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Report on
Resource Adequacy Plan (Generation)
For Torrent Power
(Ahmedabad & Surat, Gujarat)
(2025-26 to 2035-36)

August 2025

GOVERNMENT OF INDIA
MINISTRY OF POWER
CENTRAL ELECTRICITY AUTHORITY

Disclaimer

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

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Executive Summary

In December 2022, Ministry of Power notified the Electricity (Amendment) Rules, introducing a structured framework for ensuring power supply reliability through Resource Adequacy (RA) planning. As per Rule 16 of these Rules, Ministry of Power issued RA Guidelines under which Central Electricity Authority (CEA) is entrusted with the responsibility of preparing the Long-Term National Resource Adequacy Plan (LT-NRAP) to assess and ensure sufficient generation capacity at the national level. Concurrently, every Distribution Utility is required to formulate a Long-Term Distribution Licensee Resource Adequacy Plan (LT-DRAP) to reliably meet its peak electricity demand and electrical energy requirement, ensuring alignment with the national plan and promoting long-term power sector sustainability.

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 demand 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.

To support the utility in fulfilling this requirement, CEA, in collaboration with Torrent Power, has prepared the Resource Adequacy (RA) plan with a planning horizon up to 2035-36, based on the data received from the distribution utility and in compliance with the RPO trajectory specified in the Ministry of Power's Office Memorandum dated 20th October 2023. To find out the least cost option for generation capacity expansion for the period 2025-26 to 2035-36, a long-term study for Torrent Power has been carried out 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.

Reliability study has been conducted to determine the probability of unmet demand and hours by implementing variations in electricity demand, variations in RE (Solar, Wind), and forced outages of thermal generators (Coal, Gas), among other factors. The RA study has shown that Torrent Power is likely to supply reliable power despite these variations.

The total projected capacity requirement for the year 2035-36 is approximately 5,396 MW. This includes 800 MW of coal-based capacity and 1,148 MW of gas-based capacity, providing the firm power with baseload capacity needed for system reliability. Renewable energy sources contribute significantly, with 392 MW from wind, 1,117 MW from utility-scale solar, and 450 MW from hybrid projects. Additionally, 1,340 MW of Distributed Rooftop Solar (DRE) highlights the growing role of decentralized generation, while 150 MW of Firm Dispatchable Renewable Energy (FDRE) offers reliable renewable capacity. In addition to the above capacity, 450 MW/1800 MWh of battery storage is required by 2035-36. The remaining 616 MW is expected to be met through Short-Term Open Access (STOA), covering any shortfall during peak periods or contingencies.

1.0 Introduction

Torrent Power was incorporated by the acquisition of The Surat Electricity Company Ltd and The Ahmedabad Electricity Company Ltd by Torrent Group. The Company distributes power to over 4.13 million customers annually in its distribution areas of Ahmedabad, Gandhinagar, Surat, Dahej SEZ and Dholera SIR (Gujarat); Bhiwandi, Shil, Mumbra, and Kalwa (Maharashtra); Agra (Uttar Pradesh); and in the Union Territory of Dadra and Nagar Haveli, Daman and Diu. This resource adequacy study has been carried out for the demand areas of Ahmedabad and Surat only.

The annual electricity peak demand for Torrent Power is projected to grow at a CAGR of 4.63 % from 2021-22 to 2031-32 as per 20th EPS Report. The projections of Torrent Power have indicated that peak electricity demand will increase with a CAGR of 1.92 % during the period from 2025-26 to 2035-36. To satisfy resource adequacy, i.e. meeting the electricity demand reliably and at an affordable cost, the distribution utilities need to methodically plan the capacity expansion either by investing or by procuring power. Given the reduction in the cost of solar panels and technology options like battery energy storage systems, planning for a long-term optimal generation capacity mix gains tremendous importance so that the future generation capacity mix is cost-effective as well as environmentally friendly.

Ministry of Power has notified the Electricity (Amendment) Rules, 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 were notified in June 2023 by the Ministry of Power in consultation with the 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 the 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 to ensure an 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 the demand-supply situation in the grid precisely. The Resource Adequacy exercise will also help in the assessment of capacity requirements to be tied up or contracted on a long-term, medium-term, and short-term basis.

Further, the Ministry of Power, vide order dated 22nd July 2022, had notified the RPO trajectory for the states. Based on the trajectory specified, the hydro, wind, and other (solar, biomass, etc) RPO quantum in million units (MUs) has been calculated to find the additional quantum of renewable capacity that the distribution utilities must plan in addition to their existing/planned capacity to meet their RPO targets.

Resource Adequacy studies have been carried out for Torrent Power based on the inputs received from officials of Torrent Power. The study optimizes power purchase on a long-term basis while evaluating resource adequacy for meeting the demand 24x7, considering variation in demand, variation in RE generation, and forced outage of thermal capacity. The

study has also assessed the requirement of Planning Reserve Margin for Torrent power for catering to the above highlighted uncertainties, so that demand can be met reliably throughout the year.

1.1 Present Capacity Mix and Power Supply Position of Torrent Power

The present contracted capacity of Torrent Power (for Ahmedabad and Surat) as of 31.03.2025 stands at 3,076 MW. The source wise distribution is shown in Figure 1.1 and Table 1.1. The share of coal and gas is around 49% of total capacity, while the combined share of Solar and Wind (including DRE Solar) is around 51% of the contracted capacity.

Table 1.1: Source-Wise Contracted Capacity of Torrent Power

Source	Contracted capacity (MW)	% Share
Coal	362	11.8%
Gas	1,148	37.3%
Wind	392	12.7%
Solar	467	15.2%
Biomass	15	0.5%
DRE	692	22.5%
Total	**3,076**	

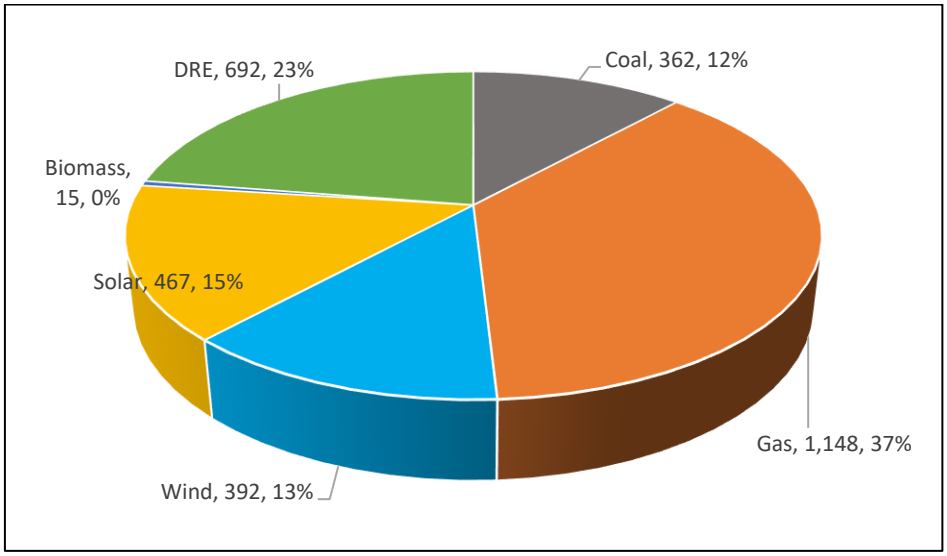


Figure 1.1: Source-Wise Contracted Capacity of Torrent Power

The annual peak electricity demand and annual electrical energy requirement (for Ahmedabad and Surat) for the last five years is shown in Table 1.2 (based on the inputs received from Torrent Power).

Table 1.2 Year-wise peak electricity demand and electrical energy requirement

Year	Actual Energy Requirement (MU)	Actual Peak Demand (MW)
2020-21	10306	2056

2021-22	11622	2221
2022-23	12497	2581
2023-24	12863	2557
2024-25	13481	2922

The month-wise peak demand and energy requirements of Torrent Power for the last five years are shown in Figures 1.2 and 1.3.

