सत्यमेव जयते

Report on Resource Adequacy Plan (Generation) for Meghalaya (2025-26 to 2035-36) (Version 2.0)

Government of India
Ministry of Power
Central Electricity Authority

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Disclaimer

This Resource Adequacy Study for the state of Meghalaya has been conducted based on data and inputs provided by the Meghalaya Power Distribution Company Limited (MePDCL). The findings, analysis and conclusions presented in this report are contingent upon the accuracy, completeness and timeliness of the information furnished by MePDCL. 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 MePDCL 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 rests entirely with MePDCL.

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 undertake a Resource Adequacy Plan (RAP) with a 10-year planning horizon, LT-DRAP to meet its own peak and electrical energy requirements. 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 Renewable Purchase Obligation (RPO) trajectory up to 2029-30 vide gazette notification dated 20th October 2023, which mandates that a specified portion of energy consumption must be met from renewable energy sources.

To support the utility in fulfilling this requirement, CEA, initially carried a Resource Adequacy (RA) study with a planning horizon up to FY 2031-32, based on the data available with CEA and NERPC and in compliance with the RPO trajectory specified in the then Ministry of Power's Office Memorandum dated 22nd July 2022. 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 RPO requirement for the utility has also been assessed in accordance with the recent gazette notified trajectory.

The electricity energy requirement and peak demand for Meghalaya, as furnished by MePDCL, are projected to increase with a CAGR of 4.3% and 3.0% respectively from 2025-26 to 2035-36. However, as per mid-term review of 20th EPS projections, the electricity energy requirement and peak demand for Meghalaya is projected to increase with a CAGR of 5.6% and 4.6% respectively from 2025-26 to 2035-36. The study has been done considering the demand projections furnished by MePDCL, as the projections from MePDCL are more aligned with the past peak demand and electrical energy requirement of the state. 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 battery 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 Meghalaya, based on existing contracted capacity and planned capacity additions, indicates that the available capacity may be insufficient to meet the projected future demand. In particular, the total unserved energy in the year 2035–36 is estimated to be approximately 0.83 BU, accounting for around 24% of the projected annual energy demand 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 with an objective to minimize the total system cost of generation including the cost of anticipated future investments while fulfilling all the technical/financial 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, RE 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 plans of the Meghalaya along with RPO constraints for solar and DRE technologies. The Renewable capacities have been assessed in view of adherence to RPO 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 at every instance. Based on the study, the likely total projected contracted capacity for the year 2035-36 is around 1,730 MW which consists of 197 MW from coal, 131 MW from gas, 783 MW from hydro, 395 MW from solar, 64 MW from Distributed Renewable Energy (DRE) source. Further, in addition to this, 160 MW of MToA/SToA arrangement will be required. This capacity shall be able to meet the projected 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 in long term, medium term, and short-term basis.

Further, Ministry of Power vide notification dated 20th October, 2023, had notified the RPO trajectory for the states/Discoms. Based on the trajectory specified, hydro, wind and other (solar, biomass etc.) RPO 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 RPO targets.

To support the utility in fulfilling the Resource Adequacy Guidelines and complying with the Renewable Purchase Obligation (RPO) notification, CEA has carried out the RA study for the state of Meghalaya based on inputs furnished by MePDCL. The study recommends an optimal resource mix up to FY 2035-36, taking into account technical and financial parameters associated with various capacities. It aims to optimize long-term power procurement while ensuring resource adequacy to meet demand on a 24×7 basis, considering variations in demand, RE generation, and forced outages 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 2031-32, based on data available with CEA and in accordance with the then RPO trajectory specified in the then Ministry of Power's Office Memorandum dated 22nd July 2022.

2.0 Highlights of the Previous RA Study (Up to FY 2031–32)

1. In the earlier Resource Adequacy (RA) study, financial year 2022-23 has been considered as the base year, and the study covered the period from 2023-24 to 2031-32. The fuel-wise contracted capacity by MePDCL as on 31st March, 2023 is given in Fig. 1.

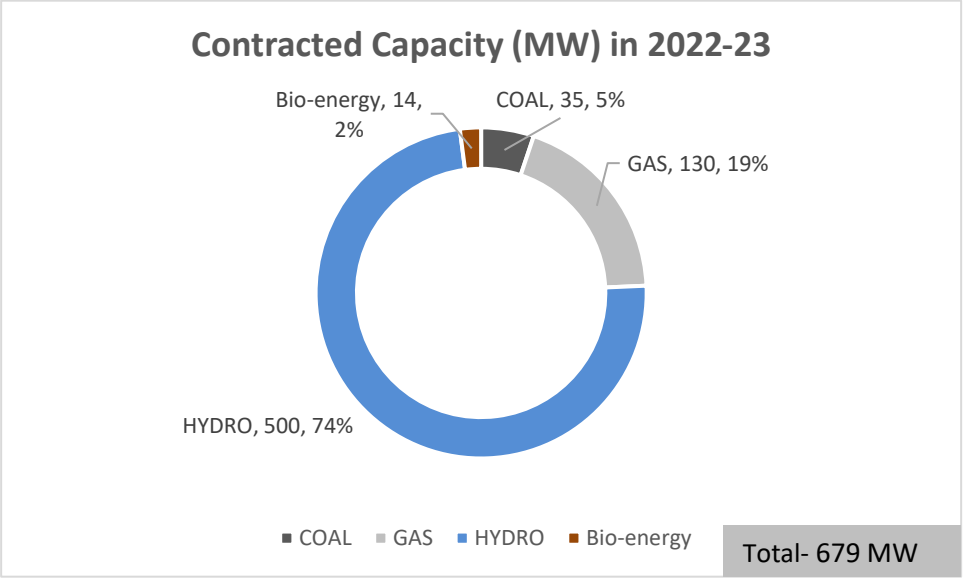


Figure 1: Fuel-wise Contracted Capacity (in MW) as on 31st March, 2023

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

Table 1: Peak electricity demand & electrical energy projections

	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32
Electrical Energy Projections (MU)	2437	2527	2618	2711	2805	2898	2993	3067	3134
Year on Year Growth		3.7%	3.6%	3.6%	3.5%	3.3%	3.3%	2.5%	2.2%
Peak Electricity Demand Projections (MW)	441	457	474	492	510	528	546	561	575
Year on Year Growth		3.6%	3.7%	3.8%	3.7%	3.5%	3.4%	2.7%	2.5%

3. To meet the above projected peak demand and 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	Gas	Hydro	Bio-energy	SToA/MToA *	Total
2023/24	35	130	517	14	152	**848**
2024/25	35	130	566	14	152	**897**
2025/26	35	130	566	14	165	**910**
2026/27	168	130	566	14	70	**948**
2027/28	182	130	566	14	74	**966**
2028/29	195	130	566	14	77	**982**
2029/30	211	130	566	14	78	**999**
2030/31	223	130	566	14	80	**1013**
2031/32	243	130	566	14	80	**1033**

*****_The SToA/MToA value represents the peak power requirement in MW and it was recommended that this requirement may be met through power procurement from the market or through bilateral agreements._

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	Coal	Hydro	Total		SToA/MToA
	Additional	Planned	Planned	Additional	Additional*
2023/24	0	17	**17**	**0**	152
2024/25	0	49	**49**	**0**	152
2025/26	0	0	**0**	**0**	165
2026/27	133	0	**0**	**133**	70
2027/28	14	0	**0**	**14**	74
2028/29	13	0	**0**	**13**	77
2029/30	16	0	**0**	**16**	78
2030/31	12	0	**0**	**12**	80
2031/32	20	0	**0**	**20**	80

**Requirement is for a particular year*

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

3.1 Present Power Scenario in Meghalaya

The power supply position for Meghalaya from 2020-21 to 2024-25 is shown in Table 4:

Table 4: Power Supply Position of Meghalaya

Power Supply Position						
Year	**Energy required (MU)**	**Energy supplied (MU)**	**Gap (MU)**	**Peak Demand (MW)**	**Peak Met (MW)**	**Demand not met (MW)**
2020-21	2,031	2,005	26	384	384	0
2021-22	2,256	2,243	13	408	408	0
2022-23	2,237	2,237	0	404	404	0
2023-24	2,236	2,066	170	405	405	0
2024-25	2,046	2,046	0	409	408	1

The data in Table 4 indicates that over the past five years, Meghalaya's energy demand and peak demand have increased at a Compound Annual Growth Rate (CAGR) of 0.18% and 1.59%, respectively.

