Report on
Resource Adequacy Plan (Generation)
for
Chhattisgarh
(2025-26 to 2035-36)
(Version 3.0)

February, 2026

Government of India
Ministry of Power
Central Electricity Authority

Contents

Disclaimer 3

Executive Summary 4

1.0 Introduction 6

2.0 Highlights of the Previous RA Study (Up to FY 2034-35) 7

3.0 RA Study for Chhattisgarh (from 2025-26 to 2035-36) 9

3.1 Present Power Scenario in Chhattisgarh 9

3.2 Demand Analysis of the FY 2024-25 10

4.0 Principles of Generation Planning 12

4.1 Generation Expansion Planning Tool -ORDENA 13

5.0 Reliability Analysis 13

5.1 Variation in Electricity Demand 14

5.2 Variation in RE 15

5.3 Forced Outage of Thermal Generators 15

6.0 Inputs/Assumptions for the Study 15

7.0 Outcome of the model 19

7.1 Unserved Energy Projections 19

7.2 Investment options to meet the unserved energy 20

7.3 Surplus Coal Capacity (in MW) 25

8.0 Conclusions 26

Disclaimer

This Resource Adequacy Study for the state of Chhattisgarh has been conducted based on data and inputs provided by the Chhattisgarh State Power Distribution Company Limited (CSPDCL). The findings, analysis and conclusions presented in this report are contingent upon the accuracy, completeness and timeliness of the information furnished by the CSPDCL. Any discrepancies or limitations in the data may affect the outcomes of the study accordingly.

In accordance with the Resource Adequacy Guidelines dated 28th June 2023, each Distribution Licensee is mandated to prepare a Resource Adequacy Plan (RAP) for a 10-year horizon, referred to as the Long-Term Distribution Licensee Resource Adequacy Plan (LT-DRAP), which shall be vetted and validated by the Central Electricity Authority (CEA). CEA has facilitated this study and prepared the report solely to assist the state of Chhattisgarh in fulfilling this requirement.

It is expressly stated that the responsibility for the implementation of the study's recommendations, ensuring the adequacy of electricity resources, and undertaking any related actions including financial implications, if any, rests entirely with the State.

Executive Summary

Ministry of Power had notified the Electricity (Amendment) Rules in December, 2022. As per Rule 16 of the Electricity (Amendment) Rules, Ministry of Power has notified Resource Adequacy (RA) Guidelines. According to these Guidelines, Central Electricity Authority (CEA) is entrusted with the responsibility of preparing the Long-Term National Resource Adequacy Plan (LT-NRAP). Further, each Distribution Utility is required to carry out a Long-Term Distribution Licensee Resource Adequacy Plan (LT-DRAP) to reliably meet its peak electricity demand and electrical energy requirements.

As per the Resource Adequacy Guidelines dated 28th June 2023, each Distribution Licensee shall prepare a Resource Adequacy Plan (RAP) with a 10-year planning horizon, LT-DRAP, to meet its own peak electricity demand and electrical energy requirement. This plan shall be vetted/validated by CEA to leverage the benefits of national-level optimization for the Distribution Licensees. The LT-DRAP shall be prepared by the Distribution Licensees on an annual rolling basis, factoring in the already contracted capacity and optimizing the requirement for additional capacity.

Government of India has notified the latest Renewable Consumption Obligation (RCO) trajectory up to 2029-30 vide gazette notification dated 27th September 2025, which mandates that a specified portion of energy consumption must be met from renewable energy sources.

To support the state in fulfilling this requirement, CEA, initially carried a Resource Adequacy (RA) study with a planning horizon up to FY 2034-35, based on the data provided by CSPDCL and in compliance with the RPO trajectory specified in the Ministry of Power's Office Memorandum dated 20th October, 2023. This study has now been updated and extended to cover the period up to FY 2035-36, incorporating the latest data furnished by the State and planning assumptions. The RCO requirement for the state has also been assessed in accordance with the latest RCO trajectory specified in the Ministry of Power's Office Memorandum dated 27th September 2025.

The electrical energy requirement and peak electricity demand for Chhattisgarh, as furnished by CSPDCL, are projected to increase with a CAGR of 4.5% and 6.0% respectively from 2025-26 to 2035-36. However, as per mid-term review of 20th EPS projections, the electricity energy requirement and peak electricity demand for Chhattisgarh is projected to increase with a CAGR of 5.2% and 4.4% respectively from 2025-26 to 2035-36. The study has been done considering the demand projections furnished by CSPDCL, as peak projections are on the higher side as compared to that of the mid-term review projections. For satisfying resource adequacy i.e., meeting the electricity demand reliably and at affordable cost, the state needs to methodically plan its capacity expansion either by investing in new generation or by procuring power. In view of the reduction in cost of solar panels and newer technology options like Energy Storage Systems, planning for long term optimal generation capacity mix gains tremendous importance so as the future generation capacity mix is cost effective as well as environment friendly.

The study for Chhattisgarh, based on existing contracted capacity and planned capacity additions, indicates that the available capacity may be insufficient to meet the projected electricity demand. In particular, the total unserved energy in the year 2035-36 is estimated to be approximately 3293 MUs, accounting for around 4.8 % of the projected electrical energy requirement for that year.

To find out the least cost option for generation capacity expansion for the period 2025-26 to 2035-36, generation expansion study has been carried out with an objective to minimize the total system cost of generation including the cost of anticipated future investments while fulfilling all the technical constraints associated with various power generation technologies. Additionally, reliability study has been carried out to determine the probability of unmet demand and hours by implementing the variation in demand, variation in RE generation and forced outage of thermal generators (Coal/ Lignite) etc.

Generation capacity expansion pathways have been considered for the long-term study based on the yearly capacity addition plan of CSPDCL along with RCO constraints for Solar, Wind and DRE technologies. The Renewable capacities have been assessed in view of adherence to RCO notified by Ministry of Power, considering the fungibility among different sources.

The Resource adequacy studies have projected likely optimal capacity mix for future years till 2035-36 which shall be able to meet anticipated demand reliably. Based on the study, the likely total projected contracted capacity for the year 2035-36 is around 31,905 MW which consists of 10,492 MW from Coal; 227 MW from Nuclear; 33 MW from Biomass; 1,004 MW from hydro; 6,468 MW from Solar; 5,028 MW from Wind; 2000 MW from Hybrid: 2,451 MW from Distributed Renewable Energy (DRE) source; 1300 MW from PSP, 2,278 MW from BESS (out of which 240 MW is already contracted); and 625 MW from SToA/MToA. This capacity shall be able to meet the projected electricity demand with prescribed reliability criteria.

1.0 Introduction

Ministry of Power has notified Electricity (Amendment) Rules 2022, in December 2022. Rule 16 (I) of the said rules stipulates that "*A guideline 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*". Accordingly, the Resource Adequacy Guidelines have been notified in June, 2023, by Ministry of Power in consultation with Central Electricity Authority.

Resource Adequacy is generally defined as a mechanism to ensure that there is an adequate supply of generation resources to serve expected demand reliably at least cost. 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 precisely due to high seasonality and intermittency in RE generation. Resource Adequacy exercise may also help in assessment of capacity requirement to be tied up or contracted on long term, medium term, and short-term basis.

Further, Ministry of Power vide notification dated 27th September 2025, had notified the latest RCO trajectory for the states/Discoms. Based on the trajectory specified, hydro, wind and other (solar, biomass etc.) RCO quantum in million units (MUs) has been calculated to find additional quantum of renewable capacity that the states/Discoms have to contract in addition to the existing/planned capacity to meet their RCO targets.

To support the state in fulfilling the Resource Adequacy Guidelines and complying with the Renewable consumption Obligation (RCO) notification, CEA has carried out the RA study for the state of Chhattisgarh based on inputs furnished by CSPDCL. The study recommends an optimal resource mix up to FY 2035-36, taking into account technical and financial parameters associated with various generation technologies. It aims to optimize long-term power procurement while ensuring resource adequacy to meet demand on a 24x7 basis, considering variations in demand, variation in RE generation, and forced outage of thermal capacities. The study also assesses the Planning Reserve Margin (PRM) required by the state to account for the aforementioned uncertainties, ensuring that demand can be reliably met throughout the year.

Prior to this, CEA had conducted the RA study for the state up to FY 2034-35, based on data furnished by the state and in accordance with the RPO trajectory specified in the Ministry of Power's Office Memorandum dated 20th October, 2023.

2.0 Highlights of the Previous RA Study (Up to FY 2034-35)

1. In the earlier Resource Adequacy (RA) study, financial year 2023-24 had been considered as the base year, and the study covered the period from 2024-25 to 2034-35. The fuel-wise contracted capacity of Chhattisgarh as on 31st March, 2024, is 9,176 MW as given in Figure 1.

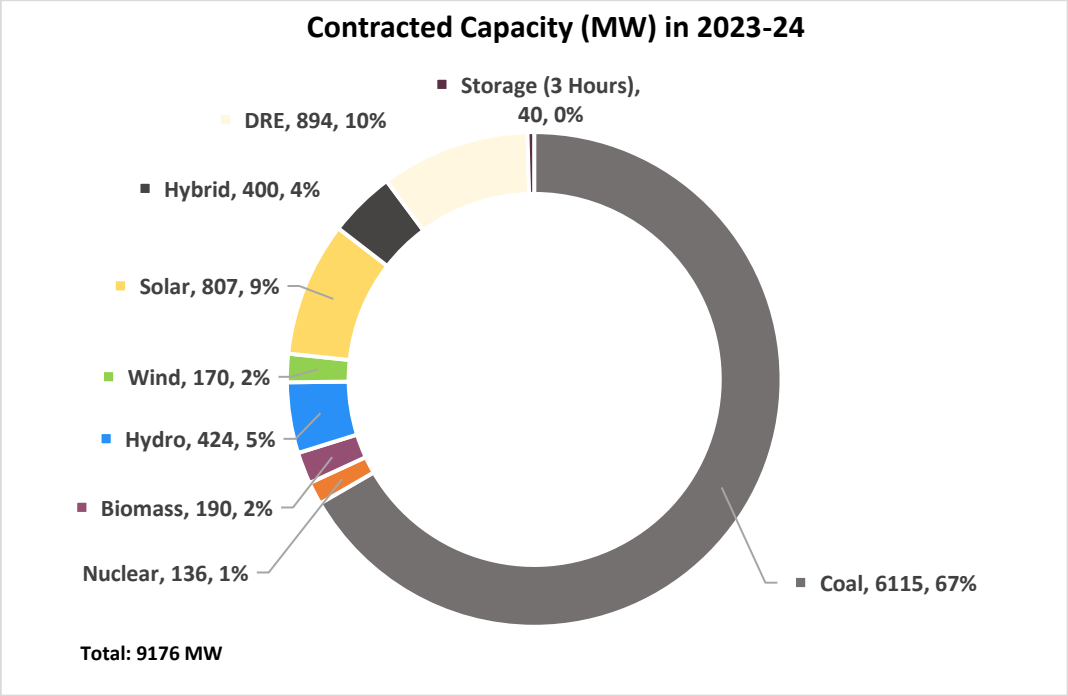

Figure 1: Fuel-wise Contracted Capacity (in MW) as on 31st March, 2024

2. The peak electricity demand and electrical energy projections that had been considered in the study is given in Table 1.