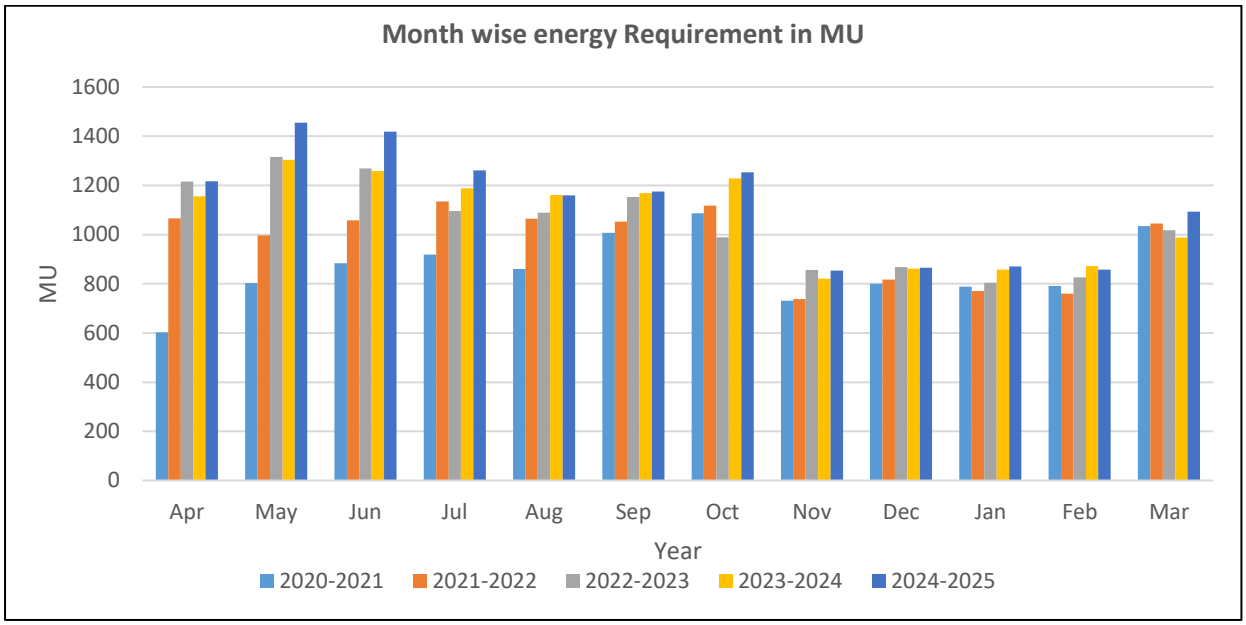


Figure 1.2: Month-wise Energy Requirement of Torrent Power in MU

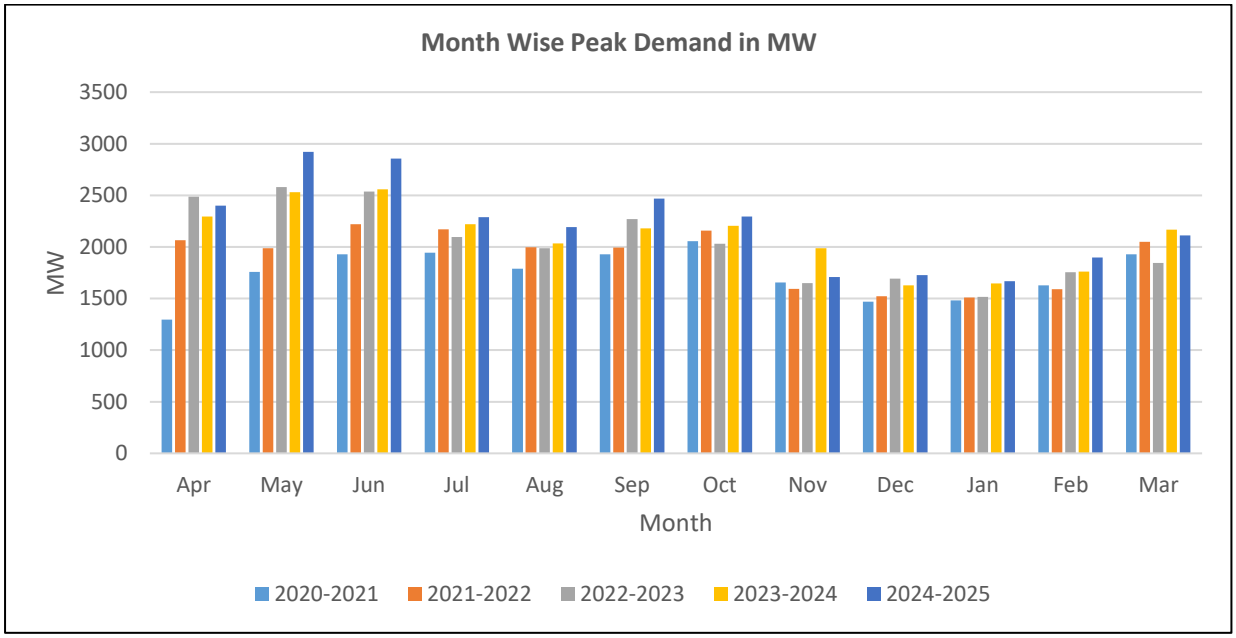


Figure 1.3: Month-wise Peak Demand of Torrent Power in MW

It can be observed that monthly peak demand is quite high during the months from April to June, with the annual peak typically occurring in May or June, and then decreases slightly, remaining almost steady for the rest of the year. Similarly, the energy requirement is higher from April to October.

1.2 Demand Analysis:

The peak demand and energy requirement during 2024-25 were around 2921 MW and 13.5 BU respectively (for Ahmedabad and Surat). The daily solar and non-solar peak demand of Torrent Power for the period 2024-25 is shown in Figures 1.4 and 1.5. It is observed that the peak occurs during May-June and during the daytime.

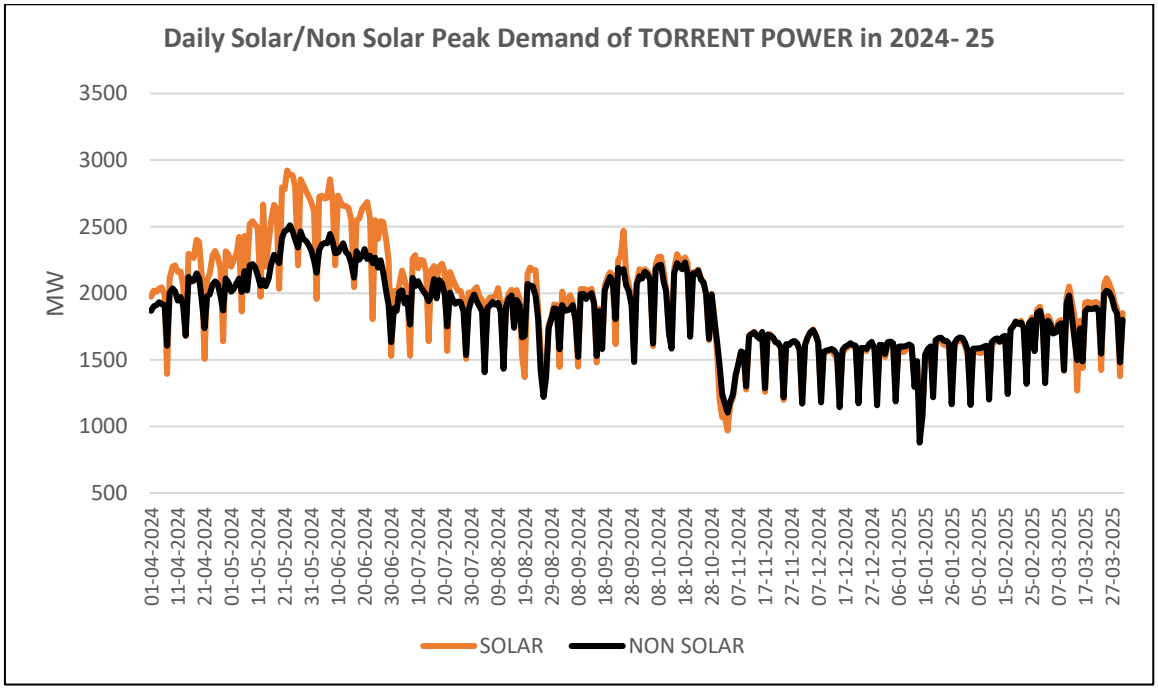


Figure 1.4: Daily Solar/Non-Solar Peak Demand in MW

The above graph reflects the comparison of the daily peak demand for the day(solar) and night (non-solar) time. It can be observed that the Solar(day) peak is higher than the non-solar (night) peak during summer and monsoon (April to October). However, during the period November to March, there is no significant difference between solar and non-solar peak demand.

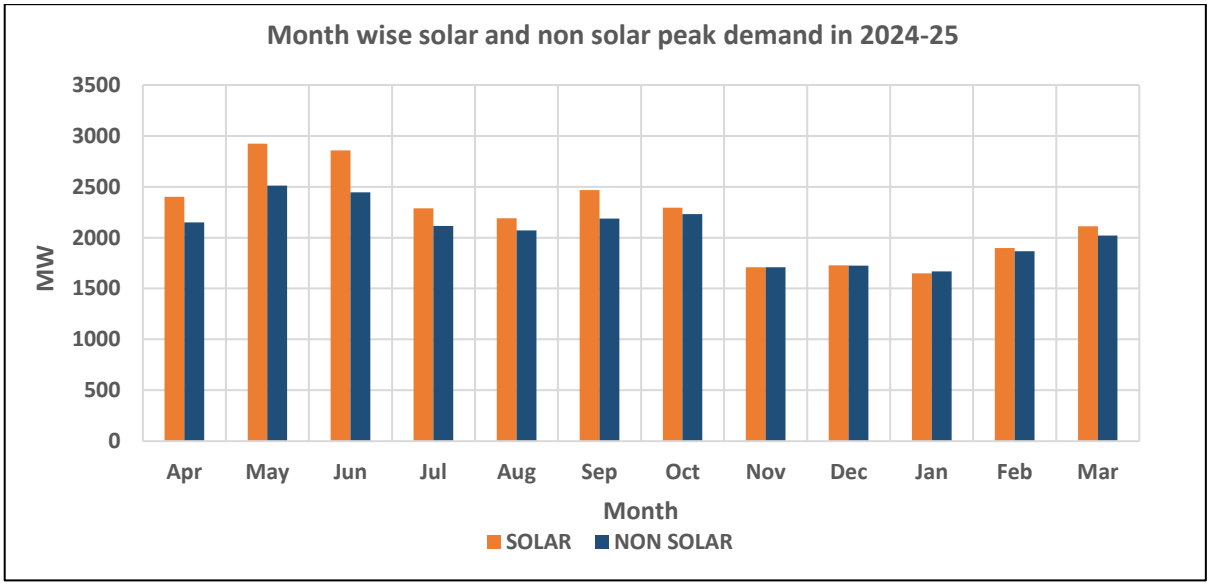


Figure 1.5: Solar vs Non-Solar Peak Demand of Torrent Power in 2024-25

The month-wise hourly average demand of Torrent Power in 2024-25 is shown in Figure 1.6.

