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Report on
Resource Adequacy Plan (Generation)
for
MSEDCL (DISCOM-Maharashtra)
(2026-27 to 2035-36)
(Version 3.0)

April, 2026

Government of India
Ministry of Power
Central Electricity Authority

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Disclaimer

This Resource Adequacy Study for MSEDCL has been conducted based on data and inputs provided by the MSEDCL. The findings, analysis and conclusions presented in this report are contingent upon the accuracy, completeness and timeliness of the information furnished by the MSEDCL. 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 MSEDCL 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 DISCOM.

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 electrical energy consumption of designated consumers must be met from renewable energy sources.

To support the DISCOM in fulfilling this requirement, CEA, initially carried a Resource Adequacy (RA) study with a planning horizon up to FY 2033-34, based on the data provided by MSEDCL 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 DISCOM and planning assumptions. The RCO requirement for the DISCOM 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 MSEDCL, as furnished by MSEDCL, are projected to increase with a CAGR of 5.2% and 5.3% respectively from 2026-27 to 2035-36. However, as per 20th EPS projections, the electricity energy requirement and peak electricity demand for MSEDCL is projected to increase with a CAGR of 3.8% and 4.3% respectively from 2026-27 to 2035-36. The study has been done considering the electricity demand projections furnished by MSEDCL. For satisfying resource adequacy i.e., meeting the electricity demand reliably and at affordable cost, the DISCOM 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 MSEDCL, 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 26,601 MUs, accounting for around 9.1 % of the projected electrical energy requirement for that year.

To find out the least cost option for generation capacity expansion for the period 2026-27 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 MSEDCL 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 1,28,744 MW which consists of 27,477 MW from Coal; 1,077 MW from Gas; 1,191 MW from Nuclear; 3,601 MW from Biomass; 3,445 MW from hydro; 39,754 MW from Solar; 2,631 MW from Wind; 11,344 MW from Hybrid; 1,468 MW from FDRE, 12,232 MW from Distributed Renewable Energy (DRE) source; 13,274 MW from PSP; 9,750 MW from BESS; and 1500 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 Discom in fulfilling the Resource Adequacy Guidelines and complying with the Renewable consumption Obligation (RCO) notification, CEA has carried out the RA study for the Discom, MSEDCL, based on inputs furnished by MSEDCL. 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 Discom 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 Discom up to FY 2033-34, based on data furnished by the Discom 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 2033-34)

1. In the earlier Resource Adequacy (RA) study, financial year 2022-23 had been considered as the base year, and the study covered the period from 2024-25 to 2033-34. The fuel-wise contracted capacity of MSEDCL as on 31st March, 2023, is 35,328 MW as given in Figure 1.

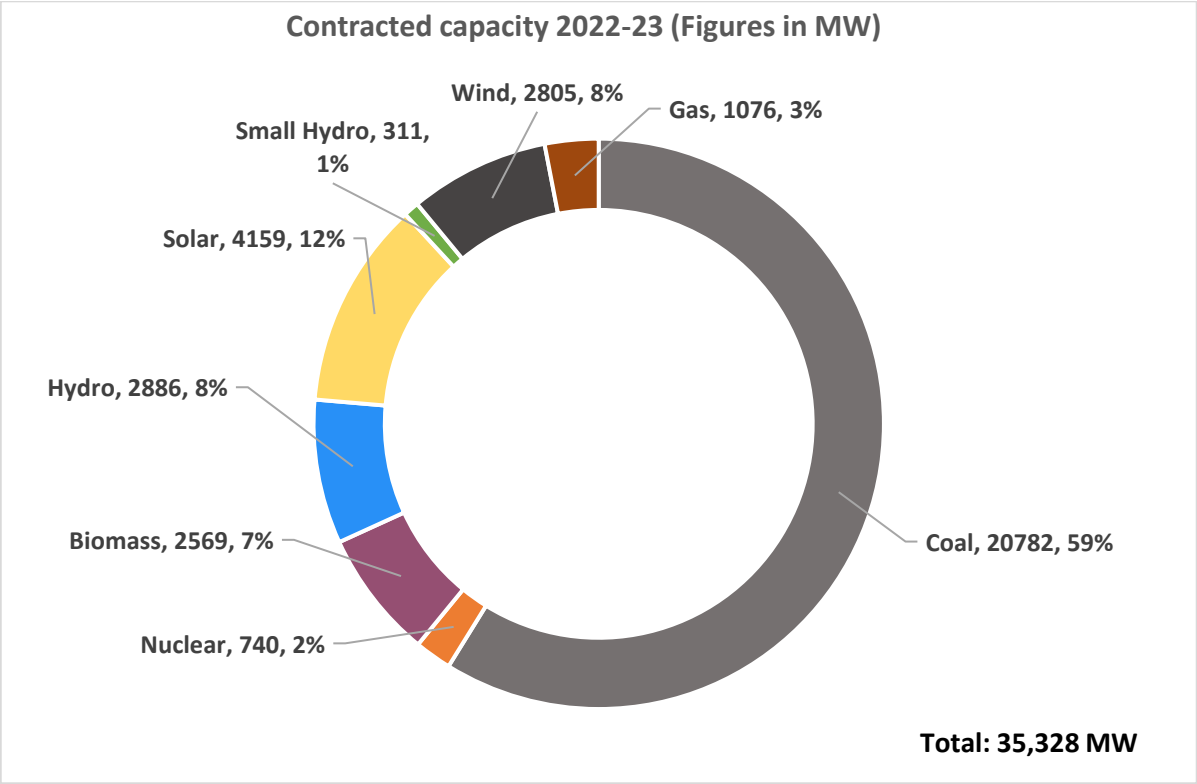


Figure 1: Fuel-wise Contracted Capacity (in MW) as on 31st March, 2023

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 MSEDCL

	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34
Electrical Energy Projections (MU)	167746	175261	183949	192180	200590	210874	216301	221229	230034	239511
Year on Year Growth		4.48%	4.96%	4.47%	4.38%	5.13%	2.57%	2.28%	3.98%	4.12%
Peak Electricity Demand Projections (MW)	24963	27621	30892	34298	35596	37163	38726	39000	40414	41956
Year on Year Growth		10.65%	11.84%	11.02%	3.79%	4.40%	4.20%	0.71%	3.63%	3.82%

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 (MW)

Year	Coal	Gas	Nuclear	Biomass	Hydro	Wind	Solar	PSP	Storage (4 Hours)	STOA	DRE	Total
2024-25	22442	1076	1186	2749	2812	3405	10658	574	0	2482	2052	**49437**
2025-26	22442	1076	1186	3439	2812	3905	17068	574	0	3310	3001	**58813**
2026-27	22442	1076	1186	3439	2921	5405	21568	574	378	2359	4050	**65399**
2027-28	22442	1076	1186	3439	3234	6905	25068	574	853	1687	5171	**71635**
2028-29	22670	1076	1186	3439	3338	8405	26285	574	1180	2057	6379	**76589**
2029-30	25275	1076	1186	3439	3338	9905	26285	574	1180	1117	7737	**81113**
2030-31	25894	1076	1186	3439	3338	11405	27285	574	1320	1250	8818	**85585**
2031-32	26018	1076	1186	3439	3626	12905	28285	574	1411	1218	9922	**89660**
2032-33	26560	1076	1186	3439	3949	14405	29285	574	1755	1487	11254	**94970**
2033-34	27562	1076	1186	3439	3949	15905	30285	574	2094	1457	12694	**100222**

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

FY	Thermal		Nuclear	Hydro		Solar		Wind		Biomass	Storage (4 Hours)	Yearly STOA	DRE	Total	
	Planned	Additional	Planned	Planned	Additional	Planned	Additional	Planned	Additional	Planned	Additional	Additional	Additional	Planned	Additional
2024-25	1660	0	223	183	0	4943	0	500	0	76	0	2482	2052	**7585**	**4534**
2025-26	0	0	0	0	0	6410	0	500	0	690	0	3310	949	**7600**	**4259**
2026-27	0	0	0	109	0	4000	500	0	1500	0	378	2359	1049	**4109**	**5786**
2027-28	0	0	0	313	0	3000	500	0	1500	0	475	1687	1121	**3313**	**5283**
2028-29	228	0	0	104	0	717	500	0	1500	0	327	2057	1208	**1049**	**5592**
2029-30	3564	42	0	0	0	0	0	0	1500	0	0	1117	1358	**3564**	**4017**
2030-31	0	619	0	0	0	0	1000	0	1500	0	140	1250	1081	**0**	**5590**
2031-32	0	124	0	288	0	0	1000	0	1500	0	91	1218	1103	**288**	**5036**
2032-33	0	542	0	323	0	0	1000	0	1500	0	344	1487	1332	**323**	**6205**
2033-34	0	1002	0	0	0	0	1000	0	1500	0	339	1457	1440	**0**	**6738**
Total	**5452**	**2329**	**223**	**1320**	**0**	**19070**	**5500**	**1000**	**12000**	**766**	**2094**		**12693**	**27831**	

3.0 RA Study for MSEDCL (from 2026-27 to 2035-36)

3.1 Present Power Scenario in MSEDCL

The actual peak electricity demand and electrical energy requirement for MSEDCL from 2022-23 to 2024-25 is given in Table 4.