As of March 2025, the total contracted capacity for Meghalaya is 696 MW. Out of the total contracted capacity (CC), the share of non-fossil fuel-based CC is 73 %.

The fuel-wise contracted capacity as on 31st March, 2025 is given in Table 5 and Fig. 2.

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

Source	**Contracted Capacity (MW)**	**Percentage**
Coal	53	8%
Gas	131	19%
Hydro	512	73%
Total	**696**	**100.0%**

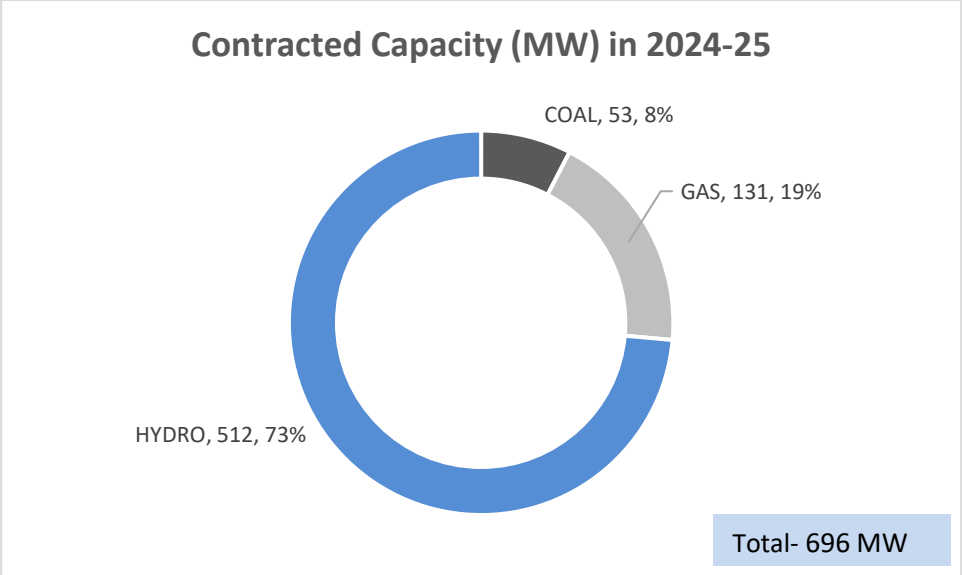


Figure 2: Fuel-wise Contracted Capacity (in MW) as on 31st March, 2025

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 State of Meghalaya is typically during the months of December and January. Meghalaya witnesses peak demand during non-solar hours.

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

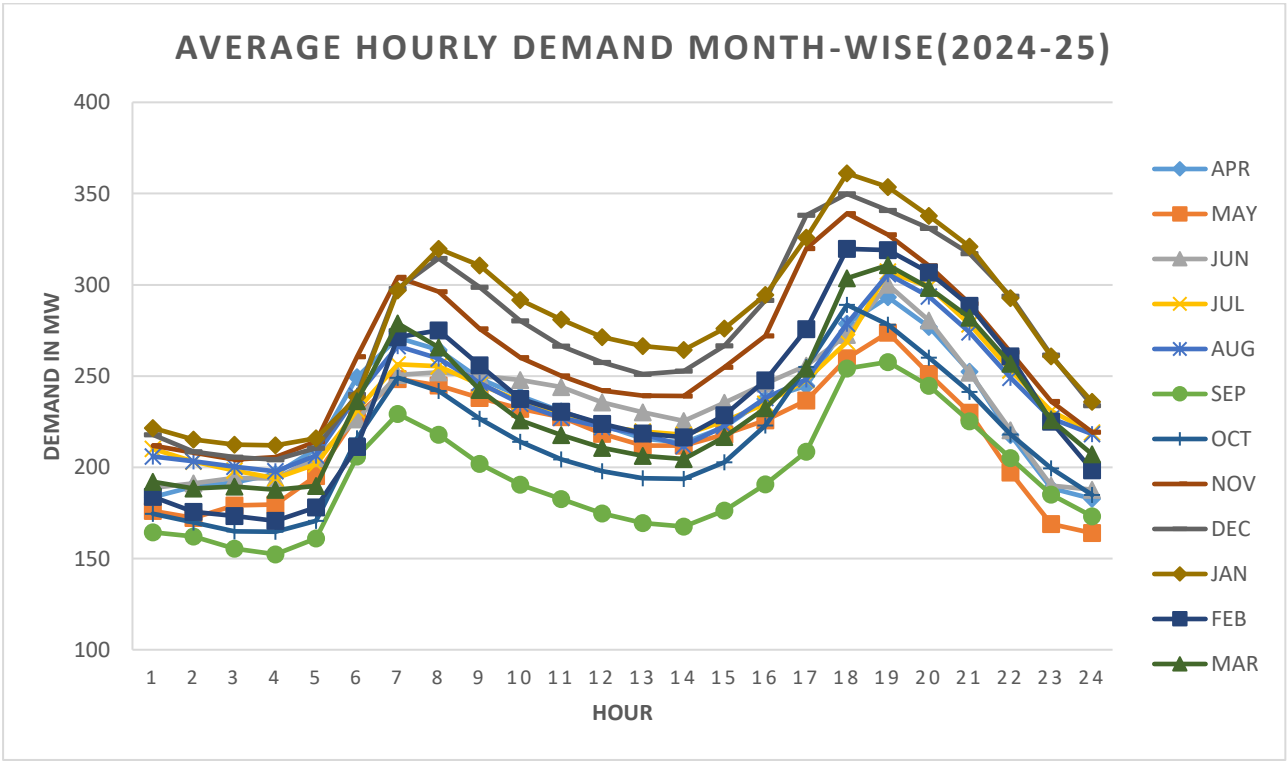


Figure 3: Average Hourly Demand Variation (Month-wise) for 2024-25

From the hourly demand data of 2024-25 the daily peak during solar hours (05:00 to 17:00 hrs) and non-solar hours are plotted in Fig. 4.