Table 1: Peak electricity demand and electrical energy projections as per 20th EPS

	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35
Electrical Energy Requirement Projections (MU)	41223	44130	47208	50475	53900	57983	60649	63436	67465	71750	76307
Year on Year Growth		7.1%	7.0%	6.9%	6.8%	7.6%	4.6%	4.6%	6.8%	6.8%	6.8%
Peak Electricity Demand Projections (MW)	6132	6592	7081	7602	8152	8805	9248	9713	10373	11077	11829
Year on Year Growth		7.5%	7.4%	7.4%	7.2%	8.0%	5.0%	5.0%	6.8%	6.8%	6.8%

3. To meet the above projected peak electricity demand and electrical energy requirement reliably, the source-wise projected capacity (in MW) as outlined in the previous report is given in Table 2.

Table 2: Source-wise projected capacities

YEAR	COAL	NUCLEAR	BIOMASS	HYDRO	WIND	SOLAR	Hybrid	PSP	Storage$ (4hrs)	DRE	STOA	Total
2024/25	6115	136	190	460	170	807	400	0	40	1052	502	**9871**
2025/26	6115	136	190	555	640	1507	1200	0	170	1352	476	**12342**
2026/27	6115	136	132	642	1170	3007	2000	0	1022	1352	236	**15811**
2027/28	6915	136	118	688	1570	4154	2000	0	1496	1358	0	**18435**
2028/29	7315	736	101	688	1970	4810	2000	0	2196	1714	0	**21530**
2029/30	9435	736	82	772	2370	5559	2000	0	2553	2128	0	**25634**
2030/31	9735	736	82	772	2770	5812	2000	800	2553	2473	0	**27733**
2031/32	9735	736	82	900	3170	6009	2000	800	2553	2845	0	**28830**
2032/33	9735	736	82	992	3570	6571	2000	800	2702	3301	0	**30489**
2033/34	9735	736	61	992	3970	7206	2000	800	3294	3803	0	**32597**
2034/35	9735	736	61	992	4370	8165	2000	800	3994	4355	0	**35208**

$ includes existing 40 MW, 3 hrs storage

4. The year-wise planned and additional capacity contract addition (in MW) for the above tabulated cumulative capacity is given in Table 3.

Table 3: Year-wise planned and additional capacity contract addition

Year	Coal	Nuclear	Hydro		Solar		Wind		Hybrid	PSP	Storage $ (4 hrs.)		DRE#		STOA	Total	
	Planned	Planned	Planned	Addl.	Planned	Addl.	Planned	Addl.	Planned	Planned	Planned	Addl.	Planned	Addl.	Addl.	Planned	Addl.
2024/25	**0**	**0**	35.9	0	0	0	0	0	0	0	0	0	158	0	502	**194**	**502**
2025/26	**0**	**0**	62.5	0	700	0	470	0	800	0	0	130	300	0	476	**2333**	**606**
2026/27	**0**	**0**	119.7	0	0	1500	130	400	800	0	**700@**	151	0	0	236	**1750**	**2287**
2027/28	**800@**	**0**	46.6	0	0	1147	0	400	0	0	0	474	0	6	0	**847**	**2027**
2028/29	**400**	**600@**	0	0	0	656	0	400	0	0	0	700	0	356	0	**1000**	**2112**
2029/30	**2120**	0	83.5	0	0	748	0	400	0	**800@**	0	357	0	414	0	**3004**	**1919**
2030/31	**400**	0	0	0	0	253	0	400	0	0	0	0	0	345	0	**400**	**998**
2031/32	**0**	0	128.6	0	0	197	0	400	0	0	0	0	0	372	0	**129**	**969**
2032/33	**0**	0	92	0	0	562	0	400	0	0	0	149	0	456	0	**92**	**1567**
2033/34	**0**	0	0	0	0	635	0	400	0	0	0	592	0	502	0	**0**	**2129**
2034/35	**0**	0	0	0	0	959	0	400	0	0	0	700	0	553	0	**0**	**2612**
Total	**3720**	**600**	**568.8**	**0**	**700**	**6658**	**600**	**3600**	**1600**	**800**	**700**	**3254**	**458**	**3003**		**9747**	

*****_The STOA/MTOA value reflects the yearly requirement._

$ includes existing 40 MW (3 hrs) storage

for DRE only PPA executed have been considered for studies, for other technologies PPA executed and under consideration both are considered for studies.

@PPA under consideration

3.0 RA Study for Chhattisgarh (from 2025-26 to 2035-36)

3.1 Present Power Scenario in Chhattisgarh

The power supply position for Chhattisgarh from 2020-21 to 2024-25 is given in Table 4.

Table 4: Power Supply Position of Chhattisgarh

Power Supply Position						
Year	**Energy required (MU)**	**Energy supplied (MU)**	**Gap (MU)**	**Peak Demand (MW)**	**Peak Met (MW)**	**Demand not met (MW)**
2020-21	30472	30449	22	4682	4682	0
2021-22	31908	31872	35	5019	5014	5
2022-23	37446	37374	72	5399	5399	0
2023-24	39930	39872	58	6148	6148	0
2024-25	43208	43180	28	6511	6511	0

As per the data provided by CSPDCL, as of March 2025, the total contracted capacity of Chhattisgarh is 9,783 MW. Out of the total contracted capacity (CC), the share of non-fossil fuel-based CC is around 38 %. The fuel-wise contracted capacity as on 31st March, 2025 is given in Table 5 and Figure 2.

Table 5: Fuel-wise Contracted Capacity as on March 2025

Source	**Contracted Capacity (MW)**	**Percentage**
Coal	6072	62.1%
Biomass	190	1.9%
Nuclear	136	1.4%
Hydro	435	4.4%
Wind	278	2.8%
Solar	1180	12.1%
Hybrid	400	4.1%
DRE	1052	10.8%
BESS	40	0.4%
Total	**9783**	**100**

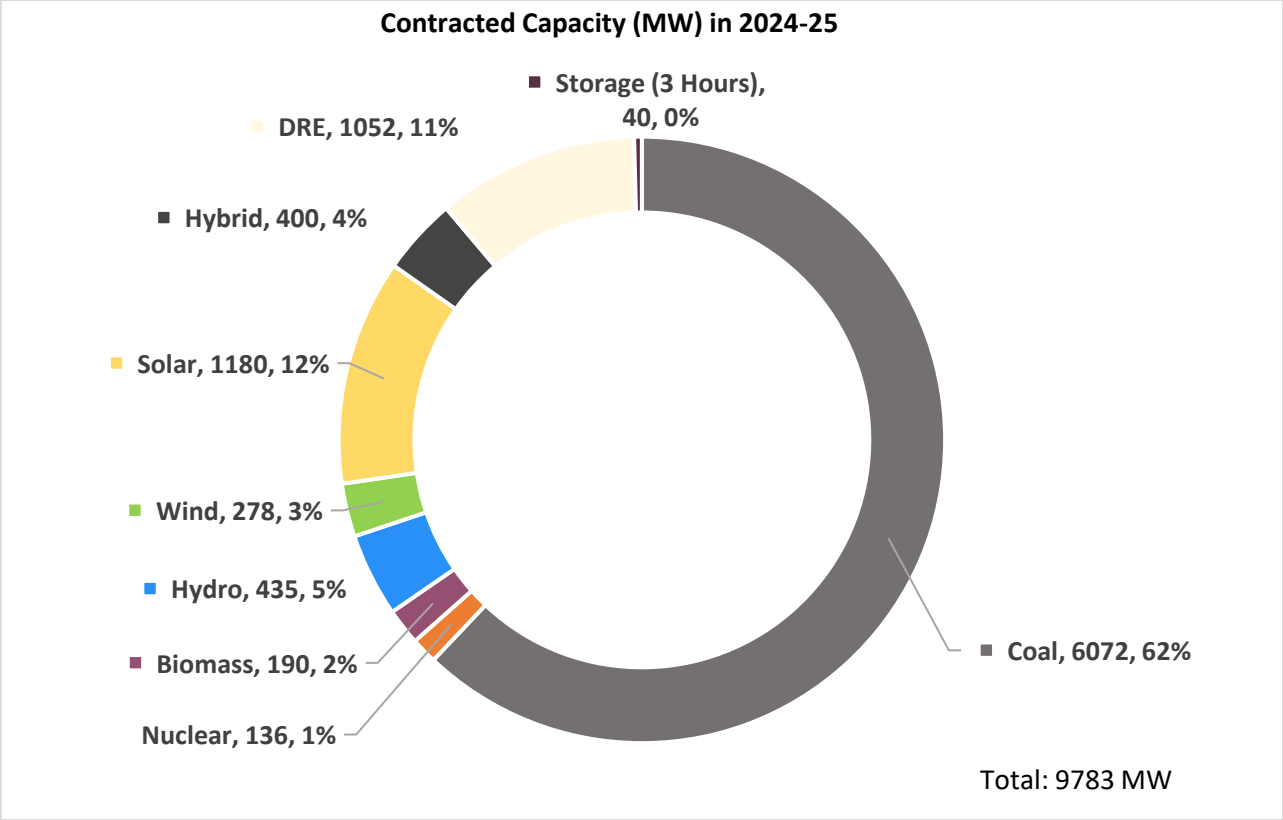

Figure 2: Fuel-wise Contracted Capacity (in MW) as on 31st March, 2025

3.2 Demand Analysis of the FY 2024-25

Hourly demand pattern of 2024-25 was analyzed and it was observed that the peak demand season for the State of Chhattisgarh is typically during the months from February to April. Chhattisgarh witness almost same peak electricity demand during solar and non-solar hours.

The month-wise average hourly demand observed for the year 2024-25 is shown in Figure 3.

