Report On
Resource Adequacy Plan
(Generation)
For GUVNL
(2025-26 to 2035-36)

June, 2026

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Disclaimer

GUVNL has entrusted the responsibility of conducting a Resource Adequacy (RA) study to the Center for Net-Zero Energy Transition (CNET) at the Green Energy Transition Research Institute (GETRI), Vadodara. In line with this, CNET has been actively carrying out the RA study for GUVNL in association with Central Electricity Authority (CEA). In December, 2025/January 2026, CEA distributed the STELLAR Model, along with the GAMS software, to all states, with a directive to conduct RA studies using the STELLAR Model to maintain uniformity in long-term country-level planning. Using the STELLAR Model, CNET has completed this study covering the fiscal years from 2025-26 to 2035-36.

This Resource Adequacy study for GUVNL has been conducted based on the data and inputs provided by GUVNL. The findings, analysis and conclusions presented in this report are contingent upon the accuracy, completeness and timeliness of the information furnished by GUVNL. Any discrepancies or limitations in the data may affect the study's outcomes 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). CNET has conducted this study and prepared the report to assist GUVNL in fulfilling this requirement.

CEA has vetted the report in fulfillment of the requirement stipulated under the aforesaid Guidelines. The vetting has been done solely based on data, inputs and assumptions provided by CNET/GUVNL. Any change in the data, inputs or assumptions by CNET/GUVNL may lead to change in the Study/Plan. 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 GUVNL.

Executive Summary

Ministry of Power had notified the Electricity (Amendment) Rules in December 2022. As per Rule 16 of the Electricity (Amendment) Rules, the Ministry of Power has notified Resource Adequacy Guidelines. As per the Resource Adequacy (RA) Guidelines, Central Electricity Authority is entrusted with preparing the Long-Term National Resource Adequacy Plan (LT-NRAP). Further, Distribution Utility needs to implement the LT-DRAP (Long-term Distribution Licensee Resource Adequacy Plan) to reliably meet the utility's peak and 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 electricity demand and electrical energy requirements. This plan shall be vetted/validated by the 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 gazette notified the Renewable Energy 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 must be met from renewable energy sources. The Gujarat Electricity Regulatory Commission (GERC) also has notified the regulation "GERC (Procurement of Energy from Renewable Sources) Regulations, 2025, effective from 12th August 2025 (herein after referred as GERC RPO Regulation, 2025), specifying the trajectory from FY 2025-26 to FY 2029-30 for procurement of energy from specified renewable energy source, in alignment with the RCO trajectory specified by the Ministry of Power vide notification No. 4617 (E) dated 20.10.2023.

To support the utility in fulfilling this requirement, CEA, in collaboration with the utility, initially conducted a Resource Adequacy (RA) study with a planning horizon up to FY 2034-35, based on the data received from the utility and in compliance with the RCO trajectory specified vide gazette notification dated 27th September 2025, as well as RPO trajectory notified by GERC RPO Regulation 2025. This study has now been updated and extended to cover the period up to FY 2035-36, incorporating the latest data furnished by the utility and planning assumptions. The RCO and RPO requirements for the utility have also been assessed in accordance with the respective statutory orders and regulations.

The electrical energy requirement for GUVNL is projected to increase at a CAGR of 6.08% for the period of 2025-26 to 2035-36, as per GUVNL projections. The projections indicate that peak electricity demand would increase with a CAGR of 6.03% for the same period. For satisfying resource adequacy, i.e. meeting the electricity demand reliably and at an affordable cost, GUVNL needs to methodically plan its capacity expansion either by investing in generation capacity or by procuring power. In view of the reduction in the cost of solar panels and technology options such as Energy Storage Systems, planning for a long-term optimal generation capacity mix is of tremendous

importance, ensuring a future generation capacity mix that is cost-effective and environmentally friendly.

The electricity demand of GUVNL DISCOMs is highest during the pre-summer and peak summer periods. It is strongly seasonal, characterized by broad summer daytime peaks, sharp winter morning ramps, and relatively flat monsoon loads.

The contracted capacity, together with GUVNL's planned future capacity, indicates that it is unlikely to meet its future electricity demand. To find out the least cost option for generation capacity expansion for the period 2025-26 to 2035-36, a long-term study for GUVNL has been carried out which minimizes 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.

Generation capacity expansion pathways have been considered for the long-term study based on the state's yearly capacity addition plans, along with RPO/RCO constraints for solar and wind technologies. Renewable capacities have been assessed in view of adherence to the RCO notified by the Ministry of Power, as well as the RPO trajectory notified by the GERC, taking into account fungibility across different sources.

Based on study, the likely total projected contracted capacity for the year 2035-36 is about 95,954 MW which consists of 19,590 MW from Coal, 2,631 MW from Gas, 1,280 MW from Nuclear, 17,507 MW from Wind, 23,738 MW from Solar, 8,256 MW from FDRE sources, 1,814 MW from Hydro, 11,348 MW of Battery Energy Storage System, 3,745 MW of PSP capacity and 6,045 MW from short and medium term contracts. This capacity shall meet the projected electricity demand while satisfying the prescribed reliability criteria.

1.0 Introduction

Ministry of Power has notified the 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 were notified by the Ministry of Power in June 2023, 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 projected demand reliably at least cost. A key aspect of resource adequacy planning is ensuring that adequate generation capacity is available, round-the-clock, to reliably serve electricity demand under various scenarios. This naturally translates into the need to ensure adequate reserve margin to accommodate varying levels of demand and supply in the grid. In the wake of high RE capacity additions, it is important to understand the demand-supply situation in the grid, given the high seasonality and intermittency of RE generation. The Resource Adequacy exercise will help assess capacity requirements to be tied up or contracted on a long-term, medium-term, and short-term basis.

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

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). In compliance of the same, CEA has vetted the LT-DRAP submitted by the GUVNL based on input datasets, modelling results furnished by the GUVNL along with the Plan. The Plan 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 24x7 basis, considering variations in demand, RE generation, and forced outages of thermal capacities. The study assesses the Planning Reserve Margin (PRM) required by the utility to account for the aforementioned uncertainties, ensuring that demand can be reliably met throughout the year.

Before this, CEA had assisted GUVNL in carrying out their RA study covering the horizon up to FY 2034-35, based on inputs furnished by GUVNL and in accordance with the RCO trajectory specified in the Ministry of Power's gazette notification dated 20th October,2023.

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

1. In the earlier Resource Adequacy (RA) study, financial year 2023-24 had been considered as the base year, and the study covered the period from 2024-25 to 2034-35. The fuel-wise tied up capacity of GUVNL as on 31.03.2024 was 32,611 MW. The Source Wise distribution is shown in Figure 1. The share of Coal (including MTOA) is around 54% of total capacity, while Solar and Wind capacities including DRE is around 35%, gas-based capacity is 8%.

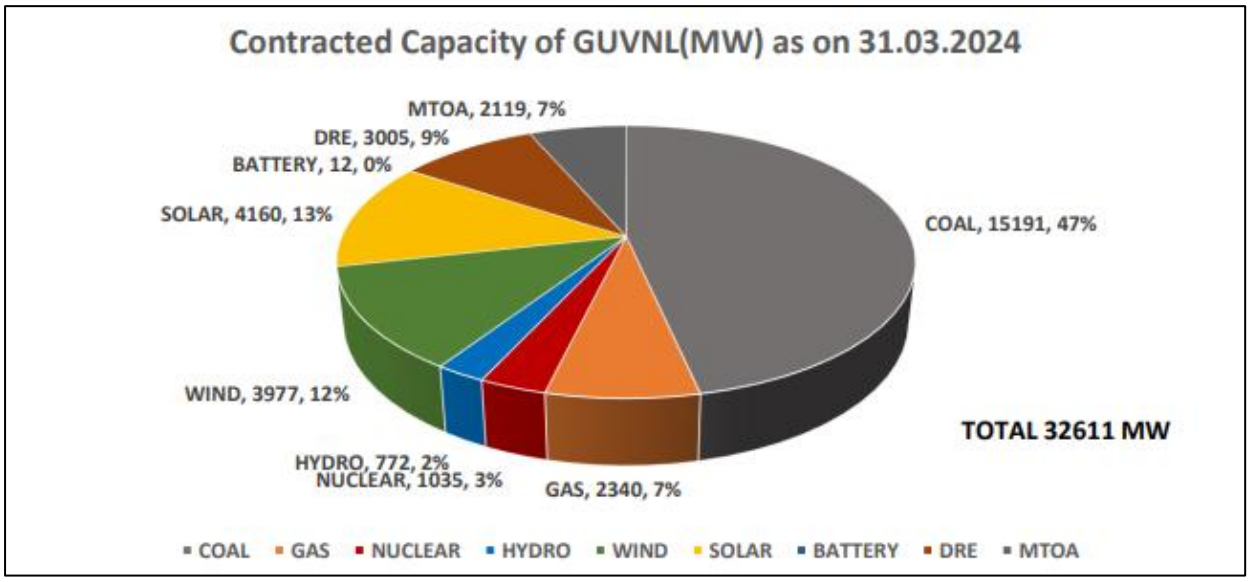


Figure 1: Source-wise Contract Capacity (in MW) as of March 2024

2. The hourly demand pattern for 2023-24 had been analysed and considered for the study.
3. The peak electricity demand and electrical energy projections as per GUVNL in consultation with CEA, which had been considered in the study, is tabulated below:

Table 1: Peak demand and Energy requirement (FY 25 to FY35)

Year	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Energy (BU)	133.5	141.6	150.0	159.0	168.5	178.7	189.5	201.1	213.5	226.7	240.9
Demand (MW)	23475	24750	26250	27750	29500	31250	33250	35250	37250	39500	42000

4. The actual peak electricity demand and electrical energy requirement of the utility observed during 2023-24 is given in
5. Table *2*.

Table 2: Actual Electrical Energy Requirement and Peak Electricity Demand in 2023-24

Year	Actual electrical energy requirement (in MU)	Actual peak electricity demand (in MW)
2023-24	128700	20964

6. To meet the projected peak electricity demand and electrical energy requirement reliably, the source-wise projected capacity (in MW) is given in Table 3.

Table 3: Projected Capacity mix

Technology	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Coal	15484	15484	16284	16438	17146	17905	17905	17905	17905	17905	17905
Gas	2340	2340	2340	2340	2340	2340	2340	2340	2340	2340	2340
Nuclear	1035	1035	1035	1035	1035	1035	1035	1035	1280	1280	1280
PSP	0	0	0	0	1480	1980	2480	2980	2980	2980	2980
BESS	1412	2412	3412	5462	5462	5462	5462	5652	7152	8652	10152
Solar	9235	14860	17422	22122	25122	28122	31122	34122	37122	40122	43122
DRE	3956	4556	5156	5756	6856	7456	7956	8456	8956	9456	9456
Wind	4647	5057	5562	6562	7562	8562	9562	10562	11562	12562	13562
FDRE		1500	3000	4500	6000	7500	9000	10500	12000	13500	15000
Hydro	798	1107	1244	1320	1320	1320	1370	1370	1870	1870	1870
Contract*	5722	4903	3505	2043	752	325	1352	1726	1065	916	1017
Total	**44629**	**53254**	**58960**	**67578**	**75075**	**82007**	**89584**	**96648**	**104232**	**111583**	**118684**

*The Contract capacity represents Short-term / medium-term capacity for the peak requirement in MW. It is recommended that this requirement be met through bilateral agreements.