Table 4: Peak Electricity Demand and Electrical Energy Requirement

Year	Actual Electrical Energy Requirement (in BU)	Actual Peak Electricity Demand (in MW)
2022-23	157	23648
2023-24	171	24038
2024-25	173	26002

As per the data provided by MSEDCL, as of March 2026, the total contracted capacity of MSEDCL is 47,495 MW. Out of the total contracted capacity (CC), the share of non-fossil fuel-based CC is around 50 %. The fuel-wise contracted capacity as on March, 2026 is given in Table 5 and Figure 2.

Table 5: Fuel-wise Contracted Capacity as on March 2026

Source	Contracted Capacity (MW)	Percentage
Coal	22467	47.3
Gas	1077	2.3
Biomass	2780	5.9
Nuclear	1191	2.5
Hydro (including small hydro)	2998	6.3
Wind	2631	5.5
Solar	8424	17.7
Hybrid	355	0.7
DRE	5232	11.0
PSP	250	0.5
BESS	90	0.2
Total	**47495**	**100**

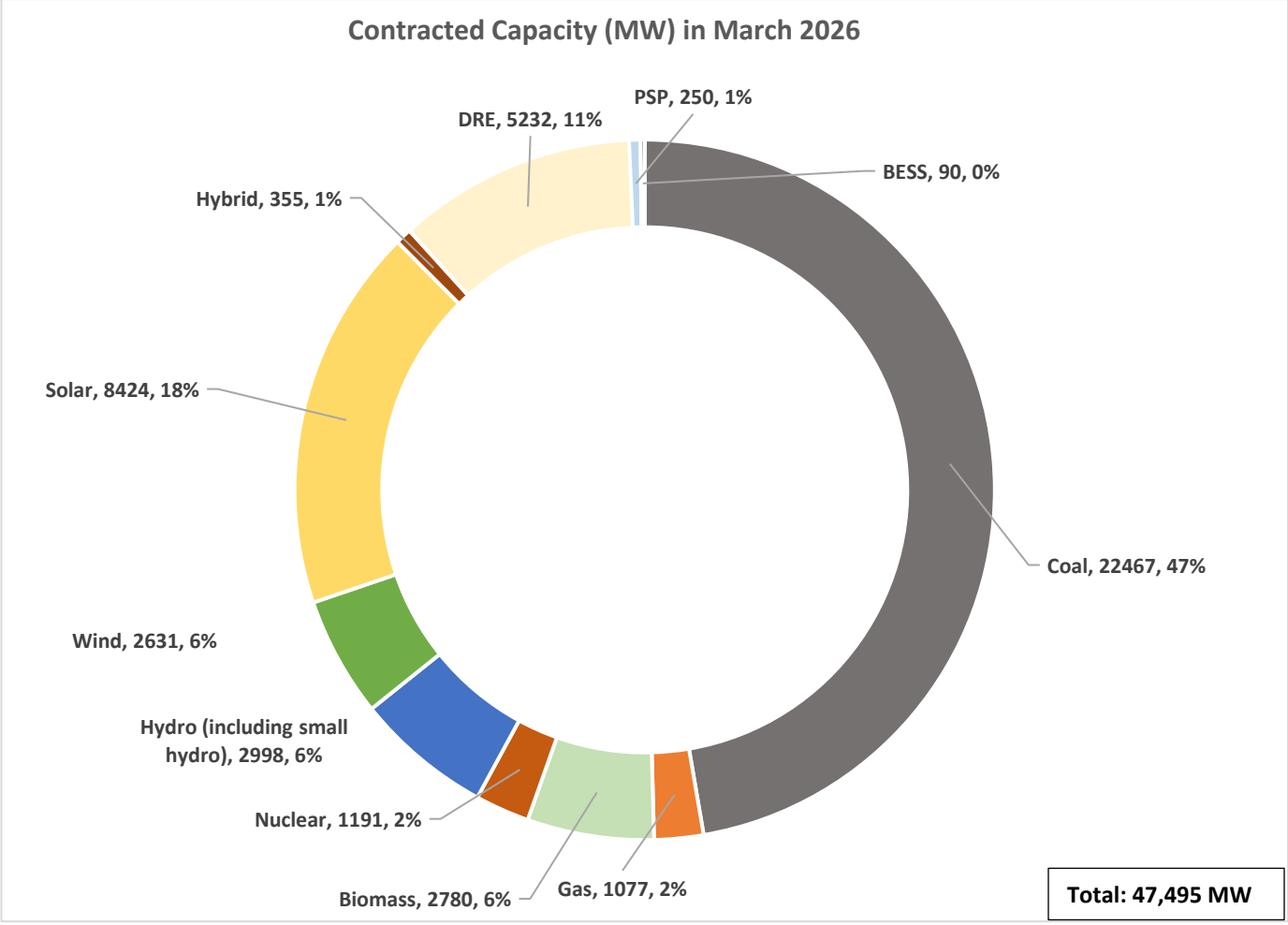


Figure 2: Fuel-wise Contracted Capacity (in MW) as on 31st March, 2026

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 MSEDCL is typically during the months from January to April. MSEDCL witnesses peak electricity demand during solar hours. The month-wise average hourly demand observed for the year 2024-25 is shown in Figure 3.

