सत्यमेव जयते

# Report on Resource Adequacy Plan (Generation) for the state of Telangana (2025-26 to 2035-36) (Version 2.0)

**January, 2026**

**Government of India**
**Ministry of Power**
**Central Electricity Authority**

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# Disclaimer

This Resource Adequacy study for the State of Telangana has been conducted based on data and inputs provided by Telangana. The findings, analysis and conclusions presented in this report are contingent upon the accuracy, completeness and timeliness of the information furnished by Telangana SLDC. 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 Central Electricity Authority (CEA). CEA has facilitated this study and prepared the report solely to assist Telangana in fulfilling this requirement.

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

# Executive Summary

Ministry of Power had notified the Electricity (Amendment) Rules in December 2022. As per Rule 16 of the Electricity (Amendment) Rules, Ministry of Power has notified Resource Adequacy (RA) Guidelines. According to these Guidelines, Central Electricity Authority (CEA) is entrusted with the responsibility of preparing the Long-Term National Resource Adequacy Plan (LT-NRAP). Further, each Distribution Utility is required to carry out a Long-Term Distribution Licensee Resource Adequacy Plan (LT-DRAP) to reliably meet its peak 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 requirement. This plan shall be vetted/validated by CEA to leverage the benefits of national-level optimization for the Distribution Licensees. The LT-DRAP shall be prepared by the Distribution Licensees on an annual rolling basis, factoring in the already contracted capacity and optimizing the requirement for additional capacity.

Government of India has also recently gazette notified the Renewable Purchase Obligation (RPO) trajectory up to 2029-30 vide gazette notification dated 20th October 2023, which mandates that a specified portion of energy consumption must be met from renewable energy sources.

To support the utility in fulfilling this requirement, CEA, in collaboration with the state, initially conducted a Resource Adequacy (RA) study with a planning horizon up to FY 2034-35, based on the data received from the state and in compliance with the RPO trajectory specified in the Ministry of Power's gazette notification dated 20th October 2023. This study has now been updated and extended to cover the period up to FY 2035-36, incorporating the latest data furnished by the State and planning assumptions. The RPO requirement for the utility has also been assessed in accordance with the recent gazette notified trajectory.

The electrical energy requirement and peak electricity demand for Telangana is projected to increase at a CAGR of 4.92% and 6.35% respectively from 2025-26 to 2035-36 as forecasted by Telangana SLDC. For satisfying resource adequacy i.e. meeting the electricity demand reliably and at affordable cost, the state needs to methodically plan its capacity expansion either by investing or by procuring power. In view of the reduction in cost of solar panels and technology options like energy storage systems, planning for long term optimal generation capacity mix gains tremendous importance so as the future generation capacity mix is cost effective as well as environment friendly.

A study has been carried out for Telangana considering the existing contract capacity and planned capacity addition. It was found that the State's likely contracted capacity may not be sufficient to meet the projected demand. Further, the total unserved energy in the year 2035-36 is expected to be about 33.6 BU which is about 22% of the annual projected electrical energy requirement during the year 2035-36.

To find out the least cost option for generation capacity expansion for the period 2025-26 to 2035-36, long-term study has been carried out with the objective to minimize the total system cost of

generation including the cost of anticipated future investments while fulfilling all the technical constraints associated with various power generation technologies. Additionally, reliability study has been carried out to determine the probability of unmet demand and hours by implementing the variation in demand, RE and forced outage of thermal generators (Coal/ Lignite) etc.

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

The Resource adequacy studies have projected likely optimal capacity mix for future years till 2035-36 which is able to meet anticipated demand reliably at every instance. Based on the study, the likely total projected contracted capacity for the year 2035-36 is around 80,856 MW which consists of 13,984 MW from Coal, 202 MW from Nuclear, 2,518 MW from Hydro, 32,884 MW from Solar, 6,128 MW from Wind, 7,580 MW from Distributed Renewable Energy (DRE), 11,725 MW Energy Storage System, 135 MW from Non-Conventional Energy sources (NCES) and 5,700 MW of STOA/MTOA. This capacity shall be able to meet the projected demand with prescribed reliability criteria.

# 1.0 Introduction

Ministry of Power has notified Electricity (Amendment) Rules, 2022, in December 2022. Rule 16 (I) of the said rules stipulates that *"A guideline for assessment of resource adequacy during the generation planning stage (one year or beyond) as well as during the operational planning stage (up to one year) shall be issued by the Central Government in consultation with the Authority".* Accordingly, the Resource Adequacy Guidelines have been notified in June, 2023 by Ministry of Power in consultation with Central Electricity Authority.

Resource Adequacy is generally defined as a mechanism to ensure that there is an adequate supply of generation resources to serve expected demand reliably at least cost. A key aspect of resource adequacy planning is to ensure that adequate generation capacities are available, round-the-clock, to reliably serve demand under various scenarios. This naturally translates into the need for ensuring adequate reserve margin, which could cater to varying levels of demand and supply conditions in the grid. In the wake of high RE generation, it is important to understand demand-supply situation in the grid precisely due to high seasonality and intermittency in RE generation. Resource Adequacy exercise may also help in assessment of capacity requirement to be tied up or contracted on long term, medium term, and short-term basis.

Further, Ministry of Power vide notification dated 20$^{th}$ October, 2023 had notified the RPO trajectory for the states/Discoms. Based on the trajectory specified, hydro, wind and other (solar, biomass etc.) RPO quantum in million units (MUs) has been calculated to find additional quantum of renewable capacity that the states/Discoms have to contract in addition to its existing/planned capacity to meet their RPO targets.

To support the utility in fulfilling the Resource Adequacy Guidelines and complying with the Renewable Purchase Obligation (RPO) notification, CEA has carried out the RA study for the state of Telangana based on inputs furnished by Telangana SLDC. The study recommends an optimal resource mix up to FY 2035-36, taking into account technical and financial parameters associated with various capacities. It aims to optimize long-term power procurement while ensuring resource adequacy to meet demand on a 24×7 basis, considering variations in demand, RE generation, and forced outage of thermal capacities. The study assesses the Planning Reserve Margin (PRM) required by the state to account for the aforementioned uncertainties, ensuring that demand can be reliably met throughout the year.

Prior to this, CEA had conducted the RA study for the State up to FY 2034-35, based on inputs from Telangana SLDC and in accordance with the RPO trajectory specified in the Ministry of Power's Gazette notification dated 20$^{th}$ October, 2023.

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

1. In the earlier Resource Adequacy (RA) study, the financial year 2023-24 had been considered as the base year, and the study covered the period from 2024-25 to 2034-35. The fuel-wise contracted capacity by the State as on March 2024, is given in Fig 1.

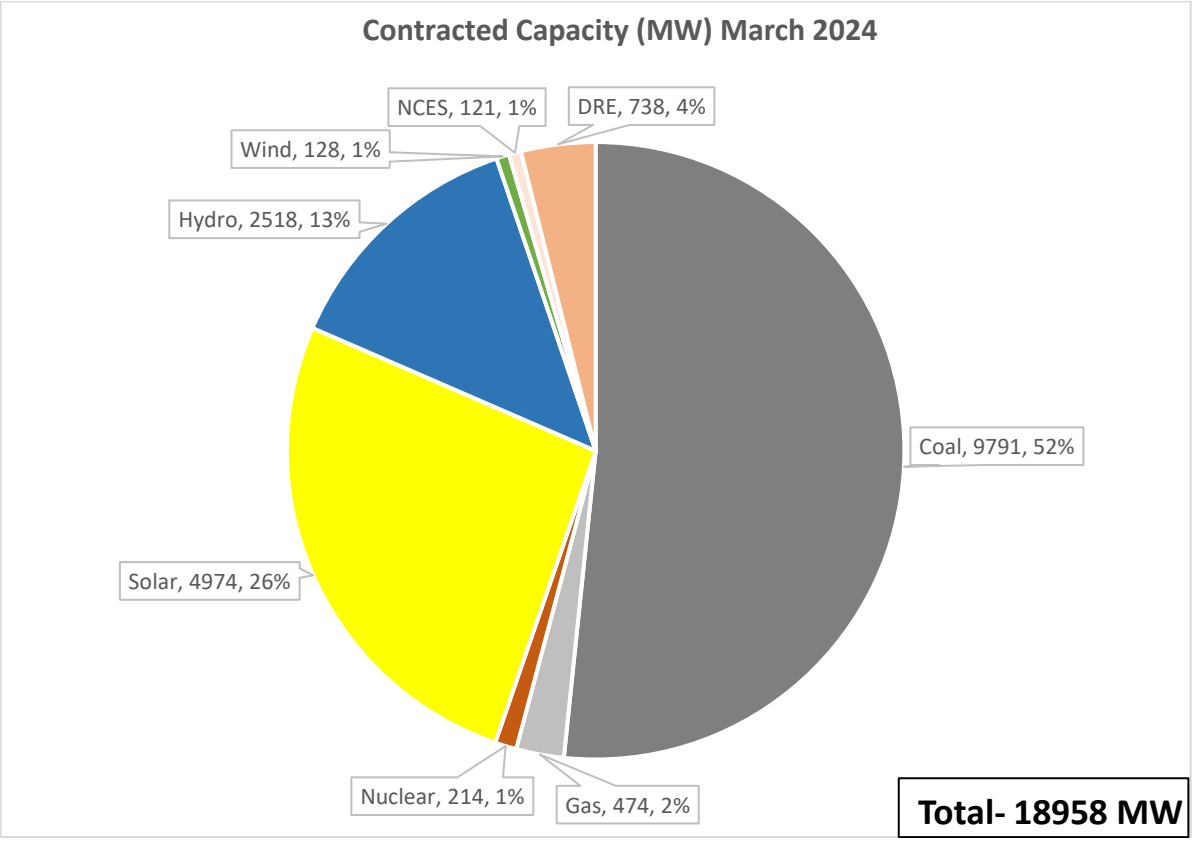



Figure 1: Contract Capacity (March 2024)

2. The hourly demand pattern for 2023-24 was analysed and had been considered as a base profile to forecast the demand for future years.

3. The peak electricity demand and electrical energy projections as per Telangana SLDC had been considered in the study is given in Table 1.

Table 1: Peak electricity demand and Electrical Energy Requirement Projections as per Telangana

| | 2024-25 | 2025-26 | 2026-27 | 2027-28 | 2028-29 | 2029-30 | 2030-31 | 2031-32 | 2032-33 | 2033-34 | 2034-35 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Energy Projections (MU) | 90962 | 96956 | 102732 | 108932 | 115347 | 122627 | 128032 | 133211 | 138600 | 144206 | 150040 |
| Year on Year Growth (%) | | 6.59% | 5.96% | 6.04% | 5.89% | 6.31% | 4.41% | 4.05% | 4.05% | 4.04% | 4.05% |

| | 2024-25 | 2025-26 | 2026-27 | 2027-28 | 2028-29 | 2029-30 | 2030-31 | 2031-32 | 2032-33 | 2033-34 | 2034-35 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Peak Demand Projections (MW) | 16877 | 18138 | 19529 | 20968 | 22488 | 24215 | 25639 | 27059 | 28558 | 30139 | 31809 |
| Year on Year Growth (%) | | 7.47% | 7.67% | 7.37% | 7.25% | 7.68% | 5.88% | 5.54% | 5.54% | 5.54% | 5.54% |

4. The actual peak electricity demand and electrical energy requirement of the state during 2023-24 and 2024-25 as per the Power Supply Position (PSP) report of CEA is given in Table 2.

