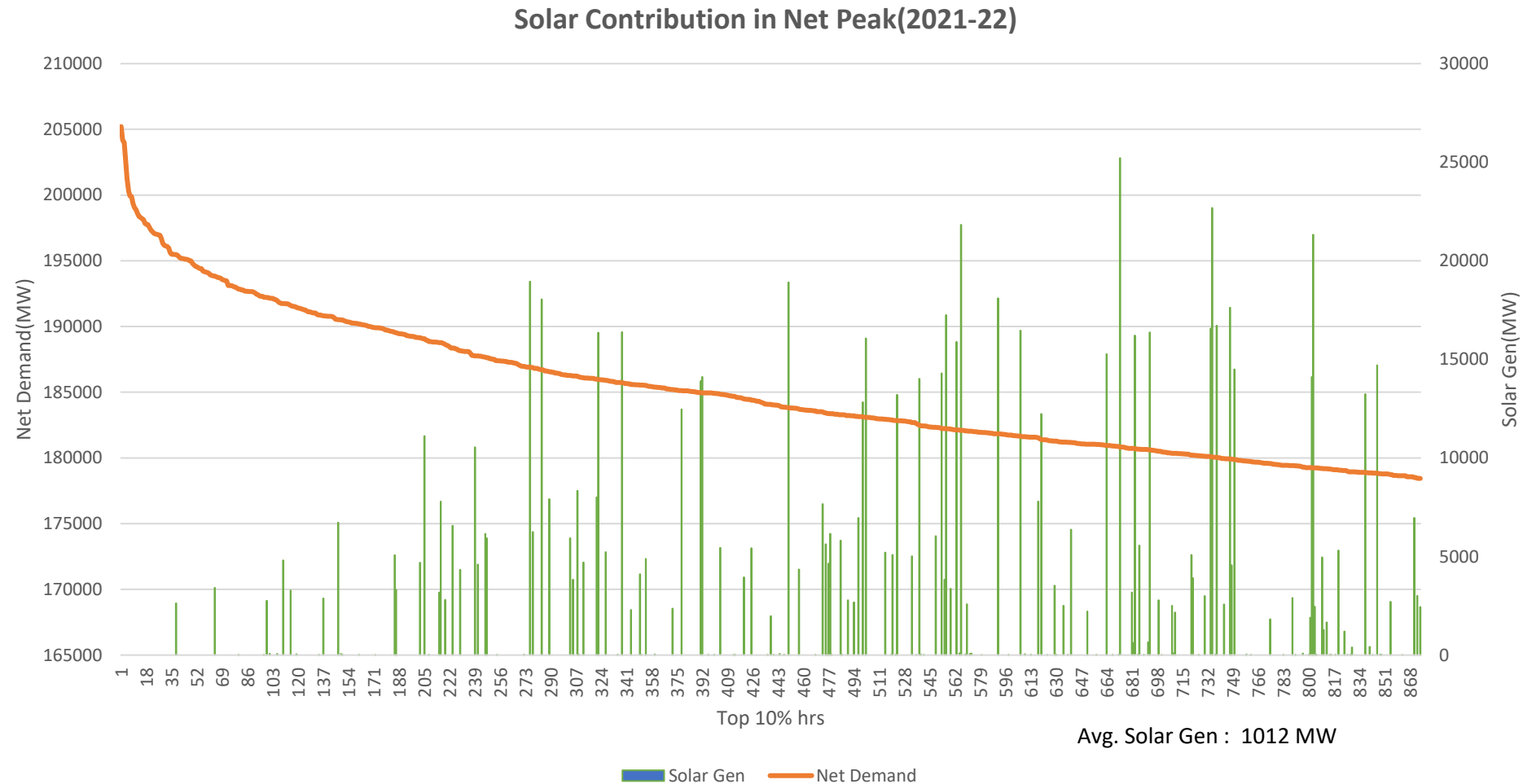
Calculation of Resource Adequacy Requirement

- RAR (supply side) = $\sum (\text{Installed Capacity} * \text{Capacity Credit})$

*Capacity credit- Percentage of installed capacity that a generator can reliably provide to meet peak demand