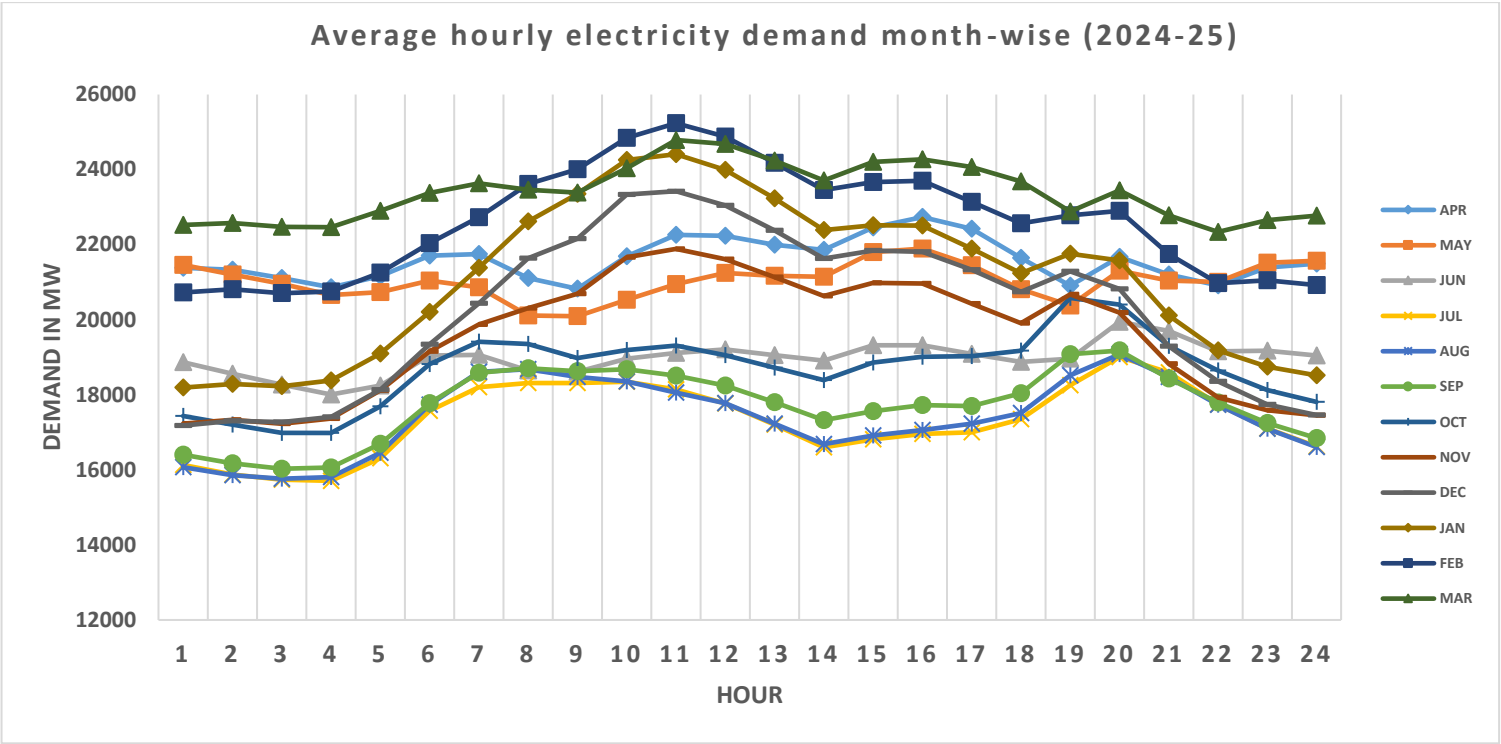


Figure 3: Average Hourly Electricity Demand Variation (Month-wise) for 2024-25

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

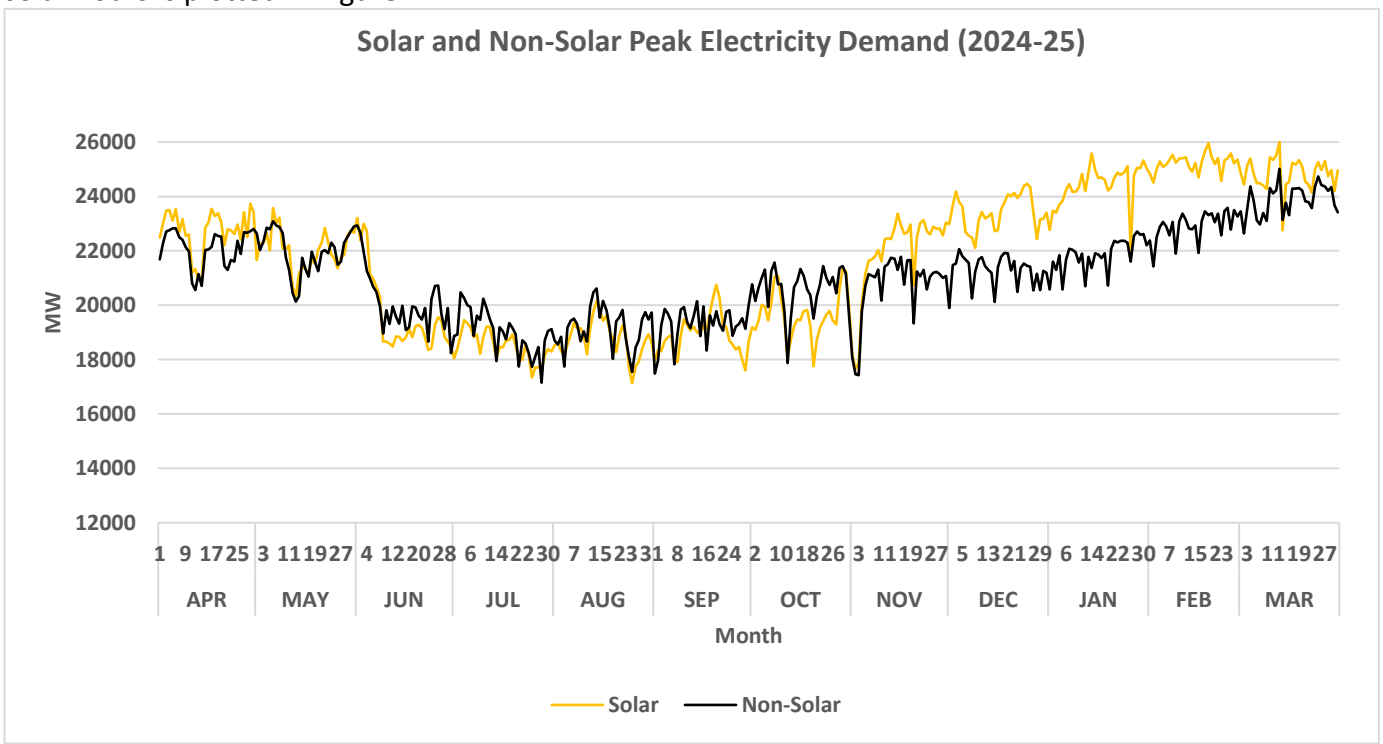


Figure 4: Solar and non-solar peak electricity demand in MW for the year 2024-25

The hourly electricity 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.

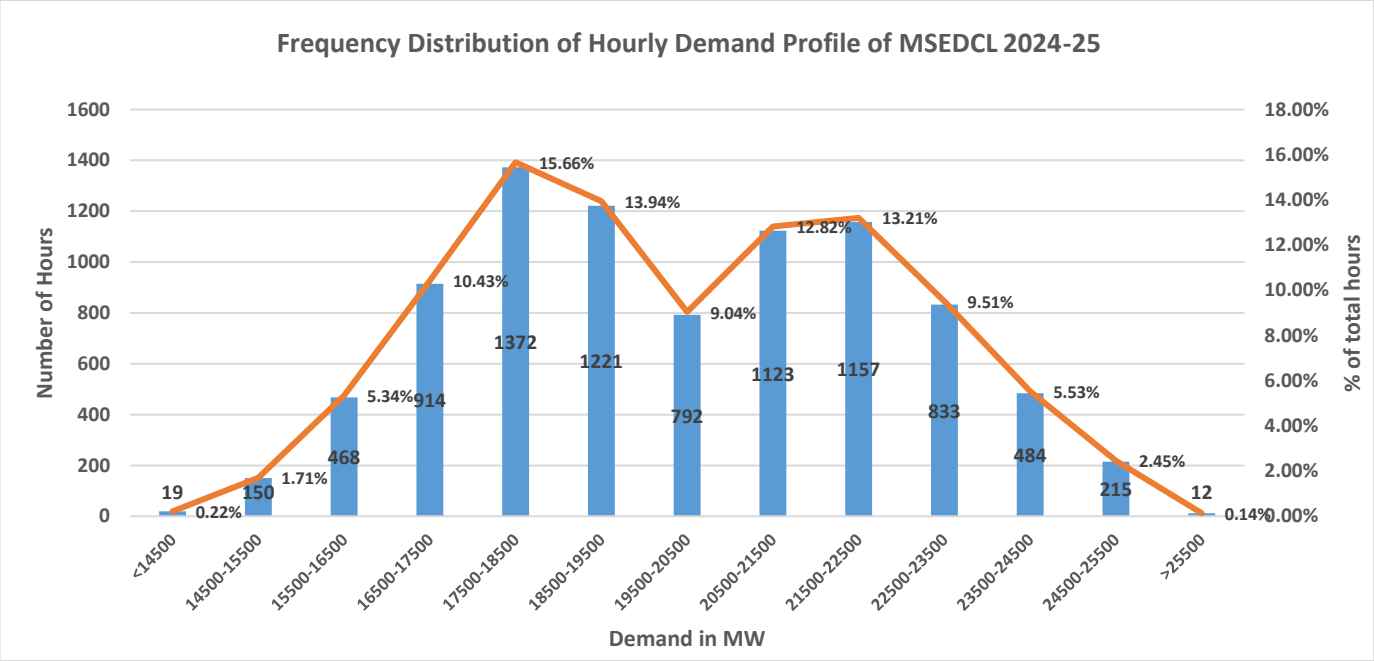


Figure 5: Frequency Distribution of Hourly Demand Profile of 2024-25

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.

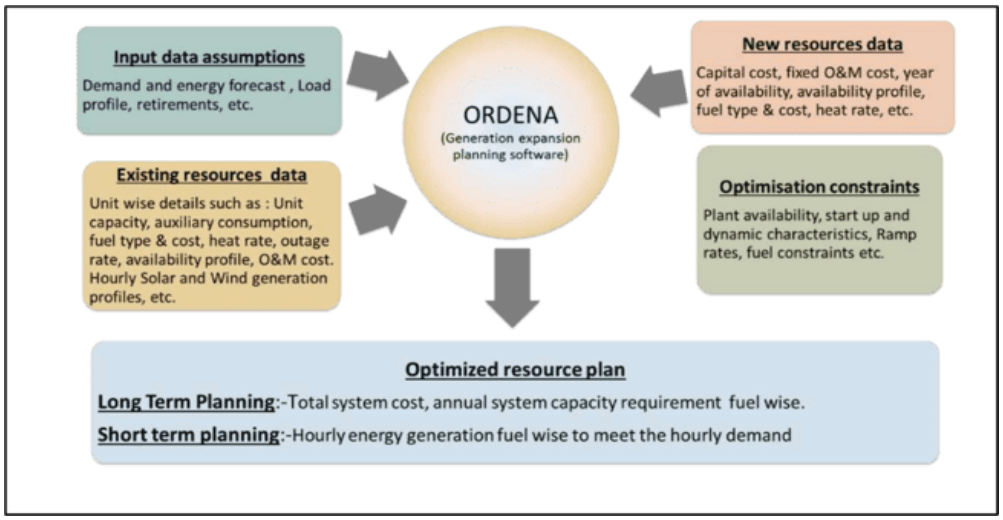


Figure 6: Schematic Diagram

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.

