# Energy Consumption Trend Analysis Synopsis

## Project Title:

Energy Consumption Trend Analysis Using Machine Learning and Statistical Methods

## Project Synopsis:

This project aims to analyze energy consumption trends across various sectors using machine learning and statistical techniques. By identifying consumption patterns, the model will help policymakers, utility providers, and businesses make informed decisions to optimize energy usage and reduce costs.

## Objective:

- Analyze historical energy consumption data to identify trends and patterns.  
- Develop predictive models to forecast future energy demands.  
- Provide actionable insights to optimize energy usage and improve efficiency.

## Data Sources and Features:

1. Data Sources:  
 - Historical energy consumption records from utility providers.  
 - Weather data (e.g., temperature, humidity).  
 - Economic and demographic data (e.g., GDP, population).  
2. Features:  
 - Time-based features (e.g., hour, day, month, season).  
 - Weather-related variables (e.g., temperature, rainfall).  
 - Sector-specific consumption patterns (e.g., residential, industrial, commercial).

## Risk Factors:

- Data Inconsistency: Incomplete or inconsistent data across different regions or sectors.  
- Seasonal Variability: Sudden changes in weather can affect consumption patterns.  
- External Influences: Economic and policy changes can impact energy consumption trends.

## Data Preprocessing:

1. Handle missing and inconsistent data using imputation techniques.  
2. Normalize and scale numerical data for consistency.  
3. Create time-series features and perform lag analysis.  
4. Encode categorical variables (e.g., region, sector).

## Model Selection:

- Baseline Models: Linear Regression, Decision Trees.  
- Advanced Models: ARIMA, LSTM, Random Forest, Gradient Boosting.  
  
Reasoning: Advanced models capture complex temporal patterns in energy consumption data, essential for accurate forecasting.

## Exploratory Data Analysis (EDA):

1. Analyze energy consumption patterns by sector and region.  
2. Perform correlation analysis between weather variables and energy usage.  
3. Visualize time-series data using line charts, heatmaps, and seasonal decomposition plots.

## Model Evaluation:

- Metrics: Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), Mean Absolute Percentage Error (MAPE).  
- Validation: Use time-series cross-validation and backtesting to ensure robustness.

## Model Deployment:

1. Platform: Deploy as a web-based dashboard using Flask or FastAPI.  
2. Interface: Provide interactive visualizations and forecasting tools.  
3. Monitoring: Implement real-time data ingestion and model performance tracking.