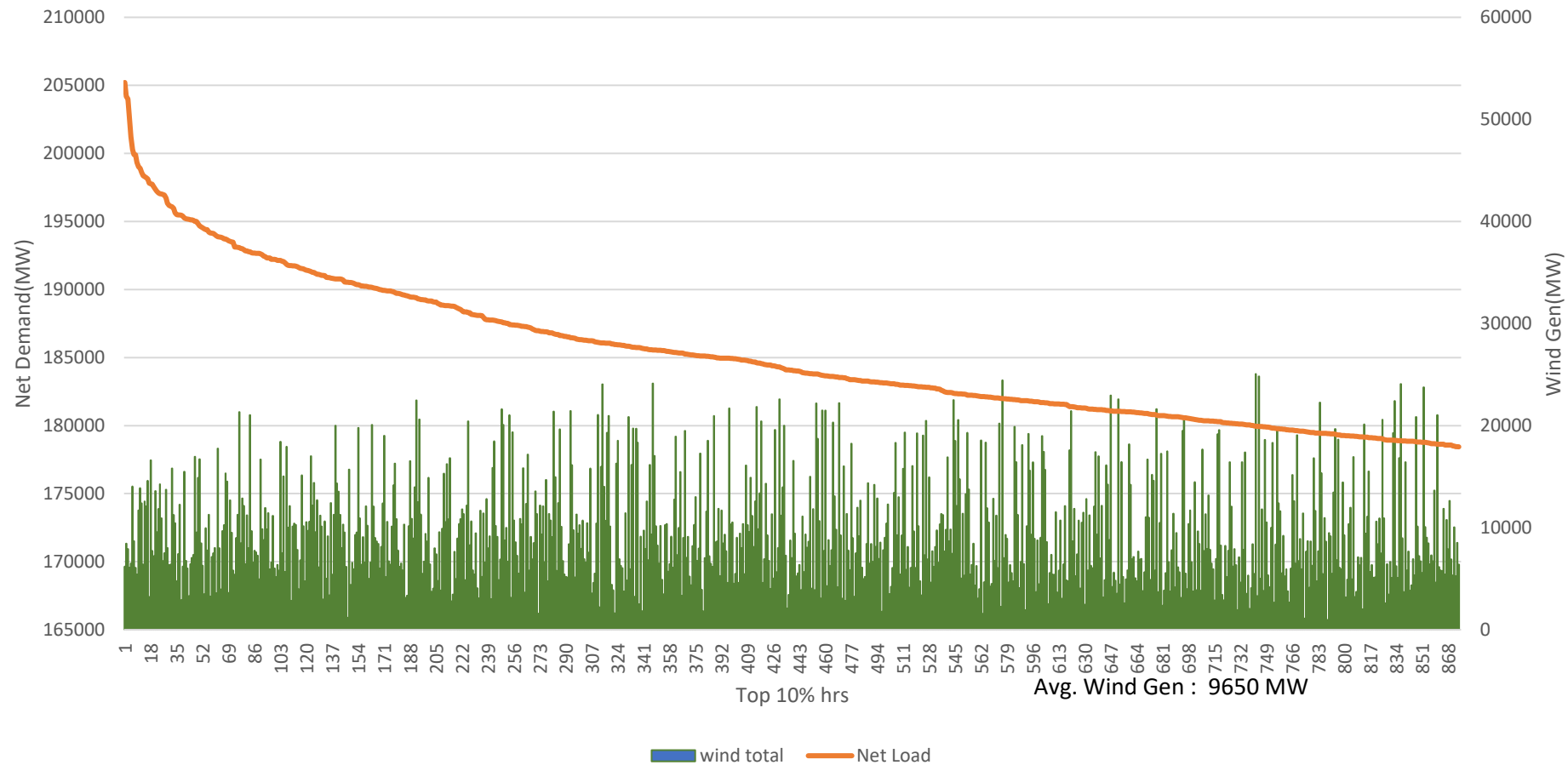
- RAR (demand side)
= Contribution to forecasted National peak demand * (1 + PRM)

Capacity Credit for Solar



Capacity Credit for Wind

Wind Contribution in net peak demand(2021-22)





Expected Energy Not Served (EENS) and Normalised ENS (NENS)

- Expected amount of total energy (MWh) that may not be served in a year
- Normalized ENS (NENS)- total expected load shed due to supply shortages (MWh) as a percent (%) of the total system energy.
- NENS value adopted by CEA for National Electricity Plan is 0.05%

