FINAL PROJECT REPORT

Coal Stock Adequacy & Risk Monitoring Dashboard for Power Plants

Sector: Energy & Power

Institute: Rishihood University

Mentor: Archit Raj

Team Members:

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- Tejas Tyagi
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Dataset Source: National Data & Analytics Platform (NDAP)

1. Cover Page

Title: Coal Stock Adequacy & Risk Monitoring Dashboard for Power Plants

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Faculty Mentor: Archit Raj

Team(G-15): Group of 6 members

2. Executive Summary (CEO-Level)

Coal is the primary fuel source for India's thermal power generation. Ensuring adequate coal stock availability is critical for uninterrupted electricity supply, grid stability, and industrial productivity.

This project addresses the lack of a consolidated analytical view for monitoring coal stock sufficiency, coverage duration, and supply dependency patterns across reporting periods. Without structured monitoring, decision-makers often respond reactively to shortages, leading to operational disruptions and increased reliance on imports.

To solve this problem, a data-driven dashboard was developed using NDAP coal stock data (2023–2026). The dashboard compares actual stock levels against normative benchmarks, tracks days of coverage trends, evaluates domestic versus imported coal dependency, and classifies operational risk into meaningful categories.

Key Insights:

- Coal stock frequently falls below normative requirements, indicating persistent shortage risk.
- Days of stock coverage improved gradually from 12 days (2023) to 16 days (2026).
- Import dependency increased significantly over time, acting as a buffer during shortage periods.
- Most operational days fall under Low Buffer or Moderate risk categories.

Key Recommendations:

- Align procurement planning with normative stock benchmarks.
- Implement risk-based inventory alerts for early shortage identification.
- Optimize domestic-import supply balance to reduce vulnerability.
- Institutionalize dashboard monitoring for proactive decision-making.

3. Sector & Business Context

The Energy and Power sector is fundamental to national economic growth, supporting industrial operations, transportation, and household consumption. In India, thermal power plants remain heavily dependent on coal as a base-load energy source.

Coal stock management is therefore a critical operational requirement. Plants must maintain sufficient coal reserves to withstand supply fluctuations, transportation delays, and demand surges. However, coal supply chains face several challenges:

- Domestic production inconsistencies
- Railway and logistics bottlenecks
- Seasonal demand spikes
- Rising dependence on imported coal

These challenges make coal stock adequacy monitoring essential for preventing power shortages and ensuring stable electricity generation.

This problem was chosen because coal stock shortages have historically caused power generation disruptions, making it a high-impact operational risk area for the sector.

4. Problem Statement & Objectives

Problem Statement

To develop a data-driven monitoring system that evaluates coal stock adequacy against normative benchmarks, tracks coverage trends, analyzes supply dependency patterns, and highlights operational risk categories for proactive planning.

Project Scope

- Analysis of coal stock and requirement data from 2023–2026
- KPI development for stock sufficiency and dependency
- Risk classification based on coverage thresholds
- Dashboard implementation in Google Sheets

Success Criteria

- Clear comparison of stock vs normative requirements
- Reliable calculation of days of stock coverage
- Identification of domestic/import dependency patterns
- Actionable risk categorization for operational decision-making

5. Data Description

Dataset Source

The dataset was sourced from the **National Data & Analytics Platform (NDAP)**, which provides standardized reporting data for coal stock levels in thermal power plants.

Data Structure

The dataset includes daily reporting periods and plant-level coal stock indicators across years 2023–2026.

Key Columns

Year	Calendar year of record
Calendar Day	Exact reporting date
Daily Requirement	Coal required per day
Domestic Stock	Available domestic coal stock
Imported Stock	Available imported coal stock
Normative Stock	Required ideal benchmark stock
Capacity of Coal Plant	Installed capacity in MW

Data Size

The dataset spans multiple years with over 5,000+ reporting day records.

Limitations

- No external variables such as demand variability or transport disruptions
- Stock adequacy does not account for sudden supply shocks
- Analysis is historical and not predictive

6. Data Cleaning & Preparation

All cleaning and transformation steps were executed in **Google Sheets**, as required by the capstone guidelines.

Cleaning Steps

- Removed blank rows and validated date formats
- Converted numeric values stored as text into usable numeric formats
- Standardized categorical fields such as Plant Type and Supply Mode
- Checked duplicates (none found)

Feature Engineering

Derived analytical columns were created:

- Total Stock = Domestic + Imported
- Stock Surplus/Deficit = Total Stock – Normative Stock
- Days of Stock Available = Total Stock / Daily Requirement
- Domestic Dependency (%) = Domestic / Total Stock
- Import Dependency (%) = Imported / Total Stock
- Risk Category classification

These features transformed raw reporting data into decision-ready metrics.

7. KPI & Metric Framework

Key KPIs were designed to measure coal stock health and operational stability.