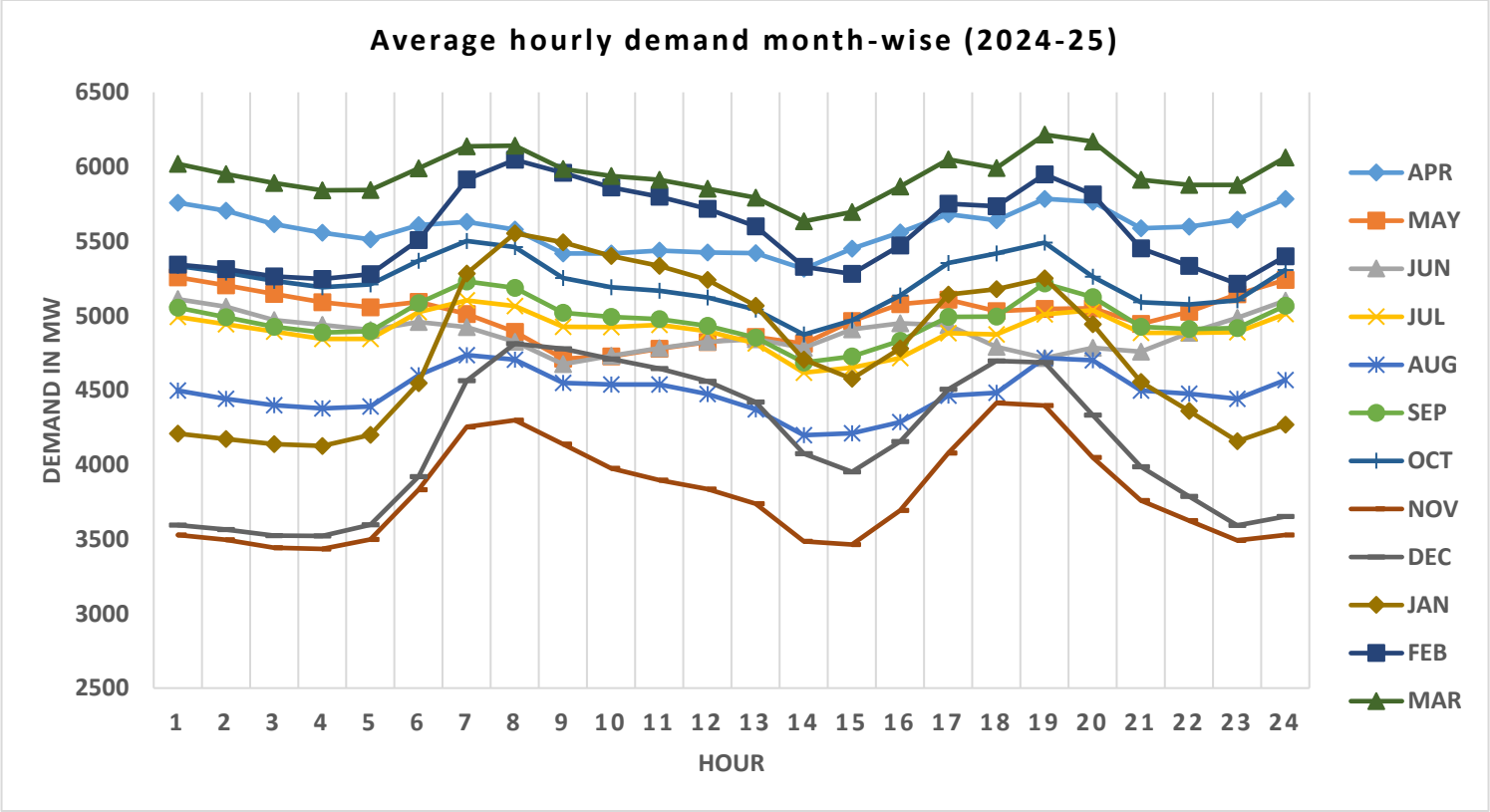

Figure 3: Average Hourly Demand Variation (Month-wise) for 2024-25

From the hourly demand data of 2024-25 the daily peak during solar hours and non-solar hours is plotted in Figure 4.

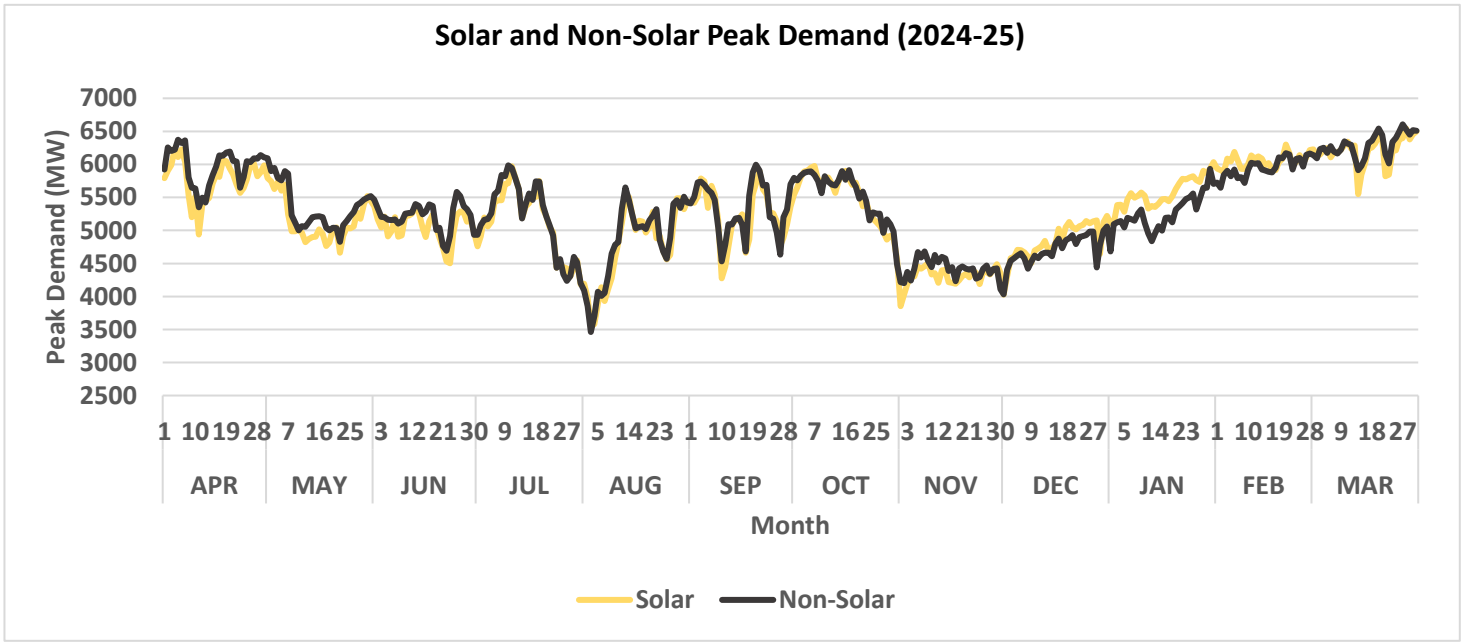

Figure 4: Solar and non-solar peak in MW for the year 2024-25

The hourly demand pattern of 2024-25 was analysed for finding out the number of occurrences of the peak and near peak electricity demand. Such instances are critical for study purpose as it is necessary to ensure resource adequacy during such instances with an optimal mix of long-term, medium-term and short-term contracts. Frequency Distribution of hourly demand profile for the year 2024-25 is shown in Figure 5.

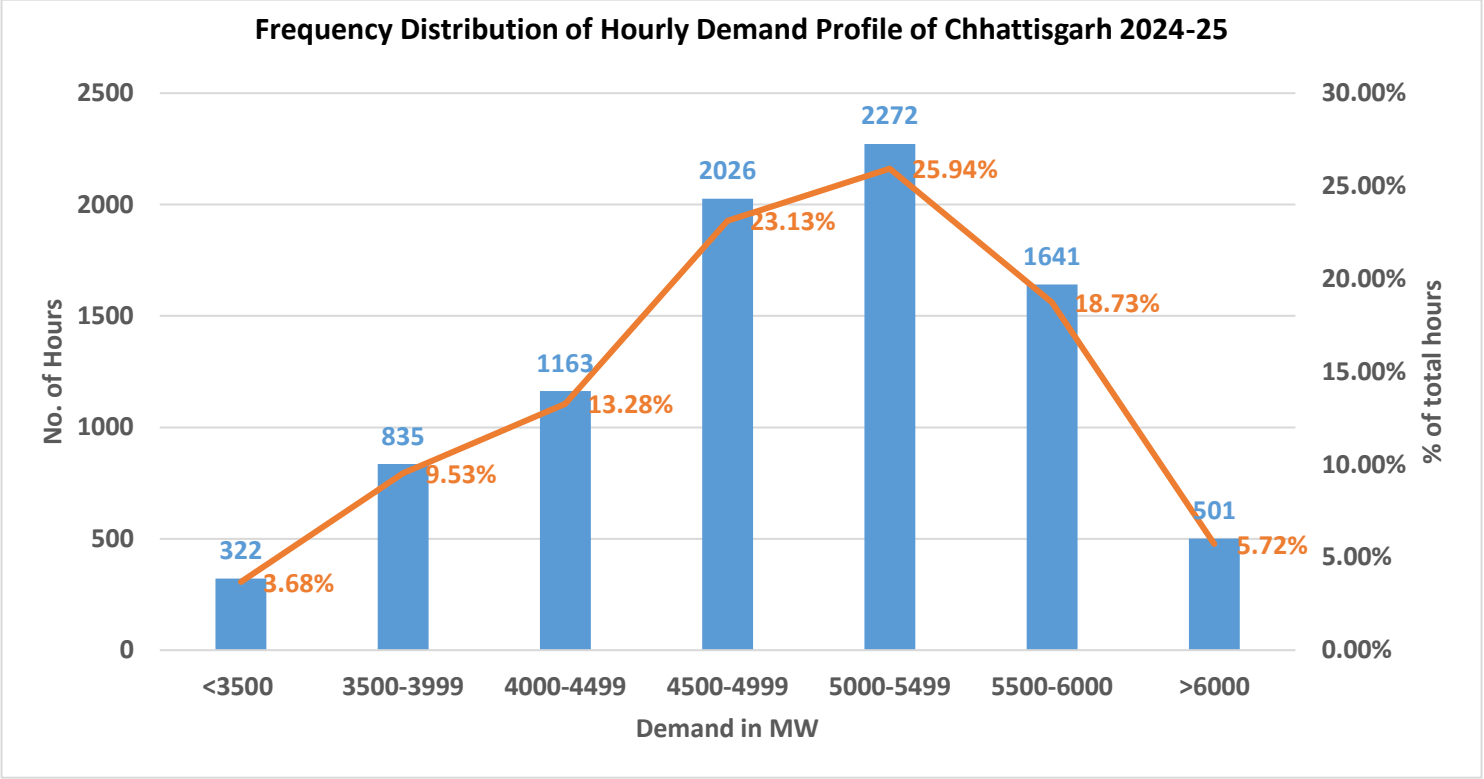

Figure 5: Frequency Distribution of Hourly Demand Profile of 2024-25

4.0 Principles of Generation Planning

The objective of Generation Planning process is to obtain an optimal generation capacity mix in the least cost manner to meet the electricity demand at every instance of time while ensuring the most efficient use of resources.

The major aspects considered in the planning process are:

i) To Supply 24x7 reliable power to the consumers
ii) To achieve objectives of all policies of the Government of India such as RCO trajectory, RE capacity addition plan etc.
iii) To achieve sustainable development.
iv) To fulfil desired operational characteristics of the system such as reliability and flexibility.
v) Most efficient use of resources.
vi) Fuel availability

4.1 Generation Expansion Planning Tool -ORDENA

The studies have been carried out using a generation expansion planning model namely ORDENA. ORDENA is a mixed integer linear optimization program that minimizes the Net Present Value (NPV) of investment and operation costs subject to several constraints. The major constraints include balancing electricity supply and demand, resource supply limits, planning and operating reserve limits, and policy targets. These constraints are met considering a broad portfolio of conventional generation, renewable generation, and storage.