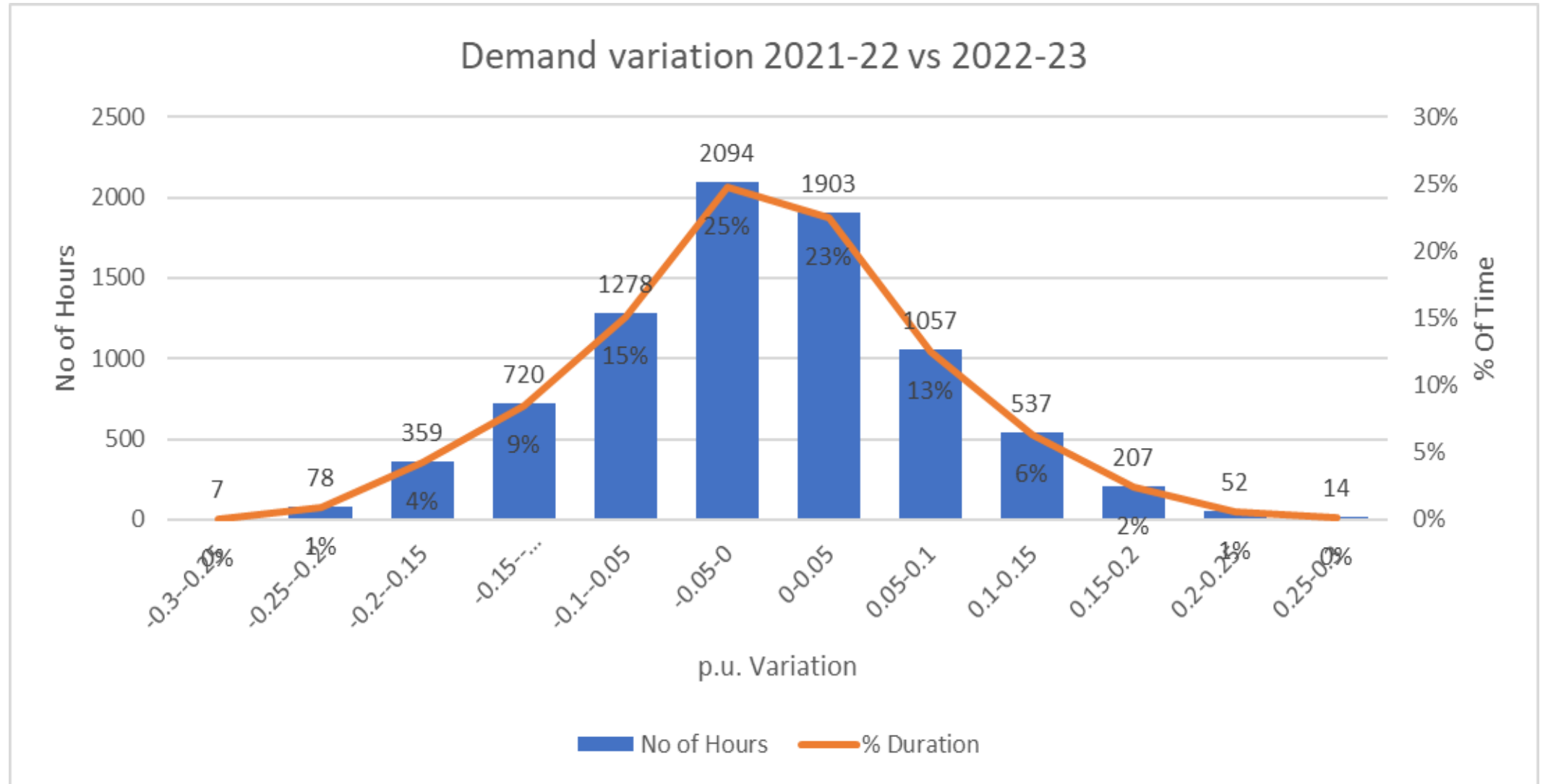
Integrated Resource Planning (IRP) for RA

- IRP- To determine the target generation capacities for meeting the forecast peak and energy demand over a specified future period.
- Inputs for IRP-
 - Reliability indices
 - Demand pattern (Hourly/sub-hourly demand pattern)
 - Estimated Load Growth
 - VRE generation profiles
 - Technical & Financial parameters of Existing, Planned and Candidate Generating Plants
 - RPO targets
 - Spinning reserve requirements

