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1. **Project details**

a. *Title*: *Design and Development of Artificial Intelligence Based Short Term Load Forecasting Model*

b. *Institute*: National Institute of Technology Raipur

2. **Aim / Objectives:**

(i) Identify and review existing methodologies including numerical techniques used in practice for load forecasting by power utilities.

(ii) Collection of load data on every 15 minutes, hourly, and monthly basis at different voltage levels from sub-stations of power transmission and distribution companies of CG state.

(iii) Generate ideas for predicting the load on every 15 minutes, hourly, and monthly basis at different voltage levels for sub-stations of power transmission and distribution companies of CG state, with the objective to reduce the error in prediction to facilitate adequate performance.

(iv) Devise and develop AI-based load forecasting scheme for every 15 minutes, hourly, and monthly basis at different voltage levels to enhance the reliability, resiliency and power quality of power system.

(v) Investigate technical feasibility and performance assessment of AI-based load forecasting scheme and numerical techniques to predict the future load using real time data set collected from state power utilities.

(vi) Make recommendations to the industry regarding feasibility of Artificial Intelligence Based Load Forecasting Methodology for Smart Grid Operational Planning of CG State.

(vii) Development of highly knowledgeable human resource with top-order skills including Graduate Internships, Postgraduate Fellowships, Doctoral Fellowships.

3. **Executive Summary (*One page*): attached separately**

4. **Scope for further work**

The proposed work can be further enhanced in the following directions:

(i) Incorporation of additional input features: Including more real time features such as Generator outages, electricity pricing, holiday indicators and a demand side variable could further improve forecasts precision.

(ii) Cross Regional Model Adaptation: Using transfer learning, the forecasting framework can be adapted for other states and regions with different consumption behaviors.

(iii) Renewable energy Forecasting Integration: Merging solar and wind generation forecasting with load forecasting will provide a comprehensive model suitable for grids with high renewable penetration.

(iv) Hybridization with Optimization Algorithm: Combine forecasting models like XGBOOST with optimization techniques like Particle Swarm Optimization (PSO) or Genetic Algorithms to simultaneously forecast and optimize load dispatch or resource allocation.

(v) Interactive Dashboard and Visualization Tools: Developing user friendly interface that displays forecasts, trends and alerts will assist load dispatchers and utility managers in real time operations.

5. Benefits visualized

• Developed and validated an AI-based Short Term Load Forecasting framework for Chhattisgarh SLDC, ensuring high accuracy and operational reliability. • AI hybrid models outperform classical methods, effectively capturing nonlinear and dynamic load behavior.
• The AI based model achieved MAE: 56.75 MW | MAPE: 1.33% | RMSE: 82.38 MW | R^2: 0.9644.
• Hybrid model (LSTM–LightGBM) improved robustness by combining temporal learning with ensemble techniques.
• The model demonstrated high robustness, scalability to other Delhi, Orissa SLDC, and adaptability, making it suitable for real-time SLDC deployment.
• Multi-state validation confirmed that the framework can be replicated for other SLDCs.
• Patent filled and Published, Title : “System and Method for Electrical Load Demand Forecasting” (Patent No. 202421072940, Published: 13 Dec 2024). (AI-based Short Term Load Forecasting framework for Chhattisgarh, Delhi and Orissa SLDC)

Operational Relevance for SLDC The developed forecasting framework can directly support:
• Day-ahead and intra-day scheduling
• Demand management and reserve estimation
• Improved dispatch planning and congestion management
• Reduction in forecasting uncertainty and operational risk • Enhanced integration of renewable energy sources.