Federated Transformer for Privacy-Preserving Smart Grid Forecasting

# Project Overview

This project aims to develop a Federated Transformer architecture for time-series forecasting within smart grid environments. It utilizes advanced transformer models, such as TransformerXL or Informer, across multiple decentralized nodes to ensure privacy-preserving training. The model enables utilities to forecast electricity usage and detect anomalies without sharing raw data, simulating real-world smart grid conditions.

# Dataset

A simulated dataset will be created by partitioning an open-source energy dataset such as the Smart Meter Energy Consumption Dataset. Each partition will represent a unique client or smart grid node to simulate federated learning.

# Frameworks & Tools

• Flower or PySyft: For simulating federated learning environments  
• TransformerXL or Informer: For implementing transformer-based time-series forecasting  
• PyTorch: Deep learning backend  
• Matplotlib / Seaborn: Visualizations and dashboard plots  
• Differential Privacy Libraries: For privacy-preserving noise injection and training simulation

# Key Deliverables

• Federated training logs from multiple smart grid clients  
• Architecture diagram outlining the federated transformer model  
• Dashboard comparing client vs. central model accuracy  
• Simulated noise injection for differential privacy and its effects on model performance

# Why This Project Matters

This project represents a convergence of cutting-edge AI research areas: deep learning with transformers, federated learning, smart grid operations, and privacy-preserving computation. It is highly relevant to real-world power systems and aligns directly with current academic and industry research in cyber-physical systems and smart infrastructure.