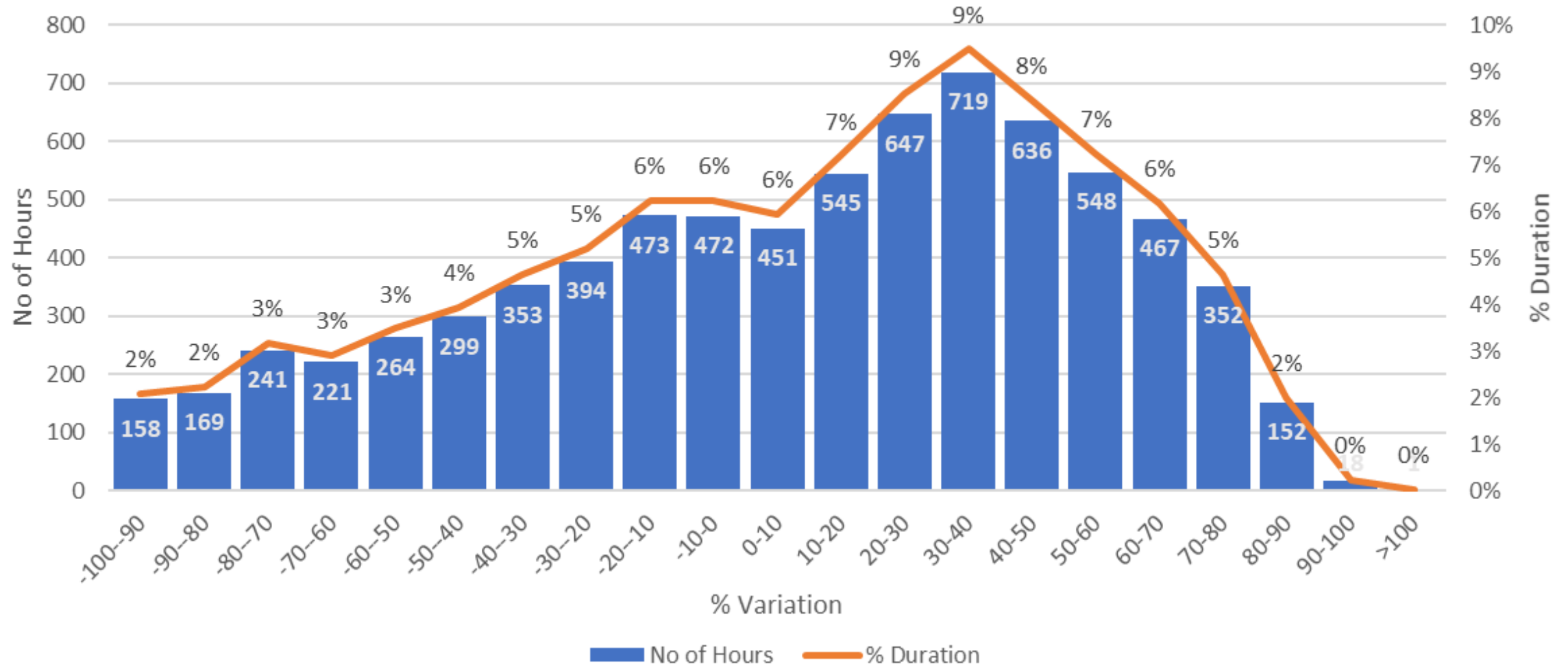
Reliability Analysis

Monte Carlo /Stochastic simulation - To factor-in the uncertainty associated with various generation resources and demand

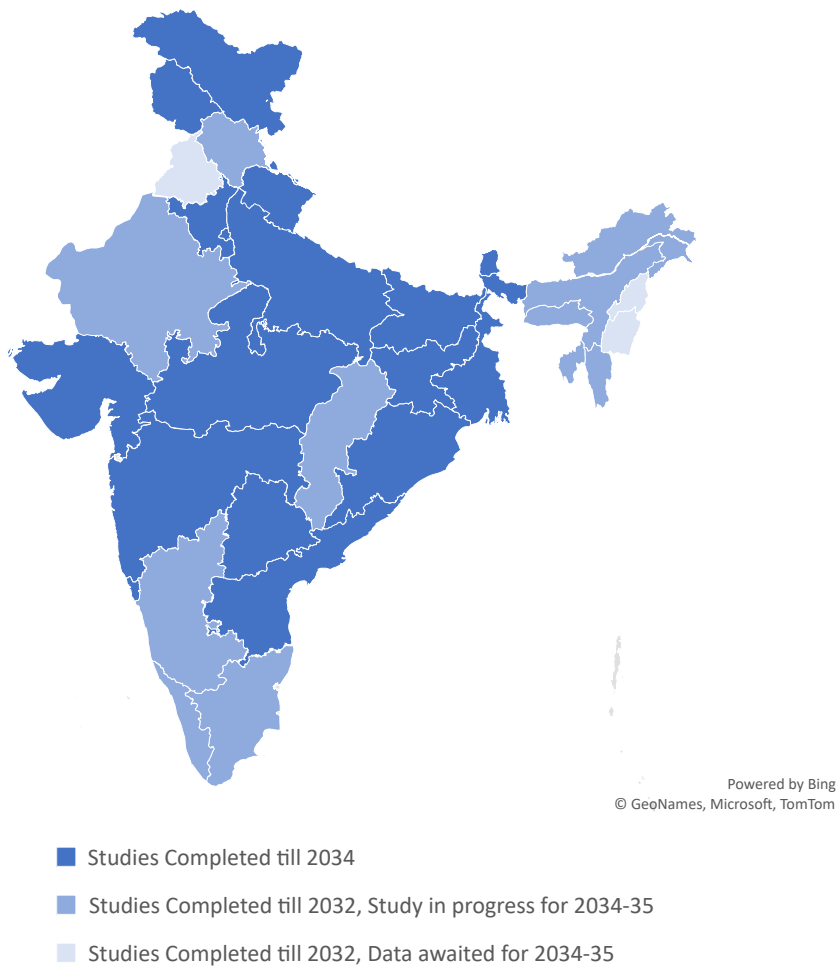
SI No.	System Parameter
1.	Forced outage of conventional generators
2.	Solar Generation
3.	Wind generation
4	Hydro generation
5.	Demand