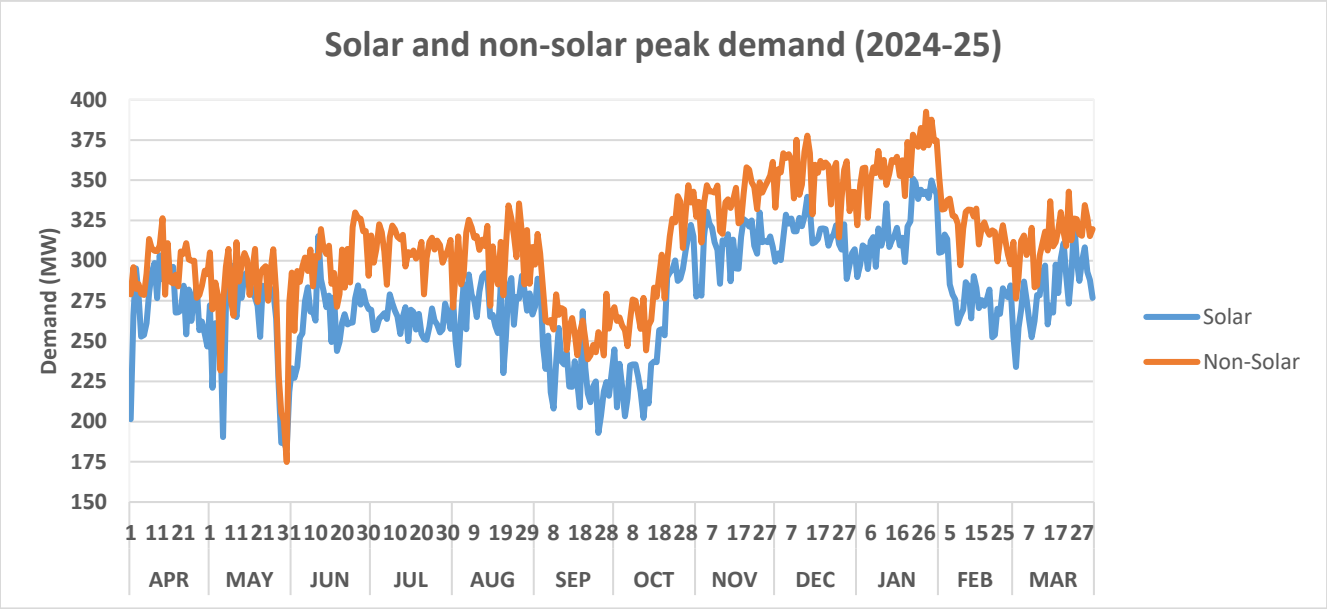


Figure 4: Solar and non-solar peak in MW for the year 2024-25

Daily peak occurs in Meghalaya during non-solar hours in almost every month of the year.

The hourly demand pattern of 2024-25 was analysed for finding out the number of occurrences of the peak and near peak 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 2024-25 is shown in Fig. 5.

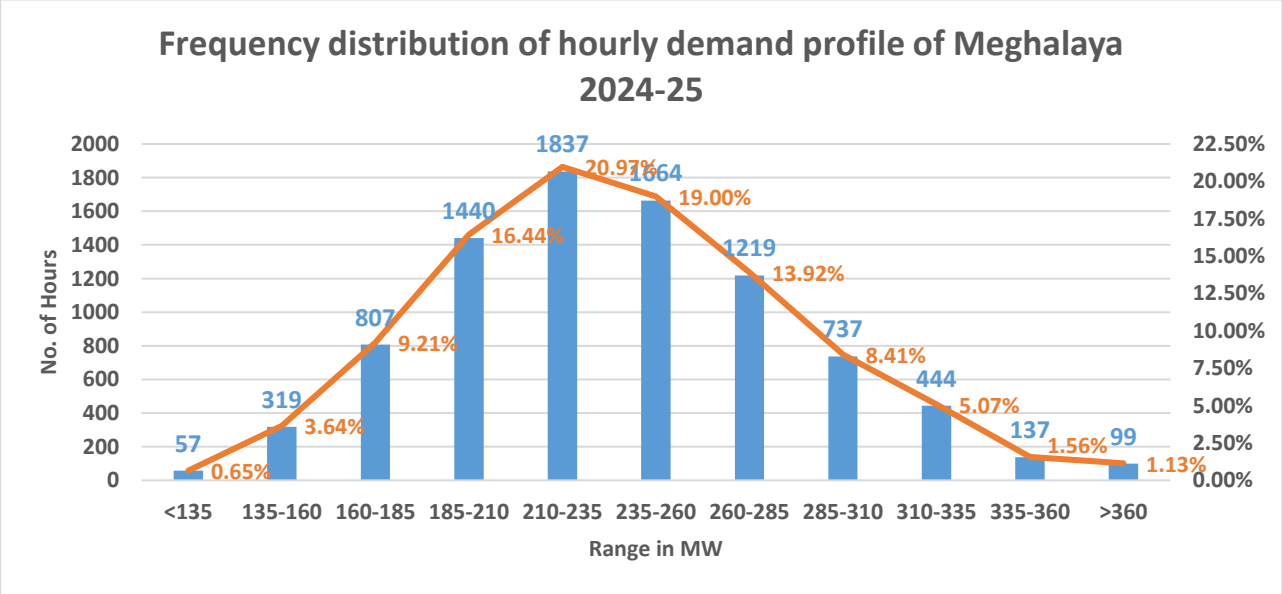


Figure 5: Frequency Distribution of Hourly Demand Profile of 2024-25

4.0 Principles of Generation Planning

The objective of the 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 RPO trajectory, RE capacity addition
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 operating 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 Fig. 6.

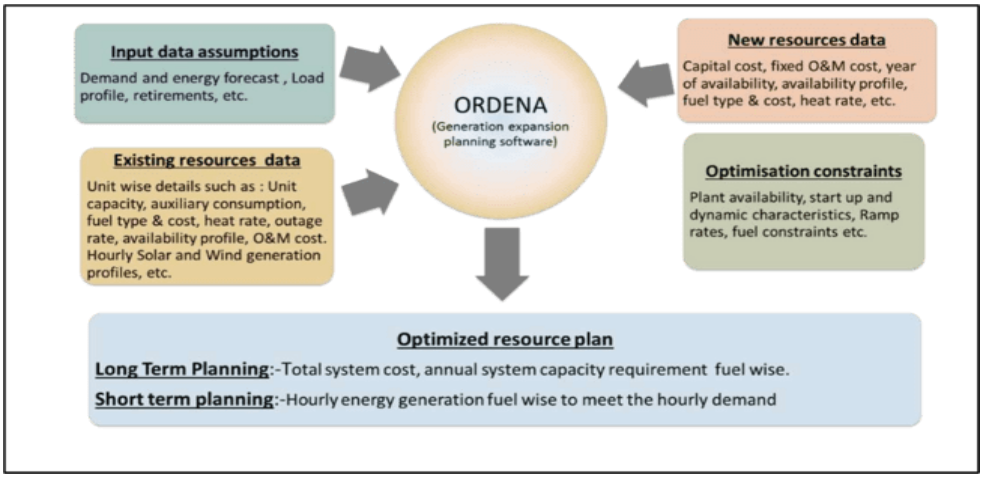


Figure 6: Schematic Diagram

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 load) 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 are simultaneously simulated to ascertain system reliability indices (i.e. Loss of load probability LOLP & Energy Not Served (ENS)) & 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 Demand variation

The variation in demand pattern for last two years viz. 2023-24 and 2024-25 has been analyzed. The demand pattern variation across 2023-24 and 2024-25 is shown in Fig. 7.