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

Table 4: Year-wise capacity additions (in MW)

Year	COAL	GAS	NUCLEAR	HYDRO	WIND	SOLAR	PSP	BATTERY	DRE	FDRE
2024/25	293	0	0	26	670	5075	0	1400	3956	0
2025/26	0	0	0	309	410	5625	0	1000	600	1500
2026/27	800	0	0	137	505	2562	0	1000	600	1500
2027/28	154	0	0	76	1000	4700	0	2050	600	1500
2028/29	708	0	0	0	1000	3000	1480	0	1100	1500
2029/30	759	0	0	0	1000	3000	500	0	600	1500
2030/31	0	0	0	50	1000	3000	500	0	500	1500
2031/32	0	0	0	0	1000	3000	500	190	500	1500
2032/33	0	0	245	500	1000	3000	0	1500	500	1500
2033/34	0	0	0	0	1000	3000	0	1500	500	1500
2034/35	0	0	0	0	1000	3000	0	1500	0	1500
Total	**2714**	**0**	**245**	**1098**	**9585**	**38962**	**2980**	**10140**	**9456**	**15000**

3.0 Resource Adequacy Study of GUVNL (2025-26 to 2035-36)

3.1 Present Power Scenario in GUVNL

As of March 2025, the total Contracted Capacity for GUVNL is 39,748 MW without Distributed RE (DRE), and the total installed capacity with DRE is 45,313 MW. Out of the total contracted capacity of GUVNL, the share of non-fossil fuel-based capacity is about 37.2%. The fuel-wise contracted capacity as on 31st March 2025, is given in Table 5 and Figure 2 below.

Table 5: Fuel-wise contracted Capacity as of March 2025

Source	Capacity (MW)	% Share
Coal	18024	45.3%
Gas	2631	6.6%
Nuclear	1035	2.6%
Wind	4597	11.6%
Solar	8278	20.8%
Hydro	857	2.2%
BESS-2H	12	0.03%
PSP	185	0.5%
Contracts#	4130	10.4%
Total Contracted Capacity	**39748**	**100%**
Solar-DRE*	5565	
Total with DRE	**45313**	

Contracts include medium/short term contracted capacity tie ups viz. MTOA STOA.

* Solar DRE do not form part of Contracted Capacity; it has been mentioned to indicate Total capacity installed in the System

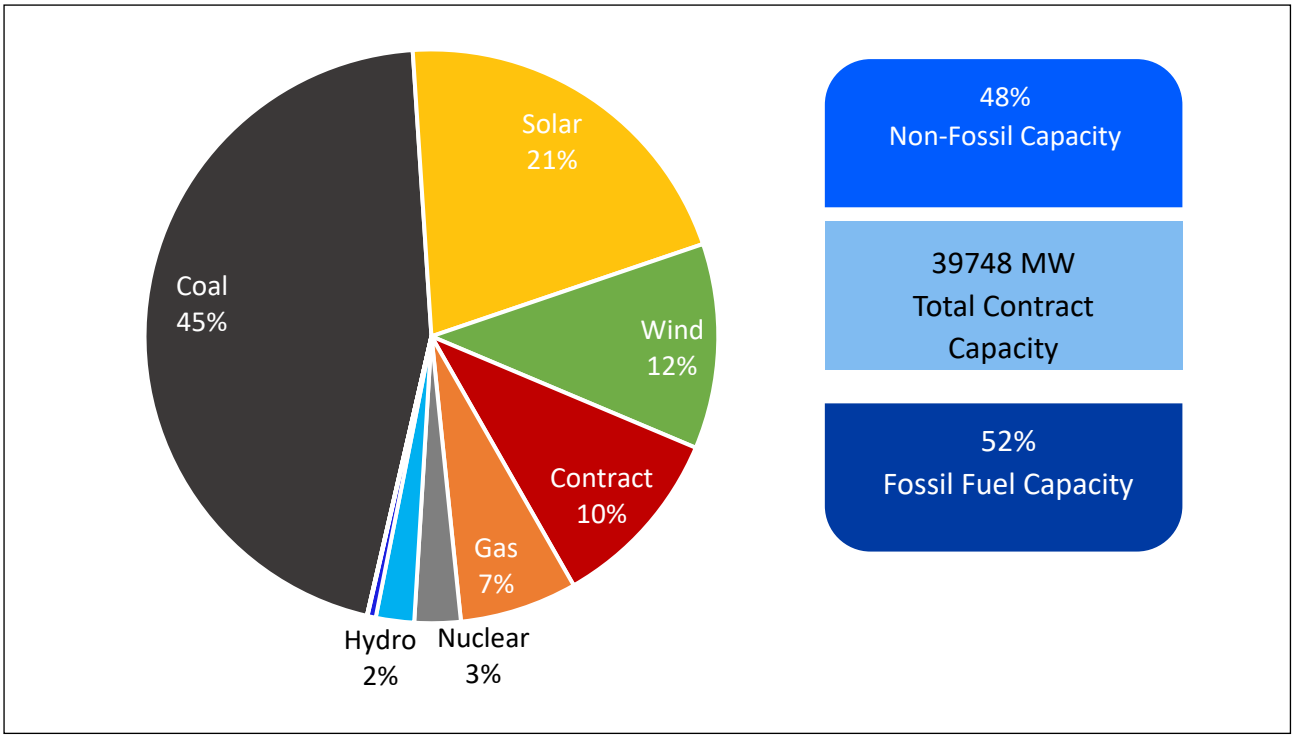


Figure 2: Fuel-wise Contracted Capacity (in MW) as of 31st March 2025

3.2 Analysis of Present Demand

The electricity demand pattern of 2024-25 was analyzed. The daily load pattern of GUVNL is characterized by a gradual early morning trough, followed by a steep morning ramp leading to a dominant daytime peak. The peak demand generally occurs during late morning or afternoon hours, with a broader plateau in summer months and a sharper peak in winter. Evening demand remains moderate relative to daytime levels, and the load gradually tapers off toward midnight. The system exhibits a single-peak structure with significant morning ramping requirements.

The hourly demand analysis reveals clear seasonal variations in the load profile of GUVNL. During the summer months, demand typically forms a broad afternoon peak, reflecting sustained cooling requirements and high daytime consumption. In contrast, winter months are characterized by a pronounced late-morning peak, along with the steepest intraday ramping, indicating sharper transitions in load within a short duration. The monsoon period shows a comparatively flatter load curve with moderated demand levels and reduced daily variation. The highest intraday fluctuations are observed during the winter season, underscoring the need for sufficient flexible generation capacity and storage solutions to effectively manage rapid demand changes and ensure system reliability.

Also, the summer months exhibit a broad afternoon peak, with maximum demand exceeding 20 GW. In contrast, winter months display a sharp late-morning peak around 10:00 to 11:00 hours, accompanied by the highest intraday ramp of approximately 6–8 GW. The monsoon months show a comparatively flat load curve with lower peak levels. The maximum intraday variation occurs in January, indicating significant ramping requirements.

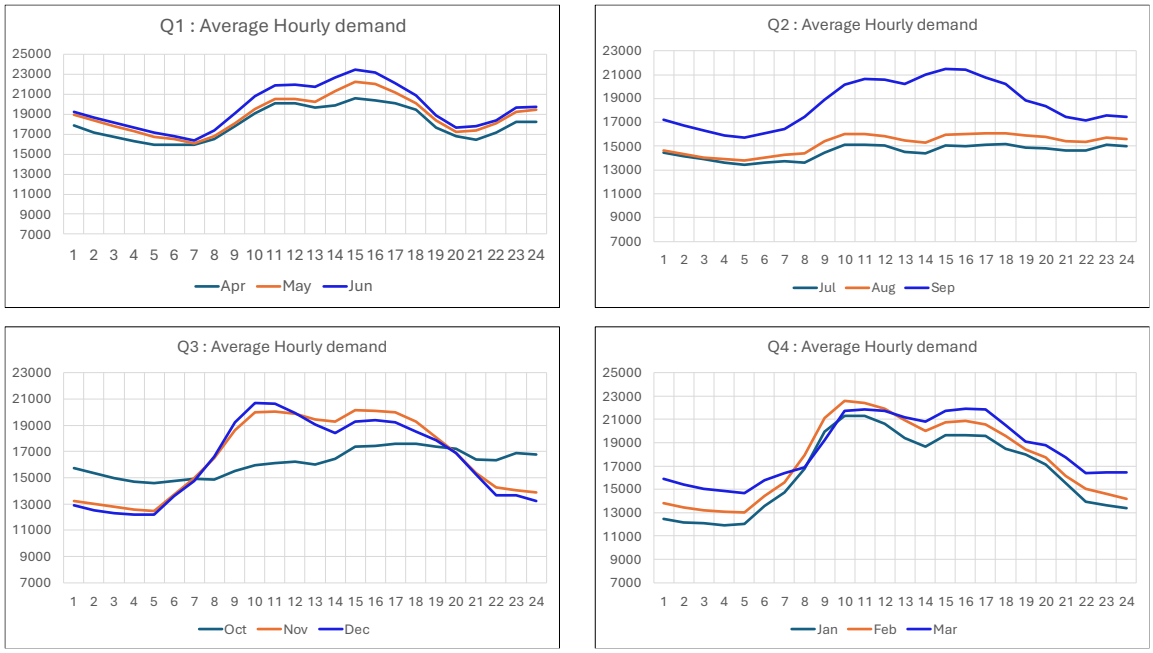


Figure 3: Average Hourly Demand Profile (Month-wise) April-March for 2024-25

GUVNL's electricity demand during solar hours is consistently higher than during non-solar hours. During Solar hours, demand remains higher than during non-solar hours, reflecting high use for commercial purposes and domestic loads. In the Summer and winter seasons, there is a wide gap between the peaks occurring during the day and night hours, indicating cooling and heating requirements, whereas during the monsoon period, peaks follow each other.

The hourly demand pattern for 2024-25 was analyzed to determine the number of occurrences of peak and near-peak demand. Such instances are critical for study purposes, as it is necessary to ensure resource adequacy with an optimal mix of long-term, medium-term, and short-term contracts.