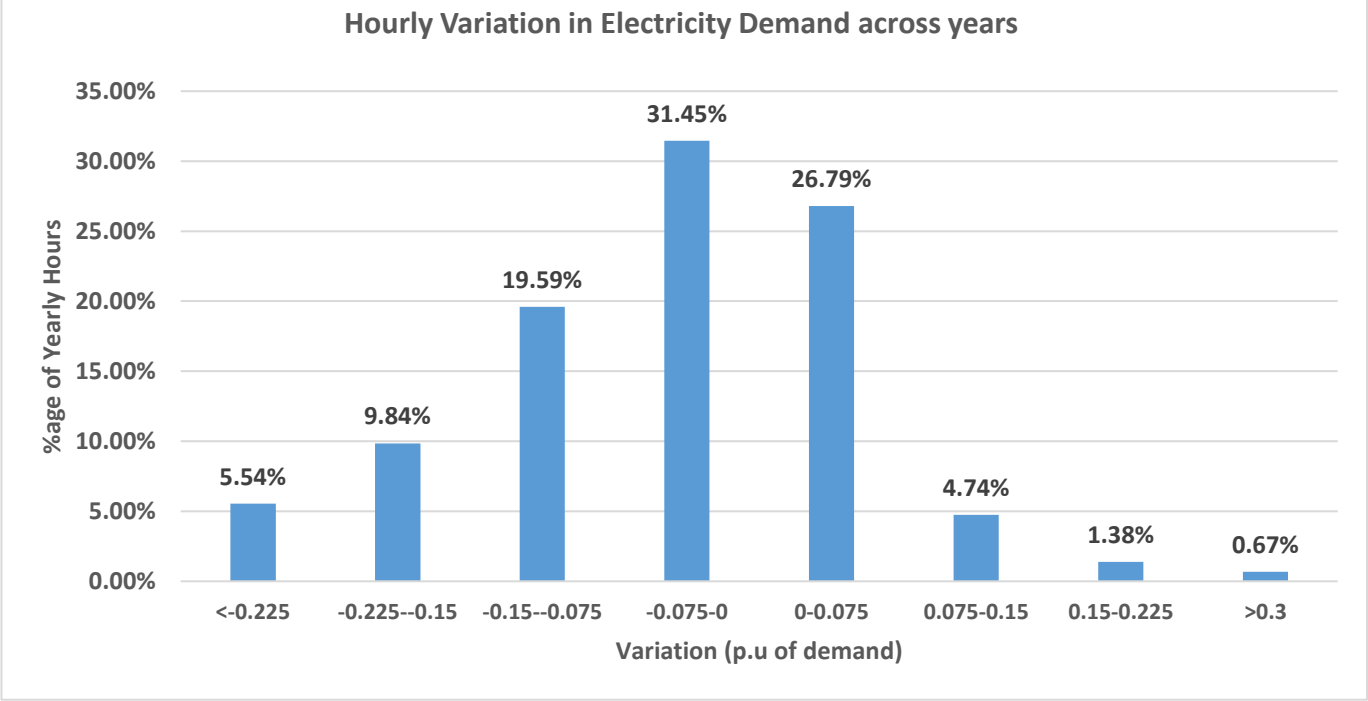


Figure 7: Hourly Variation in electricity demand across years

It can be observed that the hourly demand typically varies within ±7.5% for ~58.2% 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 ±7.5% 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 MSEDCL as per the Discom and as per 20th EPS Report is given in Table 6.

Table 6: Electricity demand projection

Year	Projections by MSEDCL		Projections as per 20th EPS	
	Peak Electricity Demand (MW)	Electrical Energy Requirement (MU)	Peak Electricity Demand (MW)	Electrical Energy Requirement (MU)
2026-27	27566	185387	32271	183949
2027-28	30792	193432	33897	192180
2028-29	31917	201970	35573	200590
2029-30	33170	211519	37601	210874
2030-31	34657	222848	38781	216301
2031-32	36303	235225	39884	221229
2032-33	38077	248401	41689	229986
2033-34	40008	262662	43576	239090
2034-35	42006	277373	45548	248554
2035-36	44028	292122	47609	258392

Electricity demand projections as per the MSEDCL have been considered in the study as the peak electricity demand as per MSEDCL takes into account the adjustment in agriculture demand.

ii) Future demand profile till the year 2035-36 has been taken as provided by MSEDCL after adjusting agriculture shifting.

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 MSEDCL. 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	Biomass	Hydro (Conventional/ Small)	Solar	FDRE	Hybrid	PSP (MW/MWh)	BESS (MW/MWh)	DRE
2026-27	0	131	129	7806	470	1089	0	660/1320	1000
2027-28	0	345	209	5068	580	1750	0	2000/4000	1000
2028-29	1600	345	57	4056	0	950	1750/14000	0	1000
2029-30	603	0	63	5200	0	200	1750/14000	0	1000
2030-31	1600	0	0	0	0	0	324/2268	0	500
2031-32	0	0	0	0	418	0	0	0	500
2032-33	0	0	313	0	0	0	0	0	500
2033-34	0	0	0	0	0	0	0	0	500
2034-35	0	0	0	0	0	0	0	0	500
2035-36	0	0	0	0	0	0	0	0	500
Total	**3803**	**821**	**771**	**22130**	**1468**	**3989**	**3824/30268**	**2660/5320**	**7000**

Note: For coal 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 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.	**2026-27**	1.97	1.34	29.94	2.70	35.95
2.	**2027-28**	2.45	1.42	31.64	3.30	38.81
3.	**2028-29**	2.95	1.42	33.10	3.90	41.36
4.	**2029-30**	3.48	1.33	34.02	4.50	43.33
5.	**2030-31**	41.00			4.50	45.50
6.	**2031-32**	42.50			4.50	47.00
7.	**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
2026-27	3526	2399	53593	59518
2027-28	4583	2656	59182	66420
2028-29	5770	2777	64739	73286
2029-30	7139	2728	69786	79653
2030-31	88750			88750
2031-32	97257			97257
2032-33	106003			106003
2033-34	115325			115325
2034-35	124655			124655
2035-36	134296			134296

DISCOM with its existing and envisaged future capacity additions will not be able to meet its RCO requirements from 2031-32 onwards.

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 26,601 MUs which is about 9.1% 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.

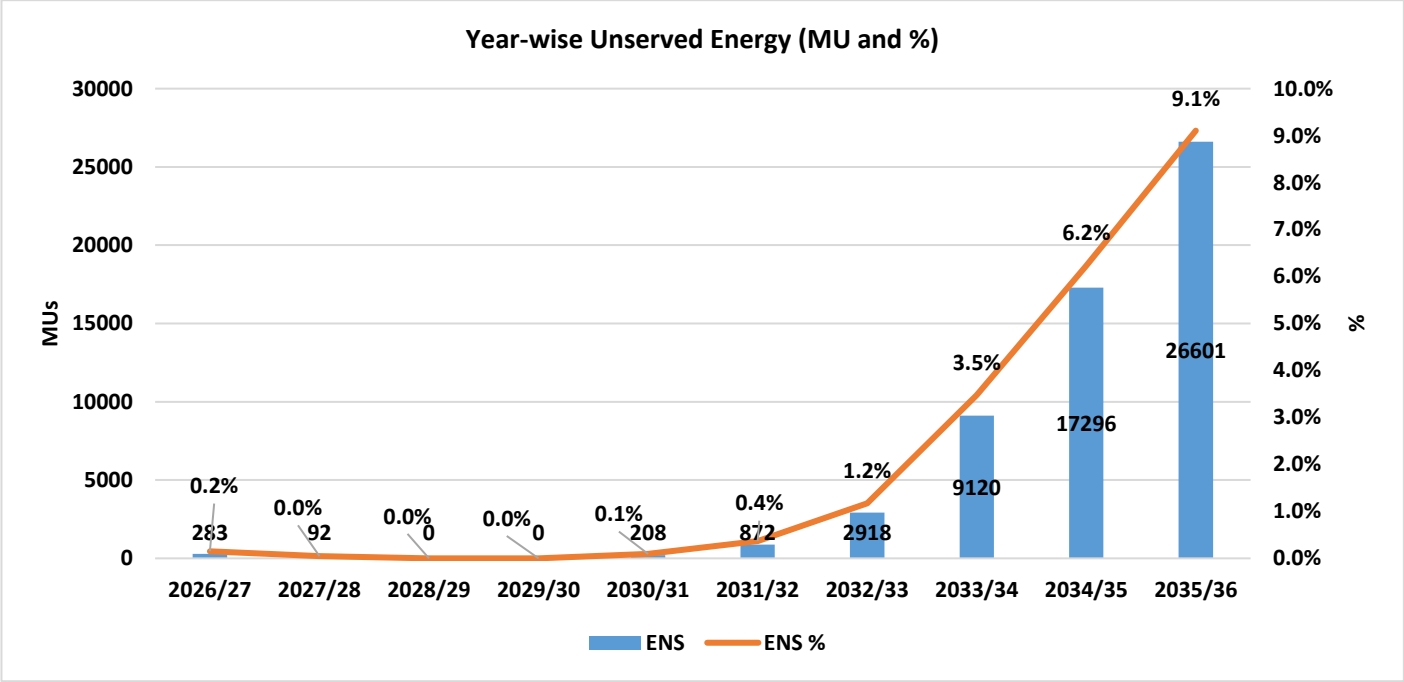


Figure 8: Yearly likely unserved energy (in MU) with the existing and planned capacities

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 (existing and planned) is unable to meet the electricity demand in almost all the months. Details are shown in Figure 9.