Table 2: Actual Peak Electricity Demand and Electrical Energy requirement

| Year | Actual Electrical Energy Requirement (in MU) | Actual Peak Electricity Demand (in MW) |
|---|---|---|
| **2023-24** | 84623 | 15622 |
| **2024-25** | 88262 | 17162 |

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

Table 3: Projected contracted capacity (in MW)

| Year | Coal | Gas | Nuclear | Hydro | Wind | Solar | Storage | DRE | NCES | STOA |
|---|---|---|---|---|---|---|---|---|---|---|
| **2024-25** | 11391 | 474 | 214 | 2518 | 528 | 10255 | 0 | 1073 | 121 | 4219 |
| **2025-26** | 13791 | 224 | 214 | 2518 | 928 | 12374 | 0 | 1594 | 121 | 4535 |
| **2026-27** | 13703 | 224 | 214 | 2518 | 1328 | 13874 | 1979 | 2179 | 121 | 3906 |
| **2027-28** | 13703 | 224 | 54 | 2518 | 1728 | 15874 | 2548 | 2821 | 121 | 4607 |
| **2028-29** | 15366 | 224 | 54 | 2518 | 2128 | 17874 | 3326 | 3530 | 115 | 3787 |
| **2029-30** | 15893 | 25 | 54 | 2518 | 2528 | 19874 | 3805 | 4330 | 77 | 4449 |
| **2030-31** | 15849 | 25 | 54 | 2518 | 2928 | 21874 | 4378 | 5024 | 77 | 5062 |
| **2031-32** | 15928 | 25 | 54 | 2518 | 3328 | 22874 | 5400 | 5749 | 77 | 5346 |
| **2032-33** | 16349 | 25 | 54 | 2518 | 3728 | 23874 | 6566 | 6526 | 70 | 5299 |
| **2033-34** | 16783 | 25 | 54 | 2518 | 4128 | 24874 | 7918 | 7356 | 70 | 5147 |
| **2034-35** | 16966 | 25 | 54 | 2518 | 4528 | 26374 | 7918 | 8242 | 70 | 6500 |

Note: NCES comprises of Mini Hydro, Industrial Waste, Municipal Waste, Bagasse, Biomass etc. based generation

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

Table 4: Year wise planned and additional capacity (in MW)

| FY | Coal | | DRE | | Solar | | Storage | | Wind | Yearly STOA |
|---|---|---|---|---|---|---|---|---|---|---|
| | Planned | Additional | Planned | Additional | Planned | Additional | Planned | Additional | Additional | Additional |
| **2024-25** | 2284 | 0 | 82 | 331 | 2281 | 3000 | 0 | 0 | 400 | 4219 |
| **2025-26** | 2400 | 0 | 96 | 425 | 619 | 1500 | 0 | 0 | 400 | 4535 |
| **2026-27** | 0 | 0 | 116 | 469 | 0 | 1500 | 0 | 1979 | 400 | 3906 |
| **2027-28** | 0 | 0 | 139 | 506 | 0 | 2000 | 0 | 569 | 400 | 4607 |
| **2028-29** | 0 | 2202 | 166 | 543 | 0 | 2000 | 0 | 777 | 400 | 3787 |
| **2029-30** | 0 | 1590 | 200 | 601 | 0 | 2000 | 0 | 479 | 400 | 4449 |
| **2030-31** | 0 | 183 | 240 | 454 | 0 | 2000 | 0 | 574 | 400 | 5062 |
| **2031-32** | 0 | 79 | 287 | 438 | 0 | 1000 | 0 | 1022 | 400 | 5346 |
| **2032-33** | 0 | 421 | 345 | 431 | 0 | 1000 | 0 | 1167 | 400 | 5299 |
| **2033-34** | 0 | 434 | 414 | 416 | 0 | 1000 | 0 | 1352 | 400 | 5147 |
| **2034-35** | 0 | 184 | 497 | 390 | 0 | 1500 | 0 | 0 | 400 | 6500 |

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

## 3.1 Present Power Scenario in Telangana

The power supply position for Telangana for 2021-22 to 2024-25 is given in the Table 5.

Table 5: Power Supply Position of Telangana

| Power Supply Position | | | | | | |
|---|---|---|---|---|---|---|
| **Year** | **Energy required (MU)** | **Energy supplied (MU)** | **Gap (MU)** | **Peak Demand (MW)** | **Peak Met (MW)** | **Demand not met (MW)** |
| 2021-22 | 70539 | 70523 | 16 | 14163 | 14160 | 3 |
| 2022-23 | 77832 | 77799 | 34 | 15497 | 15497 | 0 |
| 2023-24 | 84623 | 84613 | 9 | 15622 | 15622 | 0 |
| 2024-25 | 88262 | 88258 | 4 | 17162 | 17162 | 0 |

As of March 2025, the total contracted capacity for Telangana is 19,551 MW. Out of the total contracted capacity (CC), the share of non-fossil fuel-based Contracted Capacity is 49%.

The fuel-wise contracted capacity as on March, 2025 is given in Table 6 and Figure 2.

Table 6: Fuel-wise Contracted Capacity as on March 2025

| Source | Contracted Capacity (MW) | Percentage (%) |
|---|---|---|
| Coal | 9782 | 50.0% |
| Gas | 199 | 1.0% |
| Nuclear | 202 | 1.0% |
| Solar | 5784 | 29.6% |
| Hydro | 2518 | 12.9% |
| Wind | 128 | 0.7% |
| NCES | 135 | 0.7% |
| DRE | 803 | 4.1% |
| **Total** | **19551** | 100.0% |

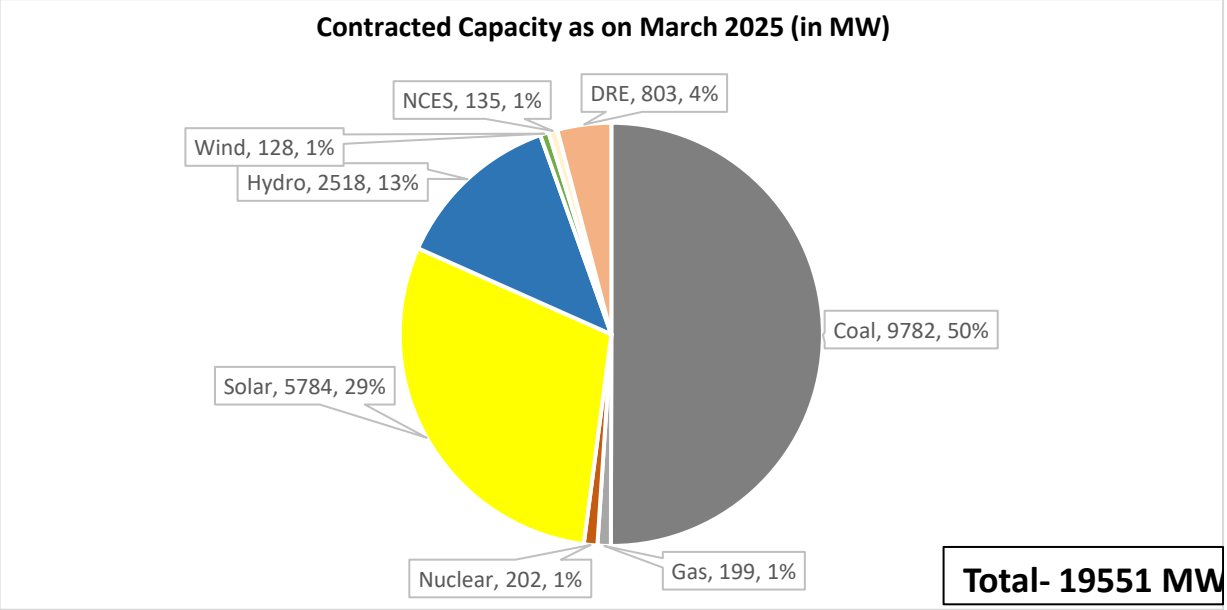



Figure 2 Fuel-wise Contracted Capacity (in MW) as on March, 2025

## 3.2 Demand Analysis of the FY 2024-25

Hourly demand pattern of 2024-25 was analyzed and it was observed that peak electricity demand in Telangana occurs in the month of March during solar hours. The month wise variation in average hourly electricity demand observed for the year 2024-25 is shown in Figure 3.