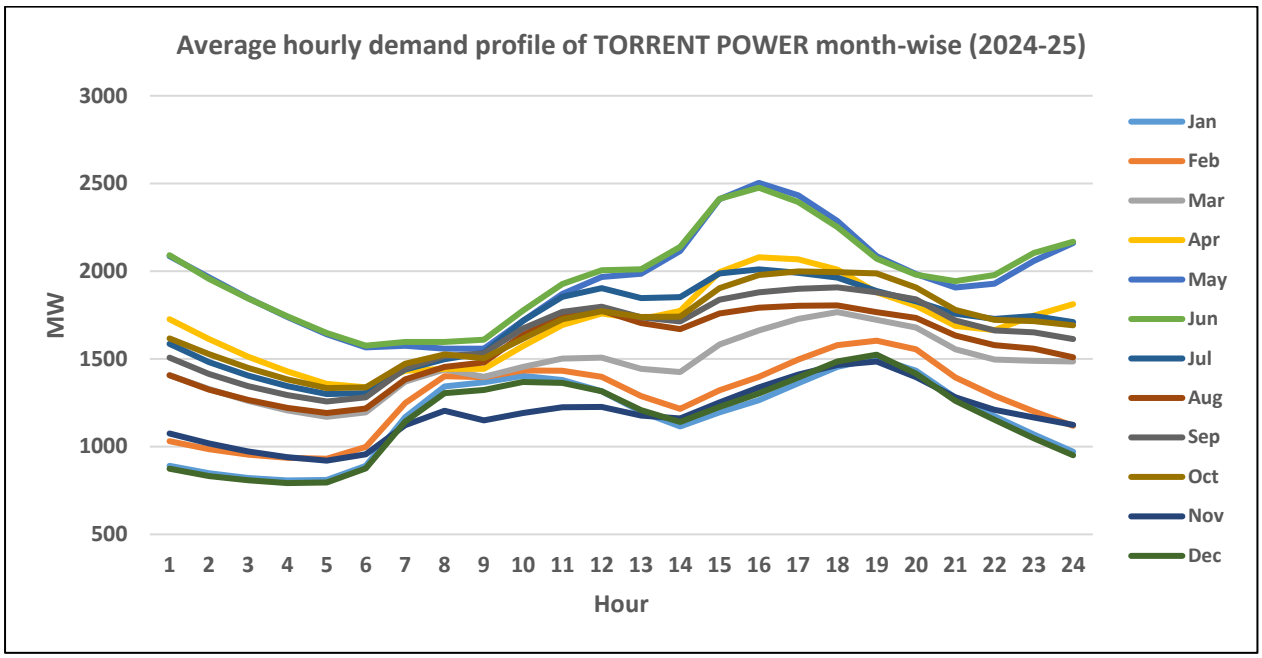


Figure 1.6: Average hourly demand month-wise (2024-25)

From the above demand pattern it is evident that the peak occurs mostly during the day hours in May and June, and the day and night demand are almost similar during November to March. However, there is a significant difference between day and night demand during the months from April to October. The demand pattern during the lean demand season is almost flat, while demand rises by about 25-30% during peak demand months. The frequency distribution pattern of demand for Torrent Power is shown in Figure 1.7. As shown in the graph, the maximum occurrences of demand range are 1250-1500 MW, followed by the 1500-1750 MW range. It can also be observed that the high demand period (>2500 MW) is only during 449 blocks (112 Hours) in a year.

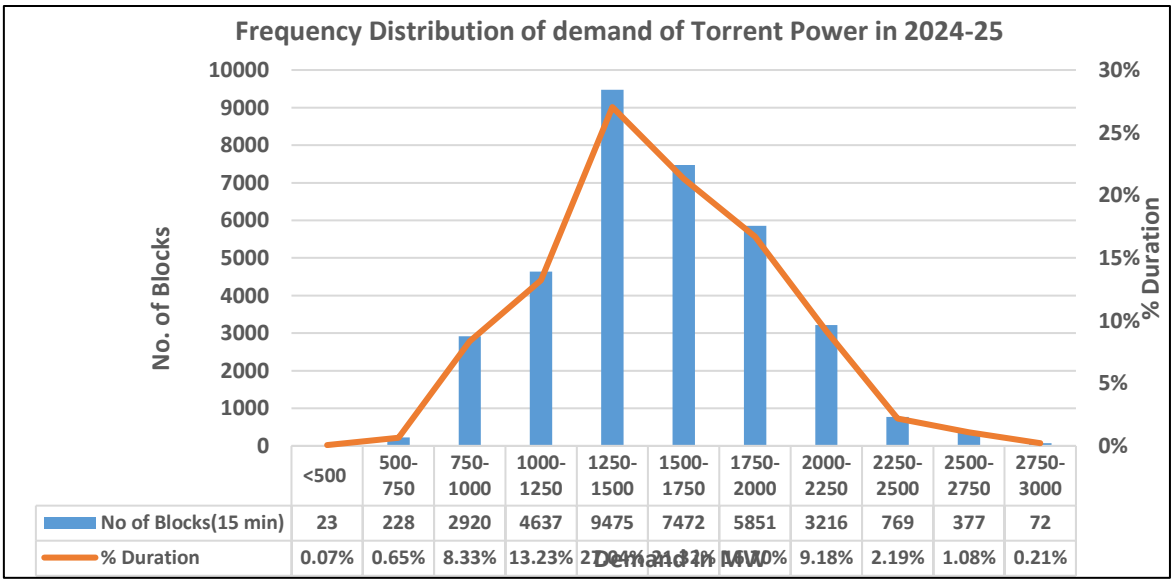


Figure 1.7: Frequency Distribution of Block-Wise Demand of Torrent Power in 2024-25

1.3 Electricity Demand Projection

The year-wise peak electricity demand and electricity energy requirement projection of Torrent Power as per 20th EPS Report is shown in Figure 1.8.

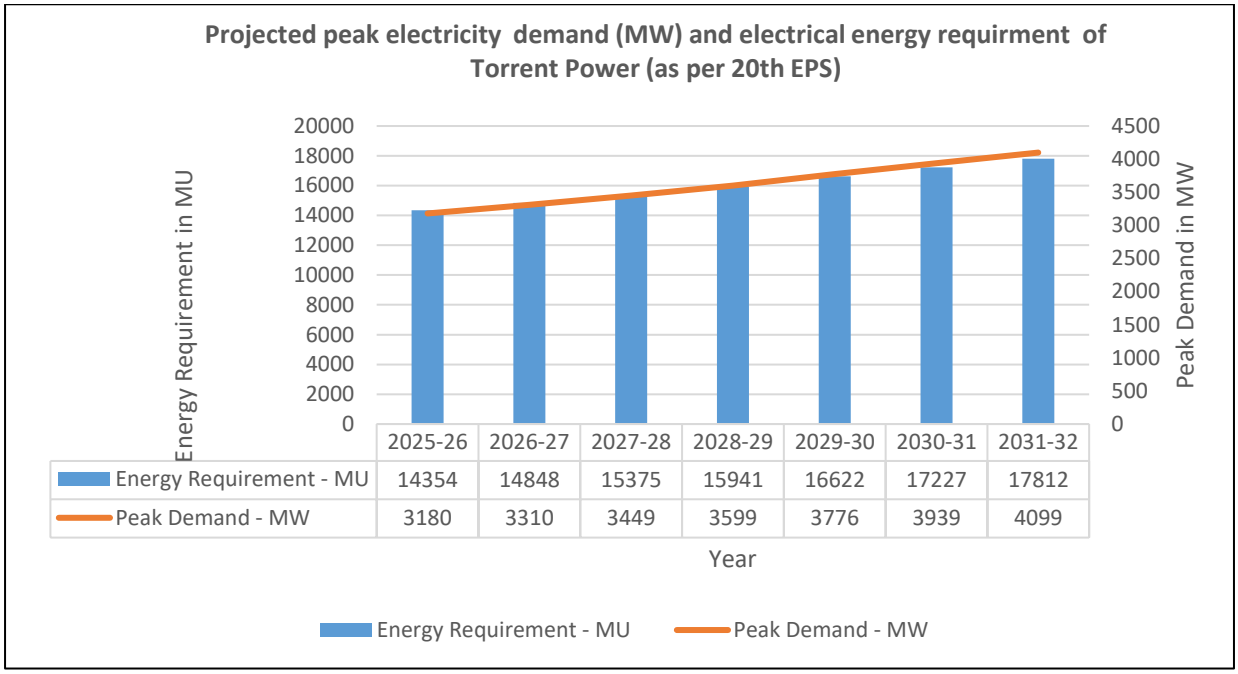


Figure 1.8: Peak Demand and electrical energy requirement (20th EPS)

However, it may be noted that the above projection of CEA includes the demand of Dahez SEZ, which has a separate energy portfolio and is not considered in the present study.

The year-wise peak electricity demand and electrical energy requirement projection of Torrent Power (Ahmedabad and Surat only) as per Torrent Power are shown in Figures 1.9 and 1.10.