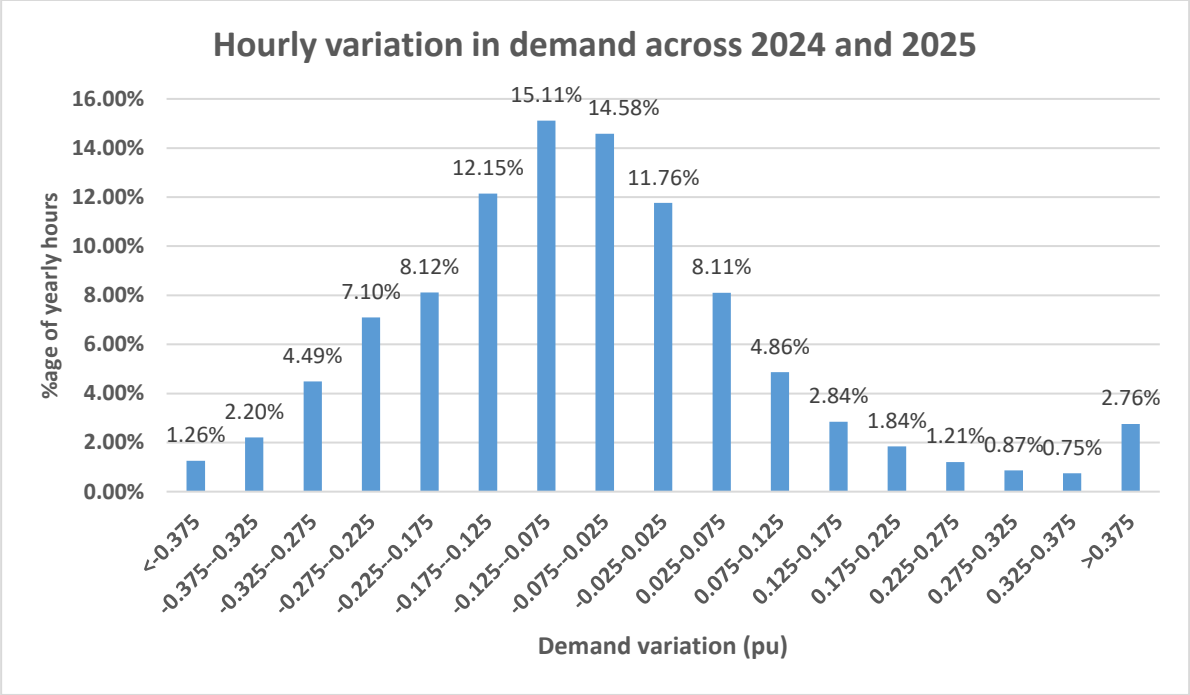


Figure 7: Hourly Variation in Demand across years

It can be observed that the hourly demand typically varies within ±12.5% for ~54% of instances. This variation is primarily due to temperature, weather parameter or any random outages of transmission line and generation units etc. This variation has been captured in the reliability study by varying the projected hourly demand for the future years by varying ±12.5% by introducing a random variable (with normal distribution) for demand as per observed behavior over the years.

5.2 RE variation

In the Long-term capacity expansion planning studies, a particular profile for Solar is considered based on the observed solar 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 hydro based generation has been varied by ± 10% 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 Meghalaya, furnished by MePDCL is given in Table 6.

Table 6: Future Demand Projection as provided by utility

	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36
MePDCL Peak Demand Projections (in MW)	416	428	441	455	468	482	497	512	527	543	559
Y-oY Growth		3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%	3.00%
MePDCL Energy Projections (in MU)	2296	2076	2200	2331	2470	2617	2774	2931	3103	3284	3500
Y-oY Growth		-9.6%	6.0%	6.0%	6.0%	6.0%	6.0%	5.7%	5.9%	5.8%	6.6%

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 and hydro generation profiles and CUFs have been referred from National Electricity Plan 2023 (Vol I Generation).

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

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

Table 7: Source wise planned capacity addition ***Fig.in MW***

FY	HYDRO (Conventional/Small)	Solar
2025/26	55	-
2026/27	6	-
2027/28	-	50
2032/33	210	-
Total	**271**	**50**

vi) **Renewable Purchase Obligation (RPO) trajectory**: Ministry of Power gazette notification dated 20th October, 2023 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 Purchase Obligation (RPO) trajectory (%) as per MoP order

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	27.35	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 RPO 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 Purchase Requirement up to FY 2035–36 is given in Table 9.

Table 9: Renewable Purchase Obligation (RPO) trajectory considered for the study

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	28.10	0.75	29.91
2.	2025-26	1.45	1.22	29.29	1.05	33.01
3.	2026-27	1.97	1.34	31.29	1.35	35.95
4.	2027-28	2.45	1.42	33.29	1.65	38.81
5.	2028-29	2.95	1.42	35.05	1.95	41.36
6.	2029-30	3.48	1.33	36.27	2.25	43.33
7.	2030-31	43.25			2.25	45.5
8.	2031-32	44.75			2.25	47
9.	2032-33	46.05			2.25	48.3
10.	2033-34	47.25			2.25	49.5
11.	2034-35	48.75			2.25	51.0
12.	2035-36	49.75			2.25	52.0

**For Hilly states*

Based on the trajectory specified, RPO 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: Total Energy required to meet RPO (MU)

Sl. No.	Year	Wind renewable energy (MU)	Hydro renewable energy	Other renewable energy	Distributed renewable energy	Total renewable energy
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1.	**2025-26**	33.3	28.0	672.5	24.1	757.9
2.	**2026-27**	40.9	27.8	649.6	28.0	746.3
3.	**2027-28**	53.9	31.2	732.4	36.3	853.8
4.	**2028-29**	68.8	33.1	817.0	45.5	964.1
5.	**2029-30**	86.0	32.9	895.9	55.6	1070.3
6.	**2030-31**	1131.9			58.9	1190.7
7.	**2031-32**	1241.4			62.4	1303.8
8.	**2032-33**	1349.7			65.9	1415.7
9.	**2033-34**	1466.2			69.8	1536.0
10.	**2034-35**	1601.0			73.9	1674.8
11.	**2035-36**	1741.3			78.8	1820.0

As indicated in Table 11, the state will be able to meet its RPO requirements with its existing and envisaged future capacity additions.

Table 11: Renewable Energy Deficit/Surplus

FY	RE Generation required to meet RPO		RE Generation available/met (From existing/ planned contracts)		RPO Surplus (+)/ Deficit (-)
	(MU)	(%)	(MU)	(%)	(%)
2025/26	757.9	33.01	1350	59	26
2026/27	746.3	35.95	1317	63	28
2027/28	853.8	38.81	1414	64	25
2028/29	964.1	41.36	1452	62	21
2029/30	1070.3	43.33	1493	60	17
2030/31	1190.7	45.5	1525	58	13
2031/32	1303.8	47	1539	55	8
2032/33	1415.7	48.3	1839	63	14
2033/34	1536.0	49.5	1896	61	12
2034/35	1674.8	51.0	1956	60	9
2035/36	1820.0	52.0	2018	58	6

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 0.83 BU which is about 24% of the energy demand in 2035-36. The year-wise likely unserved energy with the planned capacities is given in Fig 8.