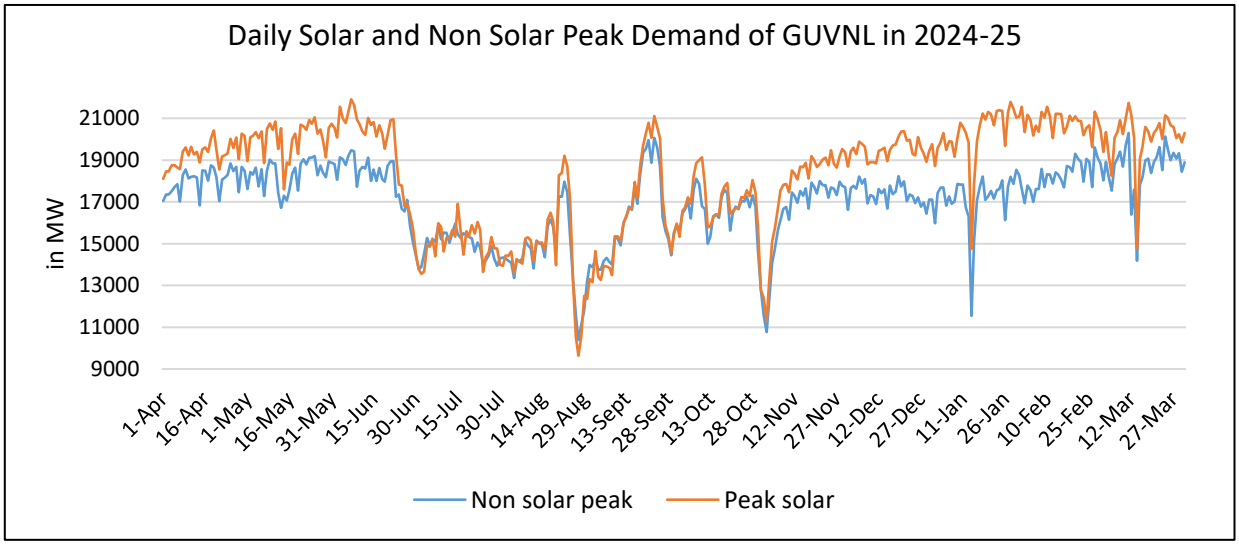


Figure 4: Daily Peak Demand of GUVNL during Solar and Non-Solar Hours (2024-25)

Figure 4 illustrates the daily Non-Solar Peak and Solar Peak demand across one year from April 2024 to March 2025. The daily peak demand analysis for GUVNL over the financial year indicates a pronounced seasonal variation. The annual maximum demand reached approximately 21.7

GW in March, while the non-solar peak reached 20.3 GW, highlighting increasing system stress during the pre-summer period. In the summer months (April–June), sustained high demand is driven primarily by cooling loads. A significant dip is observed during the monsoon months (July–August), with demand falling below 11 GW on some days. The post-monsoon and winter periods show a gradual recovery in demand, with another peak in January. The analysis underscores the importance of solar generation in mitigating daytime peak demand, while also highlighting the need for adequate firm capacity to manage evening and seasonal peaks.

Figure 5 shows the frequency distribution of hourly demand for an entire year (8,760 hours). Demand values are grouped into ranges, and the chart displays both the number of hours falling within each demand band and the percentage share of total hours.

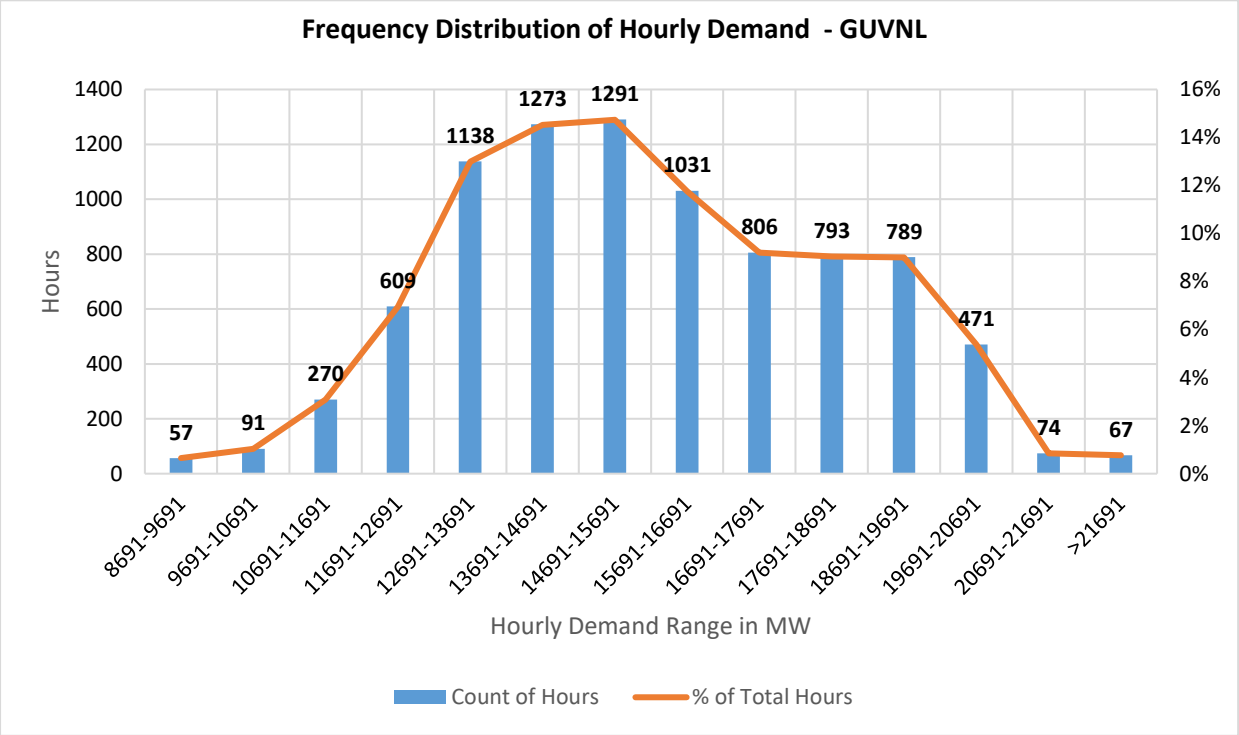


Figure 5: Frequency Distribution of Hourly Demand Profile (2024-25)

It forms a bell-shaped, slightly right-skewed pattern, indicating that most hours of the year fall within the mid-demand range. The highest concentration occurs in the 12691–16691 MW band, which accounts for 4733 hours (54%), while 13691 – 16691 band accounts for approximately 41% of total hours. It shows a stable mid-demand range, with the highest concentration of hours falling within the central operating band. High-demand conditions occur regularly, but extreme peak events are limited to 67 hours (<2%) annually. Low-demand hours are also minimal, reflecting a strong base load structure.

4.0 Principles of Generation Planning

The objective of the Generation Planning process is to obtain an optimal generation capacity mix at the least cost to meet 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 the objectives of all policies of the Government of India, such as the RPO 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 -STELLAR

Central Electricity Authority (CEA) has successfully developed an indigenous generation expansion planning tool that integrates long-term capacity planning, economic dispatch, and reliability analysis into a unified framework. Named “STELLAR” (Strategic Expansion for Long-Term Load Adequacy and Resilience), the tool represents a significant advancement in power system modelling and planning. STELLAR is a state-of-the-art optimization model framework specifically designed to support long-term decision-making in the electricity sector, with a focus on ensuring resource adequacy, operational resilience, and cost-effective system evolution in line with India's energy transition goals.

STELLAR serves as a comprehensive and robust platform for long-term generation and transmission planning, supporting informed policymaking and investment strategies in India's evolving power sector. The salient features of STELLAR include representative-day modelling, co-optimization of energy and ancillary services, demand response modelling, and reliability modelling.

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

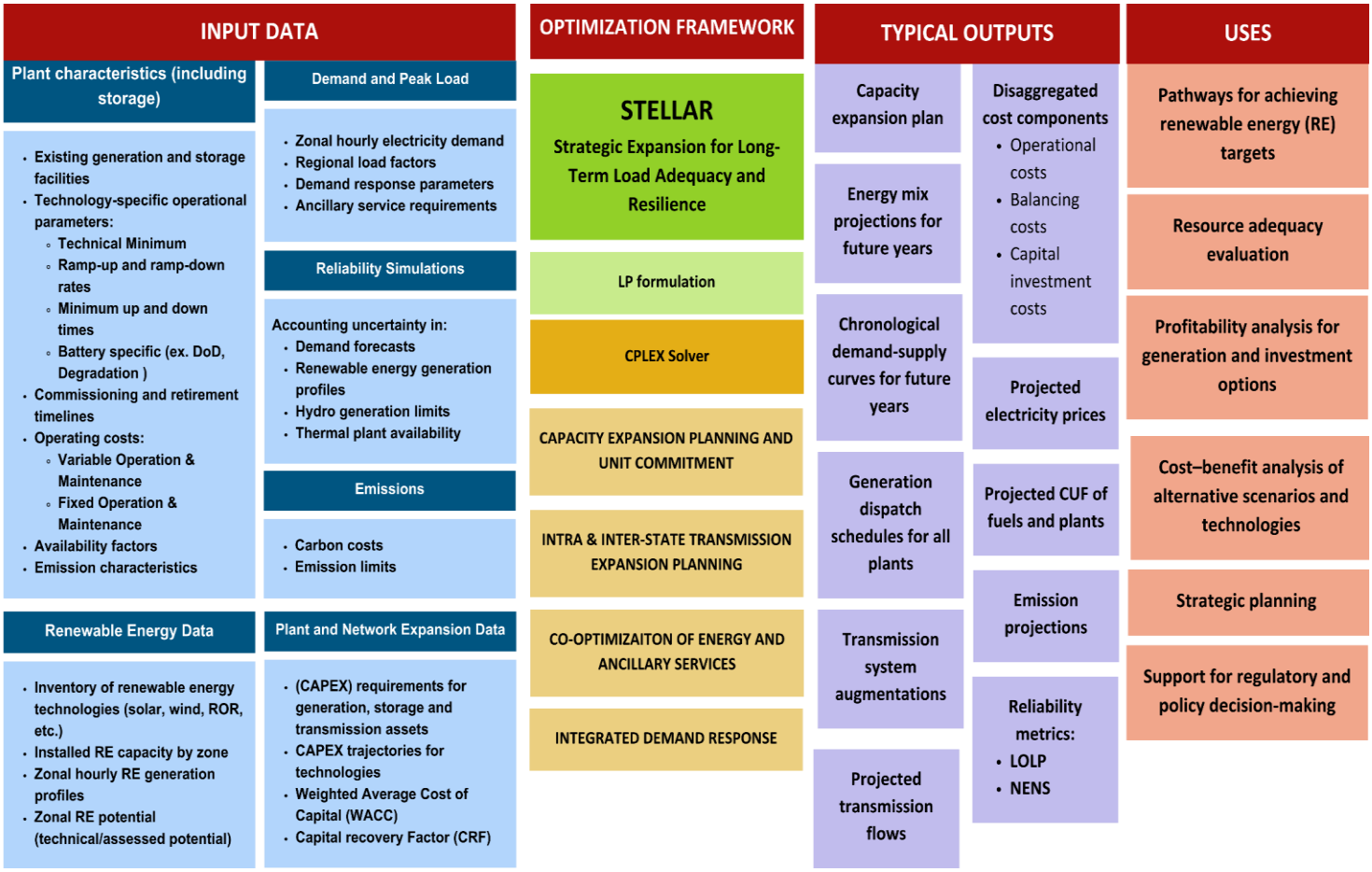


Figure 6: Schematic Diagram

5.0 Inputs for Reliability Analysis

One of the main criteria for resource adequacy studies is to determine the system's reliability in meeting demand at all times. This reliability is measured using two indices: LOLP (Loss of Load Probability) and EENS (Expected Energy Not Served). These indices have been defined in resource adequacy guidelines as follows:

- **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.
- **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 not being served, calculated in megawatt-hours (MWh). The metric can be normalised (i.e., divided by total system energy requirement) to create a Normalised Energy Not Served (NENS) metric.