ORDENA has a reliability module to determine the trustworthiness of the system using Monte Carlo simulations. The software is also capable of carrying out hourly/sub-hourly economic generation dispatch considering all the technical constraints associated with various generation technologies.

The schematic diagram of the software is given in Figure 6.

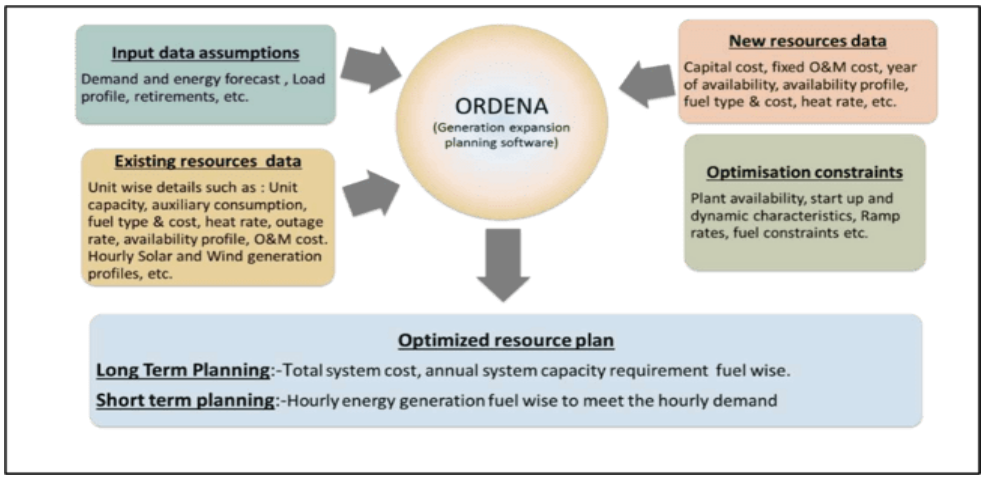

Figure 6: Schematic Diagram

5.0 Reliability Analysis

One of the main criteria of resource adequacy studies is to determine the reliability of the system to meet the demand adequately at every instance of time. This reliability is measured via two indices i.e. LOLP (Loss of Load Probability) and EENS (Expected Energy Not Served). These indices have been defined in resource adequacy guidelines as below:

- **Loss of Load Probability (LOLP)**: Measure of the probability that a system's load may exceed the generation and firm power contracts available to meet that load in a year. E.g., 0.0274% probability of load being lost.
- **Expected Energy Not Served (EENS):** Expected amount of energy (MWh) that may not be served for each year within the planning period under study. It is a summation of the expected number of megawatt hours of demand that may not be served for the year. This is an energy-centric metric that

considers the magnitude and duration of energy being not served, calculated in Mega Watt hours (MWh). The metric can be normalized (i.e. divided by total system electrical energy requirement) to create a Normalized Energy Not Served (NENS) metric.

Monte Carlo /Stochastic simulation has been used to factor-in the uncertainty associated with various generation resources and demand. It is an approach which is used to predict the probability of a variety of outcomes when the potential for random variables is present, as compared to deterministic modelling of economic dispatch model. Monte Carlo simulation helps in analysing the randomness associated with RE energy resource, demand pattern changes and forced outages of plant. A large no. of random samples of these variables is simultaneously simulated to ascertain system reliability indices (i.e. Loss of load probability, LOLP and Energy Not Served, ENS) and the system robustness in case of above variation of system parameters.

- **Planning Reserve Margin (PRM):** To meet the prescribed standard of LOLP / NENS conditions, sufficient reserve margins need to be maintained in the system for adequately addressing the demand and supply variations. Planning Reserve Margin (PRM) is the predominant metric used to ensure adequacy of generation resources in the system. PRM in a power system is generally expressed as a certain percent of the projected peak electricity demand.

5.1 Variation in Electricity Demand

The variation in electricity demand pattern for last two years viz. 2023-24 and 2024-25 (considering 2023-24 as the base year) has been analyzed. The demand pattern variation across 2023-24 and 2024-25 is shown in Figure 7.

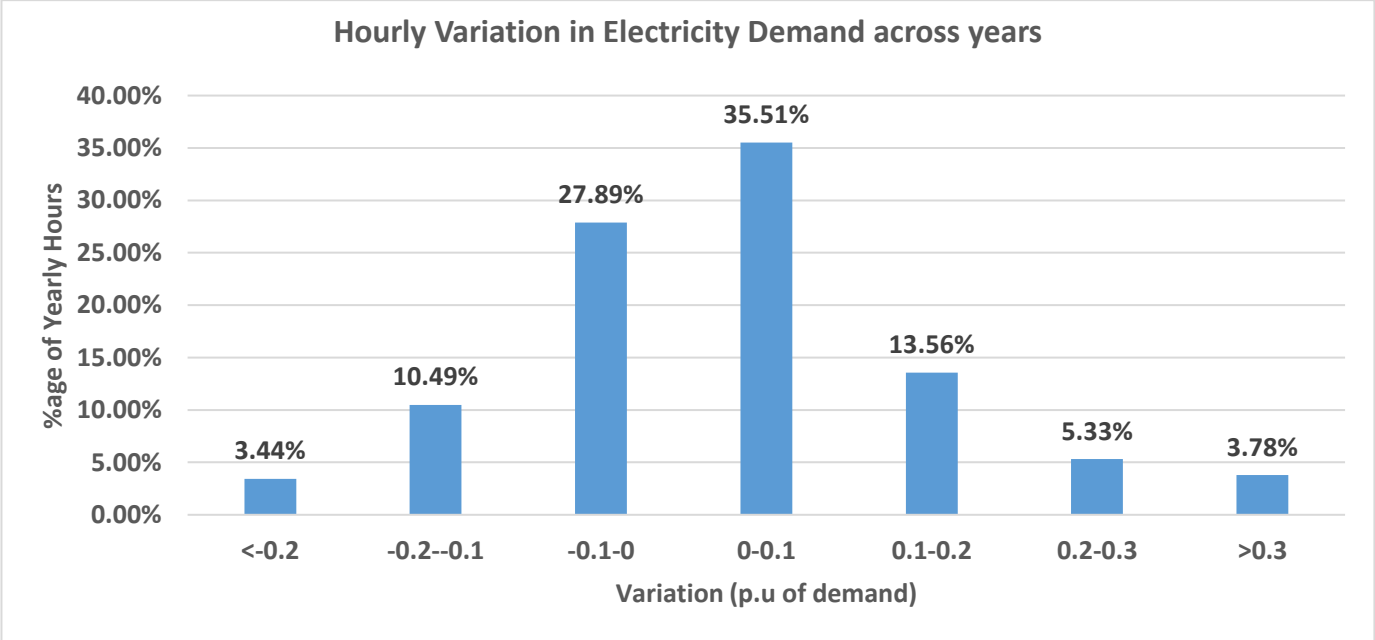

Figure 7: Hourly Variation in electricity demand across years

It can be observed that the hourly demand typically varies within ±10% for ~63.4% of instances. This variation is primarily due to temperature, weather parameter or any random outages of transmission line and generating units etc. This variation has been captured in the reliability study by incorporating a variation of ±10% in the projected hourly demand for the future years by introducing a random variable (with normal distribution) for demand as per observed behavior over the years.

5.2 Variation in RE

In the Long-term capacity expansion planning studies, a particular profile for Solar and Wind is considered based on the observed generation data to determine the optimal capacity mix. However, due to intermittent nature of these sources, generation from these non-dispatchable sources may vary across years. As per the analyses carried out based on historical generation data, solar and wind-based generation has been varied by ± 10% and ± 50% respectively to incorporate the variation in these generation sources and plan for requisite measures to mitigate such behavior.

5.3 Forced Outage of Thermal Generators

The average forced outage rate of thermal generators is typically 10% with ±5% variation. The same has been incorporated in the model.

Based on these variations, reliability studies have been carried out to ascertain robustness of the system.

6.0 Inputs/Assumptions for the Study

i) The peak electricity demand and electrical energy requirement of CSPDCL as per the state and mid-term review of 20th EPS Report is given in Table 6.

Table 6: Electricity demand projection

Year	Projections by CSPDCL		Projections as per Mid-term review of 20th EPS	
	Peak Electricity Demand (MW)	Electrical Energy Requirement (MU)	Peak Electricity Demand (MW)	Electrical Energy Requirement (MU)
2025-26	7482	43800	7209	46629
2026-27	7931	45771	7750	50124
2027-28	8407	47831	8218	53692
2028-29	8911	49983	8686	57317
2029-30	9446	52232	9124	60805
2030-31	10013	54583	9512	64016
2031-32	10613	57039	9857	66987
2032-33	11250	59606	10197	69966
2033-34	11925	62288	10499	72729
2034-35	12641	65091	10759	75240
2035-36	13399	68020	11098	77611

Electricity demand projections as per the CSPDCL have been considered in the study.

ii) Future demand profile till the year 2035-36 has been projected using the demand profile for the year 2024-25 as the base profile.

iii) The actual solar, wind and hydro generation profiles and CUFs have been considered as per the data available in CEA. The same is enclosed as Annexure.

iv) The capital cost of candidate plants for coal, solar, wind and battery/PSP technologies is detailed in the Annexure and are in alignment with current market trends and recent price discovery.

v) The planned capacity has been considered based on the capacity tie-up information as furnished by CSPDCL. The same is summarised in Table 7 and details are furnished in Annexure.

Table 7: Source-wise planned capacity addition

(Fig. in MW)

FY	Coal	Nuclear	HYDRO (Conventional/ Small)	Solar	Wind	Hybrid	PSP	DRE	BESS (MW/ MWh)
2025-26	0		60.4	700	620	800		300	
2026-27	0		179.6		130	800			200/500
2027-28	0		17						
2028-29	400		33						
2029-30	2120		83.5				800		
2030-31	700		0						
2031-32	400		0						
2032-33	0	30	103						
2033-34	0		92						
2034-35	0	30.5							
2035-36	0	30.5							
Total	**3620**	**91**	**568.5**	**700**	**750**	**1600**	**800**	**300**	**200/500**

Note: For coal, nuclear, and hydro projects, the commissioning year is determined based on the later of the CEA records and the year reported by the state.

Allocation from Hydro plants and Nuclear is taken as per actual allocation order or proposed allocation order.

vi) **Renewable Consumption Obligation (RCO) trajectory**: Ministry of Power vide gazette notification dated 27th September, 2025, had notified the source wise minimum share of consumption of non-fossil sources (renewable energy) by designated consumers, till the year 2029-30 as given in Table 8.

Table 8: Renewable Consumption Obligation (RCO) trajectory (%)

Sl. No.	Year	Wind renewable energy	Hydro renewable energy	Other renewable energy	Distributed renewable energy	Total renewable energy
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1.	2024-25	0.67	0.38	27.36	1.5	29.91
2.	2025-26	1.45	1.22	28.24	2.1	33.01
3.	2026-27	1.97	1.34	29.94	2.7	35.95
4.	2027-28	2.45	1.42	31.64	3.3	38.81
5.	2028-29	2.95	1.42	33.1	3.9	41.36
6.	2029-30	3.48	1.33	34.02	4.5	43.33

Further, in view of the country's energy transition goals as well as the long-term net zero target of 2070, it is estimated that the share of RE generation in the generation mix will continue to proportionally increase beyond 2029-30. Therefore, the RCO trajectory is assumed to rise steadily beyond 2029-30. Further, the DRE percentage has been assumed to be 4.5% beyond 2029-30. Hence, the suggested trajectory of Renewable Consumption Requirement up to FY 2035-36 is given in Table 9.