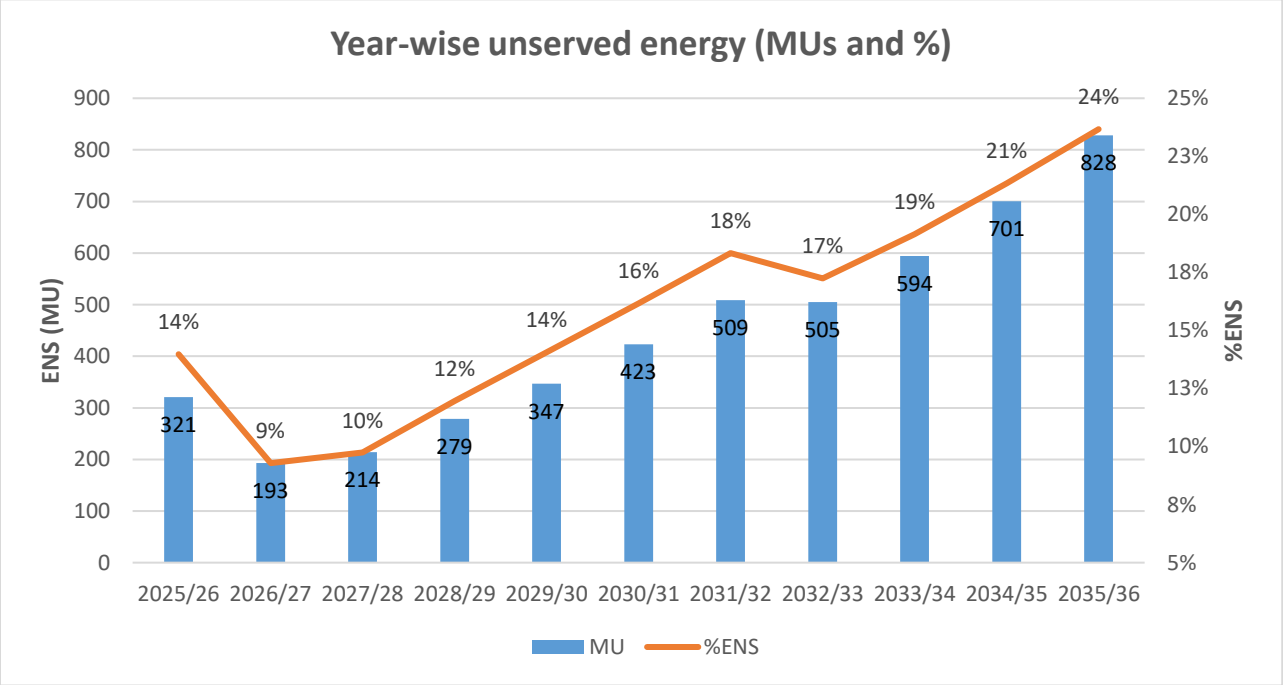


Figure 8: Yearly likely unserved energy (in MU) with the existing and planned capacities

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 demand. Details are shown in Fig. 9.

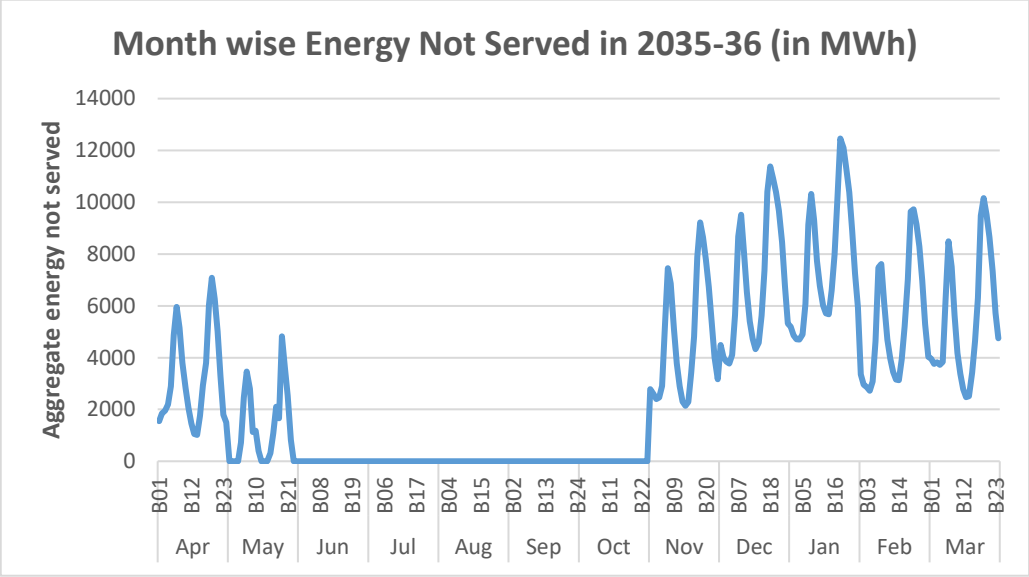


Figure 9: Block-wise Unserved Energy Pattern MWh (2035-36)

From the above figure, it can be seen that unserved energy is high during high demand and low hydro availability months viz. November to March.

7.2 Investment options to meet the unserved energy

To meet this unserved energy, energy investment options (i.e., candidate capacities) are given to the model to find the least cost optimal capacity mix required to meet the demand with RPO obligations. The capacity projections for Meghalaya are given in Table 12.

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

Year	Coal	Gas	Hydro	Solar	DRE	SToA/MToA
2025/26	53	131	561	0	20	115
2026/27	53	131	573	0	23	116
2027/28	53	131	573	100	30	116
2028/29	116	131	573	150	37	57
2029/30	124	131	573	200	45	68
2030/31	124	131	573	250	48	94
2031/32	125	131	573	299	51	120
2032/33	130	131	783	309	54	131
2033/34	149	131	783	329	57	141
2034/35	173	131	783	345	60	147