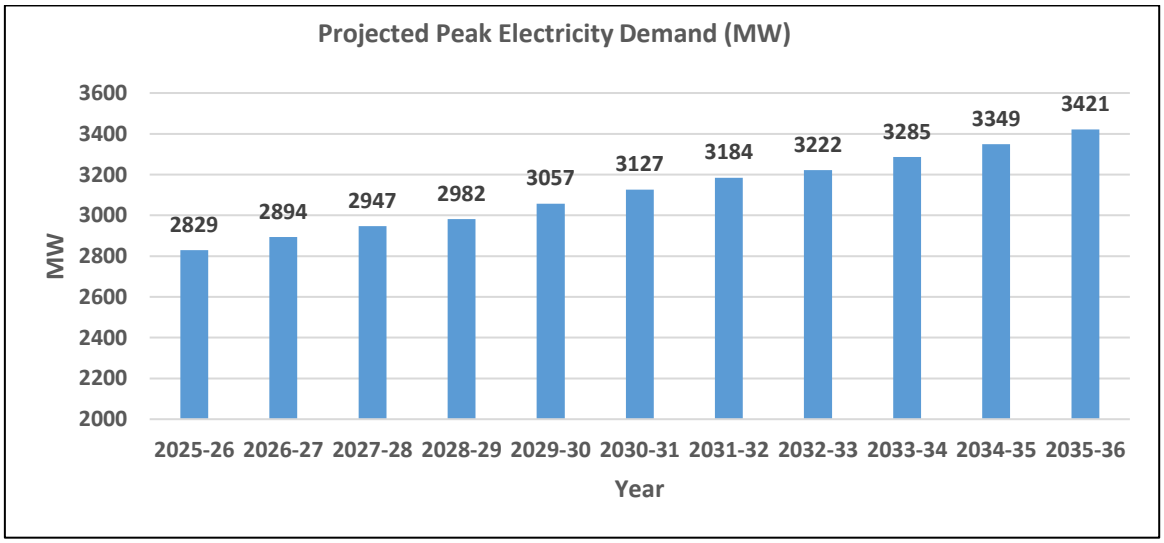


Figure 1.9: Peak Electricity Demand (Torrent Power)

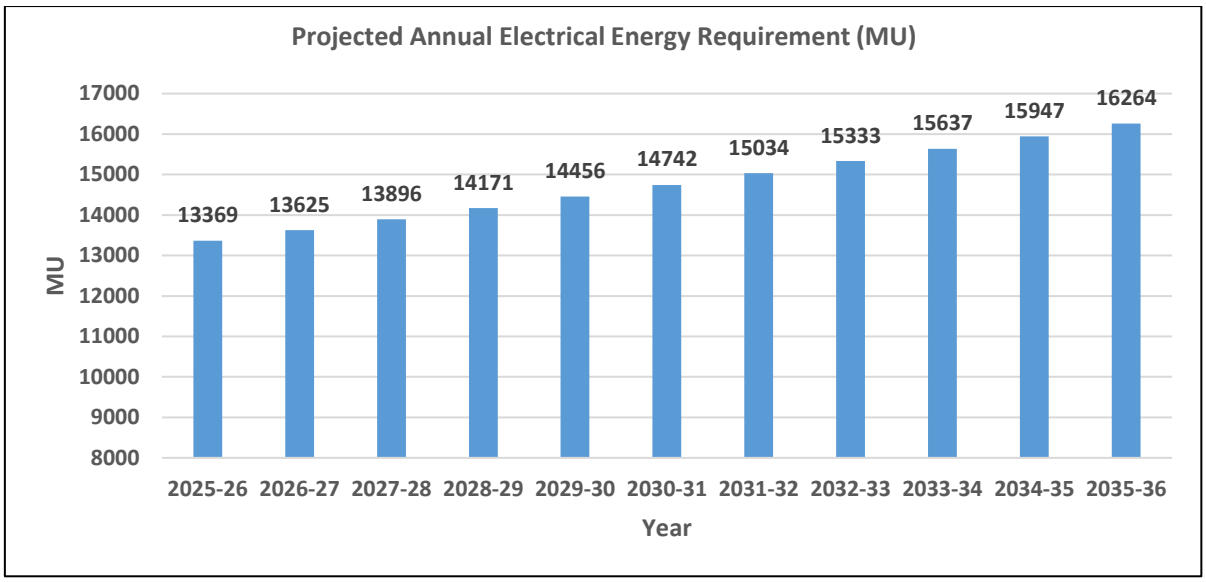


Figure 1.10: Electrical Energy requirement (Torrent Power)

The revised demand projection of Torrent Power is primarily due to the current slowdown in industrial activity, particularly in the lab-grown diamond sector, and shifting of industries due to environmental norms and space constraints within the license area.

For this Resource Adequacy Study, the projections for peak electricity demand and annual electrical energy requirement of Torrent Power have been considered based on consultations with Torrent Power officials.

2.0 Resource Adequacy Planning Studies

2.1 Principles of Generation Planning

The objective of the Generation Planning process is to obtain an optimal generation capacity mix in the most cost-effective manner to meet demand at all times while ensuring the most efficient use of resources. Planning, therefore, is an activity that encompasses balancing demand and supply at all times and in all locations, making it a regular ongoing process.

The major aspects considered in the planning process are:

- To supply 24x7 reliable power to consumers
- To achieve the objectives of all policies of the Government of India, such as RPO trajectory, RE capacity addition etc.
- To achieve sustainable development.
- To fulfill desired operational characteristics of the system, such as reliability and flexibility.
- Most efficient use of resources.
- Fuel availability

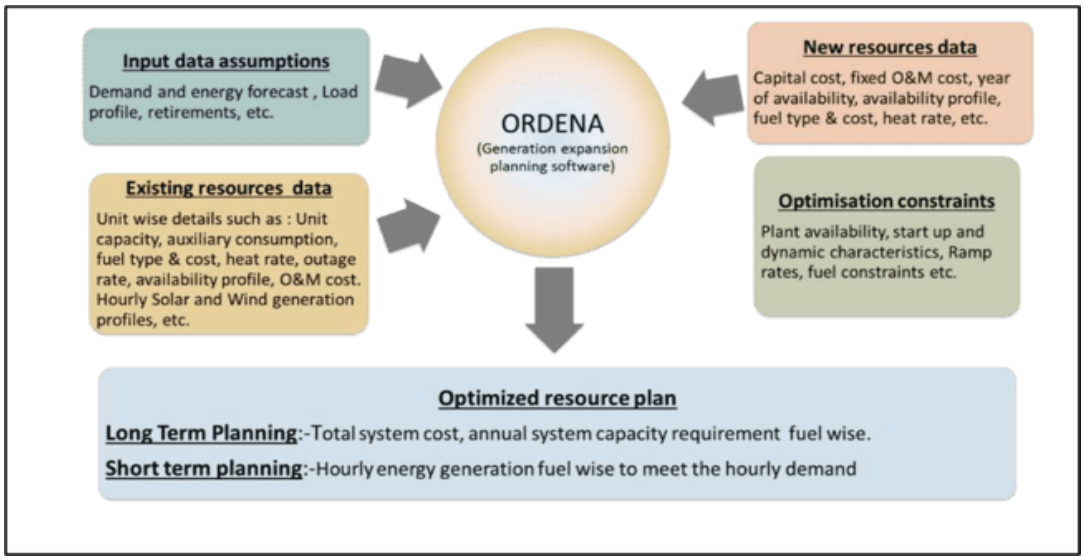
2.2 Generation Expansion Planning Tool -ORDENA

The studies were 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, 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 **Exhibit 2.1.**

Exhibit 2.1



2.3 Inputs to the Model

- **Projected peak demand and electrical energy Requirement:** The projected peak demand and electrical energy requirement projection of Torrent Power (demand areas of Ahmedabad and Surat only) has been considered in the study.
- **Hourly load profile**: The hourly load profile of the last 5 years (i.e. 2020-21 to 2024-25) has been analyzed and based on the analysis the hourly load profile for future years has been modeled.
- **Existing and Future Generation Capacity:** Based on the inputs from Torrent Power, the existing and planned capacity addition has been considered in the study. All the technical and characteristics of the generators have been modeled as per the information received from Torrent Power.
- **RE profile:** The Hourly profile of existing and planned solar and wind capacity has been modeled as per the data received from Torrent Power.

2.4 Assumptions considered in the Study

- The future peak demand and annual electrical energy requirement has been considered as per the projection of Torrent Power.
- All the cost data considered in the study are at the 2024-25 price level (Inflation has not been considered in the study.)
- Annual escalation of 1% for coal and 2% for gas (fuel cost) has been considered
- The CAPEX and OPEX for future investment consideration in the model are enclosed as Annexure II.

2.5 Planned Capacity Addition

The year wise, source wise planned capacity addition envisaged by Torrent Power is given in Table 2.1.

Table 2.1 Planned capacity addition

Source	Contracted Capacity by the Discom (31.03.2025) (MW)	Year-wise Capacity addition envisaged (MW)										
		2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36
Wind	392	0	0	0	0	0	0	0	0	0	0	0
Solar	467	150	0	0	0	0	0	0	0	0	0	0
Distributed renewable energy (DRE) (Solar)	692	0	93	90	88	87	52	55	58	61	64	64
Bioenergy	15	0	0	0	0	0	0	0	0	0	0	0
Hybrid (50% CUF)	0	0	450	0	0	0	0	0	0	0	0	0
Battery ESS (MW) for 4 Hrs.		0	0	0	200	0	0	0	0	0	0	0
Coal	362	0	0	0	0	0	800	0	0	0	0	0
Gas	1148	0	0	0	0	0	0	0	0	0	0	0
FDRE (90% Availability)	0	0	0	0	150	0	0	0	0	0	0	0
Total	**3076**	**150**	**543**	**90**	**438**	**87**	**852**	**55**	**58**	**61**	**64**	**64**

The above capacity has been considered as planned (scheduled), and year-wise phasing has been incorporated into the model. In addition to this capacity, additional capacity in terms of investment option (Coal, Solar, Wind, hybrid, BESS) has been given as an option to the model to choose from.