Table 9: Renewable Consumption Obligation (RCO) trajectory (in %) considered for the study

Sl. No.	Year	Wind renewable energy	Hydro renewable energy	Other renewable energy	Distributed renewable energy	Total renewable energy
1.	**2025-26**	1.45	1.22	28.24	2.10	33.01
2.	**2026-27**	1.97	1.34	29.94	2.70	35.95
3.	**2027-28**	2.45	1.42	31.64	3.30	38.81
4.	**2028-29**	2.95	1.42	33.10	3.90	41.36
5.	**2029-30**	3.48	1.33	34.02	4.50	43.33
6.	**2030-31**	41.00			4.50	45.50
7.	**2031-32**	42.50			4.50	47.00
9.	**2032-33**	43.80			4.50	48.30
8.	**2033-34**	45.00			4.50	49.50
9.	**2034-35**	46.00			4.50	50.50
10.	**2035-36**	47.00			4.50	51.50

Based on the trajectory specified, RCO quantum in million units (MUs) from hydro, wind, other (Solar, biomass etc.) and distributed renewable energy (DRE) is calculated and given in Table 10.

Table 10: Renewable Energy (excluding DRE) in MUs required to meet RCO

Year	Wind renewable energy (MU)	Hydro renewable energy	Other renewable energy	Total renewable energy
2025-26	625	525	12164	13314
2026-27	887	604	13486	14977
2027-28	1154	669	14904	16727
2028-29	1453	699	16304	18456
2029-30	1792	685	17522	20000
2030-31	22081			22081
2031-32	23933			23933
2032-33	25719			25719
2033-34	27630			27630
2034-35	29458			29458
2035-36	31399			31399

Table 11: Renewable Energy (excluding DRE) Deficit/Surplus

FY	RE Generation required to meet RCO		RE Generation available/met (From existing/ planned contracts)		RCO Surplus (+)/ Deficit (-)
	(MU)	(%)	(MU)	(%)	(%)
2025-26	13314	30.91	9806	22.8	-8.1
2026-27	14977	33.25	12290	27.3	-6.0
2027-28	16727	35.51	12121	25.7	-9.8
2028-29	18456	37.47	12272	24.9	-12.6
2029-30	20000	38.83	12548	24.4	-14.5
2030-31	22081	41.00	12462	23.1	-17.9
2031-32	23933	42.50	12462	22.1	-20.4
2032-33	25719	43.80	12784	21.8	-22.0
2033-34	27630	45.00	13105	21.3	-23.7
2034-35	29458	46.00	13040	20.4	-25.6
2035-36	31399	47.00	13033	19.5	-27.5

Table 11(a): DRE Deficit/Surplus

FY	DRE required to meet RCO		DRE available/met (From existing/ planned contracts)		RCO Surplus (+)/ Deficit (-)
	(MU)	(%)	(MU)	(%)	(%)
2025-26	905	2.10	1661	3.9	1.8
2026-27	1216	2.70	1661	3.7	1.0
2027-28	1554	3.30	1661	3.5	0.2
2028-29	1921	3.90	1661	3.4	-0.5
2029-30	2318	4.50	1661	3.2	-1.3

2030-31	2424	4.50	1661	3.1	-1.4
2031-32	2534	4.50	1661	2.9	-1.6
2032-33	2642	4.50	1661	2.8	-1.7
2033-34	2763	4.50	1661	2.7	-1.8
2034-35	2882	4.50	1661	2.6	-1.9
2035-36	3006	4.50	1661	2.5	-2.0

As indicated in Table 11 and 11 (a), the state with its existing and envisaged future capacity additions will not be able to meet its RCO requirements from the year 2025-26 onwards for Renewable Energy (excluding DRE). For DRE, existing and envisaged future capacity additions will not be able to meet its RCO requirements from the year 2028-29

7.0 Outcome of the model

7.1 Unserved Energy Projections

Initially, the study has been carried out considering only the existing and planned capacity contracts. The projected total unserved energy for the year 2035-36 is about 3293 MUs which is about 4.8% of the electrical energy requirement in 2035-36. The year-wise likely unserved energy with the existing and planned capacities is given in Figure 8.

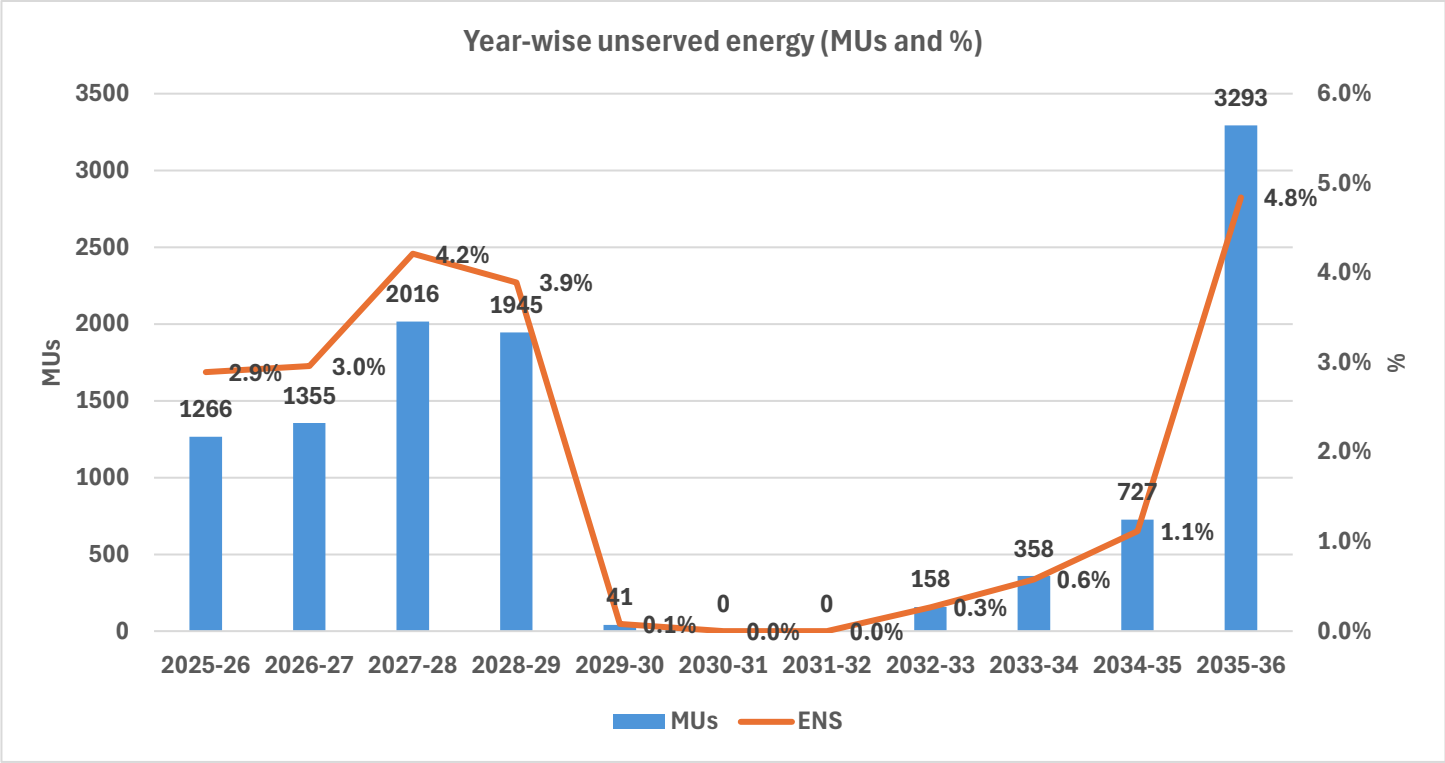

Figure 8: Yearly likely unserved energy (in MU) with the existing and planned capacities

The study has also analyzed the daily and monthly pattern of unserved energy in the year 2035-36, it can be seen that contracted capacity (present and planned) is unable to meet the electricity demand. Details are shown in Figure 9.

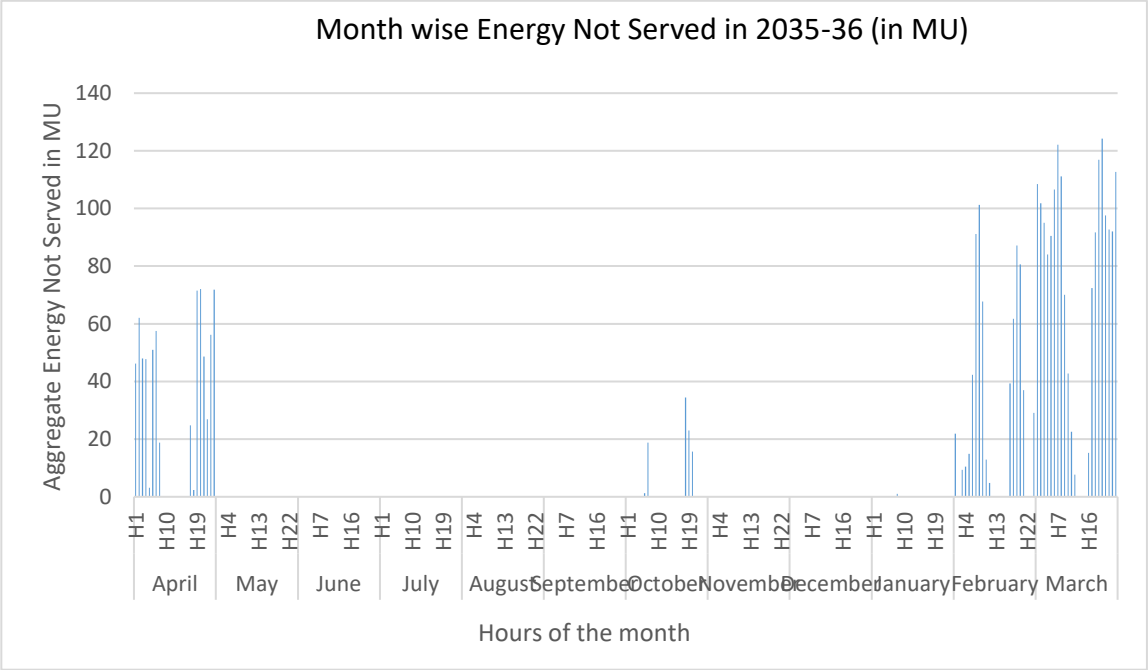

Figure 9: Block-wise Unserved Energy Pattern MWh (2035-36)

From the above figure, it can be seen that unserved energy is high during high demand season viz. February to April and is typically observed during non-solar hours.