Year	Coal	Gas	Hydro	Solar	DRE	SToA/MToA
2035/36	197	131	783	395	64	160

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

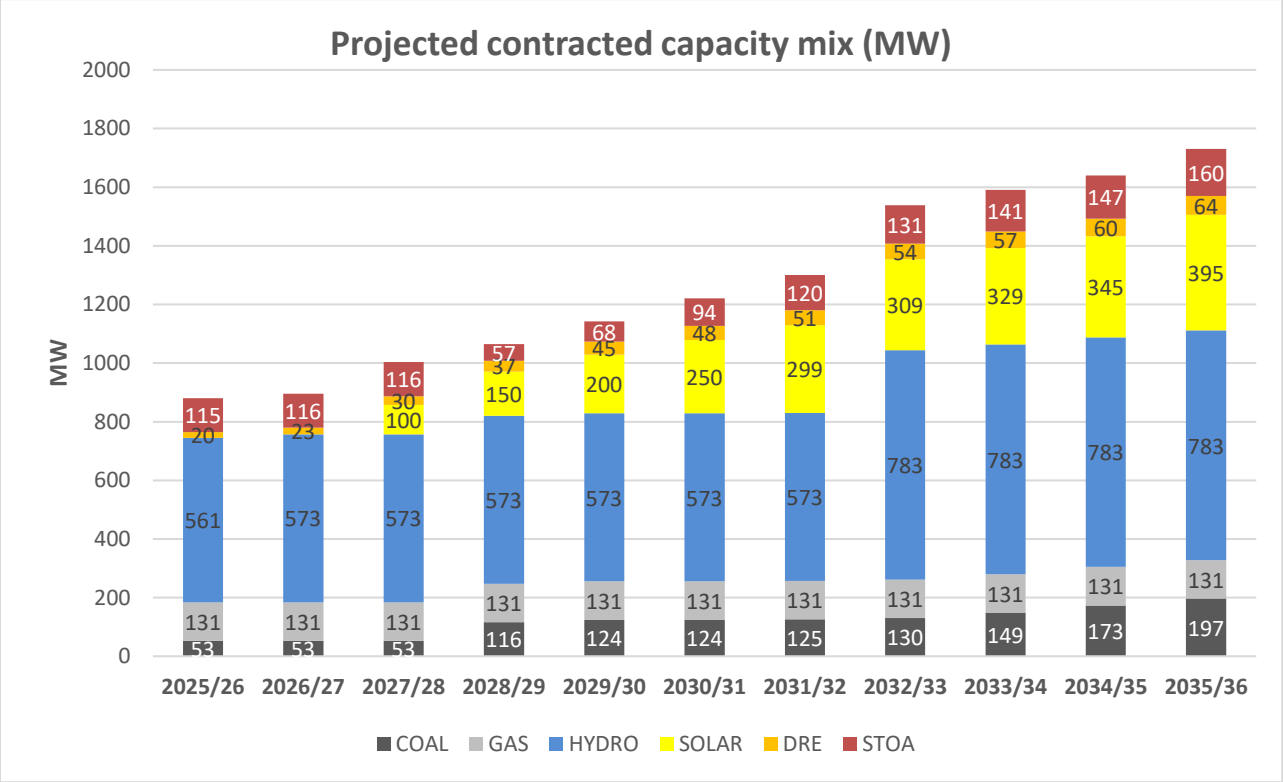


Figure 10: Projected Contracted Capacity Mix Year-wise (MW)

The SToA/MToA requirement can be fulfilled through power procurement from markets 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 (NEP)).

As per the Resource Adequacy studies, the likely total projected contracted generation capacity for the year 2035-36 is around 1,730 MW which consists of 197 MW from coal, 131 MW from gas, 783 MW from hydro, 395 MW from solar and 64 MW from Distributed Renewable Energy (DRE) sources. Furthermore, 160 MW of MToA/SToA arrangement will be required. This capacity is inclusive of the

planning reserve margin of 17% for non-solar hours and 34% for Solar hours and shall be able to meet the projected demand with prescribed reliability criteria and to comply with the stipulated Renewable Purchase Obligation (RPO) targets. Capacity mix required by 2035-36 is shown in Figure 11.

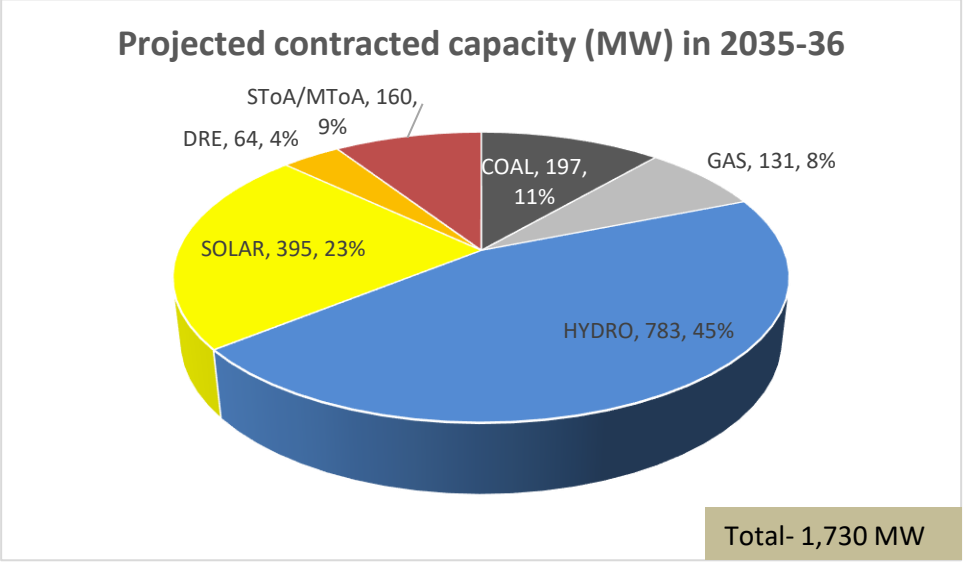


Figure 11: Contracted Capacity Mix in 2035-36

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 demand and 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 utility 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)

FY	Solar		Coal	Hydro	DRE	Total	
	Planned	Additional	Additional	Planned	Additional	Planned	Additional
2025/26	0	0	0	49	20	**49**	**20**
2026/27	0	0	0	12	3	**12**	**3**
2027/28	50	50	0	0	7	**50**	**57**
2028/29	0	50	63	0	7	**0**	**120**
2029/30	0	50	8	0	8	**0**	**66**
2030/31	0	50	0	0	3	**0**	**53**
2031/32	0	49	1	0	3	**0**	**53**
2032/33	0	10	5	210	3	**210**	**18**

FY	Solar		Coal	Hydro	DRE	Total	
	Planned	Additional	Additional	Planned	Additional	Planned	Additional
2033/34	0	20	19	0	3	**0**	**42**
2034/35	0	16	24	0	3	**0**	**43**
2035/36	0	50	24	0	4	**0**	**78**
Total	**50**	**345**	**144**	**271**	**64**	**321**	**553**