2.6 RPO trajectory of Torrent Power

The 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. Given 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 increase beyond 2029-30. The RPO trajectory considered in the study is given below in Table 2.2.

Table 2.2 Trajectory for RPO till 2029-30 as per MoP RPO order notified in October 2023

Sl. No.	Year	Wind renewable energy	Hydro renewable energy	Other renewable energy	Distributed renewable energy	Total renewable energy
(1)	(2)	(3)	(4)	(6)	(5)	(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%

Sl. No.	Year	Wind renewable energy	Hydro renewable energy	Other renewable energy	Distributed renewable energy	Total renewable energy
4	2027-28	2.45%	1.42%	31.64%	3.3%	38.81%
5	2028-29	2.95%	1.42%	33.10%	3.9%	41.36%
6	2029-30	3.48%	1.33%	34.02%	4.5%	43.33%

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 tabulated below in Table 2.3.

Table 2.3 RPO quantum in MU considering the fungibility aspect of RPO targets

Sl. No.	Year	Wind renewable energy (MU)	Hydro renewable energy (MU)	Other renewable energy (MU)	Distributed renewable energy (MU)	Total Renewable energy (MU)
(1)	(2)	(3)	(4)	(6)	(5)	(7)
1	2025-26	0	0	1796	946	2743
2	2026-27	0	0	3816	1020	4836
3	2027-28	0	0	3795	1141	4936
4	2028-29	0	0	4853	1260	6113
5	2029-30	0	0	4882	1382	6264
6	2030-31	0	0	4947	1477	6425
7	2031-32	0	0	5111	1551	6662
8	2032-33	0	0	5304	1628	6932
9	2033-34	0	0	5469	1710	7180
10	2034-35	0	0	5647	1796	7443
11	2035-36	0	0	5809	1883	7693

3.0 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): Measures 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 megawatt hours (MWh). The metric can be normalized (i.e. divided by the total energy requirement) to create a Normalized Energy Not Served (NENS).

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)) 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 expressed as a certain percent of peak load forecast of the system.

3.1 Demand variation

The variation in the demand pattern of Torrent Power for the last 5 years (2020-21 to 2024-25) has been analysed at 15 min intervals., The block-wise demand variation for consecutive years (i.e., 2024-25 Vs 2023-24, 2023-24 vs 2022-23, etc) has been analysed to determine Y-o-Y variation.

The Demand pattern variation of the 2024-25 vs 2023-24 and 2023-24 vs 2022-23 is shown in Figure 3.1 and Figure 3.2 respectively.

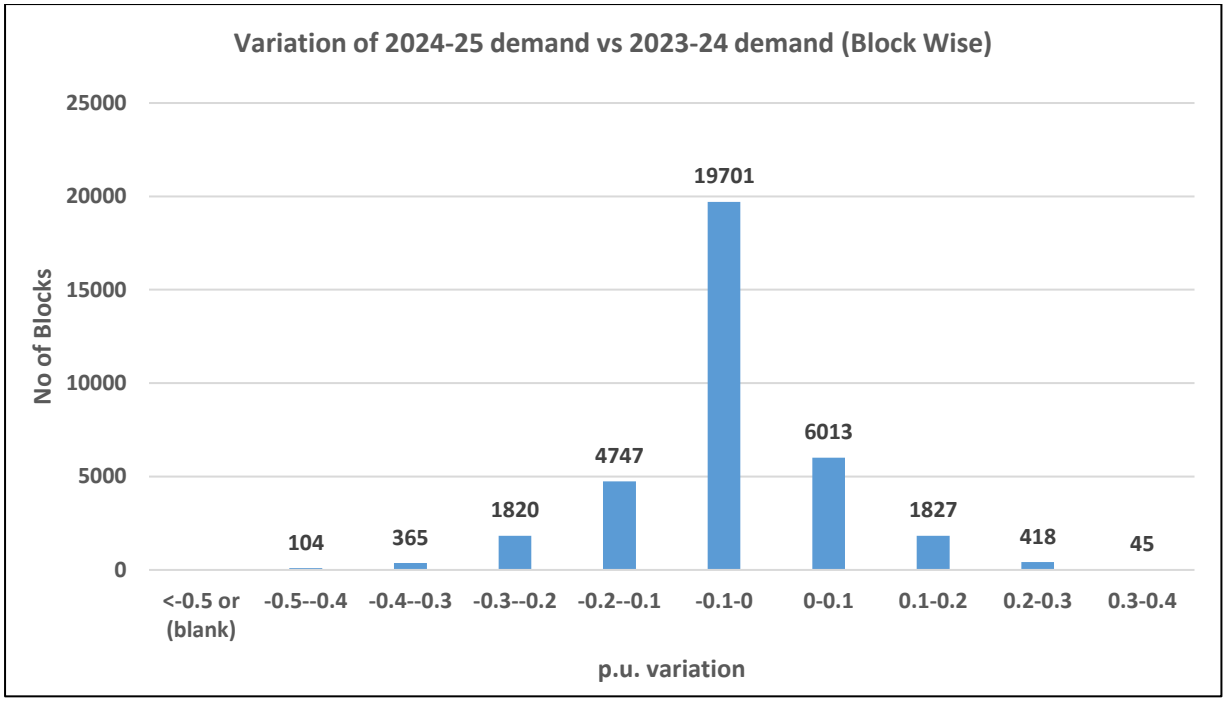


Figure 3.1: Demand variation between FY 25 & FY 24

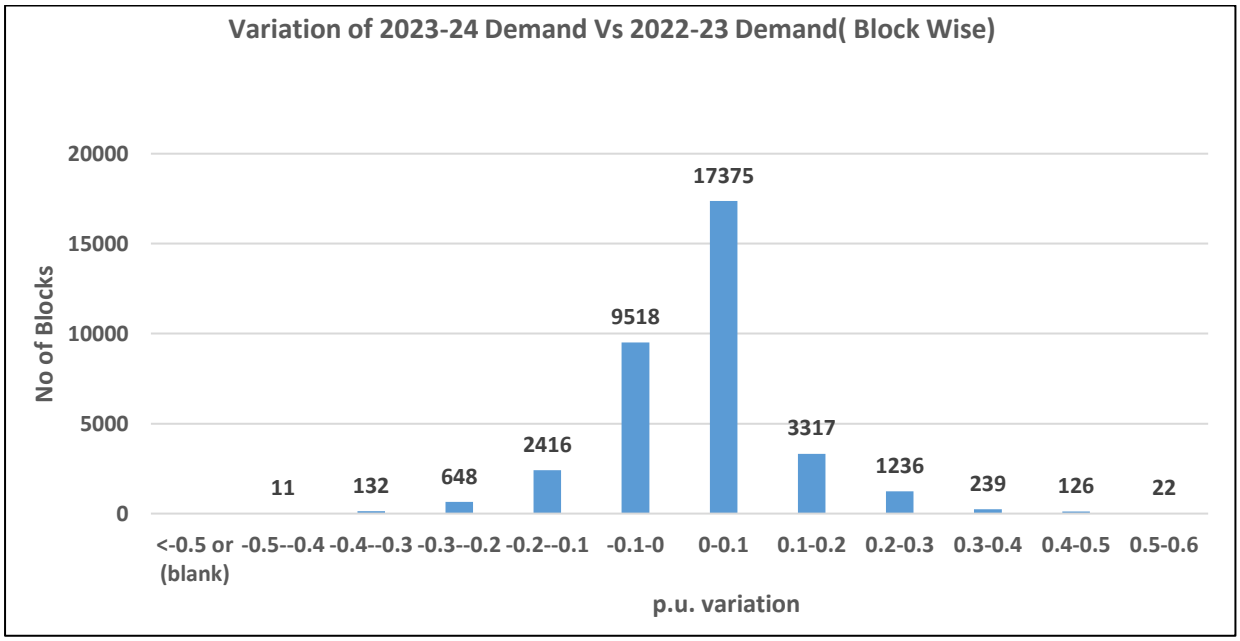


Figure 3.2: Demand variation between FY 24 & FY 23

It can be observed that the demand typically varies by ±10% from the corresponding block in the previous year (Normalised figure). This variation is primarily due to temperature, weather parameters, or any random outages of transmission lines and generation units, etc. This variation has been captured in the reliability study by varying the projected hourly demand for the future years by ±10 % by introducing a random variable (with normal distribution) for demand.

The Probability distribution and Cumulative distribution function for demand variation are shown in Figure 3.3.