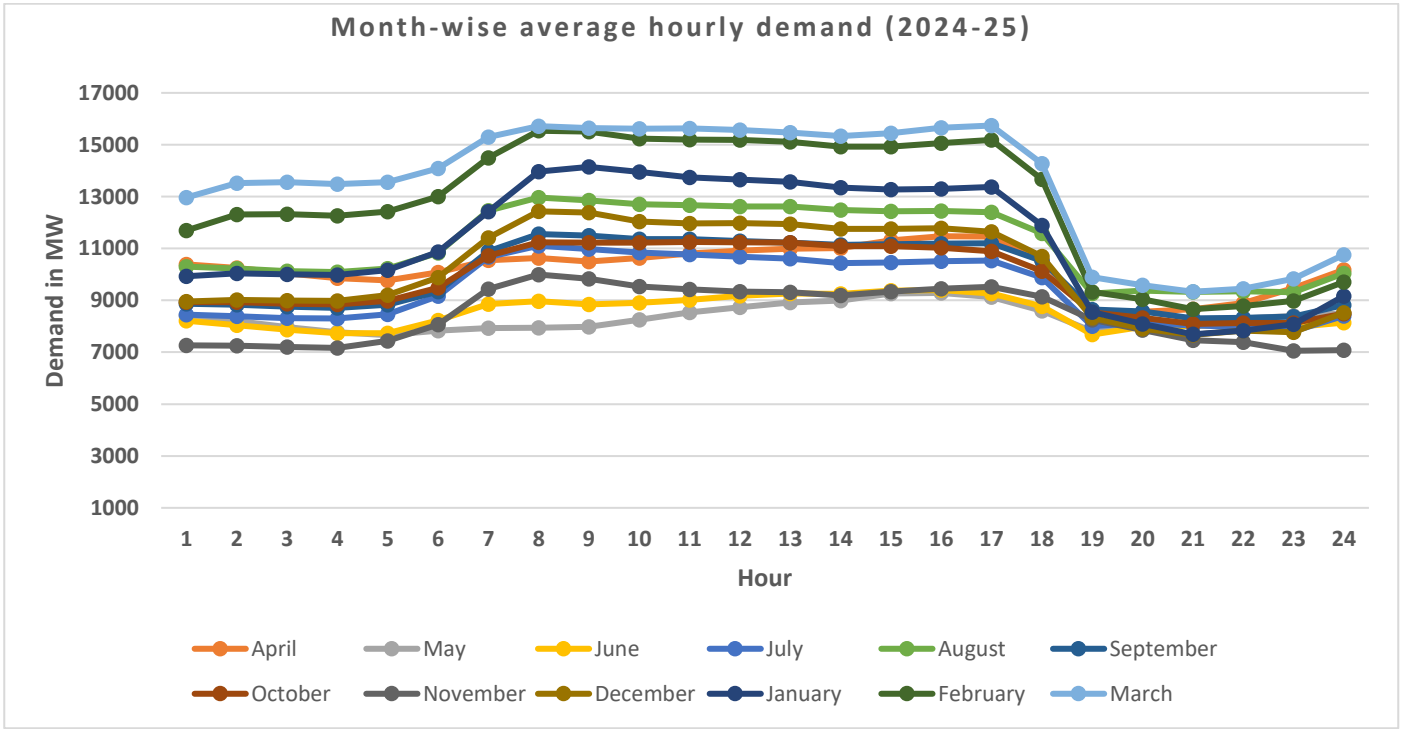



Figure 3: Average Hourly Demand Variation (Month-wise) for 2024-25

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

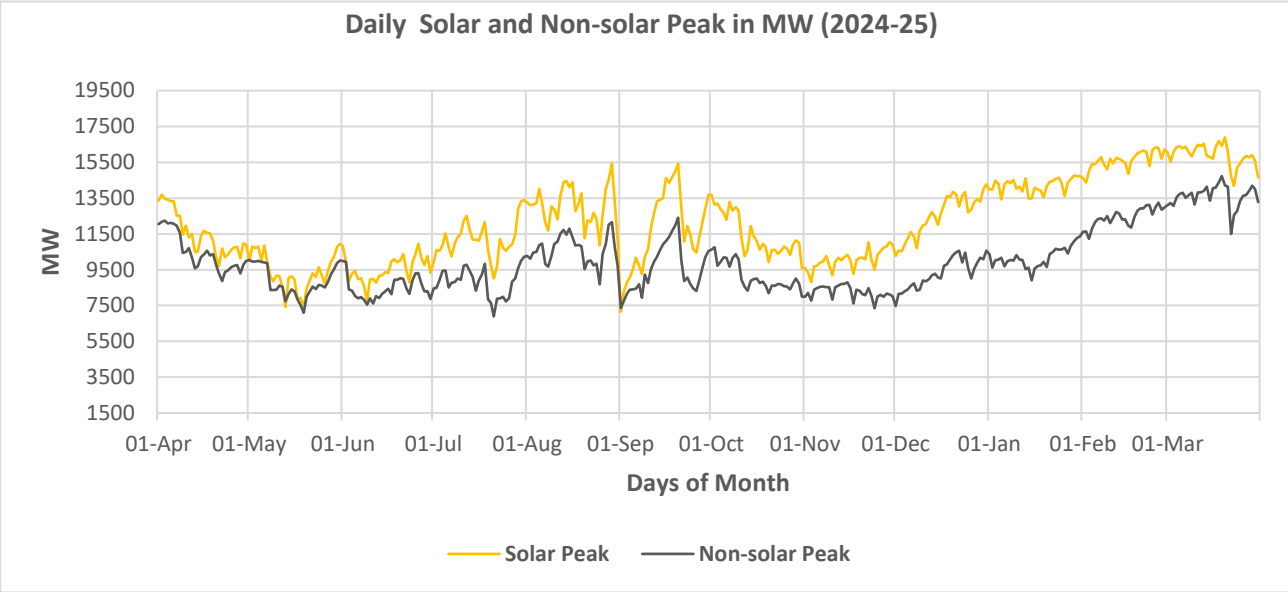



Figure 4: Solar and non-solar Peak in MW for the year 2024-25

As seen in Figure 4, the daily peak demand occurs during solar hours in the month of March.

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

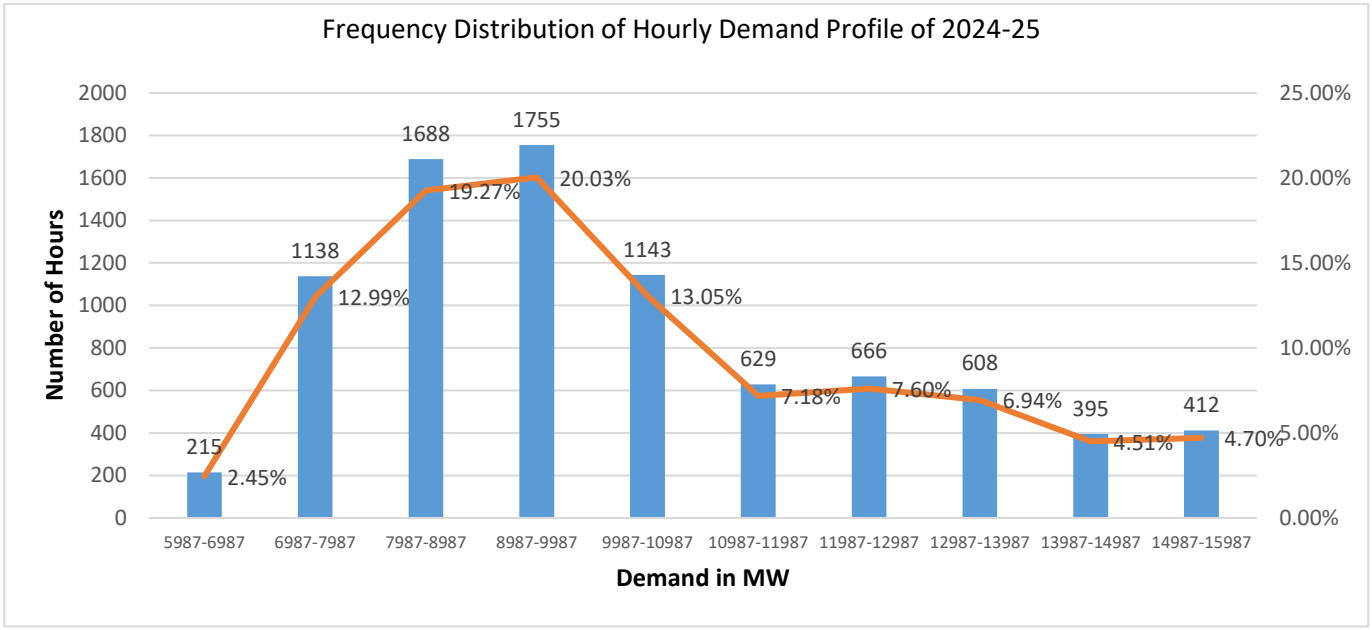



Figure 5 Frequency Distribution of Hourly Demand Profile of 2024-25

## 4.0 Principles of Generation Planning

The objective of the Generation Planning process is to obtain an optimal generation capacity mix in the least cost manner to meet the demand at every instance of time while ensuring the most efficient use of resources. Planning is therefore an activity encompassing balancing demand and supply at all instances of time and at all locations, which makes it a regular ongoing process.

The major aspects considered in the planning process are:

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

### 4.1 Generation Expansion Planning Tool -ORDENA

The studies 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 and operating reserve limits, and policy targets. These constraints are met considering a broad portfolio of conventional generation, renewable generation, and storage.

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

The schematic diagram of the software is given in Exhibit.

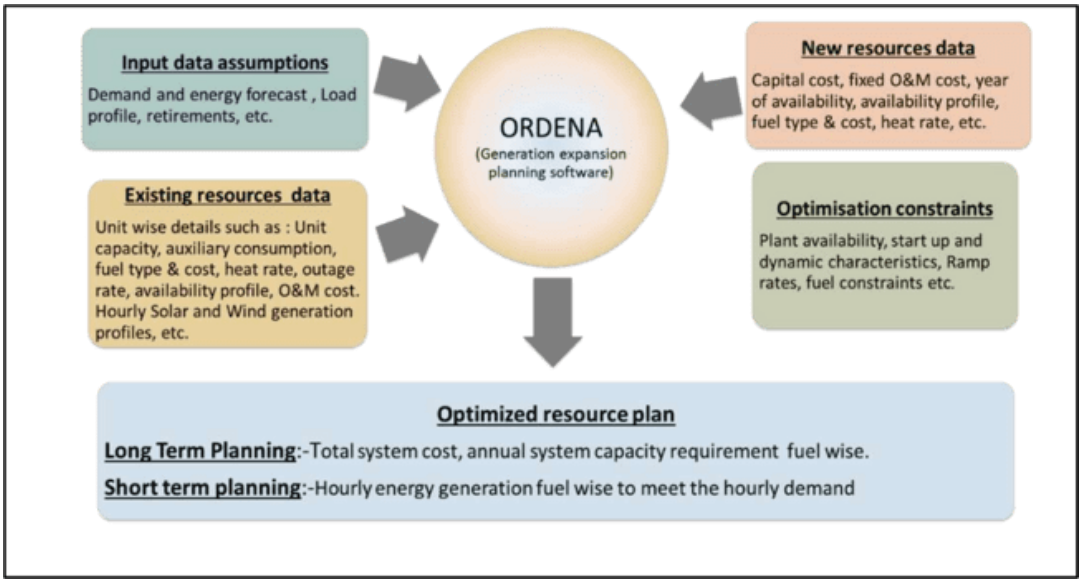



**Exhibit: Schematic Diagram-Ordena**

## 5.0 Reliability Analysis

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

- **Loss of Load Probability (LOLP)**: Measure of the probability that a system's load may exceed the generation and firm power contracts available to meet that load in a year. E.g., 0.0274 % probability of load being lost.
- **Expected Energy Not Served (EENS):** Expected amount of energy (MWh) that may not be served for each year within the planning period under study. It is a summation of the expected number of megawatt hours of demand that may not be served for the year. This is an energy-centric metric that considers the magnitude and duration of energy being not served, calculated in Mega Watt hours (MWh). The metric can be normalized (i.e., divided by total system electrical energy requirement in MWh) to create a Normalized Energy Not Served (NENS) metric.

Monte Carlo /Stochastic simulation has been used to factor-in the uncertainty associated with various generation resources and demand. It is an approach which is used to predict the probability of a variety of outcomes when the potential for random variables is present, as compared to deterministic modelling of economic dispatch model. Monte Carlo simulation helps in analysing the randomness associated with RE energy resource, demand pattern changes and forced outages of plant. A large number of random samples of these variables are simultaneously simulated to ascertain system reliability indices (i.e. Loss of load probability LOLP & Normalised Energy Not Served (NENS)) & 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 projected peak load of the system.

## 5.1 Variation in Electricity Demand

The variation in electricity demand pattern for the past two years has been analyzed. The hourly demand variation for consecutive years (i.e., 2023-24 and 2024-25 considering 2023-24 as base) has been analyzed. The Demand pattern variation of 2023-24 and 2024-25 is shown below.