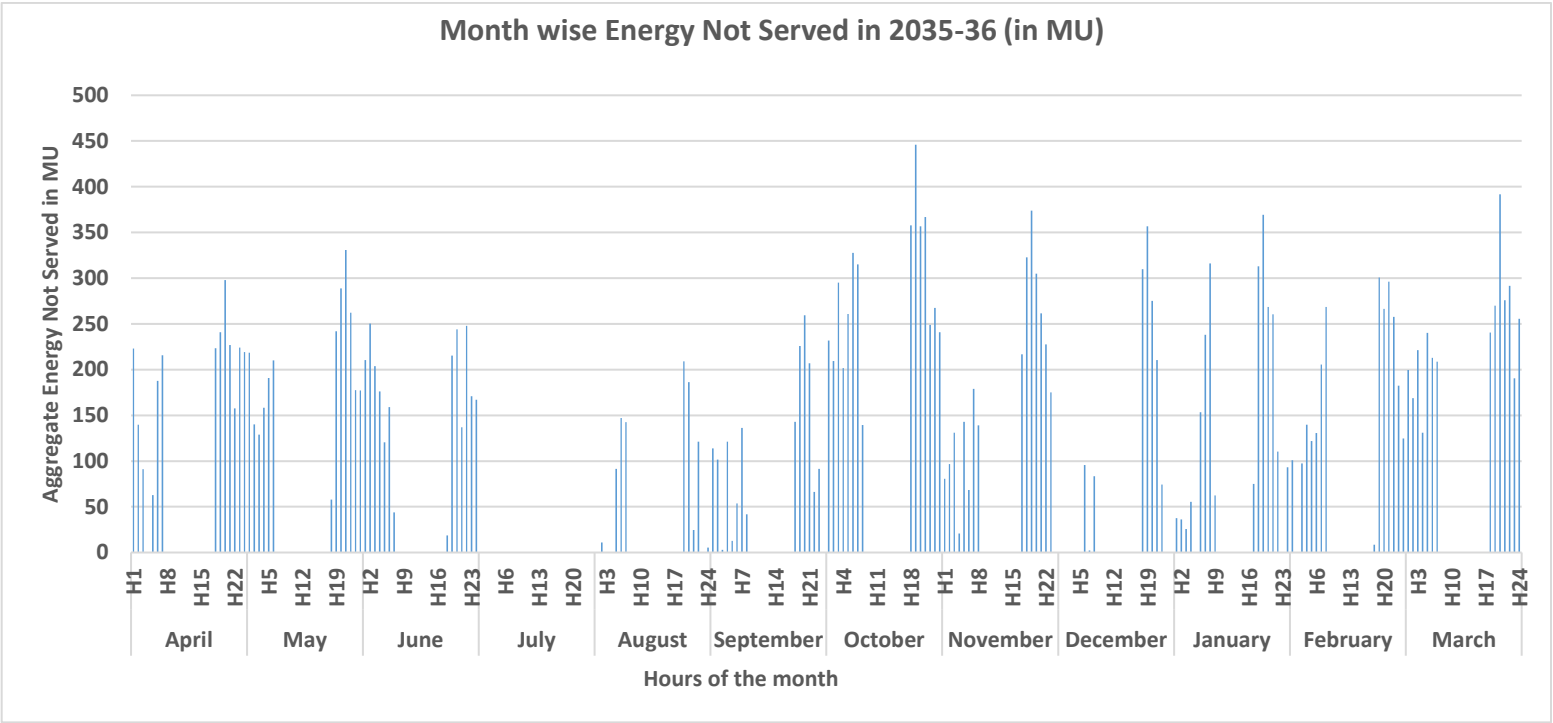


Figure 9: Block-wise Unserved Energy Pattern MWh (2035-36)

From the above figure, it can be seen that unserved energy is typically observed during non-solar hours in almost every month in 2035-36.

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 MSEDCL are given in Table 11.

Table 11: Year-wise contracted capacity projections (existing, planned, to be tied up) (in MW)

Year	Coal	Gas	Nuclear	Biomass	Hydro	Wind	Solar	Hybrid	PSP	Battery	DRE	FDRE	STOA	Total
2026-27	22467	1077	1191	2911	3127	2631	16230	1444	250	750	6232	470	1883	**60662**
2027-28	22467	1077	1191	3256	3336	2631	21298	3194	250	2750	7232	1050	487	**70218**
2028-29	24067	1077	1191	3601	3393	2631	25354	4144	2000	2750	8232	1050	0	**79489**

2029-30	24670	1077	1191	3601	3456	2631	30554	4344	3750	2750	9232	1050	0	**88305**
2030-31	25277	1077	1191	3601	3132	2631	30554	4344	4074	2750	9732	1050	480	**89892**
2031-32	25277	1077	1191	3601	3132	2631	31554	4344	5274	3750	10232	1468	1500	**95030**
2032-33	25277	1077	1191	3601	3445	2631	32554	5844	7774	4750	10732	1468	1500	**101843**
2033-34	25562	1077	1191	3601	3445	2631	34854	7344	10274	5750	11232	1468	1500	**109929**
2034-35	26467	1077	1191	3601	3445	2631	37154	9344	12274	7250	11732	1468	1500	**119133**
2035-36	27477	1077	1191	3601	3445	2631	39754	11344	13274	9750	12232	1468	1500	**128744**

The projected contracted capacity mix, year-wise, is given in Figure 10 and Figure 11.

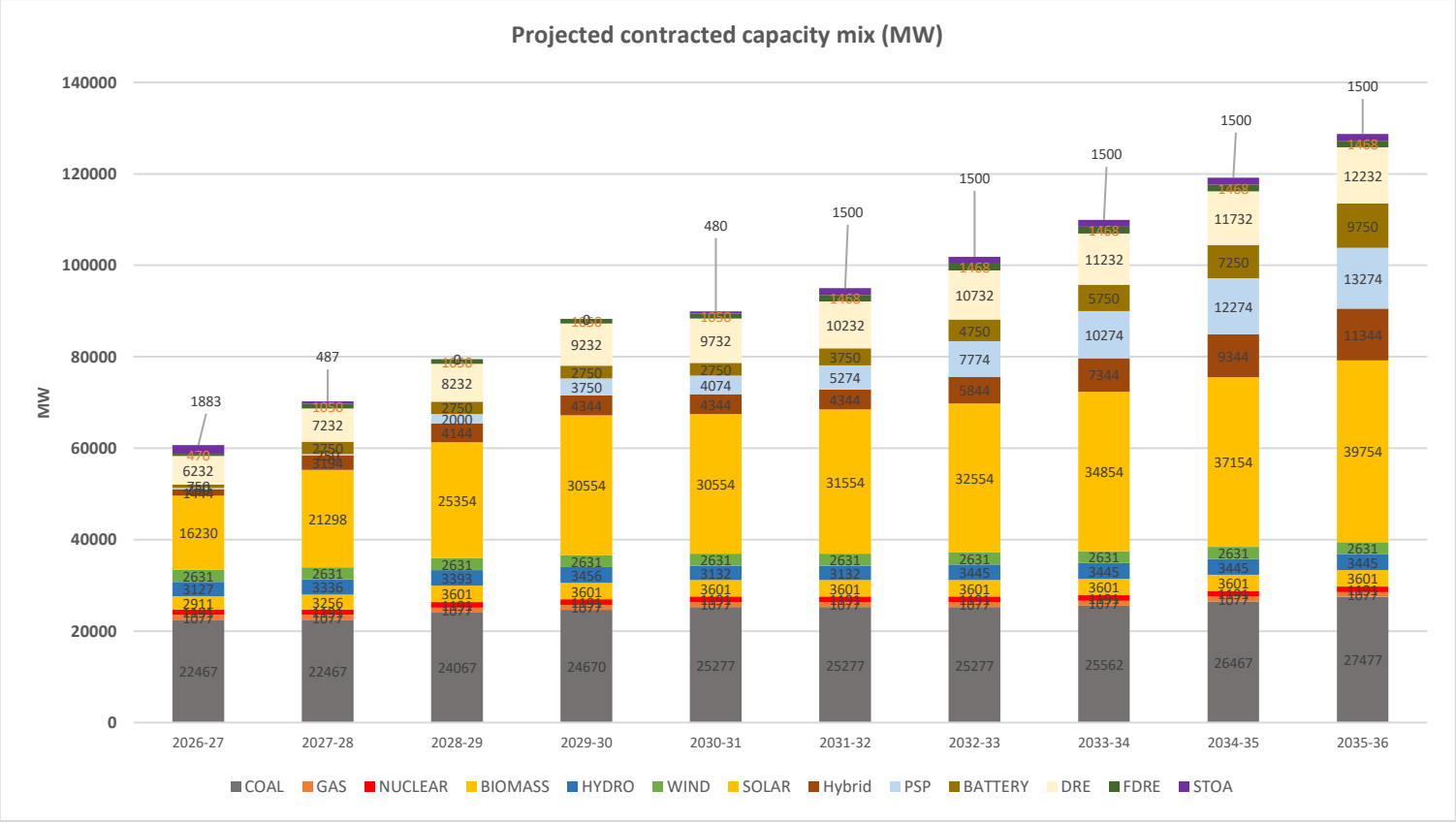


Figure 10: Year-wise Projected Contracted Capacity Mix (MW)