7.2 Investment options to meet the unserved energy

To meet the unserved energy and fulfilling RCO requirement, energy investment options (i.e., candidate capacities) have been given to the model to find the least cost optimal capacity mix required to meet the electricity demand. The capacity projections (existing, planned, to be tied up) for Chhattisgarh are given in Table 12.

Table 12: Year-wise contracted capacity projections (in MW)

Year	Coal	Nuclear	Biomass	Hydro	Wind	Solar	Hybrid	PSP	BESS	DRE	STOA	Total
2025-26	6072	136	190	495	898	1880	1200	0	40	1352	1303	**13567**
2026-27	6072	136	176	675	1028	1880	2000	0	240	1352	1403	**14962**
2027-28	6072	136	106	692	1628	3680	2000	0	1240	1352	1306	**18212**
2028-29	6472	136	99	725	2228	4032	2000	0	1418	1566	1129	**19805**
2029-30	8592	136	81	809	2374	4190	2000	800	1418	1890	0	**22289**
2030-31	9292	136	63	809	2974	4581	2000	800	1418	1976	0	**24048**
2031-32	9692	136	63	809	3574	4852	2000	800	1418	2066	0	**25409**
2032-33	9692	166	54	912	4164	4852	2000	800	1418	2155	0	**26213**
2033-34	9692	166	47	1004	4764	4926	2000	800	1418	2253	0	**27069**
2034-35	9692	196	33	1004	5028	5523	2000	800	1778	2350	0	**28404**
2035-36	10492	227	33	1004	5028	6468	2000	1300	2278	2451	625	**31905**

The projected contracted capacity mix, year-wise, is given in Figure 10.

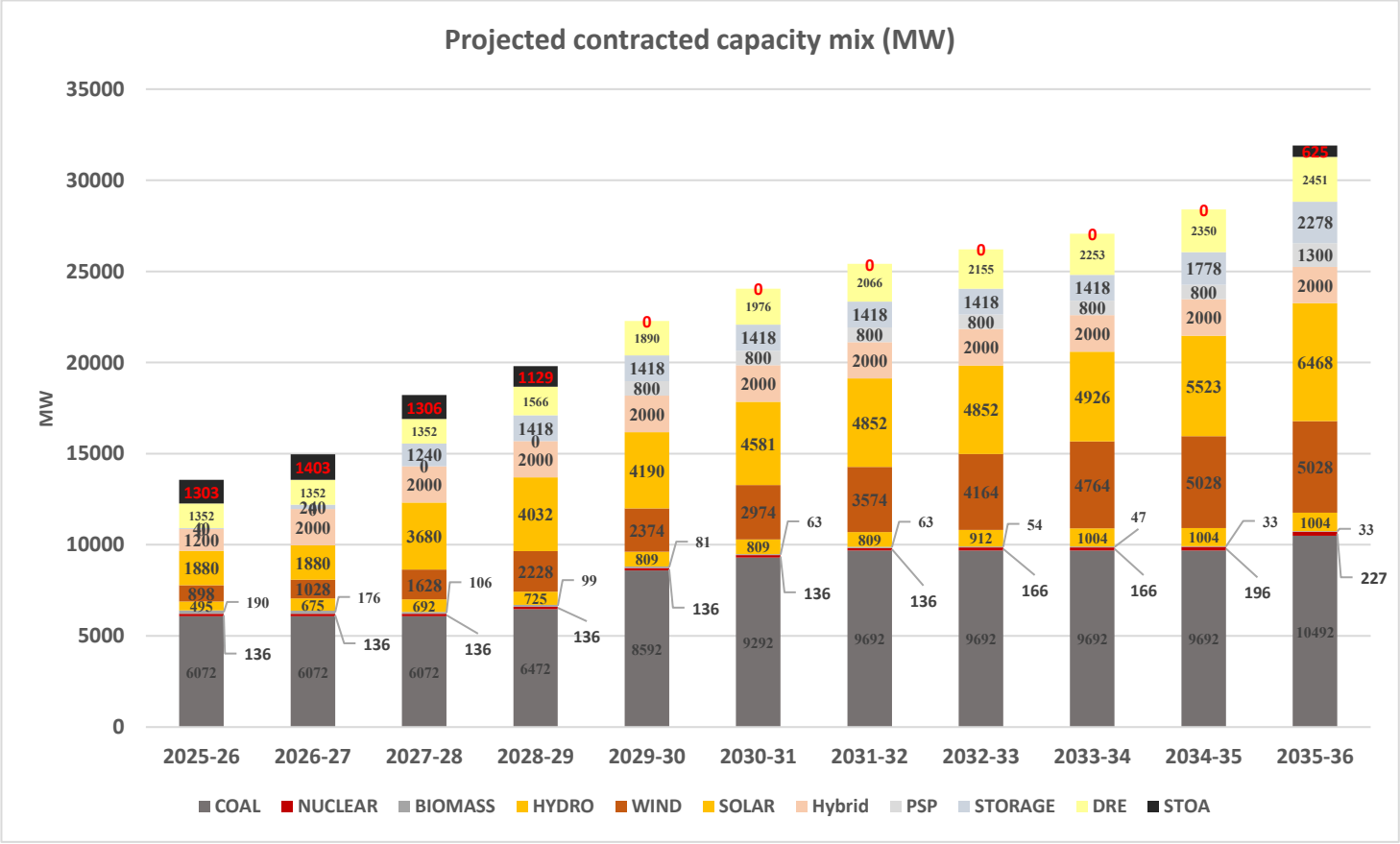

Figure 10: Year-wise Projected Contracted Capacity Mix (MW)

The SToA/MToA requirement can be fulfilled through power procurement from market or bilateral agreements. The SToA/MToA value reflects the peak value requirement and seasonal banking requirements in terms of MW.

Reliability studies have been conducted based on the projected capacity for the year 2035-36. The analysis confirms that the projected capacity meets the reliability criteria specified in the National Electricity Plan (NEP), with the Loss of Load Probability (LoLP) and Not-Served Energy (NENS) remaining within the permissible limits of 0.2% and 0.05%, respectively (as specified in the National Electricity Plan).

As per the resource adequacy studies, the likely total projected contracted capacity for the year 2035-36 is around 31,905 MW which consists of 10,492 MW from Coal; 227 MW from Nuclear; 33 MW from Biomass; 1,004 MW from hydro; 6,468 MW from Solar; 5,028 MW from Wind; 2000 MW from Hybrid: 2,451 MW from Distributed Renewable Energy (DRE) source; 1300 MW from PSP; 2,278 MW from BESS (40 MW of 3 hrs, 200 MW of 2.5 hrs and remaining 4 hrs); and 625 MW from SToA/MToA. This capacity shall be able to meet the projected electricity demand with prescribed reliability criteria. This capacity shall be able to meet the projected demand with prescribed reliability criteria and to comply with the stipulated Renewable Consumption Obligation (RCO) targets. Based on the capacity addition, the planning reserve margin works out to around 10%. The storage requirement can be met from PSP or a combination of PSP and BESS. Capacity mix required by 2035-36 is shown in Figure 11.

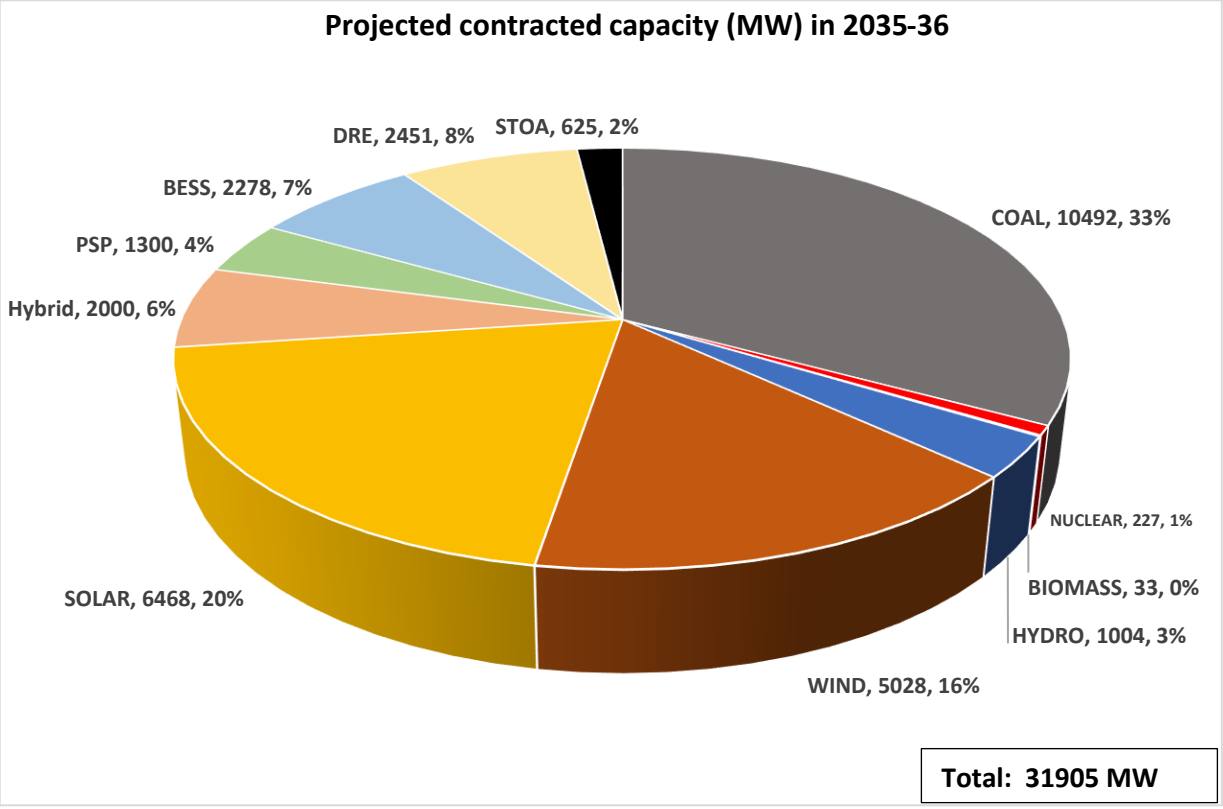

Figure 11: Contracted Capacity Mix in 2035-36

It is important to note that any deviations in the commissioning schedule of the planned capacity could result in a situation where the state is unable to meet the projected peak electricity demand and electrical

energy requirements identified in this study with the available resources. Such changes may also lead to an increase in the cost of meeting the state's power demand reliably.

As per the study, the state likely needs to contract the following capacities (planned and additional) every year till 2035-36 to meet its demand reliably as shown in Table 13.