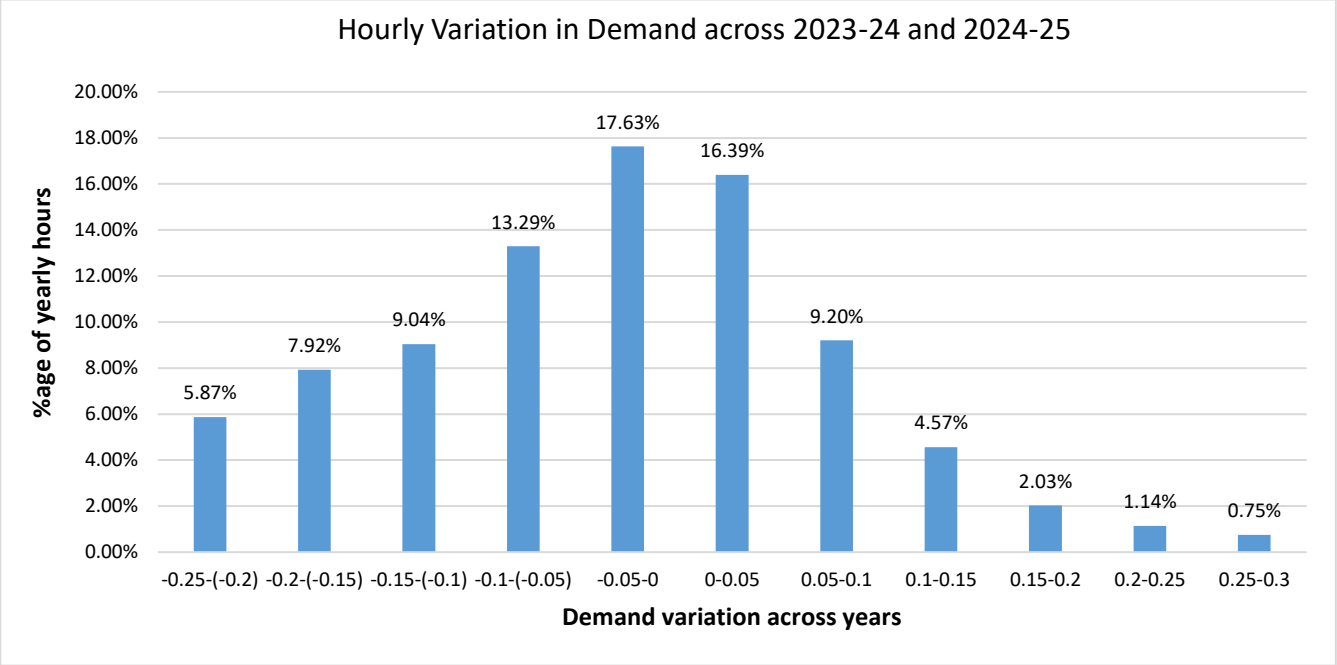



Figure 6 Hourly Variation in Demand across years

It can be observed that the hourly demand typically varies ±10% for about 57% of instances. This variation is primarily due to temperature, weather parameter or any random outages of transmission line and generating units etc. This variation has been captured in the reliability study by varying the projected hourly demand for the future years by varying ±10% by introducing a random variable (with normal distribution) for demand as per observed behavior over the years.

## 5.2 Variation in RE

In the long-term capacity expansion planning studies, a particular profile for Solar and wind is considered based on the observed solar and wind generation data to determine the optimal capacity mix. However, due to intermittent nature of these sources, the generation from these non-dispatchable sources may vary across years. As per the analyses carried out based on historical generation data, solar and hydro based generation has been varied by ± 10 % and wind generation

has been varied by ± 50% to incorporate the variation in these generation sources and plan for requisite measures to mitigate such behavior.

### 5.3 Forced Outage of Thermal Generators

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

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

## 6.0 Inputs/Assumptions for the Study

i) The electrical energy requirement of Telangana, furnished by Telangana SLDC and projections available in the revised 20th EPS (Electric Power Survey) is tabulated below.

Table 7 Future Demand Projection as provided by Telangana SLDC and as per revised 20th EPS Report

| Year | Projections by Telangana SLDC | | | | Projections as per revised 20th EPS | | | |
|---|---|---|---|---|---|---|---|---|
| | Peak Electricity Demand | | Electrical Energy Requirement | | Peak Electricity Demand | | Electrical Energy Requirement | |
| | Projections (MW) | Y-o-Y Growth | Projections (MWh) | Y-o-Y Growth | Projections (MW) | Y-o-Y Growth | Projections (MWh) | Y-o-Y Growth |
| **2025-26** | 18444 | | 94436 | | 18424 | | 99855 | |
| **2026-27** | 19859 | 7.67% | 100435 | 6.35% | 19953 | 8.30% | 108125 | 8.28% |
| **2027-28** | 21322 | 7.37% | 106497 | 6.04% | 21240 | 6.45% | 116497 | 7.74% |
| **2028-29** | 22868 | 7.25% | 112768 | 5.89% | 22539 | 6.11% | 125099 | 7.38% |
| **2029-30** | 24624 | 7.68% | 119885 | 6.31% | 23761 | 5.42% | 133444 | 6.67% |
| **2030-31** | 26072 | 5.88% | 125169 | 4.41% | 24882 | 4.72% | 141376 | 5.94% |
| **2031-32** | 27516 | 5.54% | 130233 | 4.05% | 25902 | 4.10% | 148870 | 5.30% |
| **2032-33** | 29040 | 5.54% | 135501 | 4.05% | 26955 | 4.07% | 156694 | 5.26% |
| **2033-34** | 30648 | 5.54% | 140982 | 4.05% | 27884 | 3.45% | 163925 | 4.61% |
| **2034-35** | 32346 | 5.54% | 146685 | 4.05% | 28708 | 2.96% | 170661 | 4.11% |
| **2035-36** | 34137 | 5.54% | 152626 | 4.05% | 29812 | 3.84% | 177219 | 3.84% |

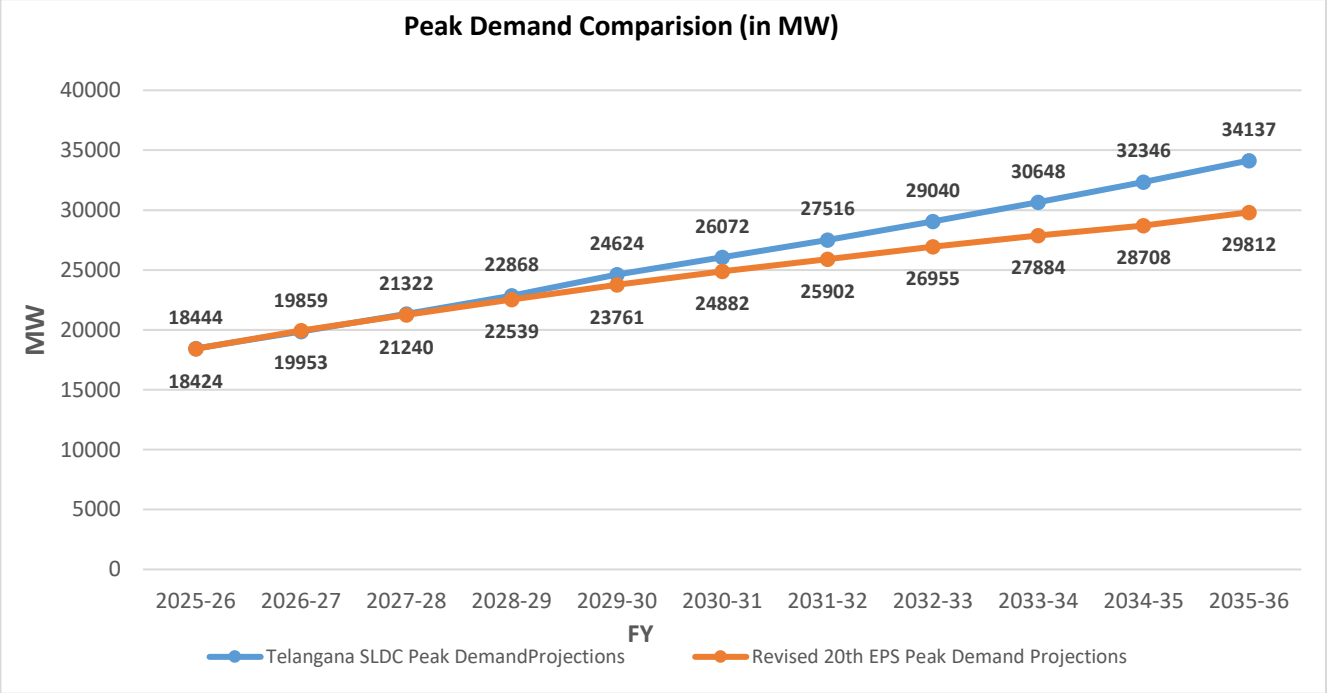



Figure 7 Comparison of Peak Demand Projections of Revised 20th EPS vs Telangana SLDC

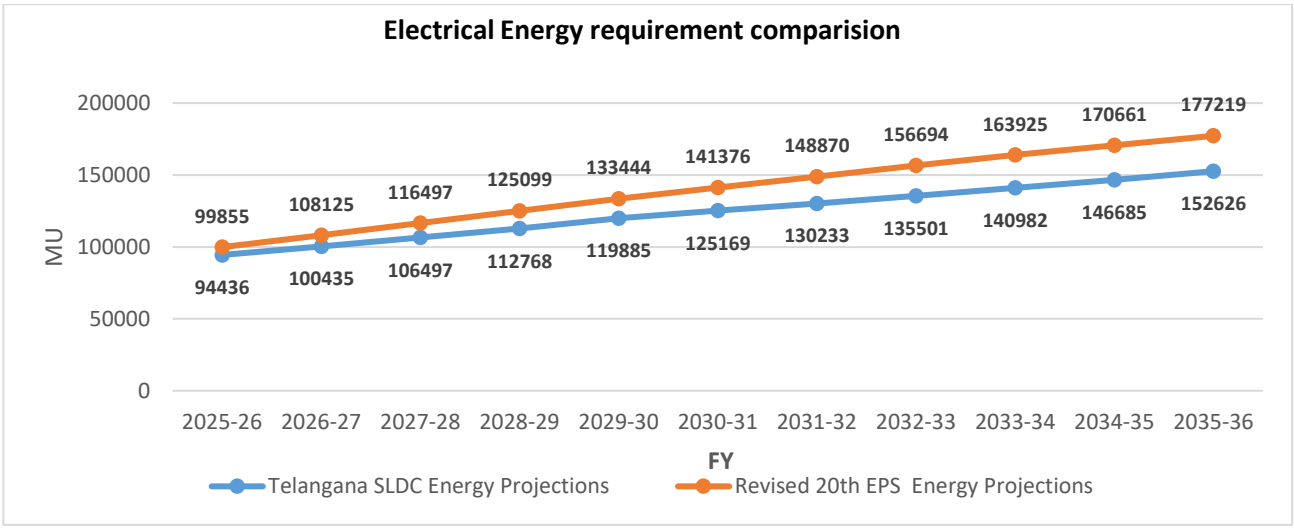



Figure 8 Comparison of Electrical Energy Requirement Projections of revised 20th EPS vs Telangana SLDC

The electrical energy requirement projection of Telangana SLDC is found to be lower than revised 20th EPS. However, the Peak Demand projections of Telangana SLDC is higher than that of revised 20th EPS. The peak demand and energy requirement projections from Telangana SLDC have been considered in the Study.

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

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

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

v) The year-wise planned capacity tie-up as per Telangana SLDC is given below.