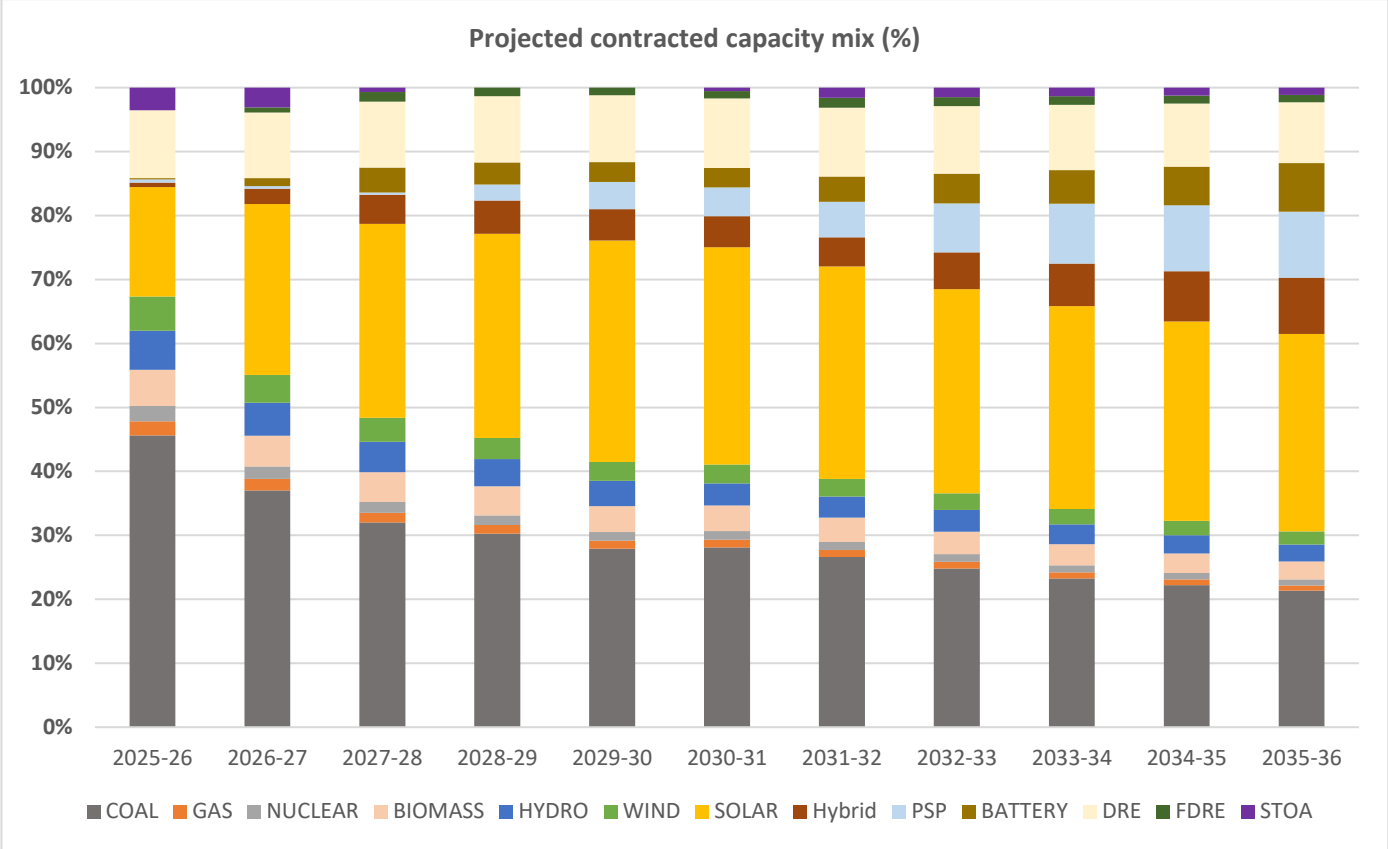


Figure 11: Year-wise projected contracted capacity (in %)

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.

The share of non-fossil fuel-based capacity in the entire contracted capacity mix is likely to increase to about 77% from about 50% as on March 2026 reflecting substantial transition towards clean energy resources. 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 Normalised Energy Not-Served (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 1,28,744 MW which consists of 27,477 MW from Coal; 1,077 MW from Gas; 1,191 MW from Nuclear; 3,601 MW from Biomass; 3,445 MW from hydro; 39,754 MW from Solar; 2,631 MW from Wind; 11,344 MW from Hybrid; 1,468 MW from FDRE; 12,232 MW from Distributed Renewable Energy (DRE) source; 13,274 MW from PSP; 9,750 MW from BESS; and 1,500 MW from SToA/MToA. 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 be around 12%. The projected Capacity mix required by 2035-36 is shown in Figure 12.

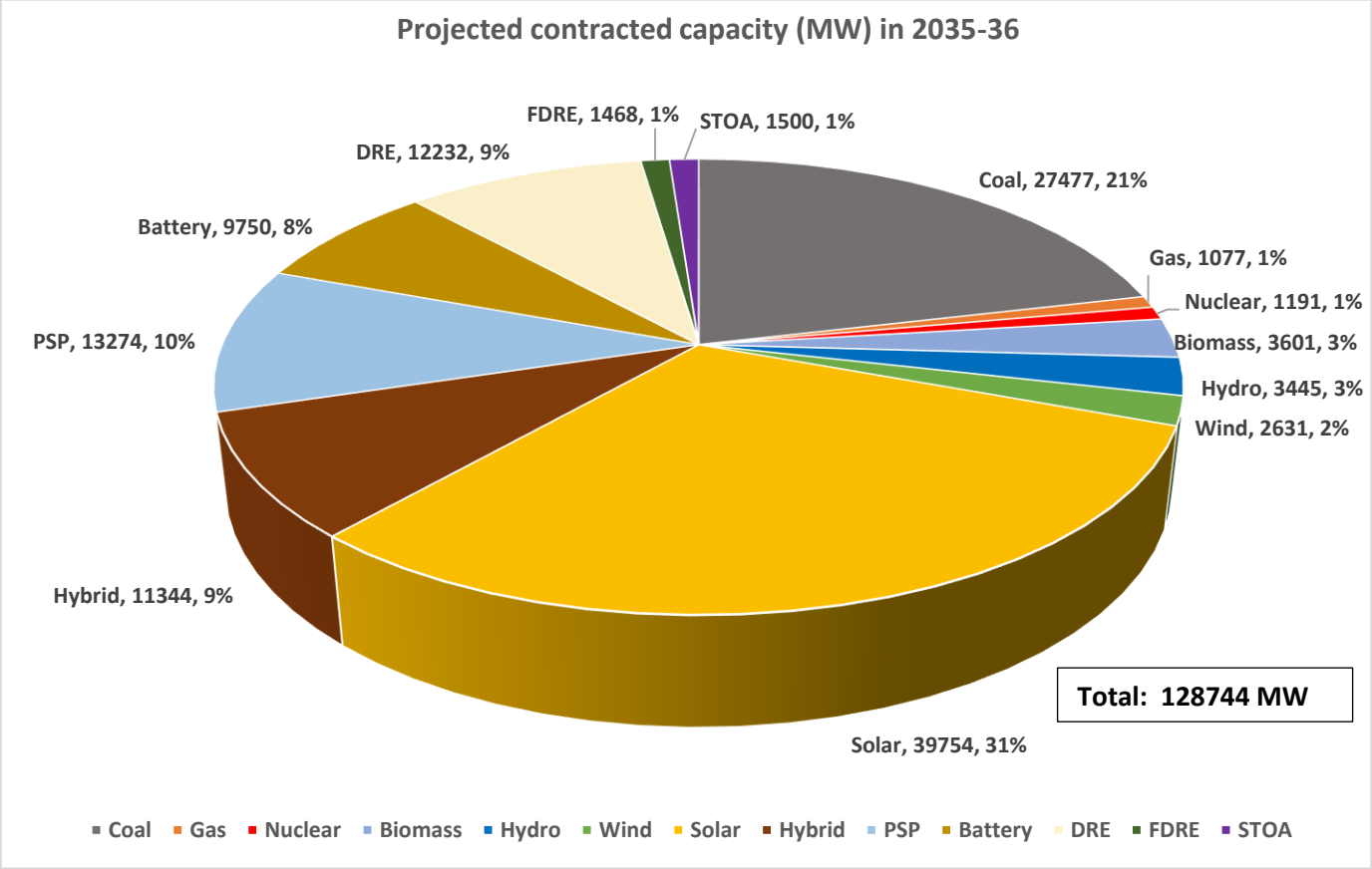


Figure 12: Contracted Capacity Mix in 2035-36

It is important to note that any deviations in the commissioning schedule of the planned capacity could result in a situation where the Discom 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 Discom's power demand reliably.