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

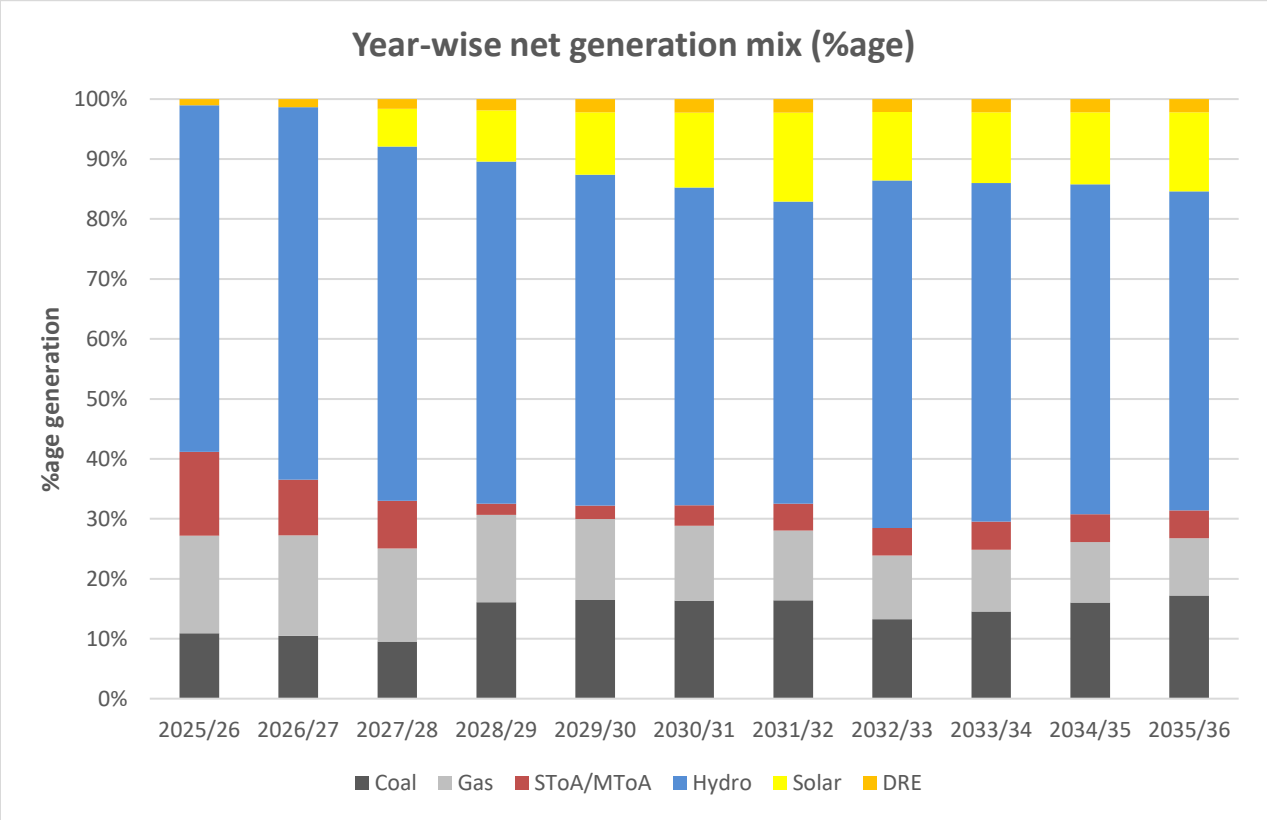


Figure 12: Year-wise projected net generation mix (in %)

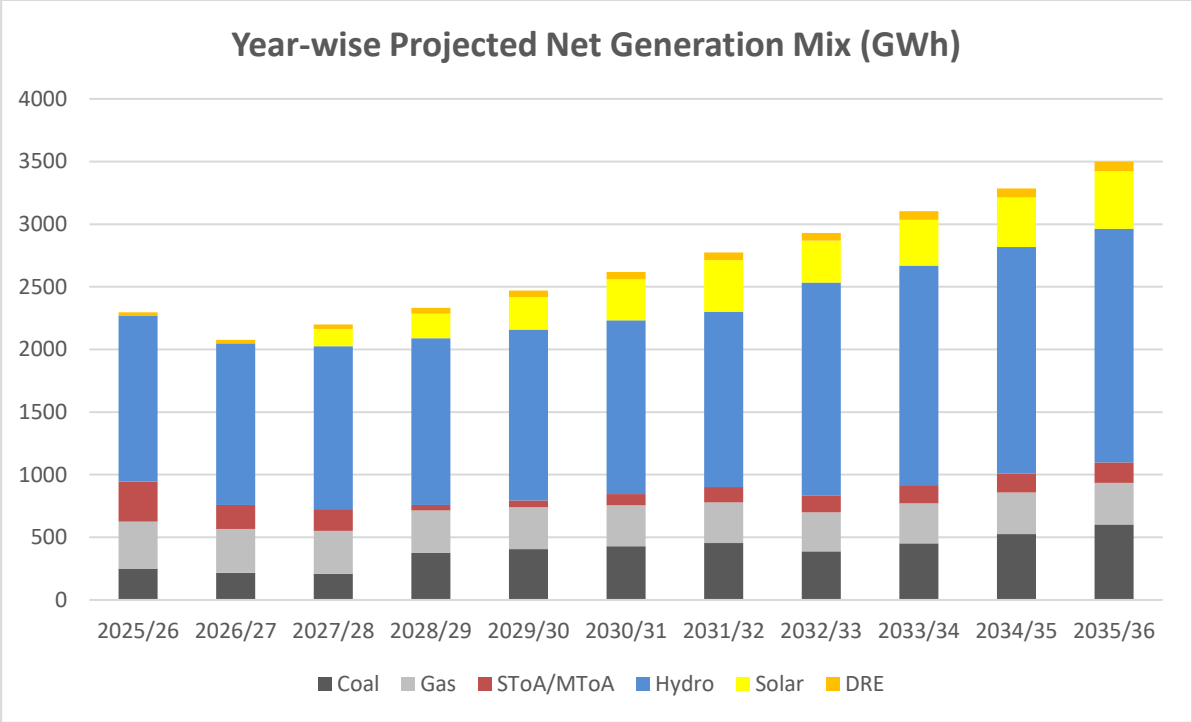


Figure 13: Year-wise projected net generation (in GWh)

7.3 Coal Capacity Performance

The coal capacity PLF is expected to remain in the range of around 36% - 57% for the years till 2036 ensuring higher absorption increasing contracts from renewable energy. Coal capacity PLF is shown in Figure 14.

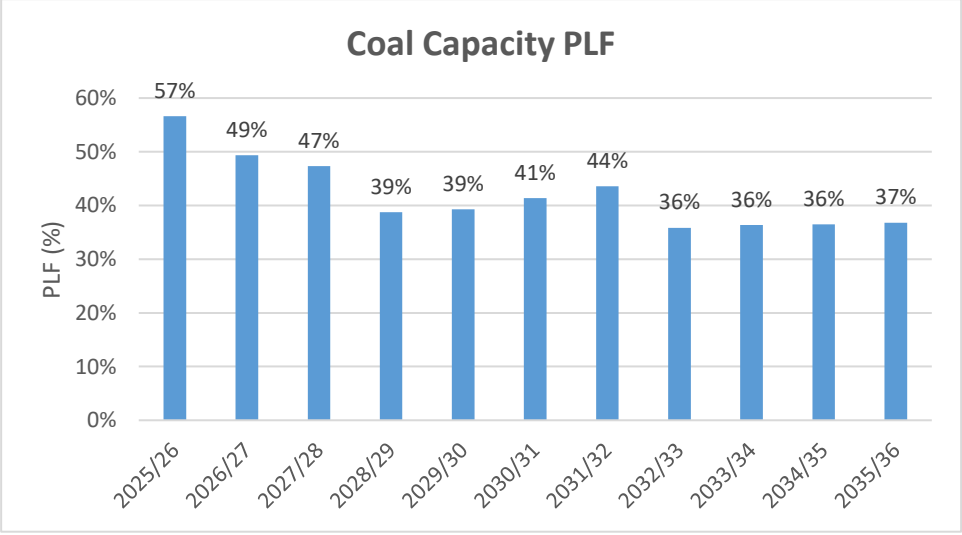


Figure 14: Year-wise coal contracts PLF (in %)

7.4 Day-wise Surplus Coal Capacity (in MW)

Surplus capacity is available with the state due to RE availability, Demand variation etc. The pattern of surplus capacities has been observed as shown in Figure 15. This capacity can be shared/banked with other states or DISCOMs, helping to reduce the fixed cost burden on utilities and ultimately lowering costs for consumers. The state has likely surplus capacity of around 40 MW available in 2026-27 during the months from June to September as demand is low and hydro availability is high during these months. The surplus capacity is shown below in fig. 15.