Table 8 Source wise planned capacity addition (MW) as per Telangana SLDC

| FY | Coal | Solar | DRE | Storage |
|---|---|---|---|---|
| **2025-26** | 1600 | 0 | 112 | 0 |
| **2026-27** | 2400 | 2100 | 133 | 225 |
| **2027-28** | 0 | 0 | 160 | 0 |
| **2028-29** | 0 | 0 | 192 | 0 |
| **2029-30** | 800 | 0 | 231 | 0 |
| **2030-31** | 0 | 0 | 277 | 0 |
| **2031-32** | 0 | 0 | 332 | 0 |
| **2032-33** | 0 | 0 | 399 | 0 |
| **2033-34** | 0 | 0 | 478 | 0 |
| **2034-35** | 0 | 0 | 574 | 0 |
| **2035-36** | 0 | 0 | 689 | 0 |
| **Total** | **4800** | **2100** | **3577** | **225** |

vi) **Renewable Purchase Obligation (RPO) trajectory**: Ministry of Power vide 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.

Table 9 Renewable Purchase Obligation (RPO) trajectory as per MoP order

| Sl. No. | Year | Wind renewable energy | Hydro renewable energy | Other renewable energy | Distributed renewable energy | Total renewable energy |
|---|---|---|---|---|---|---|
| 1. | 2024-25 | 0.67 % | 0.38 % | 27.35 % | 1.5 % | 29.91 % |
| 2. | 2025-26 | 1.45 % | 1.22 % | 28.24 % | 2.1 % | 33.01 % |
| 3. | 2026-27 | 1.97 % | 1.34 % | 29.94 % | 2.7 % | 35.95 % |
| 4. | 2027-28 | 2.45 % | 1.42 % | 31.64 % | 3.3 % | 38.81 % |
| 5. | 2028-29 | 2.95 % | 1.42 % | 33.1 % | 3.9 % | 41.36 % |
| 6. | 2029-30 | 3.48 % | 1.33 % | 34.02 % | 4.5 % | 43.33 % |

Further, in view of the country's energy transition goals as well as the long-term net zero target of 2070, it is estimated that the share of RE generation in the generation mix will continue to proportionally increase beyond 2029-30. Hence, the suggested trajectory of Renewable Purchase Requirement up to FY 2035-36 is presented in Table 10.

Table 10 Renewable Purchase Obligation (RPO) trajectory considered for the study

| Sl. No. | Year | Wind renewable energy | Hydro renewable energy | Other renewable energy | Distributed renewable energy | Total renewable energy |
|---|---|---|---|---|---|---|
| 1. | 2024-25 | 0.67% | 0.38% | 27.35% | 1.50% | 29.91% |
| 2. | 2025-26 | 1.45% | 1.22% | 28.24% | 2.10% | 33.01% |
| 3. | 2026-27 | 1.97% | 1.34% | 29.94% | 2.70% | 35.95% |
| 4. | 2027-28 | 2.45% | 1.42% | 31.64% | 3.30% | 38.81% |
| 5. | 2028-29 | 2.95% | 1.42% | 33.10% | 3.90% | 41.36% |
| 6. | 2029-30 | 3.48% | 1.33% | 34.02% | 4.50% | 43.33% |
| 7. | 2030-31 | 41.00% | | | 4.50% | 45.50% |
| 8. | 2031-32 | 42.50% | | | 4.50% | 47.00% |
| 9. | 2032-33 | 43.80% | | | 4.50% | 48.30% |
| 10. | 2033-34 | 45.00% | | | 4.50% | 49.50% |
| 11. | 2034-35 | 46.50% | | | 4.50% | 50.50% |
| 12. | 2035-36 | 47.50% | | | 4.50% | 51.50% |

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:

Table 11 Total Electrical Energy required to meet RPO (MU)

| Sl. No. | Year | Wind renewable energy (MU) | Hydro renewable energy | Other renewable energy | Distributed renewable energy | Total renewable energy |
|---|---|---|---|---|---|---|
| **1.** | **2025-26** | 1369.3 | 1152.1 | 26668.7 | 1983.2 | 31173.3 |
| **2.** | **2026-27** | 1978.6 | 1345.8 | 30070.2 | 2711.7 | 36106.3 |
| **3.** | **2027-28** | 2609.2 | 1512.3 | 33695.5 | 3514.4 | 41331.3 |
| **4.** | **2028-29** | 3326.7 | 1601.3 | 37326.2 | 4397.9 | 46652.1 |
| **5.** | **2029-30** | 4172.0 | 1594.5 | 40784.9 | 5394.8 | 51946.2 |
| **6.** | **2030-31** | 51319.3 | | | 5632.6 | 56951.9 |
| **7.** | **2031-32** | 55348.8 | | | 5860.5 | 61209.3 |
| **8.** | **2032-33** | 59349.4 | | | 6097.5 | 65446.9 |
| **9.** | **2033-34** | 63441.8 | | | 6344.2 | 69786.0 |
| **10.** | **2034-35** | 68208.5 | | | 6600.8 | 74809.3 |
| **11.** | **2035-36** | 72497.2 | | | 6868.2 | 79365.4 |

Table 12 Renewable Energy other than DRE

| FY | RE Generation required to meet RPO | RE Generation required to meet RPO | RE Generation available/met (From existing/ planned Contracts) | RPO met (%) | RPO Surplus (+) / Deficit (-) |
|---|---|---|---|---|---|
| | (MU) | (%) | (MU) | (%) | (%) |
| **2025-26** | 26668.7 | 28.40% | 16314.7 | 17.3% | -13.6% |
| **2026-27** | 30070.2 | 30.91% | 20458.2 | 20.4% | -12.9% |
| **2027-28** | 33695.5 | 33.25% | 20659.7 | 19.4% | -16.1% |
| **2028-29** | 37326.2 | 35.51% | 20961.3 | 18.6% | -18.9% |
| **2029-30** | 40784.9 | 37.47% | 21218.5 | 17.7% | -21.1% |
| **2030-31** | 51319.3 | 41.00% | 21305.4 | 17.0% | -24.0% |
| **2031-32** | 55348.8 | 42.50% | 21638.7 | 16.6% | -25.9% |
| **2032-33** | 59349.4 | 43.80% | 22400.1 | 16.5% | -27.3% |
| **2033-34** | 63441.8 | 45.00% | 23211.2 | 16.5% | -28.5% |
| **2034-35** | 68208.5 | 46.50% | 23946.4 | 16.3% | -30.2% |
| **2035-36** | 72497.2 | 47.50% | 24815.3 | 16.3% | -31.2% |

Table 13 Renewable Energy from DRE

| FY | DRE required to meet RPO | DRE required to meet RPO | DRE available | DRE available | Surplus (+)/ Deficit (-) |
|---|---|---|---|---|---|
| | (MU) | (%) | (MU) | (%) | (%) |
| **2025-26** | 1983.2 | 1.50% | 1158 | 1.23% | -0.87% |
| **2026-27** | 2711.7 | 2.10% | 1327 | 1.32% | -1.38% |
| **2027-28** | 3514.4 | 2.70% | 1530 | 1.44% | -1.86% |
| **2028-29** | 4397.9 | 3.30% | 1774 | 1.57% | -2.33% |
| **2029-30** | 5394.8 | 3.90% | 1645 | 1.37% | -3.13% |
| **2030-31** | 5632.6 | 4.50% | 1909 | 1.53% | -2.97% |
| **2031-32** | 5860.5 | 4.50% | 2188 | 1.68% | -2.82% |
| **2032-33** | 6097.5 | 4.50% | 2547 | 1.88% | -2.62% |
| **2033-34** | 6344.2 | 4.50% | 3020 | 2.14% | -2.36% |
| **2034-35** | 6600.8 | 4.50% | 3812 | 2.60% | -1.90% |
| **2035-36** | 6868.2 | 4.50% | 4449 | 2.91% | -1.59% |

As indicated in the tables above, the state will not be able to meet its RPO requirements based on the existing and planned contracts from 2025-26 to 2035-36.

# 7.0 Outcome of the Study

## 7.1 Unserved Energy Projections

Initially, the study has been carried out considering only the existing and planned capacity contracts as per Telangana SLDC. Considering the existing and planned capacity contracts, the state will not be able to meet its electrical energy requirement and the total unserved energy for the year 2035-36 has been estimated as 33.6 BU. The year-wise likely unserved energy with the existing and planned capacities is given in Figure 9.

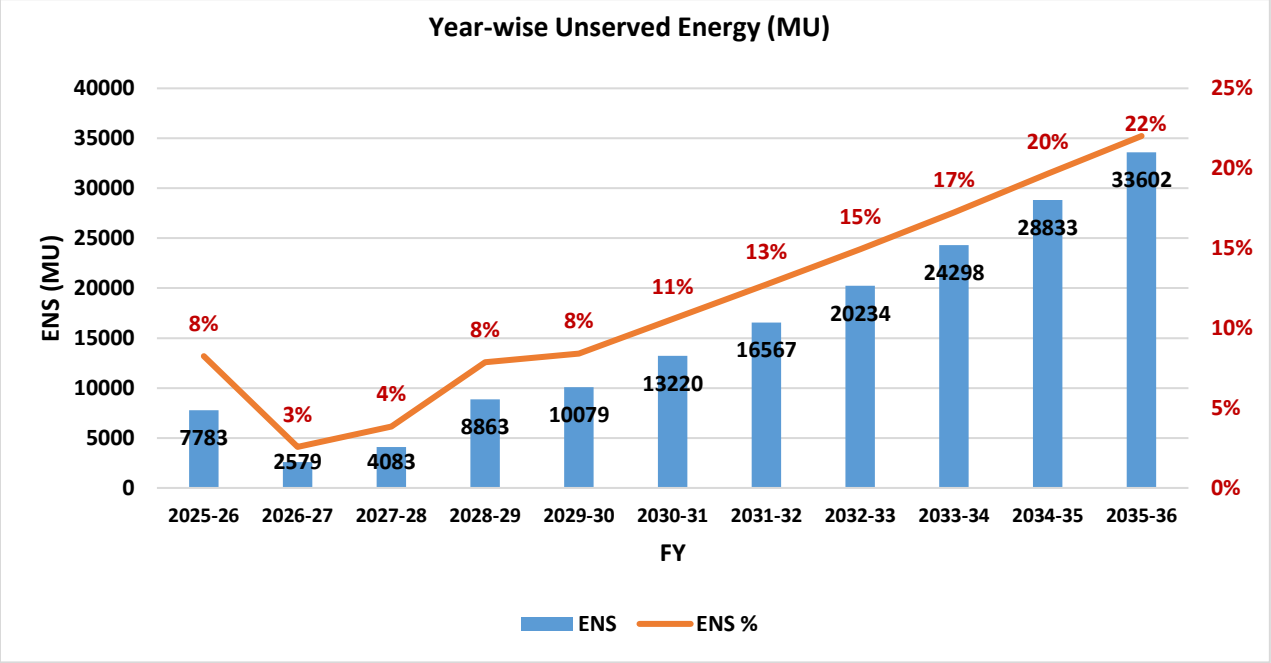



Figure 9 Yearly likely unserved energy (in MU) with the existing and planned capacities

The study has also analyzed the daily and monthly pattern of unserved energy in the year 2035-36 and it can be seen that contracted capacity (existing and planned) is unable to meet the projected electricity demand.