Monte Carlo/Stochastic simulation has been used to account for the uncertainty associated with various generation resources and demand. It is an approach used to predict the probability

of a variety of outcomes when random variables are present, as opposed to deterministic modelling in the economic dispatch model. Monte Carlo simulation helps analyse the randomness associated with RE energy resources, demand patterns, and plant forced outages. A large number of random samples of these variables is simultaneously simulated to estimate system reliability indices (i.e., Loss of Load Probability LOLP & Energy Not Served (ENS)) & the system's robustness in the face of the above variation in system parameters.

Planning Reserve Margin (PRM): To meet the prescribed LOLP/NENS conditions, sufficient reserve margins must be maintained in the system to adequately address demand and supply variations. Planning Reserve Margin (PRM) is the predominant metric used to ensure adequacy of generation resources in the system. In a power system, PRM is generally expressed as a percentage of projected peak electricity demand.

5.1 Variation in electricity demand

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

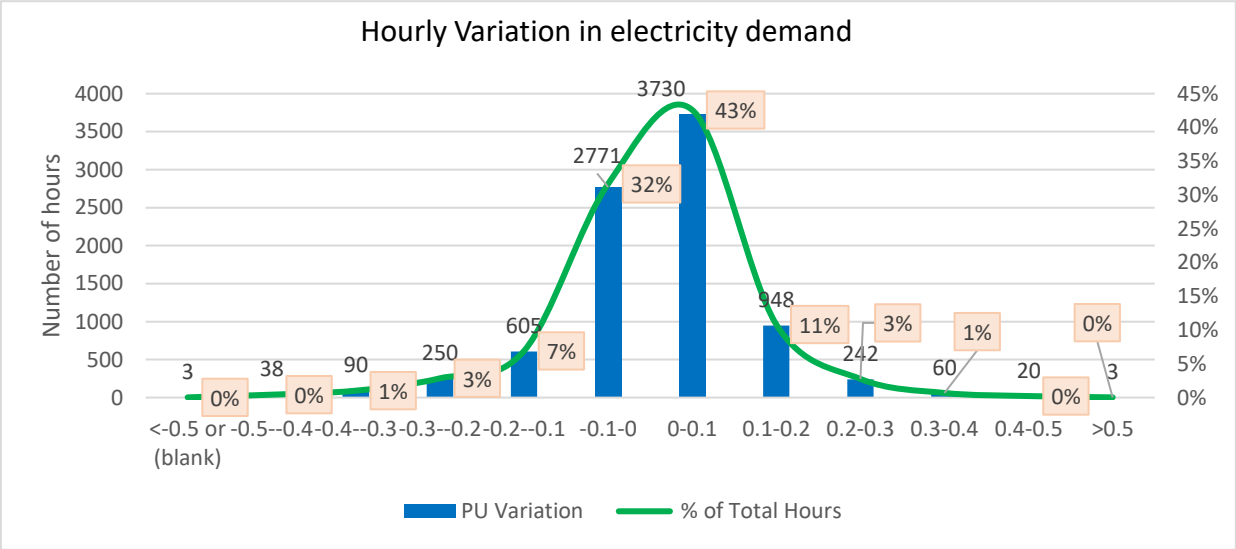


Figure 7: Hourly Variation in Electricity Demand across 2023-24 and 2024-25

It can be observed that the hourly demand typically varies within ±10% in ~74% of instances, and the demand trajectory reflects steady, incremental growth with minimal year-to-year distortion and no extreme volatility. This variation is primarily due to temperature, weather conditions, or random outages of transmission lines and generating units. This variation has been captured in the reliability study by incorporating a variation of ±10% in the projected hourly demand for the future years by introducing a random variable (with normal distribution) for demand as per observed behavior over the years.

5.2 Variation in RE Generation

In Long-term capacity expansion planning studies, a specific profile for Solar and Wind is derived from observed generation data to determine the optimal capacity mix. However, due to the intermittent nature of these sources, generation from these non-dispatchable sources may vary across years. As per analyses based on historical generation data, solar-based generation and wind-based generation has varied by ±10 % and ±20 % respectively, reflecting the variation in these generation sources and necessitating the requisite measures to mitigate such behavior.

6.0 Inputs/Assumptions for the Study

i) The projected electrical energy requirement and peak electricity demand as estimated by the electricity department of GUVNL is given in Table 6. For the study, projections as per GUVNL have been considered. Electricity demand Projections for the State of Gujarat as per the mid-term review of 20th EPS is also given in Table 6.

ii) The Demand Considered is inclusive of demand on the grid by GUVNL DISCOM's consumers as well as that of Captive / Open Access entities, that are embedded in DISCOMs and having contracted demand with them.

Table 6: Electricity Demand Projections

Year	Energy Projections (MU)				Peak Demand Projections (MW)			
	As per GUVNL	Growth Rate	As per mid - term review of 20th EPS*	Growth Rate	As per GUVNL	Growth Rate	As per mid - term review of 20th EPS*	Growth Rate
2025-26	141687		159966		24750		27672	
2026-27	150070	5.92%	172616	7.91%	26250	6.06%	29865	7.92%
2027-28	159012	5.96%	189293	9.66%	27750	5.71%	31904	6.83%
2028-29	168552	6.00%	208193	9.98%	29500	6.31%	34706	8.78%
2029-30	178731	6.04%	229153	10.07%	31250	5.93%	37786	8.87%
2030-31	189595	6.08%	250562	9.34%	33250	6.40%	40873	8.17%
2031-32	201191	6.12%	272829	8.89%	35250	6.02%	45801	12.06%
2032-33	213572	6.15%	296563	8.70%	37250	5.67%	49242	7.51%
2033-34	226793	6.19%	321645	8.46%	39500	6.04%	52831	7.29%
2034-35	240912	6.23%	346740	7.80%	42000	6.33%	56345	6.65%
2035-36	255588	6.09%	365811	5.50%	44441	5.81%	57220	1.55%

* Mid-term review of 20th EPS projections is for the state of Gujarat

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

iv) The actual solar, hydro and wind generation profiles and CUFs have been referred from the previous year's generation data provided by GUVNL.

v) The capital costs of candidate plants are detailed in the Appendices and are aligned with current market trends and recent price discovery.

vi) The GUVNL's electrical energy and peak demand also includes the consumption by embedded consumers with Open Access and Captive capacities tied up.

vii) The planned capacity has been considered based on the tie-up information furnished by GUVNL. Source-wise planned capacity is given in Table 7. Open Access Capacities (Viz. Wind (OA), Solar (OA) and Hybrid (OA)) as envisaged to come up in subsequent years have been included in planned capacities as the demand considered in Table 6 includes the System Demand corresponding to the same:

Table 7: Source-wise planned capacity addition (in MW)

	Coal	Nuclear	Hydro	PSP	Battery 2hr	Wind (OA)*	Solar (OA)*	Hybrid (OA)*
2025-26	0	0	266	0	180	0	0	0
2026-27	0	0	196	0	3000	351	3016	1503
2027-28	154	0	77	0	0	0	0	0
2028-29	154	0	0	0	0	0	0	0
2029-30	1959	245	0	0	0	0	0	0
2030-31	304	0	50	0	0	0	0	0
2031-32	0	0	368	0	0	0	0	0
2032-33	0	0	0	0	0	0	0	0
2033-34	0	0	0	1480	0	0	0	0
2034-35	0	0	0	500	0	0	0	0
2035-36	0	0	0	1580	0	0	0	0
Total	**2571**	**245**	**957**	**3560**	**3180**	**351**	**3016**	**1503**

* OA – Open Access Capacities tied up by consumers

viii) **Renewable Purchase / Consumption Obligation trajectory**: Hon'ble GERC has notified the GERC (Procurement of Energy from Renewable Sources) Regulations, 2025, which is aligned with the Renewable Consumption Obligation(RCO), notified by MoP vide dated 27th September 2025. Accordingly, the RPO/ RCO trajectory considered for this study is given below in Table 8 with future projections considered.

Table 8: Renewable Consumption Obligation Trajectory

Sl. No.	Financial Year	RPO Obligation as per GERC RPO Regulation 2025 (Excluding DRE)	RCO Obligation as per MoP (BEE) order Sept-2025 (Excluding DRE)*	Remarks
1	2025-26	30.91%	30.91%	As per notification
2	2026-27	33.25%	33.25%	
3	2027-28	35.51%	35.51%	
4	2028-29	37.46%	37.46%	
5	2029-30	38.83%	38.83%	
6	2030-31	-	40.50%	Assumed values
7	2031-32	-	41.50%	
8	2032-33	-	42.30%	
9	2033-34	-	43.00%	
10	2034-35	-	43.50%	
11	2035-36	-	44.00%	

*The RCO obligation beyond 2029-30 are assumed values.

ix) **Maximum Build Constraint:** While the primary goal of capacity expansion is to find the most economical mix of resources to meet the specified **LOLP (0.2%) and ENS (0.05%)** targets, a purely unconstrained "Least-Cost" optimization may yield results that are practically or technically infeasible. The application of **Maximum Build Constraints** (limiting the amount of a specific technology that can be added in a single year or period) is a standard industry practice while conducting generation expansion studies. In this study, the following maximum build constraints have been adopted, after due deliberation with GUVNL.

Resource Type	Max Build Capacity (MW)
Solar Candidate	4440
Wind Candidate	1300
FDRE Candidate	1000
Coal Non-Pit Head	2000
Coal Pit Head	2000

7.0 Results of the Resource Adequacy Study

7.1 Generation Expansion- Required Capacity to meet forecasted demand.

To meet the projected electricity demand while complying with the Renewable Purchase Obligation, candidate capacities have been provided to the model to find the least-cost optimal capacity mix. The capacity projections for GUVNL are given below:

Table 9: Likely requirement of contracted capacity (existing+ planned+ additional) (in MW)

Technology	2024-25 (Base)	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36
Coal	18024	17142	16172	16326	16480	19022	19326	19326	19590	19590	19590	19590
Gas	2631	2631	2631	2631	2631	2631	2631	2631	2631	2631	2631	2631
Nuclear	1035	1035	1035	1035	1035	1280	1280	1280	1280	1280	1280	1280
PSP	185	185	185	185	185	185	185	185	185	1665	2165	3745
BESS2h		4000	8000	10557	10557	10557	10557	10557	10557	10557	10557	10557
BESS4h	12	91	791	791	791	791	791	791	791	791	791	791
Solar	8278	12718	15018	17418	17418	17418	17418	17418	17418	18909	20068	23738
Wind	4597	5007	5807	7107	8407	9707	11007	12307	13607	14907	16207	17507
FDRE				500	1500	2500	3500	4500	5500	6500	7500	8256
Hydro	857	1123	1319	1396	1396	1396	1446	1814	1814	1814	1814	1814
Contract[#]	4130	3806	1226	2134	1979	1308	3057	3087	3482	1337	3327	6045
Total Contracted Capacity	**39748**	**47737**	**52183**	**60079**	**62378**	**66794**	**71197**	**73895**	**76854**	**79981**	**85929**	**95954**
Solar OA*	2205	2205	5221	5221	5221	5221	5221	5221	5221	5221	5221	5221

Wind OA*	2681	2681	3032	3032	3032	3032	3032	3032	3032	3032	3032	3032
Hybrid OA*	1862	1862	3365	3365	3365	3365	3365	3365	3365	3365	3365	3365

Contracts included STOA/MTOA to be procured by GUVNL on a yearly basis

* Captive / OA capacities envisaged

The STOA/MTOA requirement can be fulfilled through power procurement from markets or bilateral agreements. The STOA/MTOA value reflects the peak electricity demand value requirement and seasonal banking requirements in terms of MW.