Table 13: Year-wise Capacity Addition (in MW)

Year	Coal		Nuclear	Hydro		Solar		Hybrid
	Planned	Addl.	Planned	Planned	Addl.	Planned	Addl.	Planned
2025-26	0	0	0	60	0	700		800
2026-27	0	0	0	180	0	0		800
2027-28	0	0	0	17	0	0	1800	0
2028-29	400	0	0	33	0	0	352	0
2029-30	2120	0	0	84	0	0	158	0
2030-31	700	0	0	0	0	0	391	0
2031-32	400	0	0	0	0	0	271	0
2032-33	0	0	30	103	0	0	0	0
2033-34	0	0		92	0	0	74	0
2034-35	0	0	30.5	0	0	0	597	0
2035-36	0	800	30.5	0	0	0	945	0
Total	**3620**	**800**	**91**	**569**	**0**	**700**	**4588**	**1600**

Year	PSP		BESS		DRE		STOA
	Planned	Addl.	Planned	Addl.	Planned	Addl.	Addl.
2025-26	0	0	0		300	0	1303
2026-27	0	0	200		0	0	1403
2027-28	0	0	0	1000	0	0	1306
2028-29	0	0	0	178	0	214	1129
2029-30	800	0	0	0	0	324	0
2030-31	0	0	0	0	0	86	0
2031-32	0	0	0	0	0	90	0
2032-33	0	0	0	0	0	89	0
2033-34	0	0	0	0	0	98	0
2034-35	0	0	0	360	0	97	0
2035-36	0	500	0	500	0	101	625
Total	**800**	**500**	**200**	**2038**	**300**	**1099**	

Note: For coal, nuclear, and hydro projects, the commissioning year has been determined based on the later of the CEA records and the year reported by the state.

Allocation from Hydro plants and nuclear plants has been considered as per actual allocation order or proposed allocation.

The projected gross generation mix for the state is shown in Figure 12 and 13.

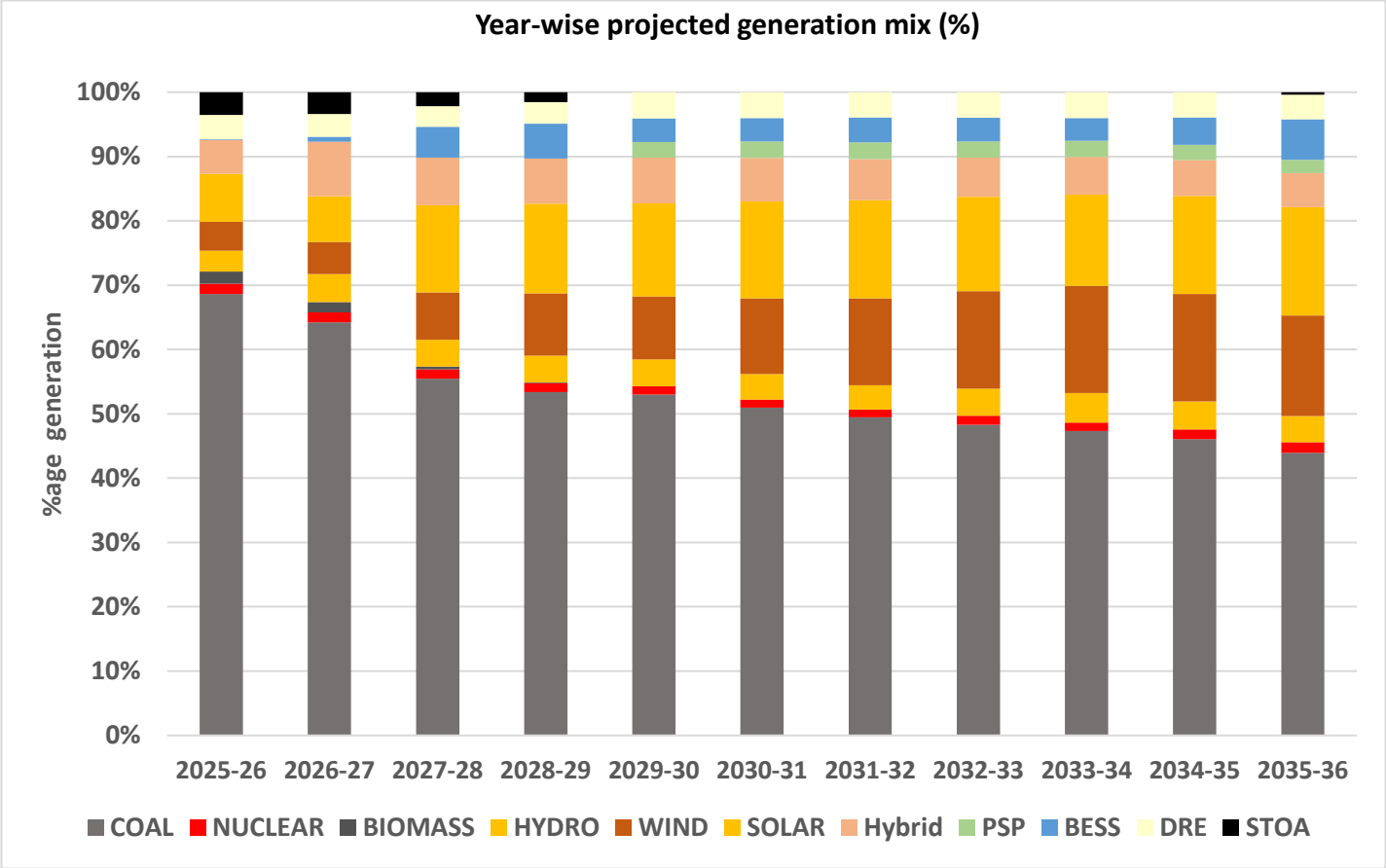

Figure 12: Year-wise projected net generation mix (in %)

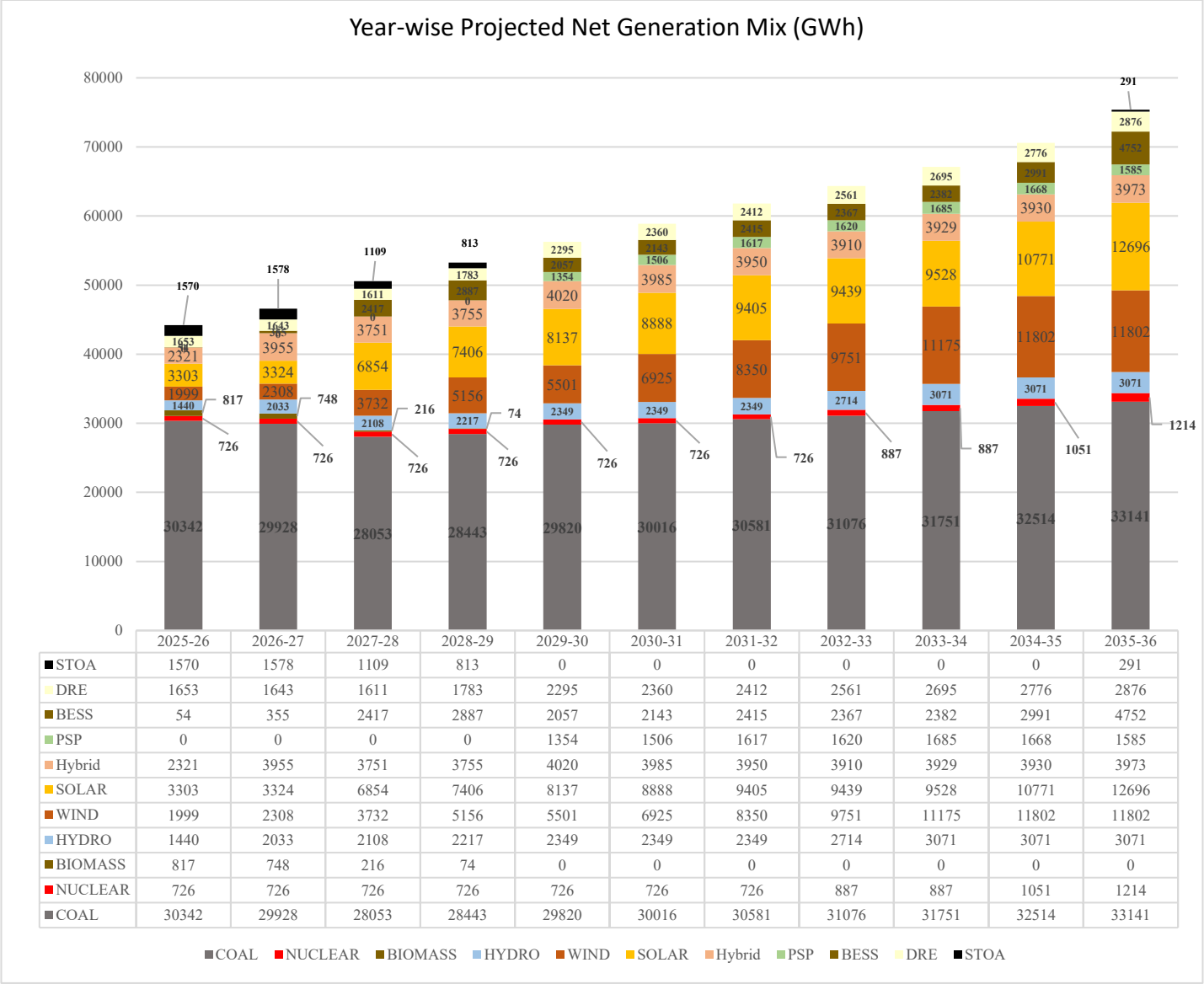

Figure 13: Year-wise projected net generation (in GWh)

7.3 Surplus Coal Capacity (in MW)

Generally, surplus capacity is available with the state due to variation in electricity demand, RE availability etc. The pattern of surplus capacities has been observed as shown in Figure 14. From the figure below, it is observed that Chhattisgarh is expected to have a minimum surplus coal-based capacity ranging between 550 MW and 1500 MW during the period from May to August and November to December respectively. This surplus capacity may be banked or shared with other states whose demand profile complements with that of Chhattisgarh.