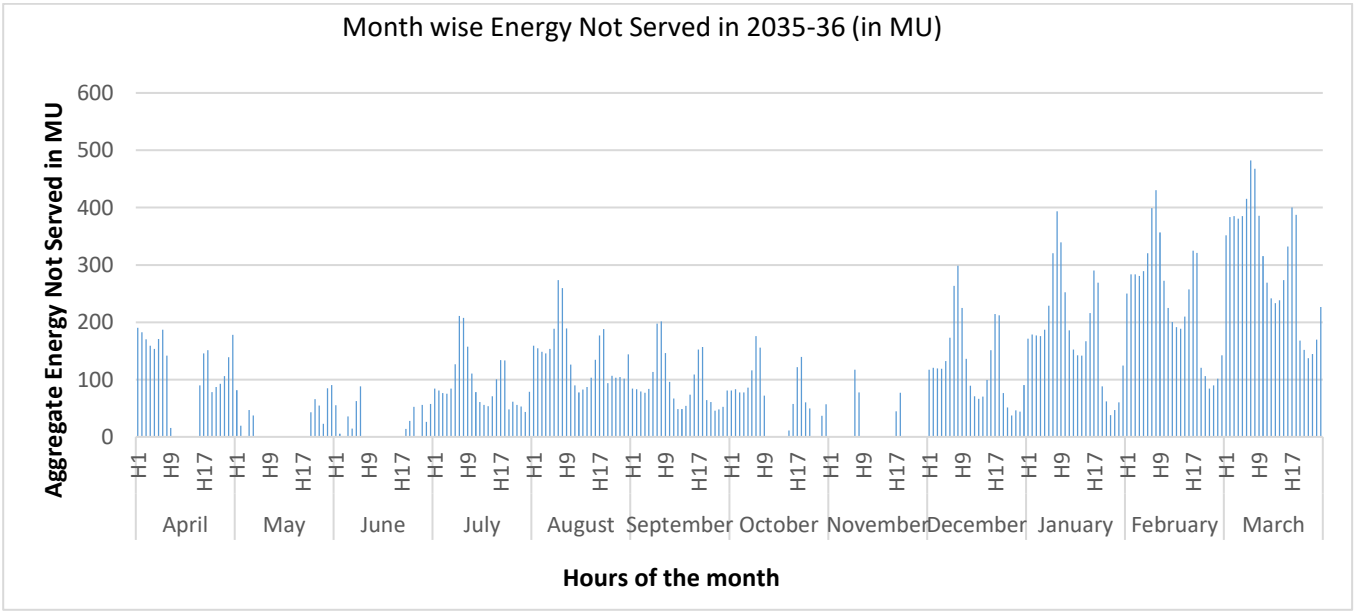



Figure 10 Block-wise Unserved Energy Pattern in MU (2035-36)

The unmet demand occurs almost during the entire year in 2035-36 as per the planned and existing capacities. However, the large quantum of unmet demand occurs from January to March months.

## 7.2 Options to meet the unserved energy

To meet this unserved energy, options (i.e., candidate capacities) have been given to the model to find the least cost optimal capacity mix required to meet the demand with RPO obligations. The capacity projections for Telangana are given below:

Table 14: Year-wise contracted capacity projections (existing + planned + additional) (in MW)

| Year | Coal | Gas | Nuclear | Hydro | Wind | Solar | PSP | Storage (2 Hour) | Storage (4 Hour) | DRE | NCES | STOA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2025-26** | 11784 | 199 | 202 | 2518 | 128 | 5784 | 0 | 0 | 0 | 1563 | 135 | 6000 |
| **2026-27** | 14184 | 199 | 202 | 2518 | 928 | 10884 | 500 | 225 | 0 | 2137 | 135 | 5162 |
| **2027-28** | 14184 | 199 | 202 | 2518 | 1728 | 13884 | 1000 | 725 | 500 | 2808 | 135 | 4669 |
| **2028-29** | 13184 | 0 | 202 | 2518 | 2528 | 16884 | 1500 | 1225 | 1000 | 3400 | 135 | 6041 |
| **2029-30** | 13984 | 0 | 202 | 2518 | 3328 | 19884 | 2000 | 1225 | 1500 | 4252 | 135 | 4407 |
| **2030-31** | 13984 | 0 | 202 | 2518 | 4128 | 22884 | 2500 | 1225 | 2000 | 4529 | 135 | 4333 |
| **2031-32** | 13984 | 0 | 202 | 2518 | 4928 | 25785 | 3000 | 1225 | 2500 | 4861 | 135 | 4266 |
| **2032-33** | 13984 | 0 | 202 | 2518 | 5728 | 27710 | 3500 | 1725 | 3000 | 5839 | 135 | 4160 |
| **2033-34** | 13984 | 0 | 202 | 2518 | 6128 | 30239 | 4000 | 2225 | 3500 | 6317 | 135 | 4259 |
| **2034-35** | 13984 | 0 | 202 | 2518 | 6128 | 31805 | 4500 | 2725 | 3500 | 6891 | 135 | 4928 |
| **2035-36** | 13984 | 0 | 202 | 2518 | 6128 | 32884 | 5000 | 3225 | 3500 | 7580 | 135 | 5700 |

The projected year-wise contracted capacity mix is given in the figure below:

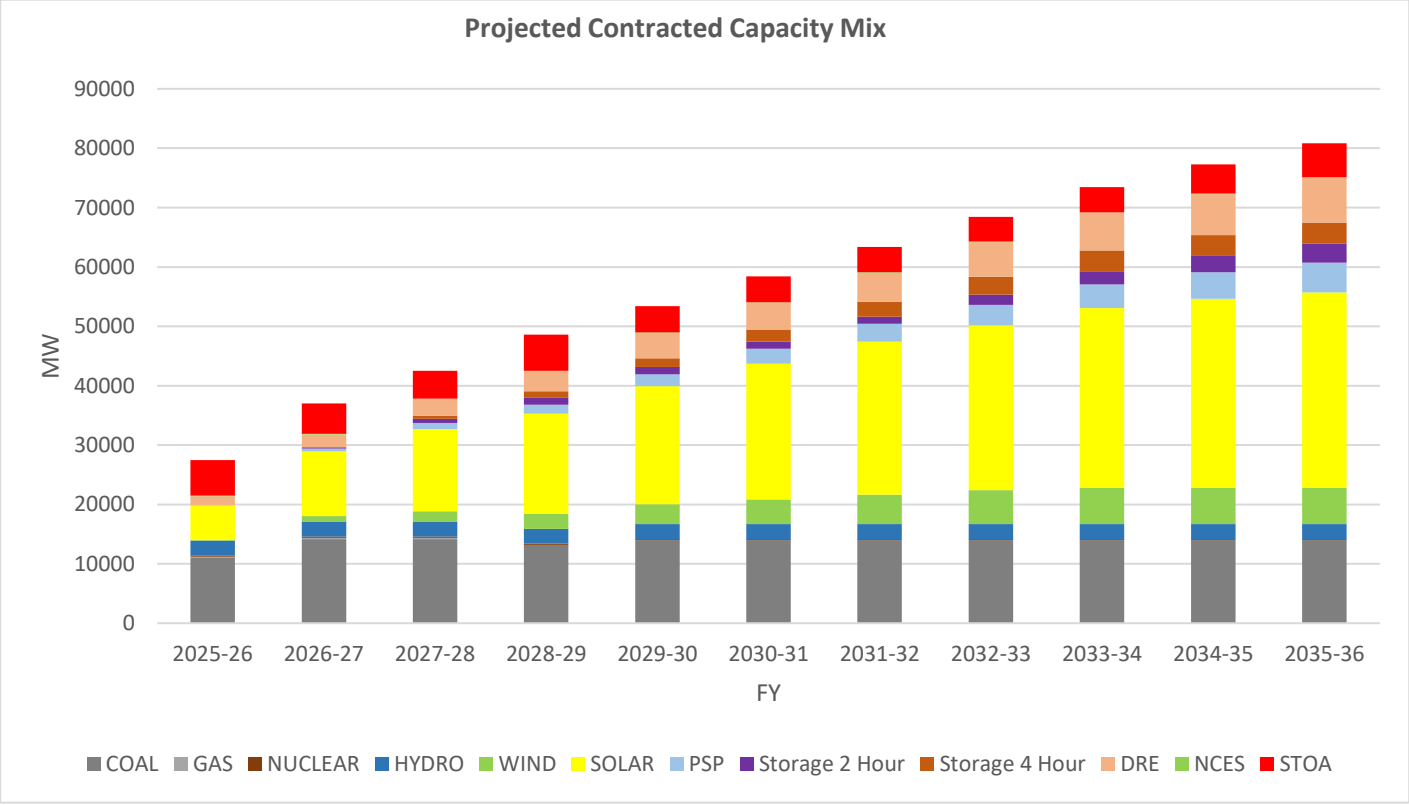



Figure 11 Projected Contracted Capacity Mix Year-wise (MW)

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

Reliability studies have been conducted based on the projected capacity for the year 2035-36. The analysis confirms that the projected capacity meets the reliability criteria specified in the National Electricity Plan (NEP), with the Loss of Load Probability (LoLP) and Normalised 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 around 80,856 MW which consists of 13,984 MW from Coal; 202 MW from Nuclear; 2,518 MW from Hydro; 32,884 MW from Solar; 6,128 MW from Wind; 7,580 MW from Distributed Renewable Energy (DRE); 11,725 MW Energy Storage System; 135 MW from Non-Conventional Energy sources and 5,700 MW of STOA/MTOA. This capacity shall be able to meet the projected demand with prescribed reliability criteria. The Storage requirement can be met from PSP or a combination of PSP and BESS.

It is important to note that any deviations in the commissioning schedule of the planned capacity could result in a situation where the state is unable to meet the projected peak demand and energy requirements identified in this study with the available resources. Such changes may also lead to an increase in the cost of reliably meeting the state’s power demand.

The Planning Reserve Margin (PRM) for Telangana has been assessed as 4%. Furthermore, the projected/contracted capacity is in compliance with the stipulated Renewable Purchase Obligation (RPO) targets.