As per the study, the utility needs to contract the following capacities (planned and additional) per year till 2035-36 to reliably meet its electricity demand.

Table 10: Planned capacity and capacity to be contracted by the utility year-wise (in MW)

Techno-logy	Year	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36	TOTAL MW
Coal	Reqd Cap	-882^	-970^	154	154	2542	304	0	264	0	0	0	1566
	Planned	-882^	-970^	154	154	1959	304	0	0	0	0	0	719
	Addl.Req	0	0	0	0	583	0	0	264	0	0	0	847
Nuclear	Reqd Cap	0	0	0	0	245	0	0	0	0	0	0	245
	Planned	0	0	0	0	245	0	0	0	0	0	0	245
	Addl.Req	0	0	0	0	0	0	0	0	0	0	0	0
Hydro	Reqd Cap	266	196	77	0	0	50	368	0	0	0	0	957
	Planned	266	196	77	0	0	50	368	0	0	0	0	957
	Addl.Req	0	0	0	0	0	0	0	0	0	0	0	0
Wind	Reqd Cap	410	800	1300	1300	1300	1300	1300	1300	1300	1300	1300	12910
	Planned	0	0	0	0	0	0	0	0	0	0	0	0
	Addl.Req	410	800	1300	1300	1300	1300	1300	1300	1300	1300	1300	12910
Solar	Reqd Cap	4440	2300	2400	0	0	0	0	0	1491	1159	3670	15460
	Planned	0	0	0	0	0	0	0	0	0	0	0	0
	Addl.Req	4440	2300	2400	0	0	0	0	0	1491	1159	3670	15460
FDRE	Reqd Cap	0	0	500	1000	1000	1000	1000	1000	1000	1000	756	8256
	Planned	0	0	0	0	0	0	0	0	0	0	0	0
	Addl.Req	0	0	500	1000	1000	1000	1000	1000	1000	1000	756	8256
PSP	Reqd Cap	0	0	0	0	0	0	0	0	1480	500	1580	3560
	Planned	0	0	0	0	0	0	0	0	1480	500	1580	3560
	Addl.Req	0	0	0	0	0	0	0	0	0	0	0	0
Battery - 2hr	Reqd Cap	4000	4000	2557	0	0	0	0	0	0	0	0	10557
	Planned	180	3000	0	0	0	0	0	0	0	0	0	3180
	Addl.Req	3820	1000	2557	0	0	0	0	0	0	0	0	7377
Battery - 4hr	Reqd Cap	79	700	0	0	0	0	0	0	0	0	0	779
	Planned	0	0	0	0	0	0	0	0	0	0	0	0
	Addl.Req	79	700	0	0	0	0	0	0	0	0	0	779

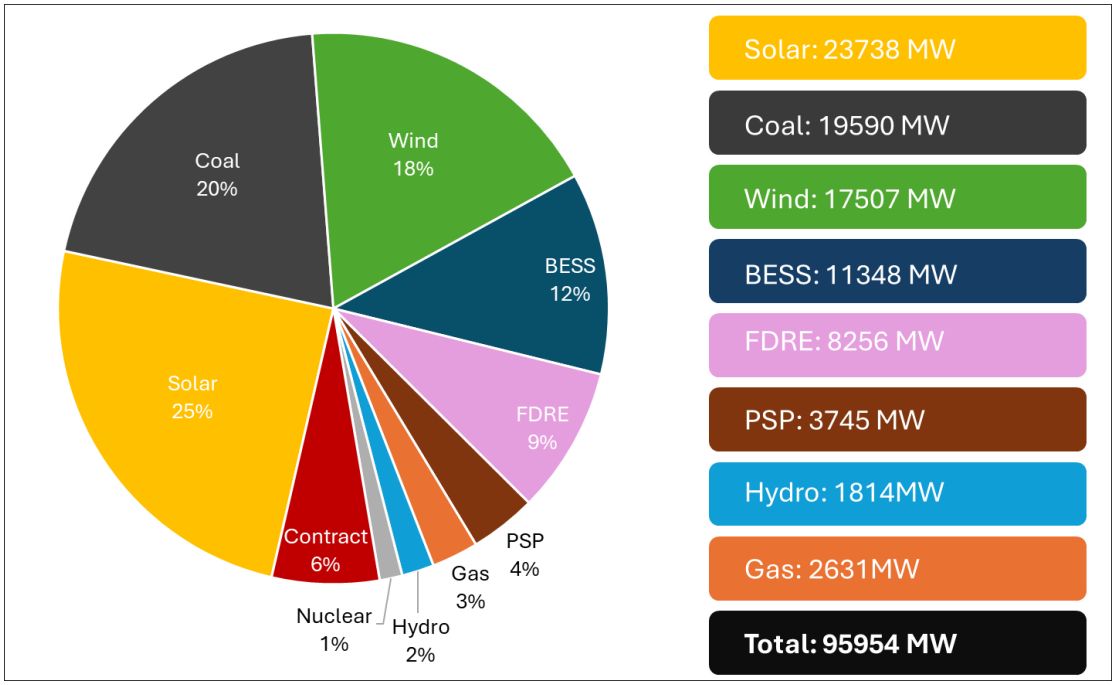
^ Negative values indicate expiring or retiring PPA/MTOA/STOA capacities.

Note: List of coal-based Generation plants, where Power Purchase Agreement (PPA) is expiring in 2025-26 and 2026-27, is appended as Appendix B

Reliability studies have been conducted based on projected capacity for 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 Normalized Energy Not Served

(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 capacity for the year 2035-36 is about 95,954 MW which consists of 19,590 MW from Coal, 2,631 MW from Gas, 1,280 MW from Nuclear, 17,507 MW from Wind, 23,738 MW from Solar, 8,256 MW from FDRE sources, 1,814 MW from Hydro, 11,348 MW of Battery Energy Storage System, 3,745 MW of PSP capacity and 6,045 MW from short and medium term contracts. This capacity shall meet the projected demand while satisfying the prescribed reliability criteria. The Planning Reserve Margin (PRM) for GUVNL has been assessed as about 12% and 9% for solar and non-solar hours respectively in the year 2035-36.



* Does not include OA/Captive capacities as the same are not contracted by GUVNL

Figure 8: Contracted Capacity Mix in 2035-36 in MW

It is important to note that any deviations from the commissioning schedule of the planned capacity could result in the utility being 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 reliably meeting the utility's power demand. Year-wise capacity projection is given in Figure 9.

Based on the Long-Term National Resource Adequacy Plan (LT-NRAP) (2026-27 to 2035-36) published by CEA, there is requirement of long- duration storage (6+ hours) in the system. Though GUVNL has planned development of 11,348 MW BESS and 3,745 MW PSP capacity by 2035-36, considering significant RE and PSP potential in Gujarat, to add rotating mass (inertia)

in the system and also improve the reliability of supply during non-solar hours, there is need for speedy development of PSP capacity in the State. As the gestation period of PSP is about four-five years, advance action should be taken by the State towards development of PSP capacity in the State. This would also facilitate the speedy integration of balance RE potential in the state of Gujarat, as adequate energy storage capacity will be crucial for managing system flexibility and optimizing transmission system for evacuation of RE power from the State. The PSP capacity can be added from 2030-31 to 2035-36 which will replace the need for commensurate BESS in that time frame. Further, steps should be taken by the State towards pumping mode operation of existing PSPs in the state.

Gujarat is facing challenges with respect to Short Circuit ratio and less inertia in most of the sub-stations in RE rich zones due to integration of inverter-based resources. This results in additional requirement of Synchronous Condenser which will incur additional cost of about Rs. 2 Cr/MVAr. Development of PSP will also help in addressing these issues.

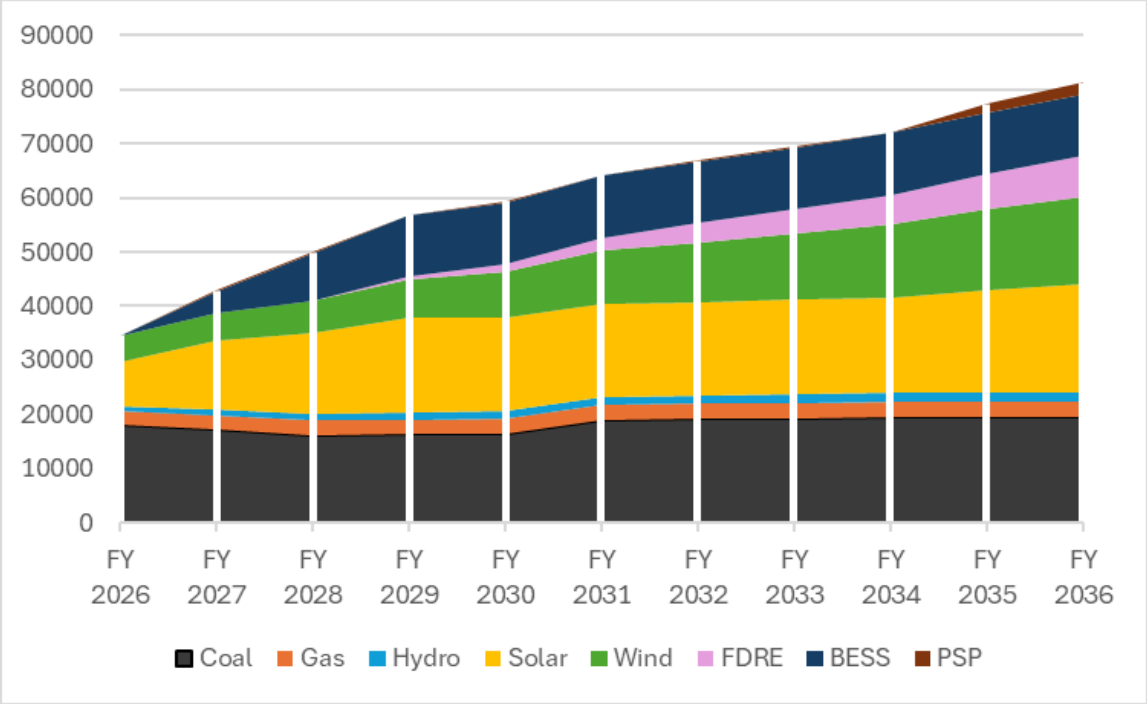


Figure 9: Projected Contracted Capacity Mix Year-wise (MW)

The total generation capacity is projected to more than double from about 39.7 GW in FY 2024-25 to 95.9 GW by FY 2035-36, driven predominantly by renewable capacity additions. Coal capacity remains broadly stable, indicating its continued role in providing firm capacity and ensuring reliability, nuclear capacities show limited growth primarily providing baseload requirements. Solar and wind capacities expand significantly (including captive plants) and account for the bulk of incremental capacity, supported by rising FDRE and hybrid resources to improve supply firmness.