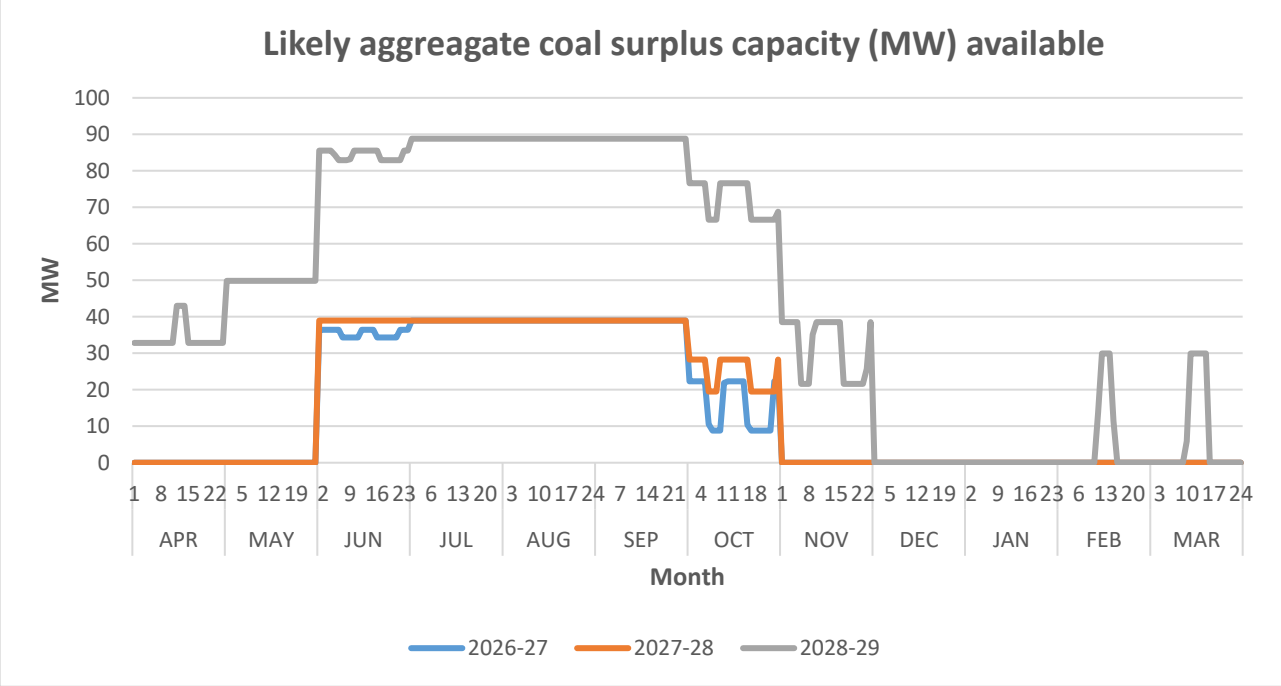


Figure 15: Surplus Coal Capacity Year-wise (MW)

8.0 Conclusions

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

1. The study has been done based on the hourly load pattern of the year 2024-25. It has been observed that the peak demand season is typically during December and January with peak demand occurring during non-solar hours.
2. The study has considered energy requirement projections as per the projections of MePDCL, which envisages that the annual energy requirement of the state is likely to grow at a CAGR of 4.3% while the peak demand for the utility is likely to grow at a CAGR of 3.0% for the period of 2025-26 to 2035-36.

3. Meghalaya is likely to witness energy deficit ranging from 0.19 to 0.83 BUs in different years from 2025-26 to 2035-36 with the existing and planned capacity addition only.
4. The state is projected to face unserved energy in the coming years and will need to contract additional fossil-based and solar-based capacities beyond those already planned. Specifically, approximately 144 MW of likely coal-based capacity and 345 MW of likely solar-based capacity is projected to be required by 2035–36. Additionally, there will be a requirement for Medium-Term Open Access (MToA) and Short-Term Open Access (SToA) ranging from around 57 MW to 160 MW in different years, as detailed in the report. These MToA/SToA needs can be met through power procurement from markets or through bilateral agreements. The MToA/SToA values represent peak demand requirements as well as seasonal banking needs, expressed in terms of megawatts (MW). The projected capacity and generation mix outlined in the report meet the utility's RPO requirements for the years 2025-26 to 2035-36.
5. The Planning Reserve Margins (PRM) for Meghalaya for non-solar and solar hours have been assessed at 17% and 34% respectively. Further, the study indicates year-wise short-term/medium-term/bilateral requirements inclusive of the PRM capacity to meet the demand optimally.
6. It is likely that MePDCL may have surplus capacity available during the months from June to September which can be shared with other utilities/states through banking / bilateral arrangements including Pushp portal.
7. Timely commissioning of planned capacities is critical to ensuring that the state can meet the projected peak demand and energy requirements identified in this study. 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

Planned Future Contracted (MW) considered in the study

Sl. No.	Tied capacity name	Type of generation	Expected COD	MePDCL share (in MW)
1.	Lower Subansiri	Hydro	2025-26	49
2.	Augmentation of Umiam-Umtru HEP	Hydro	2026-27	6
3.	Myntdu-Leshka St. II	Hydro	2032-33	210
4.	Solar Planned	Solar	2027-28	50

Assumption for Resource Adequacy Studies

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

RE CUF considered

Hydro	Small Hydro	Solar	DRE
44-48 %	20%	18%	14%

Technical Parameters

Technology	Type	Availability (%)	Ramping (%/min)	Min. Technical. (%)	Start -up time (hr)		
					Hot	Warm	Cold
Coal/ Lignite	Existing/Planned	85	1	55	2	5	10
	Candidate	88	1	55	2	5	10
Gas	Existing	90	5	40	1.5	2	3
Nuclear	Existing/Planned	68	Const. Load	-	-	-	-
Biomass	Existing/Planned	60	2	50	2	4	8
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	-	-	-	-

Technology	Type	Availability (%)	Ramping (%/min)	Min. Technical . (%)	Start -up time (hr)		
					Hot	Warm	Cold
Battery Energy Storage	Candidate	98	NA	-	-	-	-

Technology	Type	Heat Rate (MCal/MWh)		Aux. Consum. (%)	Min. online time (hr)	Min. offline time (hr)	Start-up fuel consumption (MCal/MW)		
		At max loading	At min loading				Hot	Warm	Cold
Coal	Existing/ Planned	2300 to 2879	2438 to 3052	7.0	6	4	600	1000	1800
	Candidate (SC & USC)	2060 to 2125	2183 to 2253	6.5	6	4	600	1000	1800
Gas	Existing	2000 to 2900	2260 to 3277	2.5	4	3	30	50	90
Nuclear	Existing/ Planned	2777	2777	10	6	4	-	-	-
	Candidate	2777	2777	10	-	-	-	-	-
Biomass	Existing/ Planned	4200	4450	8	6	4	600	1000	1800
	Candidate	4200	4450	8	6	4	600	1000	1800
Hydro	Existing/ Planned	-	-	0.7	-	-	-	-	-
	Candidate	-	-	0.7	-	-	-	-	-
Pumped Storage	Existing/ Planned	-	-	pump efficiency 80 %	-	-	-	-	-
	Candidate	-	-		-	-	-	-	-
Battery Energy Storage	Candidate	-	-	Round trip losses 12%	-	-	-	-	-

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	11.5 Cr	19.54 Lakh	4	25
Solar	5 Cr	1 % of Capex	0.5	25
Battery Energy Storage (2-Hour)	5.13 Cr to 3.13 Cr	1 % of Capex	0.5	14
Battery Energy Storage (4-Hour)	8.22 Cr to 4.72 Cr	1 % of Capex	0.5	14
Battery Energy Storage (5-Hour)	9.77Cr to 5.51 Cr	1 % of Capex	0.5	14
Battery Energy Storage (6-Hour)	11.31 Cr to 6.30 Cr	1 % of Capex	0.5	14