Wind generation Variation in 2022-23 Vs 2021-22

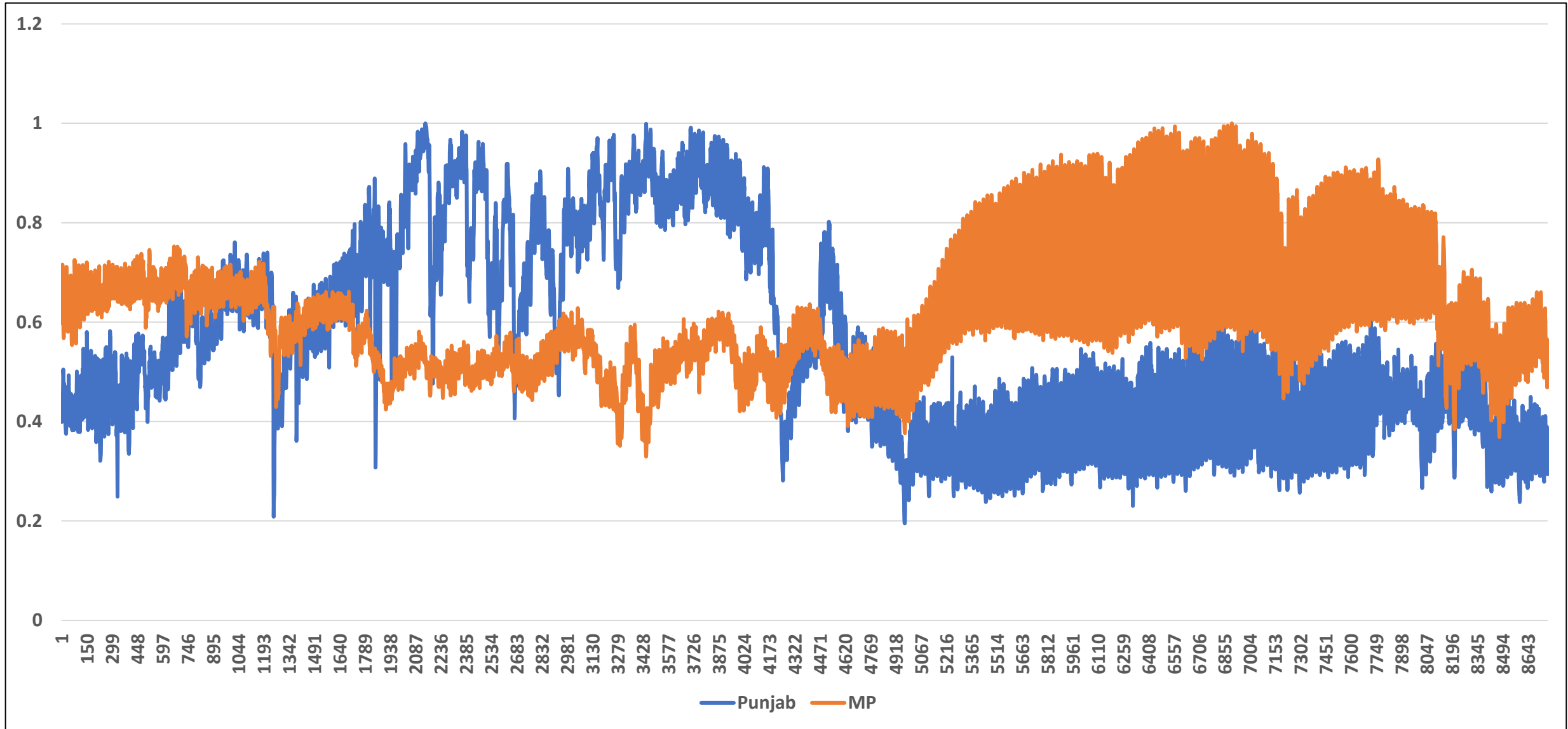


Long Term Resource Adequacy Studies of CEA

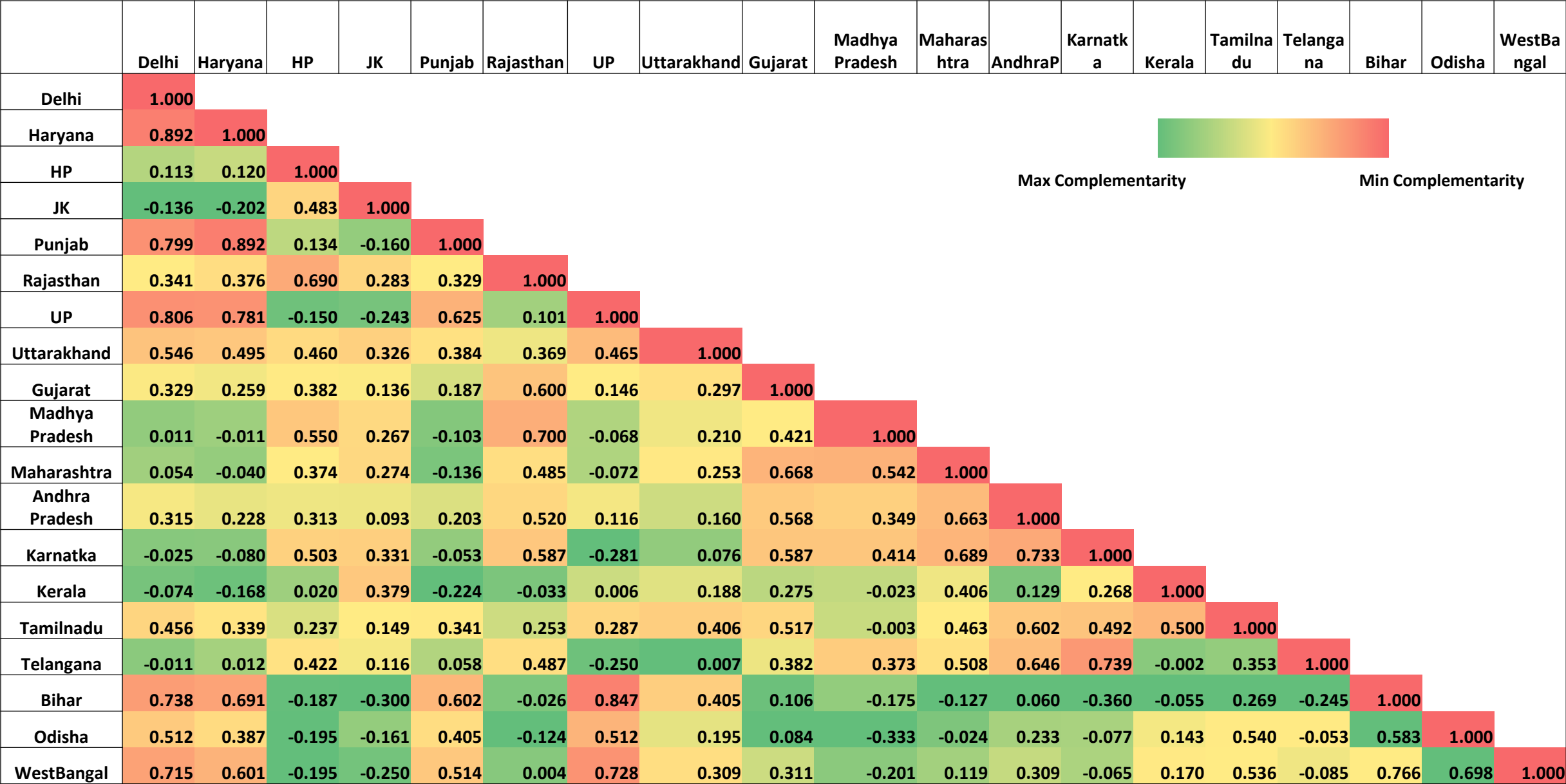


Status of RA studies	States
Studies Completed till 2034	Haryana, Jammu & Kashmir, Uttarakhand, Uttar Pradesh, Delhi, Chandigarh Maharashtra, Goa, Gujarat, Madhya Pradesh Andhra Pradesh, Telangana Bihar, Jharkhand, West Bengal, Odisha, Sikkim, DVC
Studies Completed till 2032, Study in progress for 2034-35.	Himachal Pradesh, Rajasthan Chhattisgarh Tamil Nadu, Kerala, Karnataka Assam, Tripura, Arunachal Pradesh, Meghalaya, Mizoram
Studies Completed till 2032, Data awaited for 2034-35.	Manipur, Nagaland Punjab