To manage increased RE variability and meet peak demand, storage capacity- particularly BESS and pumped storage- scales up rapidly. Non-fossil capacity (including the storage capacity) increases by more than three times over the period, indicating a decisive structural shift in GUVNL's generation mix towards renewables supported by storage. Overall, the evolving mix reflects a transition towards a renewable-led, storage-backed system with adequate firm capacity to maintain grid reliability.

7.2 Year-wise projected Generation

Table 11 depicts the year-wise projected net generation in billion units.

Table 11: Source-wise year-by-year projected generation (BUs) from different sources

Source	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36
Coal	90.93	81.93	79.90	78.86	81.08	81.15	79.99	81.01	80.90	81.49	79.92
Gas	2.27	3.20	2.54	2.15	0.51	0.53	0.58	0.91	0.76	1.17	1.15
Nuclear	6.26	6.26	6.26	6.26	7.74	7.74	7.74	7.74	7.74	7.74	7.74
Solar	26.15	31.12	36.32	36.32	36.32	36.32	36.32	36.32	39.54	42.05	49.99
Wind	9.62	11.76	15.25	18.73	22.21	25.70	29.18	32.66	36.15	39.63	43.11
FDRE	0.00	0.00	4.12	12.37	17.72	25.38	33.63	41.87	50.12	58.36	64.60
Hydro	3.00	3.93	4.29	4.29	4.29	4.52	6.26	6.26	6.26	6.26	6.26
Contract	0.64	0.05	0.14	0.25	0.06	0.21	0.23	0.33	0.09	0.29	0.74
Sub-Total	**138.86**	**138.25**	**148.82**	**159.22**	**169.92**	**181.55**	**193.92**	**207.10**	**221.56**	**237.00**	**253.49**
Solar OA*	4.77	11.29	11.29	11.29	11.29	11.29	11.29	11.29	11.29	11.29	11.29
Wind OA*	7.18	8.12	8.12	8.12	8.12	8.12	8.12	8.12	8.12	8.12	8.12
Hybrid OA*	4.57	8.25	8.25	8.25	8.25	8.25	8.25	8.25	8.25	8.25	8.25
Total	**155.38**	**165.93**	**176.49**	**186.89**	**197.59**	**209.22**	**221.59**	**234.77**	**249.23**	**264.67**	**281.16**

* Captive / OA capacities envisaged;

GUVNL's net generation shows a clear structural transition over the period. Coal-based generation declines sharply in the initial years from 90 BUs to 80 BUs, reflecting increasing renewable penetration, before stabilizing and recovering modestly toward the end of the horizon around 80 BUs to support system adequacy and peak requirements. Gas-based generation remains marginal throughout, indicating its limited role as a balancing or peaking resource rather than a base load supply source. Nuclear generation remains largely stable, with rise from 2030 onwards, and continues to provide firm baseload support.

However, it is pertinent to mention that some of the planned future contracts considered in the study (such as Chutka and Mahi Banswara Nuclear Power Plants with scheduled commissioning by 2029-30) may not be available to meet the electricity demand in the 2029-30. These projects are likely to be commissioned beyond 2031-32.

In view of the above, GUVNL may be required to tie up commensurate power in medium term/short term keeping in view the actual commissioning of the Nuclear Power Plants. Further, actual allocation of power would be in accordance with the extant guidelines and accordingly the share of GUVNL may be different than the values assumed by GUVNL.

Renewable generation expands strongly across the period. Solar and wind generation rise consistently and together, accounting for the dominant share of incremental generation, while FDRE and hybrid resources grow rapidly, indicating a shift toward a more firm and dispatchable renewable supply. Hydro generation increases gradually, particularly in the later years, strengthening system flexibility and peak support. Overall, the generation mix evolves toward a renewable-led portfolio backed by storage and firm thermal/nuclear generation, aligning decarbonization objectives with reliability and flexibility needs. The net electricity generation mix for GUVNL (excluding generation from OA/captive sources) is shown in Figure 10.

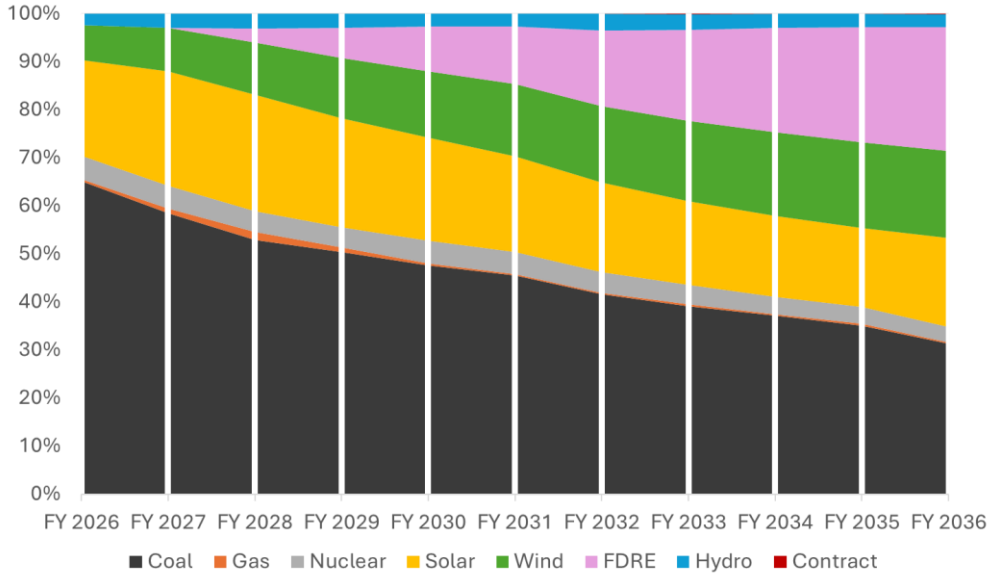


Figure 10: Net Generation mix from 2025-26 to 2035-36

7.3 Renewable Purchase / Consumption Obligation

The projected capacity and generation mix presented in the report adequately meet the utility's RCO requirements as per MoP trajectory and RPO requirements as per GERC trajectory for the study period shown in Table 12 & 13 below, respectively.

Table 12: Renewable Energy Consumption vs RCO (other than DRE) as per MoP notification

Sl. No.	Year	Wind Renewable Energy	Hydro Renewable Energy	Other Renewable Energy	% RCO Met	% RCO Target as per MoP*	% RCO Deficit (-) / Surplus(+)
1	2025-26	0.77%	2.12%	24.45%	27.34%	30.91%	-3.57%
2	2026-27	2.28%	2.76%	27.92%	32.97%	33.25%	-0.28%
3	2027-28	4.39%	2.80%	31.92%	39.10%	35.51%	3.59%
4	2028-29	6.20%	2.60%	34.75%	43.56%	37.46%	6.10%
5	2029-30	7.84%	2.45%	35.82%	46.11%	38.83%	7.28%

6	2030-31	9.18%	2.42%	37.53%	49.12%	40.50%	8.62%
7	2031-32	10.31%	3.13%	39.17%	52.61%	41.50%	11.11%
8	2032-33	11.27%	2.92%	40.46%	54.64%	42.30%	12.34%
9	2033-34	12.03%	2.73%	42.76%	57.52%	43.00%	14.52%
10	2034-35	12.65%	2.55%	44.31%	59.50%	43.50%	16.00%
11	2035-36	13.14%	2.38%	46.78%	62.30%	44.00%	18.30%

**The RCO obligation beyond 2029-30 is based on assumption.*

Table 13: RPO: Renewable Energy Purchase Obligation (other than DRE) as per GERC notification

Year	Wind Renewable Energy	Hydro Renewable Energy	Other Renewable Energy	RPO Met % (Wind, Solar, Hydro & Other RE)	% RPO Target (Wind, Solar, Hydro & Other RE)	%RPO Deficit (-) / Surplus (+)
2025-26	0.75%	2.04%	23.58%	26.37%	30.91%	-4.54%
2026-27	2.20%	2.67%	26.94%	31.82%	33.25%	-1.43%
2027-28	4.25%	2.71%	30.90%	37.86%	35.51%	2.35%
2028-29	6.02%	2.53%	33.74%	42.28%	37.46%	4.82%
2029-30	7.56%	2.37%	34.56%	44.49%	38.83%	5.66%
2030-31	Not Specified by GERC					
2031-32	Not Specified by GERC					
2032-33	Not Specified by GERC					
2033-34	Not Specified by GERC					
2034-35	Not Specified by GERC					
2035-36	Not Specified by GERC					

It is important to note that the electricity demand recorded on the grid (the drawl from the grid) reflects the net demand after accounting for energy consumed by prosumers from behind-the-meter generation. Consequently, the energy input to the STELLAR model is derived from net energy, excluding behind-the-meter generation by these prosumers. Further, the energy injected at the 11 kV level by Distributed Solar Renewable Energy (RE) projects is not captured in the drawal recorded by the SLDC. As a result, the capacities from such Distributed Solar RE and rooftop solar have not been included in the existing generation capacity contracted by GUVNL. Considering the current Distributed Renewable Energy (DRE) capacity and anticipated increase in DRE, the Renewable Purchase Obligation (RPO) targets of GERC and Renewable Compliance Obligation (RCO) targets of MoP, along with their anticipated achievements, are outlined in Table 14 and 15, respectively where Solar Rooftop Generation as per RCO and GERC benchmarks have been carried out, which were then utilized in calculating the RCO & RPO.

Table 14: Year-wise Distributed RE Obligations and their achievement for RPO as per GERC Regulations

FY	Solar Roof Top (SRT)	Dist. Solar	Generation by SRT@3.5 kWh/kW per day	Dist Solar Gen@ 22% CUF	Total DRE Gen	RPO Base Energy	DRE Target	% DRE
	MW	MW	MU	MU	MU	MU	%	%

2025-26	5605	510	7160	983	8143	147002	2.10%	5.54%
2026-27	6105	560	7799	1079	8878	147132	2.70%	6.03%
2027-28	6605	610	8438	1176	9613	158430	3.30%	6.07%
2028-29	7105	660	9077	1272	10349	169568	3.90%	6.10%
2029-30	7605	710	9715	1368	11084	181005	4.50%	6.12%
2030-31	8105	760	10354	1465	11819	193367	NA	6.11%
2031-32	8605	810	10993	1561	12554	206473	NA	6.08%
2032-33	9105	860	11632	1657	13289	220387	NA	6.03%
2033-34	9605	910	12270	1754	14024	235581	NA	5.95%
2034-35	10105	960	12909	1850	14759	251760	NA	5.86%
2035-36	10605	1010	13548	1946	15494	268986	NA	5.76%

Table 15: Year-wise Distributed RE Obligations and their achievement for RCO as per MoP notification

FY	Solar Rooftop	Distributed Solar	Generation by SRT@4kWh/kW per day	Dist. Solar Gen@22% CUF	Total DRE Gen	RCO Base energy	DRE Target	% DRE
	MW	**MW**	**MU**	**MU**	**MU**	**MU**	**%**	**%**
2025-26	5605	510	8183	983	9166	141769	2.10%	6.47%
2026-27	6105	560	8913	1079	9993	141990	2.70%	7.04%
2027-28	6605	610	9643	1176	10819	153379	3.30%	7.05%
2028-29	7105	660	10373	1272	11645	164608	3.90%	7.07%
2029-30	7605	710	11103	1368	12472	174656	4.50%	7.14%
2030-31	8105	760	11833	1465	13298	187110	NA	7.11%
2031-32	8605	810	12563	1561	14124	200306	NA	7.05%
2032-33	9105	860	13293	1657	14951	214312	NA	6.98%
2033-34	9605	910	14023	1754	15777	229597	NA	6.87%
2034-35	10105	960	14753	1850	16603	245867	NA	6.75%
2035-36	10605	1010	15483	1946	17430	263185	NA	6.62%

7.4 Day-wise Surplus Capacity (in MW)

The pattern of surplus capacity has been observed as follows. Available Surplus capacity is mainly due to seasonal variation in electricity demand. This capacity can be used for banking arrangements or shared with other states through bilateral agreements / PUShP portal, thereby reducing the utility's fixed cost burden and lowering consumers' costs. The heatmaps show the average surplus during the whole day across the four quarters of the year.