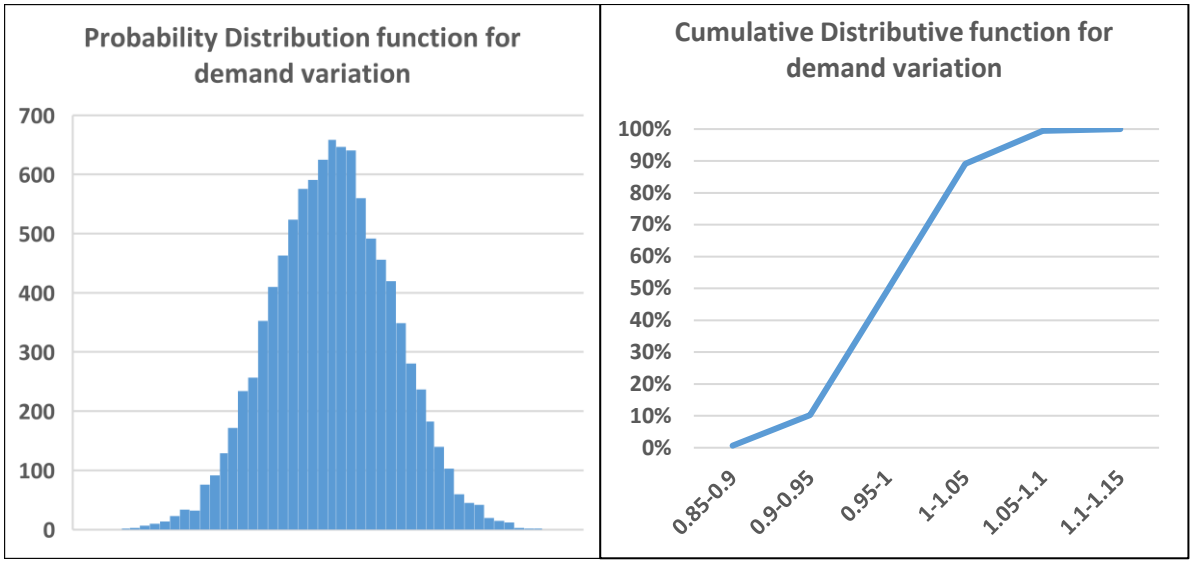


Figure 3.3: PDF & CDF of Demand Variation

3.2 Variation in RE

In the long-term capacity expansion planning studies, a particular profile for solar and wind plants is considered to determine the optimal capacity mix. However, due to the intermittent nature of these sources, the generation from these non-dispatchable sources may vary considerably. Based on the previous year's generation data, it was observed that solar generation typically varies from ±5% of the projected generation, while the variation in wind is typically ±15%.

3.3 Forced Outage of Thermal Generators

The average forced outage rate of generators of Torrent Power is typically observed at 10% with a ±5% variation. The same has been incorporated into the model.

Based on the variation, reliability studies are carried out to ascertain the robustness of the system. The LOLP and EENS of the system are within the specified range. The Planning Reserve Margin (PRM) for Torrent Power has been assessed at 8% during solar hours and 6 % during non-solar hours.

4.0 Analysis of Result

The projected year-wise capacity requirement source-wise generation is shown below in Table 4.1 and figure 4.1. Year-wise and source-wise generation is shown in Figure 4.2, and % wise distribution is shown in Figure 4.3.

Table 4.1: Year Wise Source Wise Contracted Capacity Requirement

Year	Coal	Gas	Wind	Solar	HYBRID	Storage	DRE Solar	FDRE 90%	STOA
2025/26	362	1148	392	467	0	0	692	0	1324
2026/27	362	1148	392	617	450	0	692	0	1131
2027/28	362	1148	392	617	450	0	785	0	1170
2028/29	362	1148	392	617	450	200	875	150	947
2029/30	362	1148	392	617	450	200	963	150	1008
2030/31	800	1148	392	617	450	200	1050	150	715
2031/32	800	1148	392	717	450	250	1102	150	694
2032/33	800	1148	392	817	450	300	1157	150	654
2033/34	800	1148	392	917	450	350	1215	150	639
2034/35	800	1148	392	1017	450	400	1276	150	623
2035/36	800	1148	392	1117	450	450	1340	150	616

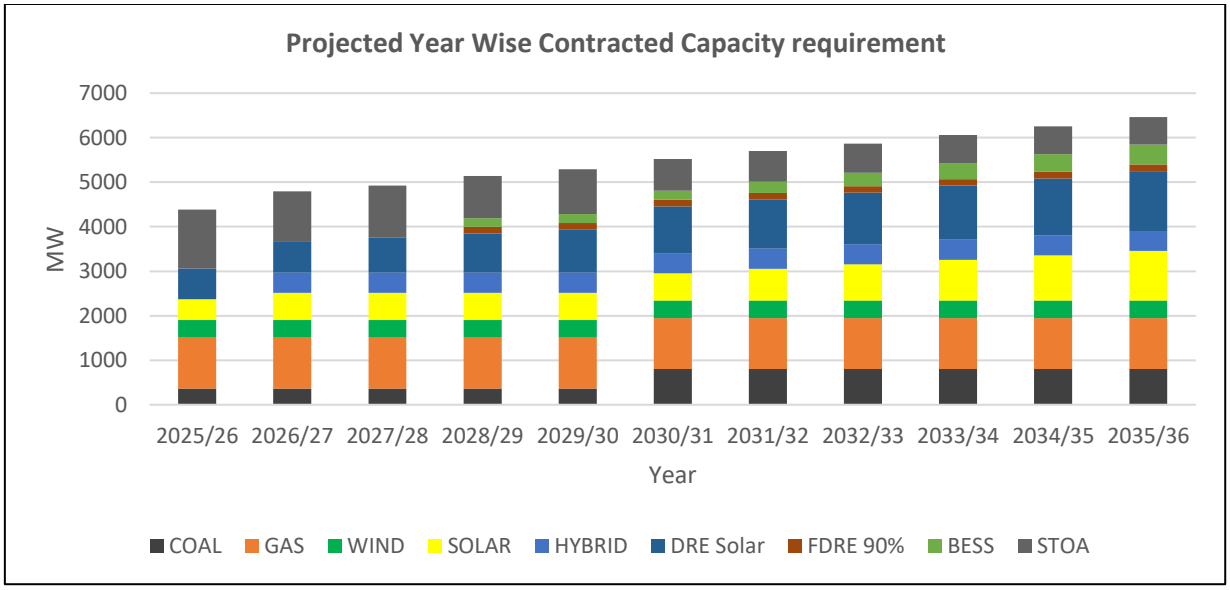


Figure 4.1: Year Wise Source Wise Contracted Capacity Requirement in Base case

The graph titled **"Projected Year-Wise Contracted Capacity Requirement"** illustrates the year-on-year projected power capacity (in MW) from various energy sources between 2025-26 and 2035-36. It highlights a steady increase in total contracted capacity from around 4,400 MW in 2025-26 to approximately 6,500 MW by 2035-36, reflecting growing electricity demand. Renewable energy sources, particularly **DRE Solar**, is likely to have significant growth and become the largest contributor (in terms of capacity) by the end of the period. **Solar**, **Hybrid**, and **BESS (Battery Energy Storage Systems)** also expand steadily, indicating a shift toward cleaner and more reliable power sources. While **Coal** and **Gas** remain relatively stable, they continue to play a key role in the base-load power mix. The appearance and growth of **FDRE (90% PLF)** from 2028-29 and increasing storage capacity suggest a rising emphasis on firm and dispatchable renewable energy.

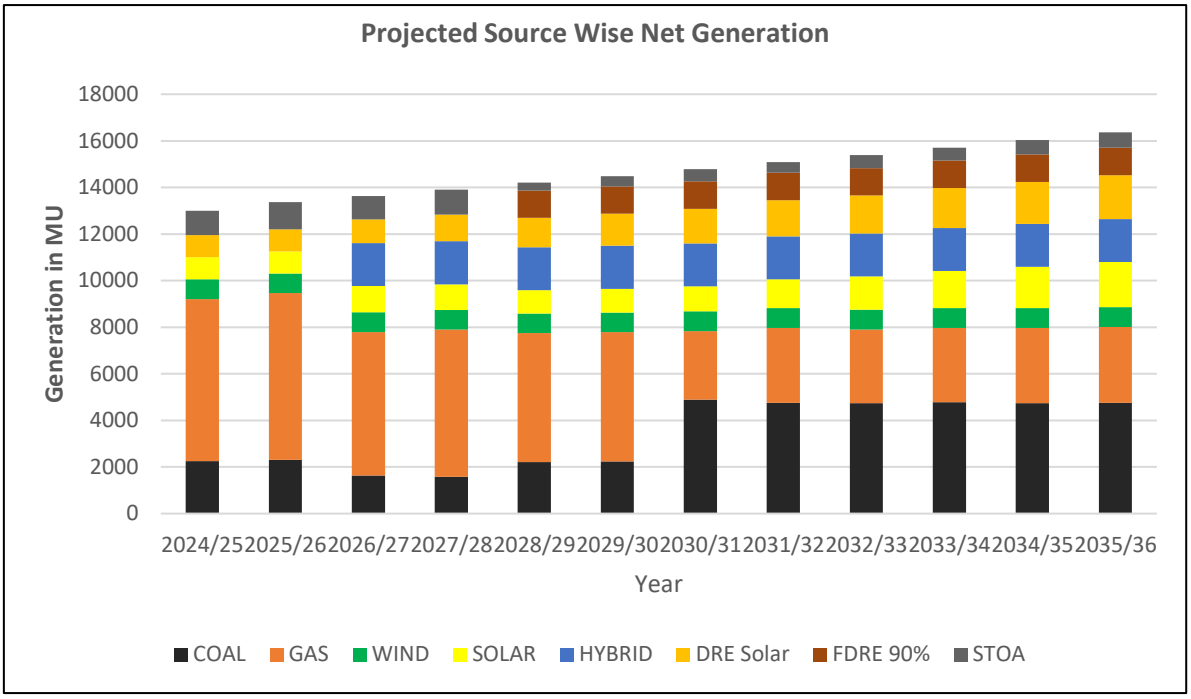


Figure 4.2: **Year Wise Source Wise Projected Net Generation in Base case**

The graph titled "Projected Source Wise Net Generation" presents the annual electricity generation, in million units (MU), from various energy sources between 2025-26 and 2035-36. Gas remains the dominant contributor, but its share in the energy mix declines over time. Coal shows a gradual increase in generation, particularly after 2030-31 with addition of new capacity. Renewable energy sources such as DRE Solar, hybrid, and Solar demonstrate consistent growth, with RE Sources becoming a significant part of the mix in later years. FDRE 90%, a firm and dispatchable renewable source, expected to be commissioned by 2028-29, indicating a shift towards more reliable green energy. Overall, the graph reflects a clear move towards a more diversified and renewable-driven power generation mix to meet future energy needs.

