Statement of Purpose

Project Title: To develop a Machine Learning framework for electricity demand projection including peak demand in urban areas
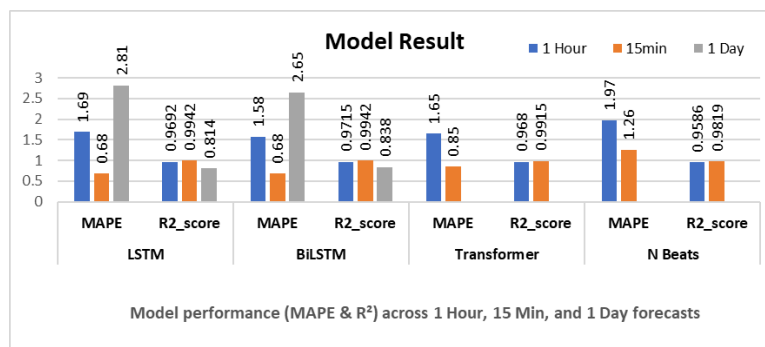

Project Summary:

This project focuses on developing a real-time electrical demand forecasting for urban and semi-urban areas to accommodate huge load variations during the winter and summer months and also during day and night during the same 24-hour window. The main objective is to develop a time-series machine learning pipeline to factor the weather effects like temperature, humidity, wind speed, precipitation and other factors like public holidays/weekly holidays, natural load growth with renewable energy development and real estate development. The Supervisory Control and Data Acquisition(SCADA) and Automatic Meter Reading(AMR) data have been obtained from the Area Load Dispatch Center (ALDC), Ambazari, under the Maharashtra State Electricity Transmission Co. Ltd. (MSETCL). Our preliminary experiments on this data with various Models like LSTM, BiLSTM, Transformers, and N-BEATS predict the demand of the future 15 minutes, 1 hour, and 1 day ahead with Mean Absolute Percentage Error(MAPE) as 1.69%, 1.58%, 1.65% and 1.97% respectively for 1 day ahead projection. However, this prediction is based only on the past consumption of electricity loads. A machine learning model be developed with suitable compensation to factor weather and holiday effects.

Motivation:

Rising demand, renewable integration, and also shifting consumption patterns create new challenges for India's power sector. For grid stability, reliable forecasting is a critical need. Load fluctuations in addition to seasonal variations cause the need for the Duck-curve effect. For distributors of state power, forecasting an accurate load is important in order to reduce the effect of imbalance in the matching of electricity demand with a power purchase. Demand increases within India's power sector. Solar energy integrates renewables, consumption patterns change, making the challenge difficult.

- 15 min forecasting: LSTM and also BiLSTM gave highly accurate results, as MAPE is equal to 0.68 and R^2 is above 0.99.
- BiLSTM had the best 1-hour forecasting performance (MAPE = 1.58, R^2 = 0.9715).
- N-BEATS as well as Transformers showed a promising potential with dependencies longer-term.

Model performance (MAPE & R^2) across 1 Hour, 15 Min, and 1 Day forecasts

Future Directions

The future directions include building hybrid models, integrating weather and socio-economic factors for richer predictions and deploying a real-time application interface for utility operations.

Relevant Skills and Experience:

- **Skills:** Data handling, visualization, analytics, and hands on experience in applying machine learning models

- **Experience:**
  - Worked on sentiment analysis of text data in an IIT BHU hackathon.
  - Used machine learning model to analyze category of research papers at the IIT Kharagpur hackathon