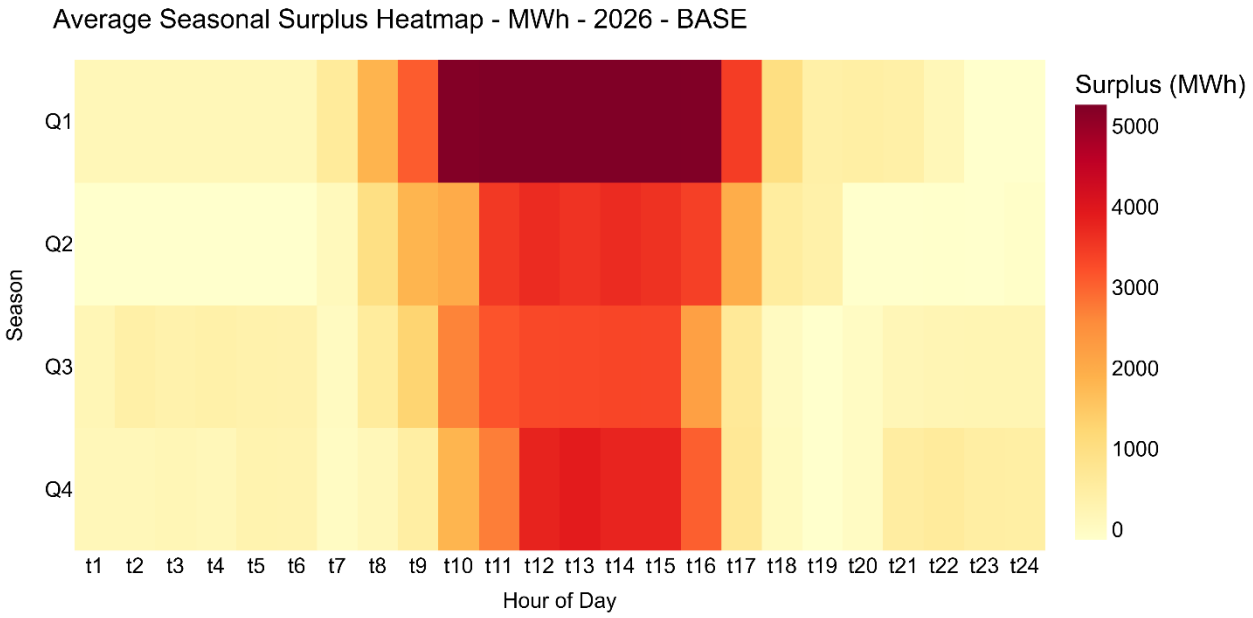


Figure 101: Average Seasonal Surplus Heatmap (2025-26)

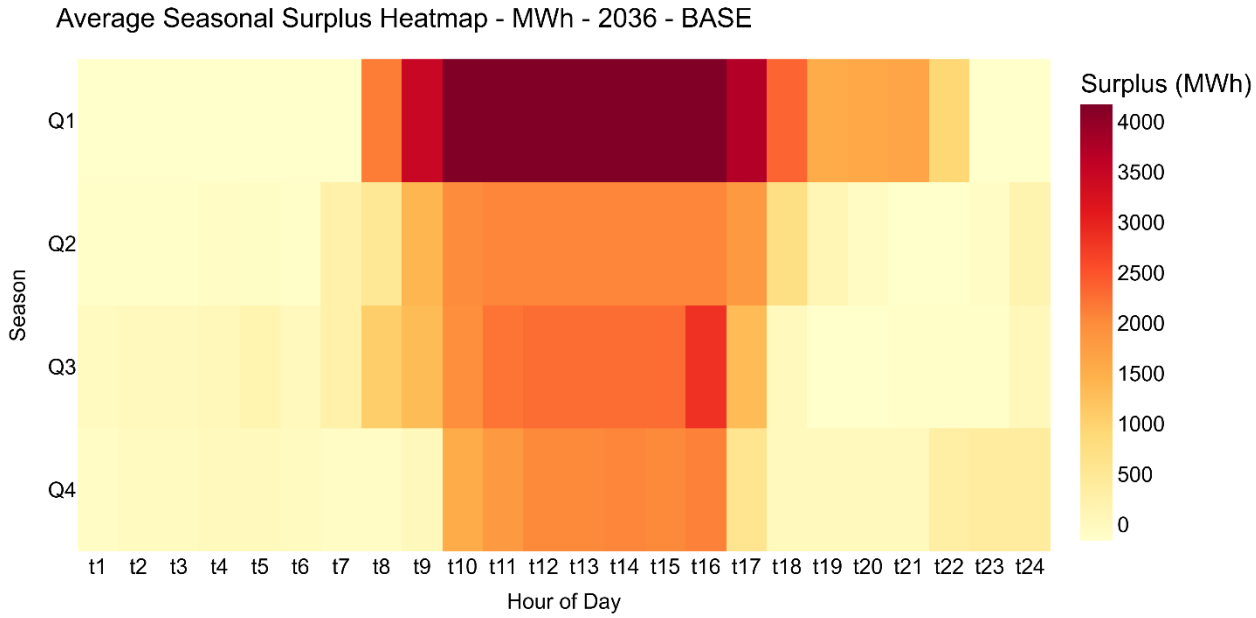


Figure 11: Average Seasonal Surplus Heatmap (2035-36)

8.0 Reliability Analysis

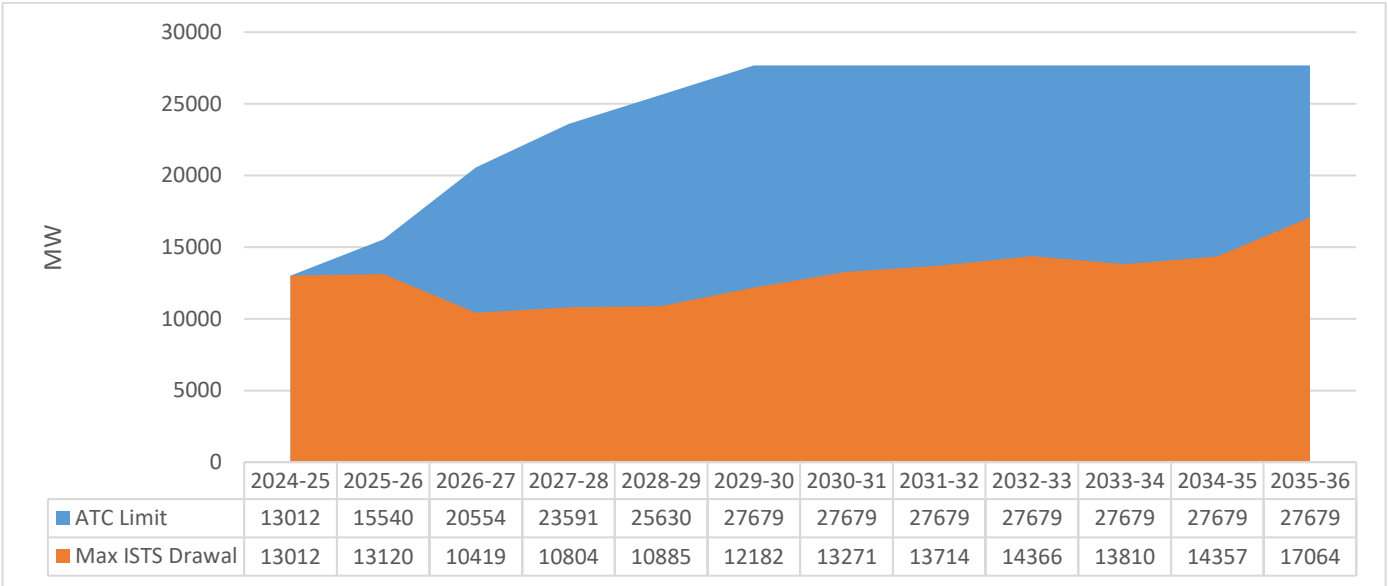
A probabilistic reliability analysis using Monte Carlo simulations has been conducted. The year-wise summary of reliability Indices is tabulated as under. As it is evident from the table, the reliability iterations are yielding average ENS and LOLP figures which are below the prescribed

criteria across the planning horizon and therefore the results indicate that generation capacity is adequate to meet the specified reliability criteria of 0.2% LOLP and 0.05% ENS.

Parameter	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36
LoLP - (%) - BASE	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
ENS - MU – Avg	5.17	1.29	0.00	0.00	0.00	0.00	0.00	0.00	4.37	1.10	0.00
LoLP - Average(%)	0.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.03	0.00
NENS - (%) – Avg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max ENS over iterations – MU	63.39	17.75	0.00	0.00	0.00	0.00	0.00	0.00	52.36	21.99	0.00
Max NENS over iterations - %	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00

9.0 Drawal of power from the Inter-State Transmission System (ISTS)

The study provides important information regarding the maximum power withdrawal from the Inter-State Transmission System (ISTS) by GUVNL. This data provides valuable insights into the amount of General Network Access (GNA) that GUVNL needs to maintain over the next ten years. Figure 13 illustrates the maximum ISTS drawal compared to the projected Available Transfer Capacity (ATC) limit for the state of Gujarat. Gujarat needs to assess the required GNA quantum and accordingly enhancement of GNA may be planned as per requirement.



	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36
ATC Limit	13012	15540	20554	23591	25630	27679	27679	27679	27679	27679	27679	27679
Max ISTS Drawal	13012	13120	10419	10804	10885	12182	13271	13714	14366	13810	14357	17064

Figure 12: Max ISTS Drawal vs ATC Limit

10.0 Plant Utilization

Plant utilization provides valuable insights into assets that incur fixed costs for availability rather than generation output. The details as per studies are shown in Table 16.