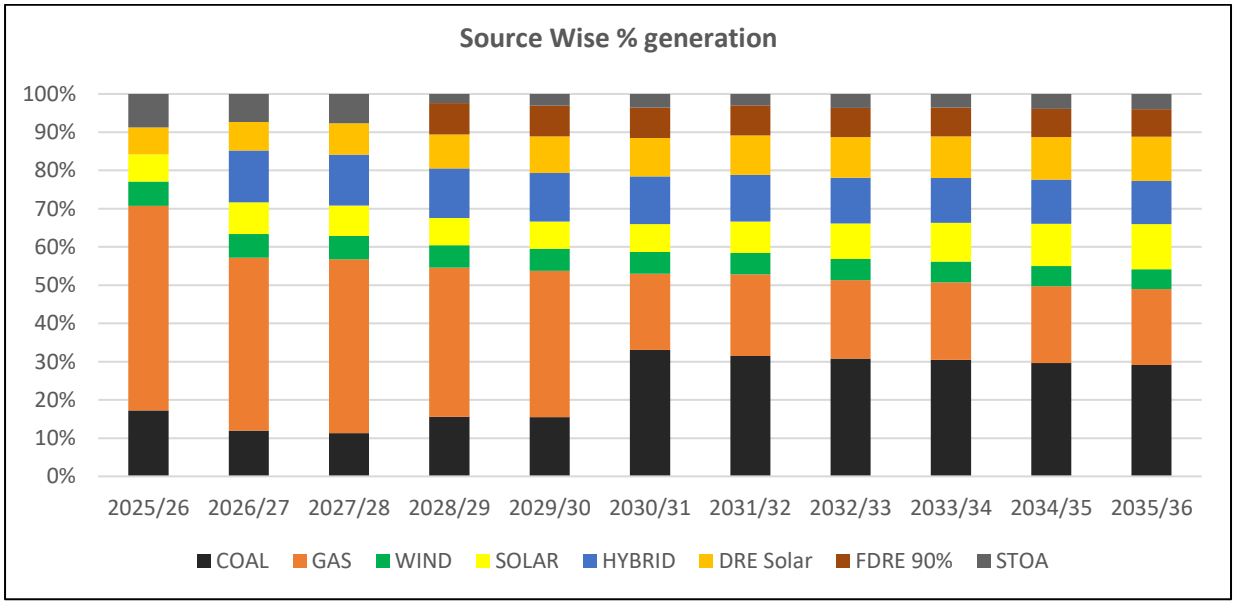


Figure 4.3: **Year Wise Source Wise % of Net Generation in Base case**

4.1 Observation and Recommendations

i. Torrent Power currently operates three units (D, E, and F) at the **Sabarmati Thermal Power Station**, with the following commissioning years and installed capacities:

- **Unit D** – Commissioned in **1978**, Capacity: **120 MW**
- **Unit E** – Commissioned in **1984**, Capacity: **121 MW**
- **Unit F** – Commissioned in **1988**, Capacity: **121 MW**

These units are expected to complete over 40-45 years of operational life by the year 2030 and are approaching the end of their technically viable and efficient operational lifetime. In view of this, Torrent Power has proposed the retirement of these three aging units by 2030-31 and intends to establish a new 800 MW thermal power plant under SHAKTI Policy B(iv)(ii). To facilitate this transition, the company has requested additional coal linkages for the proposed plant. The new plant will benefit from modern design, reduced auxiliary consumption, and lower emissions compared to the existing units.

ii. As on March 2025, fossil fuel-based sources, primarily gas and coal constitute the dominant share of the projected contracted capacity, contributing approximately 49% in the capacity mix. However, their relative share gradually declines over the years, falling to around 30–35% by 2035–36. In contrast, non-fossil sources such as solar, wind, hybrid, distributed renewable energy (DRE), FDRE, and battery energy storage systems (BESS) see a significant rise in both capacity and share. By 2035–36, these clean energy technologies collectively account for nearly 65–70% of the total contracted capacity.

In terms of generation mix, contribution of gas-based capacity which is around 53% in 2025–26, declines significantly to about 19 %, while contribution from coal increases from approximately 17% in 2025-26 to about 28% by 2035–36. Renewable sources—particularly hybrid, solar, DRE, and FDRE 90% demonstrate steady growth over the period.

The share of RE in the generation mix increases from 21% in 2025-26 to about 45 % in 2035-36, while share of fossil fuel sources reduce from 71 % in 2025-26 to 47% by 2035-36.

iii. The significant VRE (solar and wind) capacity addition planned by Torrent Power requires storage capacity to store excess generation and support the grid during high-demand hours. The storage requirement is estimated to be required starting from 2028-29, and it will increase to 450 MW/1800 MWh (4 Hours) by 2035-36.

iv. The hourly dispatch on a typical day in 2035-36 is shown in Figure 4.5. As shown in the graph, the coal capacity is running at maximum available capacity during night hours. However, during solar hours it backs down to the technical level (55%) to accommodate maximum solar energy and again ramps up in the evening hours to provide support during high-demand hours. During solar hours, excess RE generation (generation above the demand graph) is stored in the battery and gets dispatched during non-solar hours.

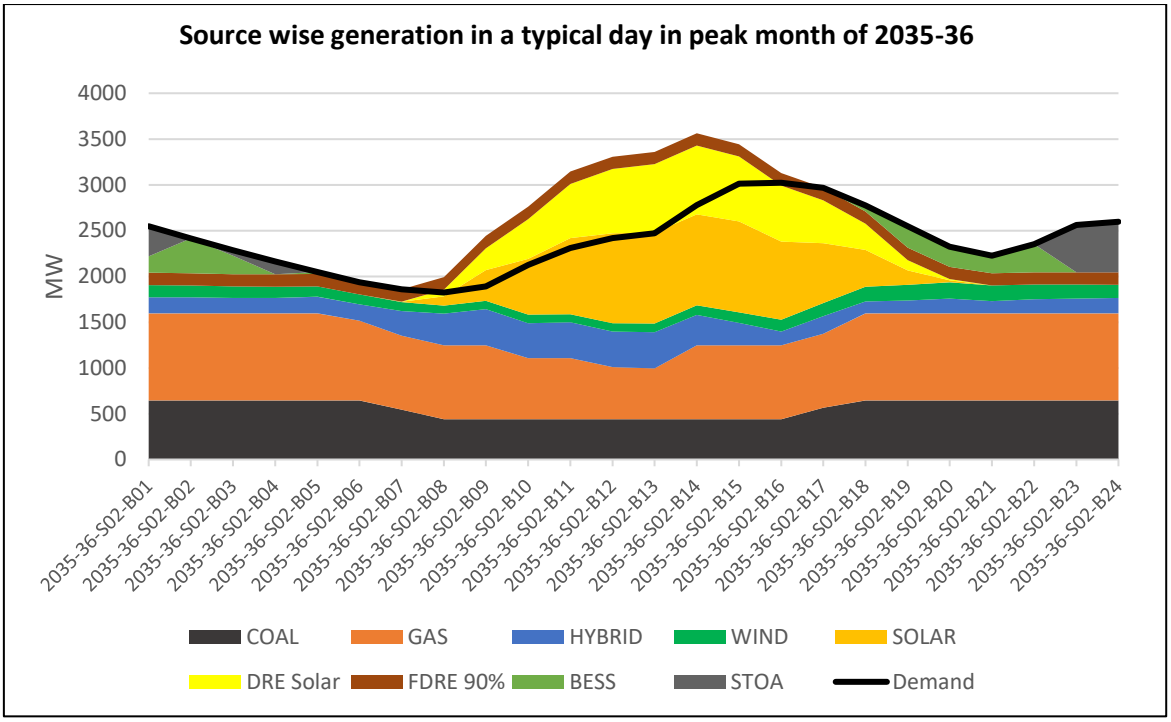


Figure 4.5 Hourly Source-wise Dispatch in a typical day in 2035-36

v. The model has estimated a requirement for short-term capacity (STOA) during peak demand hours, which are characterized by high load but limited duration. Rather than investing in additional dedicated capacity to meet these infrequent peaks, the model suggests that the demand can be reliably met through short-term solutions such as banking arrangements with other distribution companies, energy exchanges, or bilateral contracts. Furthermore, the reliance on STOA can be reduced by implementing effective demand-side management strategies, which can help to flatten peak loads and improve overall system flexibility.

The graph shows that the utilization of this STOA is very low and limited to only a high-demand period in the year as shown in Figure 4.6. Also, the utilization will be very low in future years as more capacity is available during the high-demand period.