Complimentary Load Profile of MP and Punjab



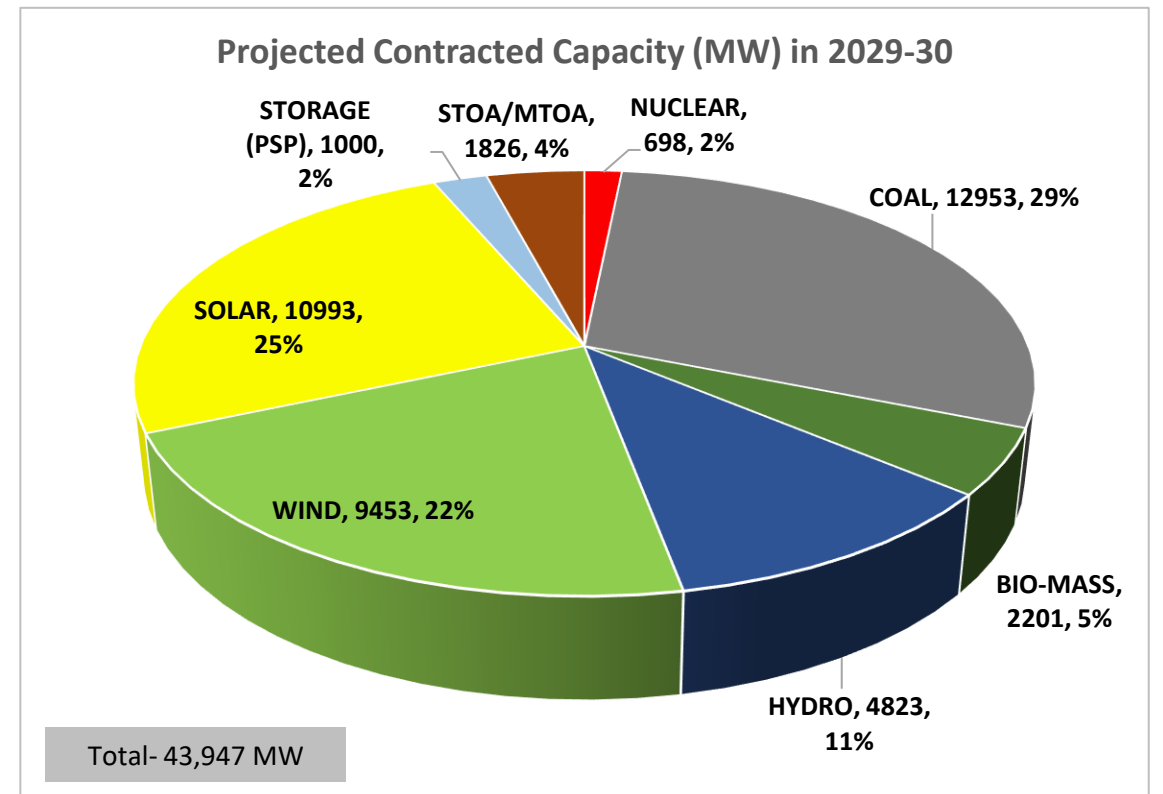
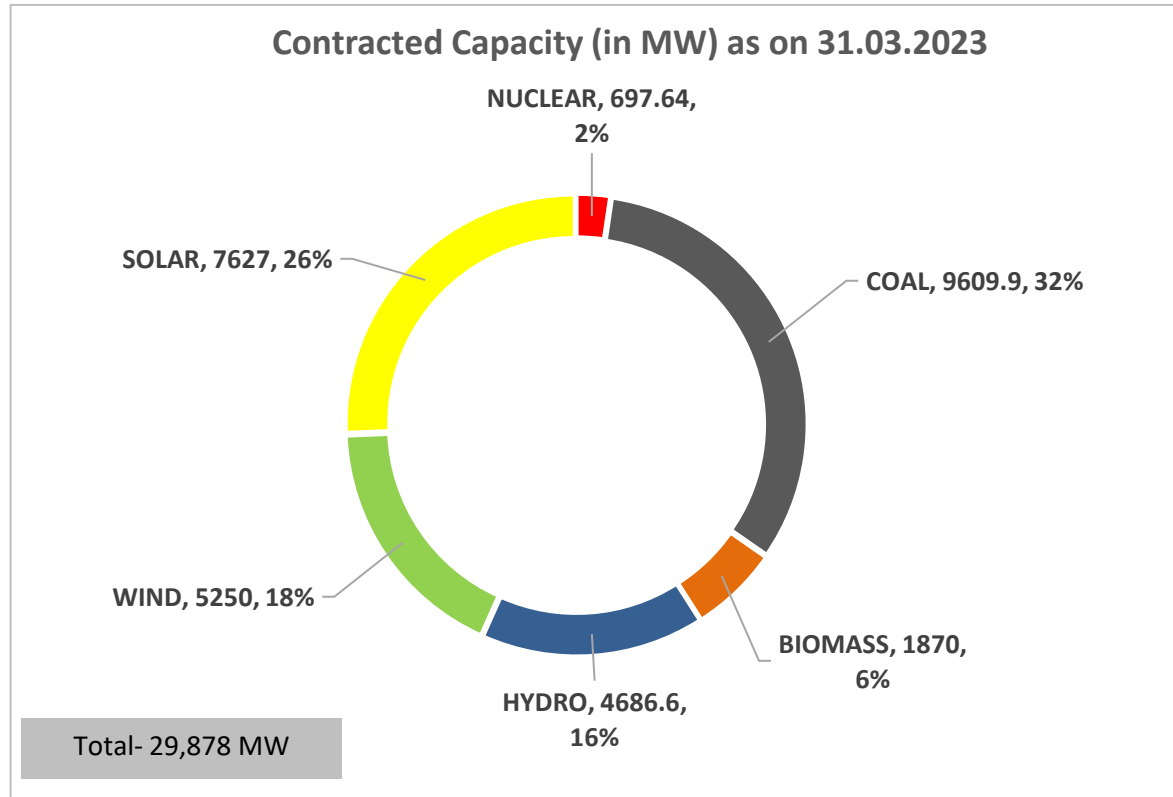
Complimentary analysis of States