Table 16: Year-wise trend of Plant utilization (gross PLF) in percentage by source

Technology	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35	2035-36
Coal	64.8	62.0	59.9	58.5	51.9	51.1	50.4	50.3	50.2	50.6	49.7
Gas	10.2	14.4	11.4	9.7	2.3	2.4	2.6	4.1	3.4	5.3	5.2
Nuclear	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0
PSP	28.0	25.9	26.0	25.6	25.1	26.1	26.4	26.2	18.3	19.1	17.9
BESS2h	8.9	9.8	10.4	10.4	9.8	10.3	9.8	9.5	9.1	9.2	9.3
BESS4h	17.1	17.1	14.9	15.8	16.1	16.0	15.8	15.5	15.2	14.6	15.3
Solar	23.5	23.7	23.8	23.8	23.8	23.8	23.8	23.8	23.9	23.9	24.0
Wind	21.9	23.1	24.5	25.4	26.1	26.6	27.1	27.4	27.7	27.9	28.1
FDRE			94.1	94.1	80.9	82.8	85.3	86.9	88.0	88.8	89.3
Hydro	30.5	34.0	35.1	35.1	35.1	35.7	39.4	39.4	39.4	39.4	39.4

The PLF of Coal is average PLF considering all the contracted coal-based capacity. The old inefficient and units with high variable cost may not operate throughout the year, leading to reduction in overall average PLF of the coal fleet. The Gas plants exhibit the lowest PLF across all generating sources, indicating operation only during peak hours. The PLF of Gas plants is expected to increase over the next two years due to the limited new generation capacity to be commissioned within that period.

The Battery candidates have been modeled to have a maximum of 750 cycles per year, the Plant Load Factor (PLF) of the BESS 2h asset is approximately 10%, which translates to around 876 hours of operation per year. With a 2-hour discharge cycle, the BESS 2h is expected to complete 438 cycles annually. In comparison, the BESS4h asset operates at a PLF of about 15%, also resulting in a total of 328 cycles (each of 4 hours) per year. Going forward, the current policy on BESS utilization should be reviewed, as BESSs are fixed-cost assets.

11.0 Conclusions

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

1. The study has considered electrical energy requirement projections and peak electricity demand projections as per GUVNL, which envisages that the annual electrical energy requirement and the peak electricity demand of the utility are likely to grow at a CAGR of CAGR of 6.08% and 6.03% respectively for the period of 2025-26 to 2035-36. The peak electricity demand and electrical energy requirement in 2035-36 are 44.4 GW and 255.6 BU, as per the projections by GUVNL.

2. Based on the demand pattern of the last few years, it is seen that the peak electricity demand for GUVNL occurs in summer. For, FY 2024-25, the annual peak occurred in March while the summer months (Apr-June) showed sustained broad daytime peaks.

3. To meet the projected demand, the likely total projected contracted capacity for the year 2035-36 is about 95,954 MW which consists of 19,590 MW from Coal, 2,631 MW from Gas, 1,280 MW from Nuclear, 17,507 MW from Wind, 23,738 MW from Solar, 8,256 MW from

FDRE sources, 1,814 MW from Hydro, 11,348 MW of Battery Energy Storage System, 3,745 MW of PSP capacity and 6,045 MW from short and medium term contracts. This capacity shall meet the projected demand while satisfying the prescribed reliability criteria.

4. GUVNL needs to contract additional renewable capacities, including Solar, wind and Energy Storage, for meeting electrical energy requirements other than the planned capacities. In addition, the utility will likely require MTOA/STOA arrangements ranging from around 3800 MW in FY 2025-26 to around 6000 MW in FY 2035-36, as outlined in the report. In terms of State's total contracted capacity, these short to medium term arrangements account for 8% in the year 2025-26 and 6% in 2035-36. The STOA/MTOA requirement can be fulfilled through power procurement from the market or bilateral/banking agreements.
5. The Planning Reserve Margin for the GUVNL has been assessed as about 12% during solar hours and 9% during non-Solar hours for the year 2035-36.
6. LT-DRAP was also verified against the coincident peak requirement to be met by GUVNL at the time of national peak, as provided for in the Long-term National Resource Adequacy Plan (LT-NRAP) published by CEA for the period from 2026-27 to 2035-36. It was found that the planned capacity for FY 2026-27 and FY 2027-28 is adequate to meet the coincident peak demand while maintaining the required national level PRM.
7. It is likely that the state may have surplus capacity, which can be shared with other utilities/states through banking/bilateral arrangements, including the PUShP portal.
8. Accurate demand assessment is fundamental to capacity expansion modelling and directly impacts the Resource Adequacy (RA) study outcomes. To achieve realistic and data-driven results, DISCOMs are strongly encouraged to adopt scientific tools and robust methodologies for demand forecasting.
9. Timely commissioning of planned capacities is critical to ensuring that the utility can meet the projected peak electricity demand and electrical 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 utility's power demand.
10. Some of the planned future contracts considered in the study (such as Chutka and Mahi Banswara Nuclear Power Plants with scheduled commissioning by 2029-30 as per GUVNL) may not be available to meet demand in the 2029-30. These projects are likely to be commissioned beyond 2031-32. Further, actual allocation of power would be in accordance with the extant guidelines and accordingly the share of GUVNL may be different than the values assumed by GUVNL.
11. GUVNL is suggested to periodically review the progress of all the under construction/planned projects and accordingly plan alternate sources of baseload/firm power for the intervening period until the projects are actually available.

12. While adhering to resource adequacy guidelines, environmental considerations must be systematically integrated into the planning and contracting of new capacity additions to ensure sustainable and responsible system development.

13. Based on the Long-Term National Resource Adequacy Plan (LT-NRAP) (2026-27 to 2035-36) published by CEA, there is requirement of long- duration storage (6+ hours) in the system. Though GUVNL has planned development of 11,348 MW BESS and 3,745 MW PSP capacity by 2035-36, considering significant RE and PSP potential in Gujarat, to add rotating mass (inertia) in the system and also improve the reliability of supply during non-solar hours, there is need for speedy development of PSP capacity in the State. As the gestation period of PSP is about four-five years, advance action should be taken by the State towards development of PSP capacity in the State. Further, steps should be taken by the State towards pumping mode operation of existing PSPs in the state.

APPENDICES

Appendix A : Planned Future Contracted (MW) considered in the study

S No.	Plant Name	Source Type	Year of commissioning	Share (in MW)
1	TALCHER_III	Coal	2027-28	154
2	SIPAT_III	Coal	2028-29	154
3	DURGAPUR_TPS_II	Coal	2029-30	359
4	KODERMA_TPS_IIa	Coal	2029-30	100
5	KODERMA_TPS_IIb	Coal	2029-30	100
6	RAGHUNATHPUR_TPS_IIA	Coal	2029-30	300
7	RAGHUNATHPUR_TPS_IIB	Coal	2029-30	300
8	UKAI_7	Coal	2029-30	800
9	GADARWARA_II	Coal	2030-31	304
10	CHUTKA	Nuclear	2029-30	122.5
11	MAHI BANSWARA	Nuclear	2029-30	122.5
12	KIRU	Hydro	2025-26	80
13	RANGIT_IV	Hydro	2025-26	24
14	SUBANSIRI	Hydro	2025-26	162
15	PAKALDUL	Hydro	2026-27	85
16	RATLE	Hydro	2026-27	46
17	TEESTA_VI	Hydro	2026-27	65
18	KWAR	Hydro	2027-28	77
19	DUGAR	Hydro	2030-31	50
20	DIBANG	Hydro	2031-32	368
21	BESS Phase-II Tender	BESS2h	2025-26	180
22	BESS Phase-IV Tender	BESS2h	2026-27	500
23	BESS Phase-VI Tender	BESS2h	2026-27	500
24	BESS Phase-VII Tender	BESS2h	2026-27	2000
25	UKAI DAM	PSP	2033-34	1480
26	DHAROI DAM	PSP	2034-35	500
27	SUKHI DAM	PSP	2035-36	1580
28	Wind (OA)	Wind	2026-27	351
29	Solar (OA)	Solar	2026-27	3016
30	Hybrid (OA)	Hybrid	2026-27	1503

Appendix B: GUVNL expiring PPA details

S No.	Coal	Source Type	Year	PPA Capacity (in MW)	PPA Capacity Share Expiring (in MW)
1	BARH_1	Coal	2026-27	164	139
2	DADRI_I	Coal	2026-27	577	577
3	DARLIPALLI_I	Coal	2025-26	14	14
4	FARAKKA_I_II	Coal	2025-26	255	255
5	FARAKKA_III	Coal	2025-26	60	60
6	KAHELGAON_I	Coal	2026-27	141	141
7	KHARGONE	Coal	2025-26	270	5
8	KORBA	Coal	2025-26	380	25
9	MSTPS	Coal	2025-26	456	456
10	NPGCL	Coal	2026-27	50	50
11	TALCHER_I	Coal	2025-26	24	24
12	TANDA_II	Coal	2025-26	44	44
13	UNCHAHAR_I	Coal	2026-27	63	63

Assumption for Resource Adequacy Studies

1. Electrical energy requirement & peak electricity demand requirement: As per projections of GUVNL.
2. Demand Profile: Based on hourly demand profile of 2024-25 as shared by GUVNL.
3. Existing & Planned Capacity: As per the information shared by GUVNL.
4. Cost parameters: based on information in National Electricity Plan and recent market trends.

RE CUF considered as per GUVNL

Wind	**Solar**	**DRE**	**FDRE**	**Hybrid**
22.5%	22.8%	22%	94%	29.11%

Technical Parameters

Technology	Type	Availability (%)	Ramping (%/min)	Min. Technical (%)
Coal/ Lignite	Existing/Planned	85	1	55
	Candidate	85	1	55
Gas	Existing	85	5	40
Nuclear	Existing/Planned	75	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		-	-
Pumped Storage Plants	Existing/Planned	95	10	-
	Candidate		10	-
Battery Energy Storage System	Candidate	98	NA	-

Technology	Type	Heat Rate (MCal/MWh)		Aux. Consum. (%)	Min. online time (hr)	Min. offline time (hr)
		At max loading	At min loading			
Coal	Existing/ Planned	2300 to 2879	2438 to 3052	7.0	6	4
	Candidate (SC & USC)	2060 to 2125	2183 to 2253	6.5	6	4
Gas	Existing	2000 to 2900	2260 to 3277	2.5	4	3
Nuclear	Existing/ Planned	2777	2777	10	6	4
	Candidate	2777	2777	10	-	-
Biomass	Existing/ Planned	4200	4450	8	6	4
	Candidate	4200	4450	8	6	4
Hydro	Existing/ Planned	-	-	0.7	-	-
	Candidate	-	-	0.7	-	-
Pumped Storage Plants	Existing/ Planned	-	-	Round Trip efficiency 80%	-	-
	Candidate	-	-		-	-

Technology	Type	Heat Rate (MCal/MWh)		Aux. Consum. (%)	Min. online time (hr)	Min. offline time (hr)
		At max loading	At min loading			
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. Inter State ATC limit has not been considered in the study. Additionally, for modelling the charged BESS under the Solar + BESS configuration, the BESS capacity has been created at a separate node, with its charging arranged by the generator, unlike in the standalone BESS setup.

Financial Parameters

Following cost parameters have been assumed by GUVNL:

Resource	Capex* (in ₹/MW)	O&M Fixed Cost (in ₹/MW)	Construction Time (in years)	Amortization /Life time (in years)
Coal	14 Cr	34 Lakh	4	25
Solar	4.5 Cr	1 % of Capex	1	25
Wind	9.1 Cr	1 % of Capex	2	25
FDRE	31.4 Cr	1 % of Capex	2	25
Battery Energy Storage (2-Hour)	2.5 Cr	1 % of Capex	1	15
Battery Energy Storage (4-Hour)	5 Cr	1 % of Capex	1	15
PSP	6 Cr	30 Lakh	4	40