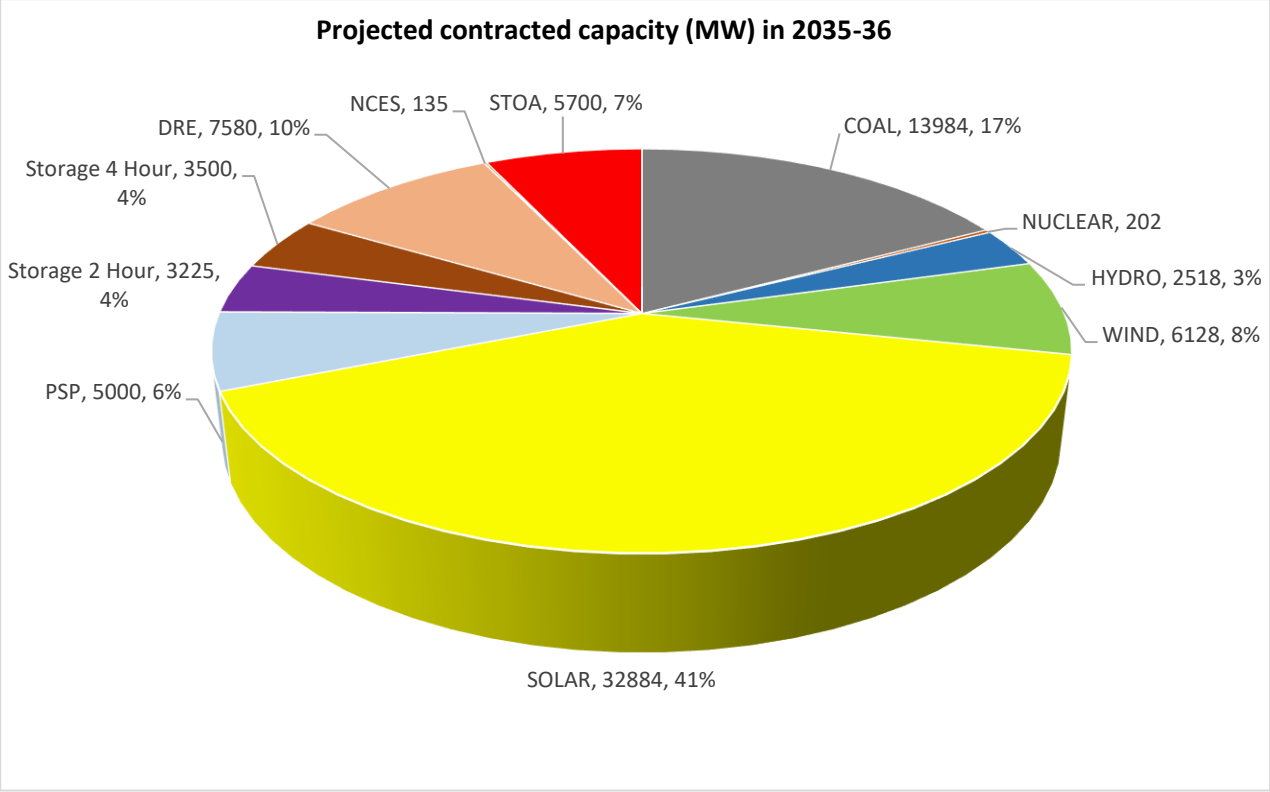



Figure 12 Projected Contracted Capacity Mix in 2035-36

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

Table 15 Year wise Capacity Addition (in MW)

| | Coal | Wind | Solar | | DRE | | PSP |
|---|---|---|---|---|---|---|---|
| **Year** | **Planned Contracts** | **Additional Requirement** | **Planned Contracts** | **Additional Requirement** | **Planned Contracts** | **Additional Requirement** | **Additional Requirement** |
| **2025-26** | 1600 | 0 | 0 | 0 | 112 | 646 | 0 |
| **2026-27** | 2400 | 800 | 2100 | 3000 | 133 | 441 | 500 |
| **2027-28** | 0 | 800 | 0 | 3000 | 160 | 513 | 500 |
| **2028-29** | 0 | 800 | 0 | 3000 | 192 | 400 | 500 |
| **2029-30** | 800 | 800 | 0 | 3000 | 231 | 621 | 500 |
| **2030-31** | 0 | 800 | 0 | 3000 | 277 | 0 | 500 |
| **2031-32** | 0 | 800 | 0 | 2901 | 332 | 0 | 500 |
| **2032-33** | 0 | 800 | 0 | 1925 | 399 | 579 | 500 |
| **2033-34** | 0 | 400 | 0 | 2528 | 478 | 0 | 500 |
| **2034-35** | 0 | 0 | 0 | 1566 | 574 | 0 | 500 |
| **2035-36** | 0 | 0 | 0 | 1079 | 689 | 0 | 500 |
| **TOTAL** | **4800** | **6000** | **2100** | **25000** | **3577** | **2554** | **5000** |

| | Storage (2 Hour) | | Storage (4 Hour) | MTOA/STOA |
|---|---|---|---|---|
| **Year** | **Planned Contracts** | **Additional Requirement** | **Additional Requirement** | **Additional Requirement** |
| **2025-26** | 0 | 0 | 0 | 6000 |
| **2026-27** | 225 | 0 | 0 | 5162 |
| **2027-28** | 0 | 500 | 500 | 4669 |
| **2028-29** | 0 | 500 | 500 | 6041 |
| **2029-30** | 0 | 0 | 500 | 4407 |
| **2030-31** | 0 | 0 | 500 | 4333 |
| **2031-32** | 0 | 0 | 500 | 4266 |
| **2032-33** | 0 | 500 | 500 | 4160 |
| **2033-34** | 0 | 500 | 500 | 4259 |
| **2034-35** | 0 | 500 | 0 | 4928 |
| **2035-36** | 0 | 500 | 0 | 5700 |
| **TOTAL** | **225** | **3000** | **3500** | **-** |

The projected net generation mix for the State is shown in Figure 13.

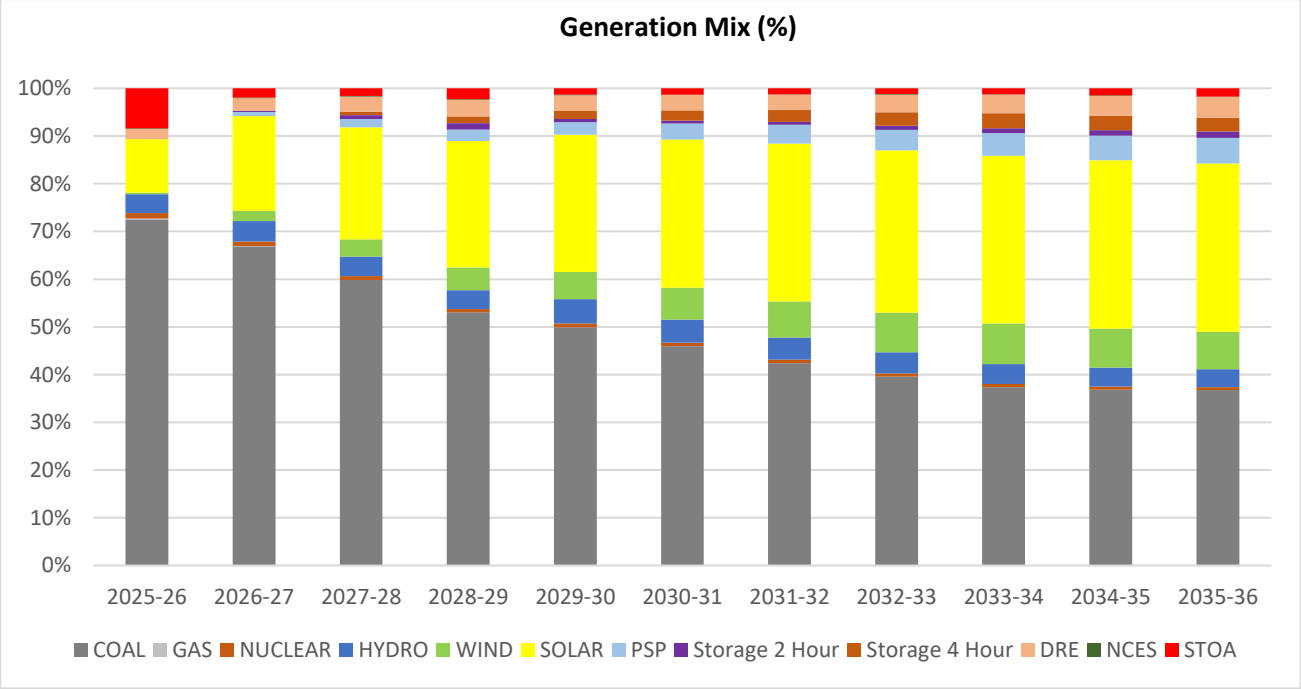
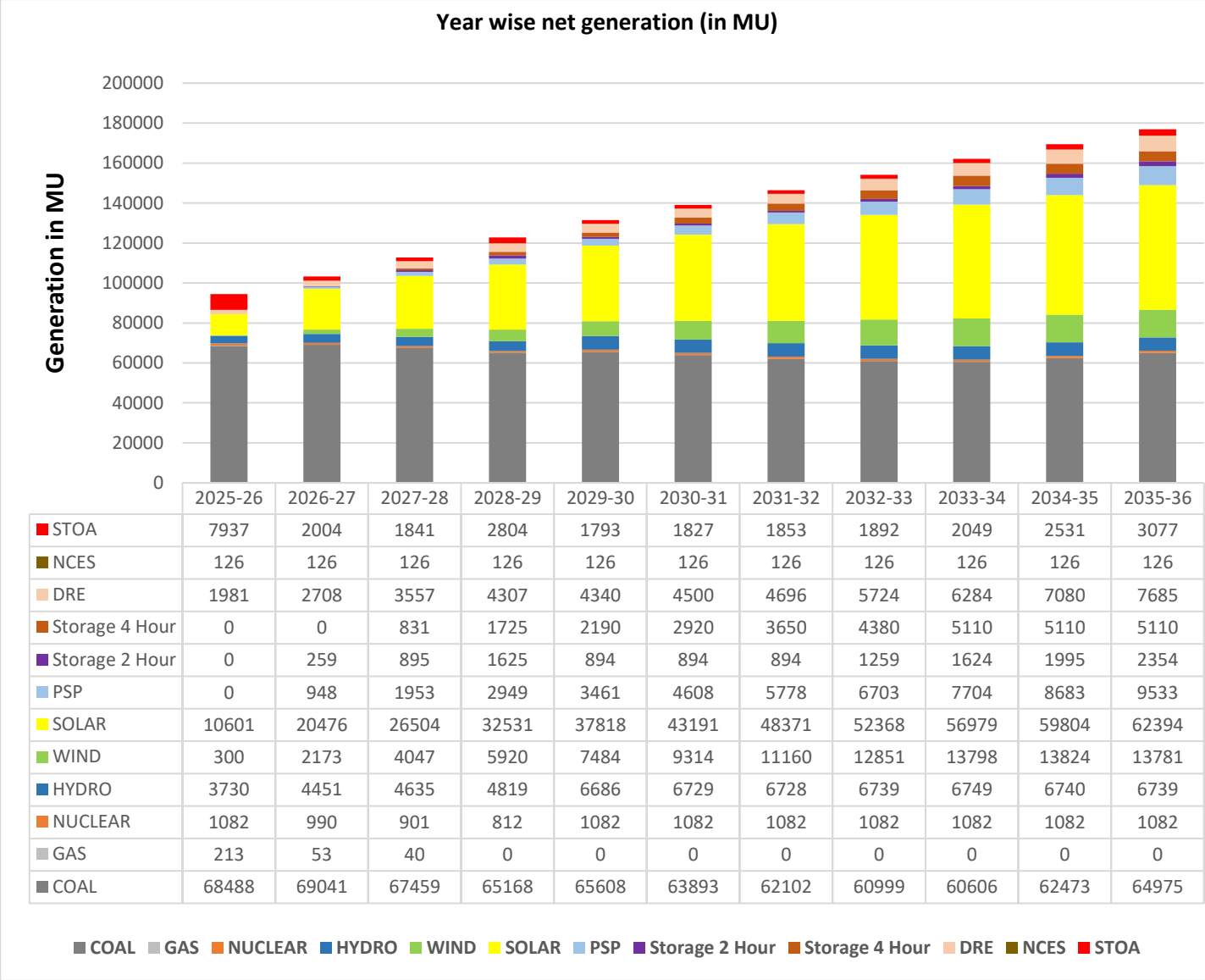