As per the study, the Discom likely needs to contract the following capacities (planned and additional) every year till 2035-36 to meet its demand reliably as shown in Table 12.

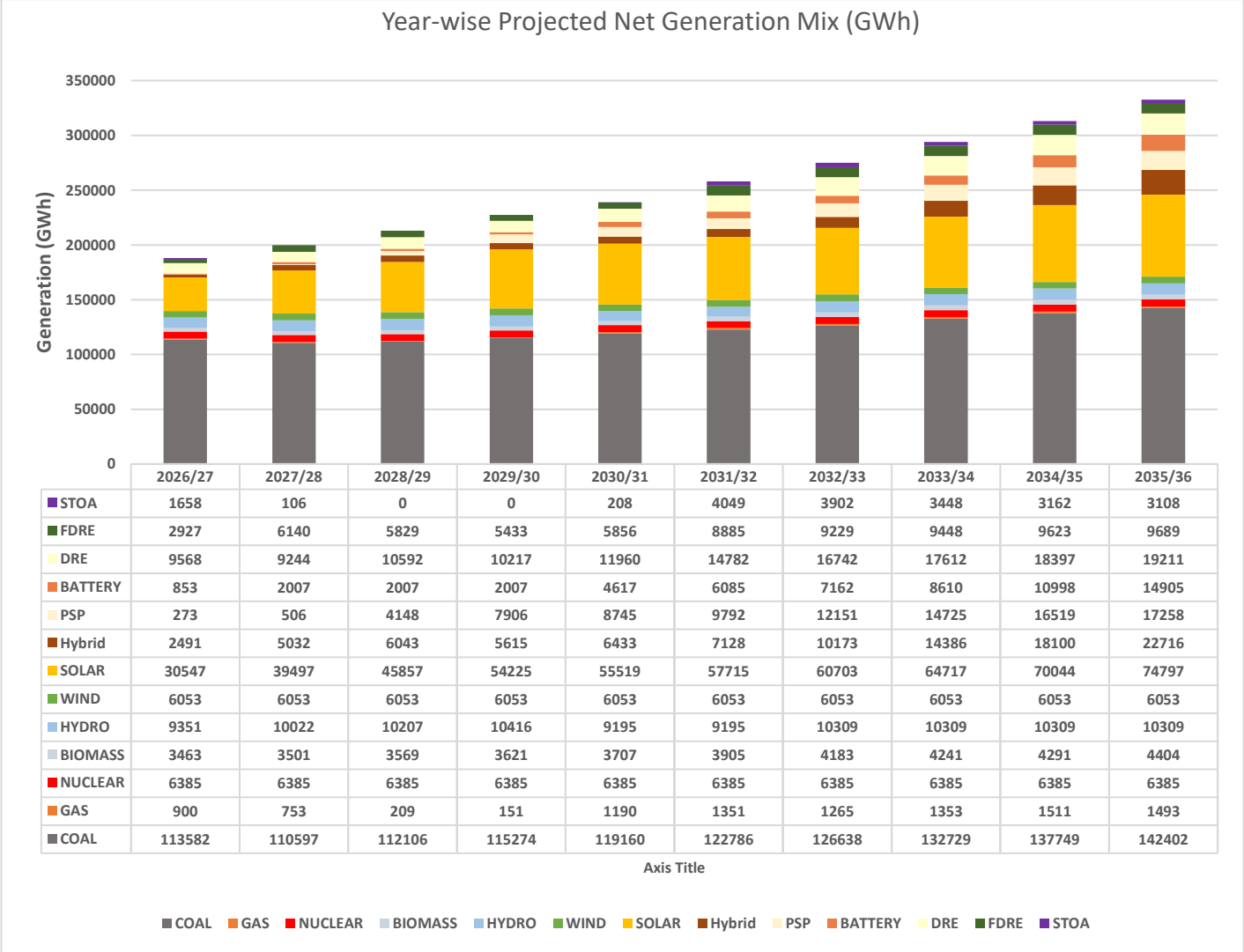
Table 12: Year-wise Capacity Addition (in MW)

Year	Coal		Biomass	Hydro	Solar		Hybrid	
	Planned	Addl.	Planned	Planned	Planned	Addl.	Planned	Addl.
2026-27	0	0	131	129	7806	0	1089	0
2027-28	0	0	345	209	5068	0	1750	0
2028-29	1600	0	345	57	4056	0	950	0
2029-30	603	0	0	63	5200	0	200	0
2030-31	1600	0	0	0	0	0	0	0
2031-32	0	0	0		0	1000	0	0
2032-33	0	0	0	313	0	1000	0	1500
2033-34	0	286	0	0	0	2300	0	1500
2034-35	0	905	0	0	0	2300	0	2000
2035-36	0	1010	0	0	0	2600	0	2000
Total	**3803**	**2200**	**821**	**771**	**22130**	**9200**	**3989**	**7000**

Year	FDRE	PSP (6 hrs) (MW/MWh)		BESS (MW/MWh)		DRE	STOA
	Planned	Planned	Addl.	Planned (2 Hrs)	Addl. (4 Hrs)	Planned	Addl.
2026-27	470	0	0	660/1320	0	1000	1739
2027-28	580	0	0	2000/4000	0	1000	1883
2028-29	0	1750/14000	0	0	0	1000	487
2029-30	0	1750/14000	0	0	0	1000	0
2030-31	0	324/2268	0	0	0	500	0
2031-32	418	0	1200	0	1000	500	480
2032-33	0	0	2500	0	1000	500	1500
2033-34	0	0	2500	0	1000	500	1500
2034-35	0	0	2000	0	1500	500	1500
2035-36	0	0	1000	0	2500	500	1500
Total	**1468**	**3824/30268**	**9200/55200**	**2660/5320**	**7000/28000**	**7000**	

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 has been considered as per actual allocation order or proposed allocation.

The projected gross generation mix for the Discom is shown in Figure 13.



	2026/27	2027/28	2028/29	2029/30	2030/31	2031/32	2032/33	2033/34	2034/35	2035/36
STOA	1658	106	0	0	208	4049	3902	3448	3162	3108
FDRE	2927	6140	5829	5433	5856	8885	9229	9448	9623	9689
DRE	9568	9244	10592	10217	11960	14782	16742	17612	18397	19211
BATTERY	853	2007	2007	2007	4617	6085	7162	8610	10998	14905
PSP	273	506	4148	7906	8745	9792	12151	14725	16519	17258
Hybrid	2491	5032	6043	5615	6433	7128	10173	14386	18100	22716
SOLAR	30547	39497	45857	54225	55519	57715	60703	64717	70044	74797
WIND	6053	6053	6053	6053	6053	6053	6053	6053	6053	6053
HYDRO	9351	10022	10207	10416	9195	9195	10309	10309	10309	10309
BIOMASS	3463	3501	3569	3621	3707	3905	4183	4241	4291	4404
NUCLEAR	6385	6385	6385	6385	6385	6385	6385	6385	6385	6385
GAS	900	753	209	151	1190	1351	1265	1353	1511	1493
COAL	113582	110597	112106	115274	119160	122786	126638	132729	137749	142402

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

7.3 Surplus Coal Capacity (in MW)

Generally, surplus capacity is available with the Discom 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 MSEDCL is expected to have a minimum surplus coal-based capacity ranging between 1600 MW and 4700 MW during the period from July to September in 2026-27. This surplus capacity may vary in different years as reflected in Figure 14 depending on the anticipated capacity addition and demand growth. The surplus capacity may be banked or shared with other states/Discoms whose demand profile complements with that of MSEDCL.