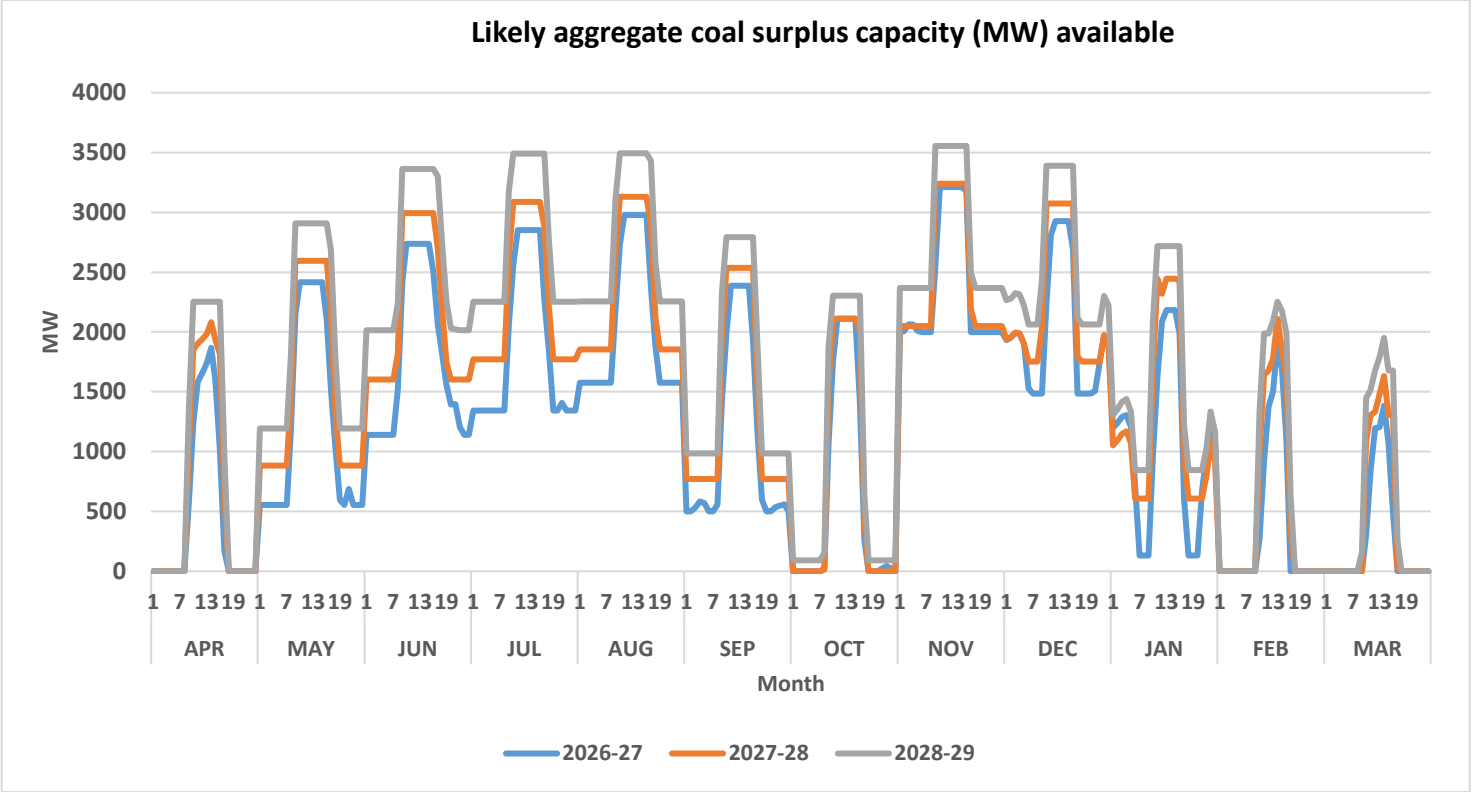

Figure 14: Surplus Coal Capacity Year-wise (MW)

8.0 Conclusions

Based on the Resource Adequacy studies of Chhattisgarh up to the year 2035-36, the following conclusions may be drawn:

1. The study has considered energy requirement projections as per the projections furnished by CSPDCL, which envisages that the annual electrical energy requirement and peak electricity demand of the state for the period 2025-26 to 2035-36 is likely to grow at a CAGR of 4.5% and 6.0% respectively. It has been observed that the peak demand season is typically from February to April, with Chhattisgarh witnessing almost same peak electricity demand during solar and non-solar hours.
2. Considering only the existing and planned capacity addition, the projected total unserved energy (ENS) for the year 2035-36 is about 3293 MUs which is about 4.8% of the energy demand in 2035-36. The state will need to contract additional Coal, Solar, Wind-based and Energy Storage capacities beyond those already planned.
3. As per the studies, the likely total projected contracted capacity for the year 2035-36 is around 31,905 MW which consists of 10,492 MW from Coal; 227 MW from Nuclear; 33 MW from Biomass; 1,004 MW from hydro; 6,468 MW from Solar; 5,028 MW from Wind; 2000 MW from Hybrid: 2,451 MW from Distributed Renewable Energy (DRE) source; 1300 MW from PSP; 2,278 MW from BESS (40 MW of 3

hrs, 200 MW of 2.5 hrs and remaining 4 hrs); and 625 MW from SToA/MToA. The storage requirement can be met from PSP or a combination of PSP and BESS.

4. In addition to the existing and already planned contracts, the state needs to tie up approximately 800 MW from Coal, 4588 MW of Solar; 4000 MW of Wind; 1099 MW of DRE; 500 MW of PSP; 2038 MW of 4-Hour Battery Energy Storage System by 2035-36 (refer Table 13). Additionally, there will be a requirement for Medium-Term Open Access (MToA) and Short-Term Open Access (SToA) ranging from around 625 to 1405 MW in different years, as detailed in the report. These MToA/SToA needs can be met through power procurement from market or through bilateral agreements. The MToA/SToA values represent capacity required to meet peak electricity demand as well as seasonal banking needs, expressed in terms of megawatts (MW). The projected capacity and generation mix outlined in the report meet the state's RCO requirements for the years 2027-28 to 2035-36.
5. As per studies, the state is expected to have a minimum surplus coal-based capacity ranging between 550 MW and 1500 MW respectively during the period from May to August and November to December. This surplus capacity may be banked or shared with other states whose demand profile complements with that of Chhattisgarh.
6. The Planning Reserve Margin (PRM) for Chhattisgarh has been assessed to be around 10%. Further, the study indicates year-wise short-term/medium-term/bilateral requirements inclusive of the PRM capacity to meet the demand optimally.
7. Timely commissioning of planned capacities is critical for ensuring that the state meets its projected peak electricity demand and electrical energy requirements reliably. Any deviation from the planned schedule may lead to resource shortfalls and could significantly increase the cost of reliably meeting the state’s power demand.

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Annexure

Details of upcoming plants considered in the study

Note: For coal, nuclear, and hydro projects, the commissioning year is determined based on the later of the CEA records and the year reported by the state.

SR. NO	POWER PLANT	Chhattisgarh's SHARE (MW)	TYPE OF GENERATION	EXPECTED COD/ REMARK
1	NTPC LARA STAGE II UNIT 1&2	800	THERMAL	400 MW FY 2028-29 400 MW FY 2029-30
2	Korba West CSPGCL (2X660 MW)	1320	THERMAL	2029-30
3	SIPAT STAGE – III	400	THERMAL	2028-29
4	NTPC, GADARWARA	300	THERMAL	2030-31
5	NTPC, Lara Stage-III	800	THERMAL	400 MW FY 2030-31 400 MW FY 2031-32
6	CHUTKA NUCLEAR POWER PROJECTS	61	NUCLEAR	30.5 MW FY 2034-35 30.5 MW FY 2035-36
7	MAHI BANSWARA NUCLEAR POWER PROJECTS	30	NUCLEAR	2032-33
8	Parbati-II	41	HYDRO	2025-26
9	SUBANSARI LOWER HEP	155	HYDRO	19.4 MW FY 2025-26 135.6 MW FY 2026-27
10	PAKALDUL HEP	23	HYDRO	2026-27
11	RATLE HEP	12	HYDRO	2028-29
12	KIRU HEP	21	HYDRO	2026-27
13	Teesta-VI HEP	17	HYDRO	2027-28
14	KWAR HEP	21	HYDRO	2028-29
15	DIBANG MULTIPURPOSE PROJECT	103	HYDRO	2032-33
16	SAWALKOT HE PROJECT	92	HYDRO	2033-34
17	SMALL HYDRO	84	HYDRO	2029-30
18	Wind	750	Wind	620 MW FY 2025-26 130 MW FY 2026-27
19	Hybrid	1600	Hybrid	800 MW FY 2025-26 800 MW FY 2026-27
20	Solar	700	Solar	2025-26
21	PSP (to be set up by CSPGCL)	800	PSP	2029-30
22	BESS	200 MW/500MWh	Battery	2026-27
23	DRE	300	DRE	2025-26
	TOTAL	**8630**		

Allocation from Hydro plants and Nuclear plants is taken as per actual allocation order or proposed allocation order.

Subansiri Lower, Unit 2 (share of Chhattisgarh: 19.4 MW) got commissioned in 2025-26.

300 MW DRE has been considered as planned as per previous study.

800 MW, MBPL is assumed to be taken as 2035-56, as the same is in CEA candidate list.

Dugar by NHPC limited is not considered in planned list because as per CEA, it is not expected to get commissioned till 2035-56.

MBPL is not considered in planned list because as per CEA, project is uncertain till 2035-36.

Assumption for Resource Adequacy Studies

1. Electricity Demand & peak requirement: As per information furnished by the State.

2. Demand Profile: Based on hourly demand profile of 2024-25.
3. Existing & Planned Capacity: As per the information shared by the state.
4. Cost parameters: based on information in National Electricity Plan.

RE CUF considered

Hydro	Wind	Solar	DRE
33-35%	26%	21-22%	14%

Technical Parameters

Technology	Type	Availability (%)	Ramping (%/min)	Min. Technical. (%)
Coal/ Lignite	Existing/Planned	85	1	55
	Candidate	88	1	55
Gas	Existing	90	5	40
Nuclear	Existing/Planned	68	Const. Load	-
Biomass	Existing/Planned	60	2	50
Hydro	Existing/Planned/ Candidate	As per available hourly generation profile	100	-
Solar	Existing/Planned		-	-
	Candidate		-	-
Wind	Existing/Planned		-	-
	Candidate		-	-
Pumped storage	Existing/Planned	95	50	-
	Candidate		50	-
Battery Energy Storage	Candidate	98	NA	-

Technology	Type	Heat Rate (MCal/MWh)		Aux. Consum. (%)	Min. online time (hr)	Min. offline time (hr)
		At max loading	At min loading			
Coal	Existing/ Planned	2300 to 2879	2438 to 3052	7.0	6	4
	Candidate (SC & USC)	2060 to 2125	2183 to 2253	6.5	6	4
Gas	Existing	2000 to 2900	2260 to 3277	2.5	4	3
Nuclear	Existing/ Planned	2777	2777	10	6	4
	Candidate	2777	2777	10	-	-

Technology	Type	Heat Rate (MCal/MWh)		Aux. Consum. (%)	Min. online time (hr)	Min. offline time (hr)
		At max loading	At min loading			
Biomass	Existing/ Planned	4200	4450	8	6	4
	Candidate	4200	4450	8	6	4
Hydro	Existing/ Planned	-	-	0.7	-	-
	Candidate	-	-	0.7	-	-
Pumped Storage	Existing/ Planned	-	-	Round trip efficiency 80 %	-	-
	Candidate	-	-		-	-
Battery Energy Storage	Candidate	-	-	Round trip efficiency 88%	-	-

Transmission Parameters

A single node has been considered for the purpose of study with all generating units and demand connected to the node. No transmission bottleneck has been considered for the study. Interstate ATC limit has not been considered in the study.

Financial Parameters

Following cost parameters have been assumed:

Resource	Capex (in ₹/MW)	O&M Fixed Cost (in ₹/MW)	Construction Time (in years)	Amortization /Life time (in years)
Coal	12 Cr	30 Lakh	4	25
Solar	4.5 to 4.0 Cr	1 % of Capex	1	25
Wind	7.5 Cr	1 % of Capex	2	25
Battery Energy Storage System (4-Hour)	4.98 Cr to 3.00 Cr	5.9 Lakh	1	14
PSP (6 Hour)	6 Cr	30 Lakh	4	40