KPI	Formula	Importance
Stock Adequacy Ratio	Total Stock / Normative Stock	Benchmark sufficiency
Stock Surplus/Deficit	Total – Normative	Identifies shortage/excess
Days of Stock Coverage	Total Stock / Daily Requirement	Operational buffer measure
Domestic Dependency %	Domestic / Total Stock	Supply reliance indicator
Import Dependency %	Imported / Total Stock	External vulnerability measure
Risk Category	Based on coverage thresholds	Early warning classification

These KPIs directly map to project objectives of sufficiency monitoring, stability tracking, and risk identification.

8. Exploratory Data Analysis (EDA)

Trend Analysis

Stock levels show significant variation across reporting periods, with multiple instances of total stock falling below normative benchmarks.

Coverage duration improved year-wise:

- 2023: 12.3 days
- 2024: 14.4 days
- 2025: 15.7 days
- 2026: 16.2 days

This indicates improving stability, though shortage exposure remains.

Dependency Analysis

Domestic coal remains dominant, but import contribution increased:

- Domestic dependency declined from 64% (2023) to ~53% (2026)
- Import dependency rose from 36% (2023) to ~47% (2026)

Imports act as a shortage buffer but increase vulnerability.

Risk Distribution

Risk category counts:

- Safe: 1 day
- Moderate: 807 days
- Low Buffer: 1631 days
- Critical: 34 days

Most operations occur under Low Buffer conditions, indicating persistent risk exposure.

9. Advanced Analysis

Advanced analysis focused on transforming coverage metrics into operational decision indicators.

Risk Classification

Coverage thresholds were applied:

- Safe: High buffer stock
- Moderate: Acceptable but watchful
- Low Buffer: Vulnerable zone
- Critical: Immediate shortage risk

This classification enables early warning monitoring and supports proactive procurement planning.

10. Dashboard Design

The dashboard was implemented in **Google Sheets** using pivot tables, formulas, and interactive slicers.

Executive View

- Total Stock vs Normative Requirement
- Days of Stock Available trend
- Risk Category distribution

Operational View

- Domestic vs Imported stock contribution
- Surplus/Deficit monitoring
- Time-based filtering for drill-down analysis

This design supports both high-level decision-making and detailed operational monitoring.

11. Insights Summary (Decision Language)

1. Coal stock frequently falls below normative benchmarks.
2. Days of coverage improved gradually from 2023–2026.
3. Import dependency increased significantly over time.
4. Low Buffer conditions dominate most reporting days.
5. Critical shortage days, though fewer, highlight vulnerability.
6. Surplus and deficit fluctuations indicate inefficient planning.
7. Domestic coal remains primary but is insufficient alone.
8. Dashboard monitoring reduces reactive decision-making.

12. Recommendations

Recommendation	Linked Insight	Business Impact
Align procurement with normative benchmarks	Stock deficits frequent	Reduces shortage risk
Strengthen coverage monitoring	Coverage varies widely	Prevents sudden disruptions
Balance domestic-import sourcing	Rising import reliance	Reduces vulnerability
Implement automated risk alerts	Low buffer dominates	Early preventive action
Institutionalize dashboards	Monitoring improves decisions	Faster response + efficiency

13. Impact Estimation

- Even a 5–10% reduction in critical shortage days can prevent costly power disruptions.
- Improved inventory planning reduces overstocking and understocking inefficiencies.
- Better dependency monitoring supports strategic sourcing decisions.
- Dashboard adoption reduces manual reporting effort and improves decision speed.

14. Limitations

- Analysis is limited to historical coal stock and requirement data.
- External factors such as logistics delays, demand shocks, or policy changes are not included.
- Risk classification is coverage-based and may not capture all uncertainties.
- Predictive forecasting is not implemented in the current scope.

15. Future Scope

- Integrate demand forecasting and transportation timeline data.
- Develop predictive models for shortage forecasting.
- Implement automated real-time alerts for critical risk periods.
- Expand analysis to plant-level and regional segmentation.

16. Conclusion

This project delivers a consolidated analytical dashboard to evaluate coal stock adequacy, monitor operational risk, and support proactive planning in thermal power generation. By transforming raw stock data into meaningful KPIs and risk categories, the solution strengthens decision intelligence, reduces shortage vulnerability, and improves inventory efficiency in the energy sector.

17. Appendix

- Data Dictionary
- Cleaning Log
- KPI Formulas
- Additional pivot insights

18. Contribution Matrix

Team Member	Dataset & Sourcing	Cleaning	KPI & Analysis	Dashboard	Report Writing	PPT	Overall Role
Atharva Tiwari	Yes		Yes	Yes			Project Lead,Dashboard Lead
Manas Saxena			Yes			Yes	Analysis Lead , PPT & Quality Lead
Tejas Tyagi		Yes				Yes	Data Lead, PPT & Quality Lead
Ronit Singh	Yes				Yes		Stratergy Lead
B Mohith Venkata Sai Krishna							None
Ayush Kumar							None