Year	April	May	June	July	August	September	October	November	December	January	February	March
2025-26	464	761	707	244	340	517	607	148	160	176	279	333
2026-27	318	634	571	118	230	420	578	545	529	531	609	446
2027-28	352	677	613	152	264	457	615	574	557	557	495	479
2028-29	226	586	521	0	0	278	518	84	68	0	0	0
2029-30	278	592	566	0	87	379	557	115	99	236	187	28
2030-31	257	278	43	0	0	0	444	679	658	679	679	609
2031-32	274	307	38	0	0	0	344	586	660	622	660	644
2032-33	517	405	35	0	0	0	544	621	621	621	621	550
2033-34	509	453	157	0	0	0	584	607	599	607	607	607
2034-35	566	503	317	0	0	0	592	592	592	592	592	592
2035-36	585	553	480	0	0	0	585	512	585	585	585	585

Figure 4.6: **Year-wise month-wise maximum STOA requirement in MW**

vi. The base case scenario has envisaged that the planned capacity (both renewable and conventional) will be achieved as per the trajectory of Torrent Power. However, in case of any delay in the capacity addition, the short-term requirement (STOA) may be higher than shown in the report. Similarly, the STOA requirement may be different in case of a change in the peak demand and energy requirement trajectory of Torrent Power.

vii. The graph titled **"PLF of Coal and Gas Contracted Capacity"** illustrates the Plant Load Factor (PLF) percentages for coal and gas power generation from the year 2025-26 to 2035-36. In 2025-26, coal shows a high PLF of around 73%, while gas follows closely at approximately 71%. However, with additional coal planned in 2030-31 and RE capacity addition, the PLF of gas plants continues to decrease to nearly 32 % by 2035-36.

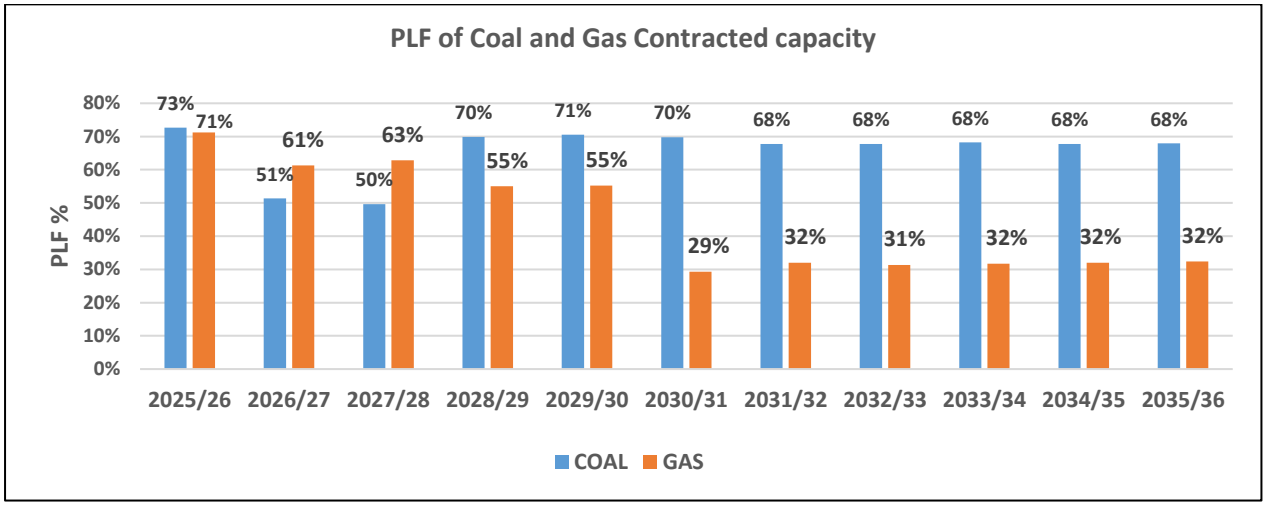


Figure 4.7: Annual PLF of Coal and Gas Capacity of Torrent Power

viii. Due to the planned coal capacity addition planned by Torrent Power, a significant amount of gas capacity may remain unutilized/under-utilized during solar hours. However, during the non-solar hours, excess gas capacity is available for only a few months of the year. The excess capacity available in those months may be utilized in many ways, such as

a. By banking arrangement with other states / discoms

b. By bilateral arrangement/Pushp portal/ power exchange

The hourly average excess capacity available during the years 2026-27, 2030-31, and 2035-36 are shown in Fig 4.8.

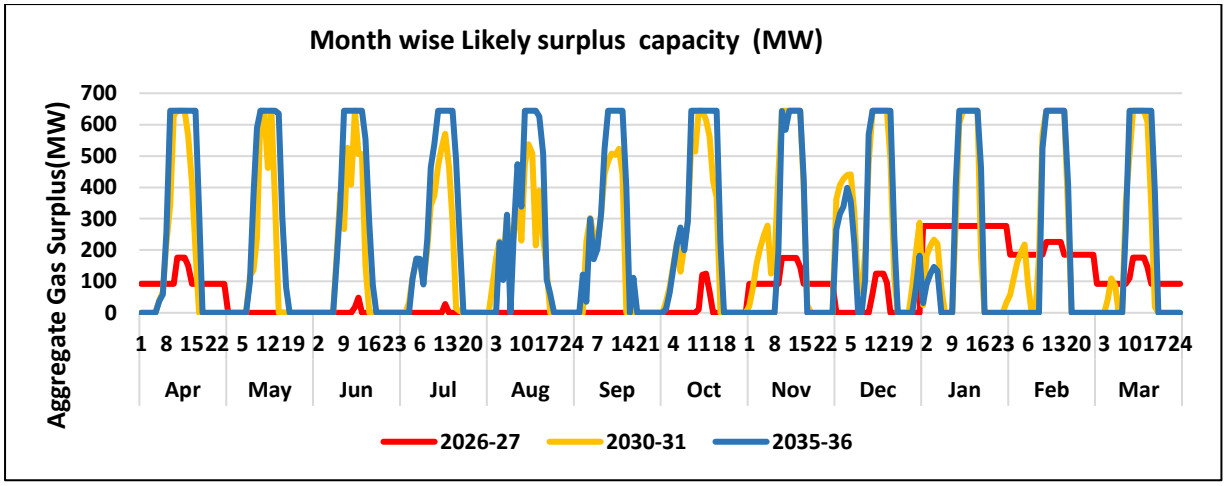


Figure 4.8: Excess Capacity Available in Different Time Intervals

ix. The model has estimated the battery requirement with a 4-hour single cycle battery operation. However, depending on the contract, this may be contracted as a 2-hour double-cycle operation based on the operational requirement.

x. A significant addition of rooftop solar capacity is planned, as per the projections received from Torrent Power. The increased intermittency due to high rooftop solar addition could pose operational challenges for grid stability and demand-supply balancing. To address these fluctuations, there is a need to augment system flexibility through the deployment of short-term Battery Energy Storage Systems (BESS)(< 1 Hour), particularly for managing ramping, frequency regulation, and intra-day variability.

5.0 Assumptions

Assumption for Resource Adequacy Studies for TORRENT POWER

1. Electricity Demand & peak requirement: As per the projection of TORRENT POWER
2. Demand Profile: Based on the hourly demand profile of 2022-23 ,2023-24 & 2024-25 (2020-21 & 2021-22 were neglected due to Covid-19's effects)
3. Existing & Planned Capacity: As per the information received from the TORRENT POWER Planning Cell
4. Cost parameters: based on information received from TORRENT POWER Planning Cell & National Electricity Plan.

RE CUF considered

Existing Solar	Existing Wind	Upcoming Solar	Hybrid power	FDRE
182 MW-18% 450 MW-28%	**24%**	**25%**	**45%**	**90% annual availability**

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 the 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)	Start-up fuel consumption (MCal/MW)		
		At max loading	At min loading				Hot	Warm	Cold

Coal	Existing/ Planned	As per inputs received from TORRENT POWER							
	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%	-	-	-	-	-

Financial Parameters

The following cost parameters have been assumed for the base year 2024-25:

Resource	Capex* (in ₹/MW)	O&M Fixed Cost (in ₹/MW)	Construction Time (in years)	Amortization /Lifetime (in years)
Coal	11.5 Cr	23 Lakh	4	25
Hydro~	6 Cr to 20 Cr	2.5% of Capex	5 to 8	40
Solar**	4.5 Cr to 4.1 Cr	1 % of Capex	0.5	25
Wind (Onshore)	6 Cr	1% of Capex	1.5	25
Wind (Offshore)	13.7 Cr	1% of Capex	1.5	25
Biomass	9 Cr	2% of Capex	3	20
Pumped Storage	3 Cr to 8 Cr	5 % of Capex	7	40
Battery Energy Storage (2 hours)	5.13 Cr to 3.13 Cr	1 % of Capex	0.5	14
Battery Energy Storage (4 hours)	8.22 Cr to 4.72 Cr	1 % of Capex	0.5	14
Battery Energy Storage (5 hours)	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

* All the CapEx figures are on an actual basis at the cost level of 2024-25, i.e., inflation is not considered while calculating CapEx.

~ The Capex values of Hydro and PSS candidates are considered as per the project cost details furnished by the respective developers for state and private sector plants and as per RCEs done periodically by CEA for central sector plants.

**Solar Cost is assumed to reduce from Rs 4.5 Cr/MW in 2024-25 to Rs 4.1 Cr/MW in 2029-30.