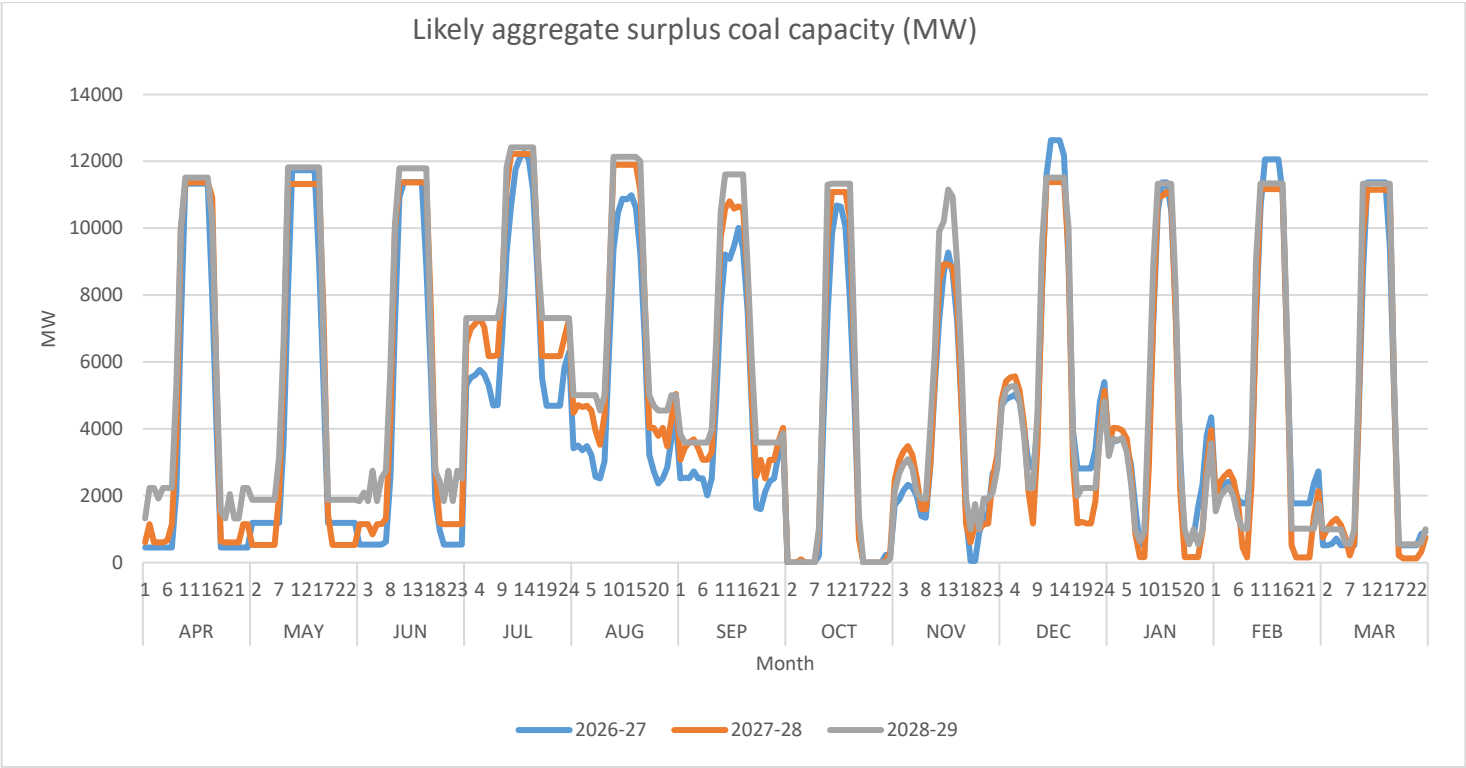


Figure 14: Surplus Coal Capacity Year-wise (MW)

8.0 Conclusions

Based on the Resource Adequacy studies of MSEDCL 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 MSEDCL, which envisages that the annual electrical energy requirement and peak electricity demand of the Discom for the period 2026-27 to 2035-36 is likely to grow at a CAGR of 5.2% and 5.3% respectively. It has been observed that the peak demand season is typically during the months from January to April, with MSEDCL witnessing peak electricity demand during solar hours.
2. Considering only the existing and planned capacity addition, the projected total unserved energy (ENS) for the year 2035-36 is about 26601 MUs which is about 9.1% of the energy demand in 2035-36. The Discom will need to contract additional Coal, Solar, Hybrid-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 1,28,744 MW which consists of 27,477 MW from Coal; 1077 MW from Gas, 1191 MW from Nuclear; 3601 MW from Biomass; 3445 MW from hydro; 39,754 MW from Solar; 2,631 MW from Wind; 11,344 MW from Hybrid; 1,468 MW from FDRE; 12,232 MW from Distributed Renewable Energy (DRE) source; 13,274 MW from PSP; 9,750 MW from BESS; and 1,500 MW from SToA/MToA.

4. In addition to the existing and already planned contracts, the Discom needs to tie up approximately 2200 MW from Coal; 9,200 MW of Solar; 7,000 MW of Hybrid; 9,200 MW of PSP (6 Hours); 7,000 MW of 4-Hour BESS by 2035-36 (refer Table 12). Additionally, there will be a requirement for Medium-Term Open Access (MToA) and Short-Term Open Access (SToA) ranging from around 1500 to 1890 MW in different years, as detailed in the report. These MToA/SToA requirements 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 2026-27 to 2035-36. The storage requirement can be met from a combination of PSP and BESS.
5. As per studies, the Discom is expected to have a minimum surplus coal-based capacity ranging between 1600 MW and 4700 MW during the period from July to September in 2026-27. This surplus capacity may be banked or shared with other states/Discoms whose demand profile complements with that of MSEDCL.
6. The Planning Reserve Margin (PRM) for MSEDCL has been assessed to be around 12%. 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 Discom 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 Discom’s power demand.

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Annexure

Details of upcoming plants considered in the study

SR. NO	POWER PLANT	MSEDCL's SHARE (MW)	TYPE OF GENERATION	EXPECTED COD/ REMARK
1	Raipur Ext TPP	1600	THERMAL	2028-29
2	NTPC LARA STAGE II UNIT 1&2	228	THERMAL	2029-30
3	SIPAT STAGE – III	264	THERMAL	2029-30
4	NTPC, GADARWARA Stage-II	111	THERMAL	2029-30
5	Thermal Tender	1600	THERMAL	2030-31
6	Biomass	821	Biomass	131 MW FY 2026-27 345 MW FY 2027-28 345 MW FY 2028-29
7	SUBANSARI LOWER HEP	129	HYDRO	2026-27
8	PAKALDUL HEP	100	HYDRO	2027-28
9	KIRU HEP	109	HYDRO	2027-28
10	KWAR HEP	54	HYDRO	2028-29
11	SMALL HYDRO	3	HYDRO	2028-29
12	RATLE HEP	63	HYDRO	2029-30
13	HEO HEP	25		2032-33
14	DIBANG MULTIPURPOSE PROJECT	288	HYDRO	2032-33
15	JSW PHSP (8 Hours)	1500	PSP	750 MW FY 2028-29 750 MW FY 2029-30
16	Torrent Power Ltd PHSP (8 Hours)	2000	PSP	1000 MW FY 2028-29 1000 MW FY 2029-30
17	Sardar Sarovar (7 Hours)	324	PSP	2030-31
18	FDRE	1468	Wind	470 MW FY 2026-27 580 MW FY 2027-28 418 MW FY 2031-32
19	Hybrid	3989	Hybrid	1089 MW FY 2026-27 1750 MW FY 2027-28 950 MW FY 2028-29 200 MW FY 2029-30
20	Solar	22130	Solar	7806 MW FY 2026-27 5068 MW FY 2027-28 4056 MW FY 2028-29 5200 MW FY 2029-30
21	BESS (2 hours)	2660	Battery	660 MW FY 2026-27 2000 MW FY 2027-28
22	DRE	7000	DRE	1000 MW FY 2026-27 1000 MW FY 2027-28 1000 MW FY 2028-29 1000 MW FY 2029-30 500 MW FY 2030-31 500 MW FY 2031-32 500 MW FY 2032-33 500 MW FY 2033-34 500 MW FY 2034-35 500 MW FY 2035-36
	TOTAL	**46466**		

Note: 1) 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.

2) Allocation from Hydro plants is taken as per actual allocation order or proposed allocation order. As per proposed allocation, MSEDCL will not have allocation from Luhri and Sunni HEP

3) From 2030–31 onwards, 324 MW of pumped storage capacity (PSP) from Sardar Sarovar will be commissioned. Consequently, this capacity will be deducted from the existing hydro capacity. The current installed hydro capacity from Sardar Sarovar is 391.5 MW and will therefore be reduced to 67.5 MW from 2030–31 onwards.

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	Hybrid	FDRE	DRE
33-35%	26%	22-23%	23-24%	75-76%	18%

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	10	-
Solar	Existing/Planned		-	-
	Candidate		-	-
Wind	Existing/Planned		-	-
	Candidate		-	-
Hybrid	Existing/Planned		-	-
	Candidate		-	-
Pumped storage	Existing/Planned	95	10	-
	Candidate		10	-
Battery Energy Storage	Candidate	98	NA	-

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

Technology	Type	Heat Rate (MCal/MWh)		Aux. Consum. (%)
		At max loading	At min loading	
Biomass	Existing/ Planned	4200	4450	8
	Candidate	4200	4450	8
Hydro	Existing/ Planned	-	-	0.7
	Candidate	-	-	0.7
Pumped Storage Projects	Existing/ Planned	-	-	Round trip efficiency 80 %
	Candidate	-	-	
Battery Energy Storage System	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
Hybrid	7 Cr	1 % of Capex	2	25
Battery Energy Storage System (2-Hour)	2.5 Cr to 1.5 Cr	3 Lakh	1	15
Battery Energy Storage System (4-Hour)	4.98 Cr to 3.00 Cr	6 Lakh	1	15
PSP (6 Hour)	6 Cr	30 Lakh	4	40