Figure 13 Year-wise projected gross generation mix (in %)




| | 2025-26 | 2026-27 | 2027-28 | 2028-29 | 2029-30 | 2030-31 | 2031-32 | 2032-33 | 2033-34 | 2034-35 | 2035-36 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| STOA | 7937 | 2004 | 1841 | 2804 | 1793 | 1827 | 1853 | 1892 | 2049 | 2531 | 3077 |
| NCES | 126 | 126 | 126 | 126 | 126 | 126 | 126 | 126 | 126 | 126 | 126 |
| DRE | 1981 | 2708 | 3557 | 4307 | 4340 | 4500 | 4696 | 5724 | 6284 | 7080 | 7685 |
| Storage 4 Hour | 0 | 0 | 831 | 1725 | 2190 | 2920 | 3650 | 4380 | 5110 | 5110 | 5110 |
| Storage 2 Hour | 0 | 259 | 895 | 1625 | 894 | 894 | 894 | 1259 | 1624 | 1995 | 2354 |
| PSP | 0 | 948 | 1953 | 2949 | 3461 | 4608 | 5778 | 6703 | 7704 | 8683 | 9533 |
| SOLAR | 10601 | 20476 | 26504 | 32531 | 37818 | 43191 | 48371 | 52368 | 56979 | 59804 | 62394 |
| WIND | 300 | 2173 | 4047 | 5920 | 7484 | 9314 | 11160 | 12851 | 13798 | 13824 | 13781 |
| HYDRO | 3730 | 4451 | 4635 | 4819 | 6686 | 6729 | 6728 | 6739 | 6749 | 6740 | 6739 |
| NUCLEAR | 1082 | 990 | 901 | 812 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 | 1082 |
| GAS | 213 | 53 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| COAL | 68488 | 69041 | 67459 | 65168 | 65608 | 63893 | 62102 | 60999 | 60606 | 62473 | 64975 |

*Figure 14 Year-wise projected gross generation (in GWh)*

## 7.3 Day-wise Surplus Coal Capacity

Surplus capacity is available with the State due to RE availability, Demand variation etc. The pattern of surplus capacities is given below. This capacity can be shared with other states/ Discoms and reduce the fixed cost burden on the utility resulting in reduction in the cost to consumer. The State has minimum surplus capacity of around 2600 MW during May to July months and around 2200 MW during September to November in 2028-29 as shown below which can be shared with other states/ Discoms.

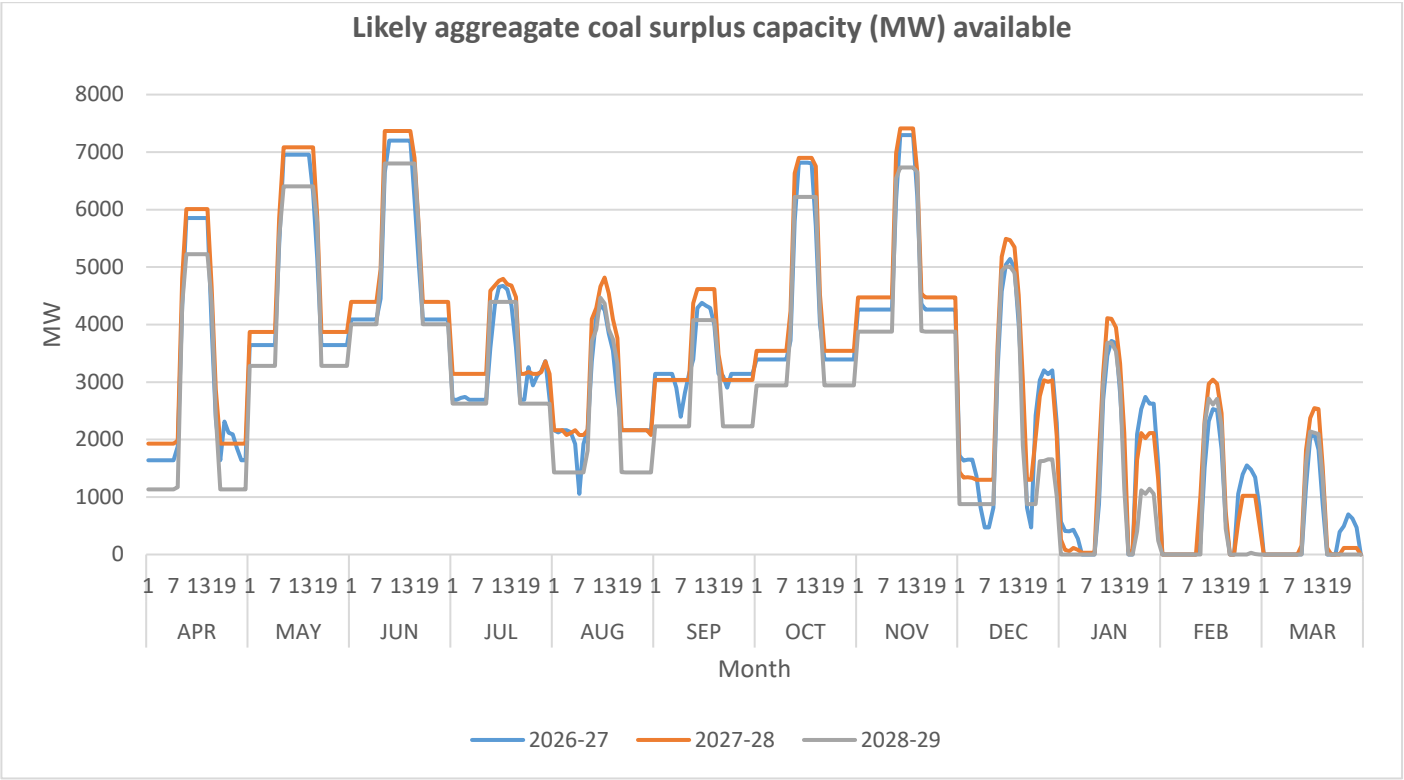



Figure 16 Surplus Coal Capacity (MW)

## 8.0 Conclusions

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

1. The study has considered electrical energy requirement projections as per Telangana SLDC, which envisages that the annual electrical energy requirement of the state is likely to grow at a CAGR of 4.92 % while the peak electricity demand is likely to grow at a CAGR of 6.35 % for the period of 2025-26 to 2035-36. Based on the demand pattern, it is seen that the peak demand season is typically in March. The projected peak electricity demand and electrical energy requirement in 2034-35 is 34,137 MW and 1,52,626 MU respectively.
2. Considering only the existing and planned capacity addition by Telangana SLDC, the state is likely to witness energy deficit ranging from 2.5 to 33 BUs in different years from 2025-26 to 2035-36.
3. The Resource adequacy studies have projected likely optimal capacity mix for future years till 2035-36 which will meet the projected electricity demand reliably at every instance. Based on the study, the likely total projected contracted capacity for the year 2035-36 is around 80,856 MW which consists of 13,984 MW from Coal; 202 MW from Nuclear; 2,518 MW from Hydro; 32,884 MW from Solar; 6,128 MW from Wind; 7,580 MW from Distributed Renewable Energy (DRE); 11,725 MW Energy Storage System; 135 MW from Non-Conventional Energy sources and 5,700 MW of STOA/MTOA. This capacity shall be able to meet the projected demand with prescribed reliability criteria.

4. The state needs to contract STOA/MTOA of around 4,160 MW to 6,000 MW in different years as outlined in the report. The STOA/MTOA requirement can be fulfilled through power procurement from market or bilateral agreements. The STOA/MTOA value reflects the peak value requirement and seasonal banking requirements in terms of MW.
5. The projected capacity and generation mix outlined in the report meet the utility's RPO requirements for the years 2025-26 to 2035-36.
6. The Planning Reserve Margin (PRM) for Telangana has been assessed as 4%. Further, the study indicates year-wise short-term/medium-term/bilateral requirements to meet the demand optimally.
7. 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, States/Discoms are strongly encouraged to adopt scientific tools and robust methodologies for demand forecasting.
8. Timely commissioning of planned capacities is critical to ensuring that the state can meet the projected peak demand and energy requirements identified in this study. Any deviation from the planned schedule may lead to resource shortfalls and could significantly increase the cost of reliably meeting the state’s power demand.

## Annexure

### Planned Future Contracted (MW) considered in the study

| Sl. No. | Project Name | Type of generation | Expected COD | Tentative share of Telangana (MW) |
|---|---|---|---|---|
| 1. | YTPS Unit 1-2 | Thermal | 2025-26 | 1600 |
| 2. | YTPS Unit 3-5 | Thermal | 2026-27 | 2400 |
| 3. | NTPC Telangana Phase II | Thermal | 2029-30 | 800 |
| 4. | Planned Solar | Solar | 2026-27 | 2100 |
| 5. | BESS (2 Hour) | BESS | 2026-27 | 225 |

### Assumption for Resource Adequacy Studies

1. Electricity Demand Projection: As per projections made by Telangana SLDC.
2. Demand Profile: Based on hourly demand profile of 2024-25.
3. Existing and Planned Capacity: As per the information shared by the utility.
4. Cost parameters: Aligned with current market trends and recent price discovery

### RE CUF considered

| Hydro | Wind | Solar | DRE |
|---|---|---|---|
| 21 % | 24% | 20-22% | 14% |

### Technical Parameters

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

| Technology | Type | Heat Rate (MCal/MWh) | | Aux. Consumption (%) |
|---|---|---|---|---|
| | | At max loading | At min loading | |
| Coal | Existing / Planned | 2300 to 2879 | 2438 to 3052 | 7.0 |
| | Candidate (SC & USC) | 2060 to 2125 | 2183 to 2253 | 6.5 |
| Gas | Existing | 2000 to 2900 | 2260 to 3277 | 2.5 |
| Nuclear | Existing/ Planned | 2777 | 2777 | 10 |
| | Candidate | 2777 | 2777 | 10 |
| Biomass | Existing/ Planned | 4200 | 4450 | 8 |
| | Candidate | 4200 | 4450 | 8 |
| Hydro | Existing/ Planned | - | - | 0.7 |
| | Candidate | - | - | 0.7 |
| Pumped Storage Plant | Existing/ Planned | - | - | Round trip efficiency 80 % |
| | Candidate | - | - | |
| BESS | Candidate | - | - | Round trip efficiency 88% |

## Transmission Parameters

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

## Financial Parameters

Following cost parameters have been assumed:

| Resource | Capex* (in ₹/MW) | O&M Fixed Cost (in ₹/MW) | Construction Time (in years) | Amortization /Life time (in years) |
|---|---|---|---|---|
| Coal | 12 Cr | 30 Lakh | 4 | 25 |
| Solar | 4.5 Cr (reducing to 4 Cr in 2035-36) | 1 % of Capex | 1 | 25 |

| | | | | |
|---|---|---|---|---|
| Wind (Onshore) | 7.5 Cr | 1% of Capex | 2 | 25 |
| Pumped Storage Plant | 6 Cr | 30 Lakh | 4 | 40 |
| Storage (2-Hour) | 3.98 Cr to 2.42 Cr | 3 Lakh | 1 | 14 |
| Storage (4-Hour) | 4.98 Cr to 3.00 Cr | 5.9 Lakh | 1 | 14 |