Resource Adequacy Studies of Karnataka

Karnataka

	Peak (MW)	Energy (MU)
Present (2022-23)	15828	75688
Future (2029-30)	20970	110941



Capacity to be tied up till 2029-30 in addition to present contracted capacity as on 2022-23 (MW)				
COAL	PSP	WIND	SOLAR	BIOMASS
3343	1000	4204	3366	330



Karnataka-Demand projections

Source: KPTCL

Energy Requirement (MU) and Peak Demand (MW) Projections							
	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30
Energy Projections (MU)	85985	89496	93194	97095	101233	105943	110941
Year on Year Growth (Energy)	-	4.08 %	4.13%	4.19%	4.26%	4.65%	4.72%
Peak Demand Projections (MW)	15770	16580	17439	18353	19135	20025	20970
Year on Year Growth(Peak)	-	5.10%	5.18%	5.24%	4.26%	4.65%	4.71%

Karnataka-Projected Contracted Capacity (Figures in MW)

Year	COAL	NUCLEAR	BIOMASS	HYDRO	WIND	SOLAR	STOA	Total
2023/24	9610	698	1942	4823	6250	8133	1457	32912
2024/25	9610	698	2083	4823	7250	10627	1693	36783
2025/26	9610	698	2201	4823	8250	10993	1958	38532
2026/27	9610	698	2201	4823	9224	10993	2799	40347
2027/28	11832	698	2201	4823	9453	10993	1823	41822
2028/29	12518	698	2201	4823	9453	10993	2211	42896
2029/30	12953	698	2201	4823	9453	10993	1826	43945
2030-31	13545	698	2201	4823	9453	10993	1393	45105
2031-32	14750	698	2201	4823	9453	10993	1553	46470

Karnataka- Year-wise Capacity Addition (Figures in MW)

Year	COAL	PSP	WIND	SOLAR	BIOMASS	STOA/MTOA	TOTAL	
	Additional	Planned	Planned	Planned	Planned	Additional	Planned	Additional
2023/24	0	0	1000	506	72	1457	1578	1457
2024/25	0	0	1000	2494	141	1693	3635	1693
2025/26	0	0	1000	366	117	1958	1483	1958
2026/27	0	0	974	0	0	2799	974	2799
2027/28	2222	0	230	0	0	1823	230	4045
2028/29	686	0	0	0	0	2211	0	2897
2029/30	435	1000	0	0	0	1826	1000	2261
2030/31	592	1000	0	0	0	1393	1000	1985
2031/32	1205	0	0	0	0	1553	0	2758



Thank You.!!