**An Analysis of Energy Consumption in Alberta and Strategies for Sustainable Energy Practices**

*(Linta George, George Agbakpe, Kamalpreet Singh & Prajwal Nagaraj)*

***Introduction:*** We are consultants that were asked by Alberta Electric System Operator (AESO) to help with their data analysis needs. AESO is a not-for-profit organization with no financial investment in the industry. On behalf of Albertans, AESO works with industry partners and the government to make sure reliable power is there when you need it.

***Objective:*** The main objective of our project is to analyse energy consumption datasets from AESO, identify trends and patterns in energy usage, and develop actionable insights to promote sustainable energy practices. Our specific objective is to develop predictive model based on historical data can assist in forecasting future energy consumption, supporting proactive planning and decision-making.

The objective is based on key two business questions, i.e. whether there are noticeable trends in energy consumption over the years and can predictive modelling be used to anticipate future energy consumption trends?

***Stakeholder Analysis:*** Governments have a strong interest in understanding and managing energy consumption patterns for policy development, resource planning, and environmental sustainability. Furthermore, Energy providers are directly impacted by consumption patterns. They have the potential to influence consumer behaviour through pricing structures and energy efficiency programs.

Government and regulatory bodies require insights for developing and updating energy-related policies. Need data for long-term energy planning and resource allocation. Seek information to ensure compliance with environmental regulations.

***Data:*** Dataset for the project is on Alberta Electric System Operator (AESO) public data source portal(<https://public.tableau.com/app/profile/market.analytics/viz/AnnualStatistics_16161854228350/Introduction>). It covers a period of 8 years (1st January 2015 to 31st December 2023).

**Types of Analysis*:*** *With regional analysis*, we hope to identify and analyze energy consumption patterns in different sectors or industries. Region-specific metrics and comparative analysis will be used.

1. ***Predictive Modeling:*** This will be a significant achievement for this project. The main objective is to develop models to predict future energy consumption patterns using machine learning algorithms and regression models.
2. ***Load Forecasting:*** This is another critical analysis to predict future energy demand to optimize resource allocation using methods such as time-series forecasting, machine learning models.

***Architectural Overview:*** Performing data analysis on AESO dataset involves several steps, and the architectural overview helps provide a guide to our processes. This project followed the eight-stage process in data analysis thus data collection, data preprocessing, data storage, data analysis tools selection, exploratory and statistical data analysis, predictive modelling and visualisation and storytelling.

***Risk & Reward:*** Market volatility, the energy industry can be highly volatile due to conditions such as natural disasters or events, weather condition, economic conditions and geopolitical.

Innovation opportunities, with the ever-growing push for clean energy alternative sources and sustainable energy mix. The energy industry is poise for growth and offers a lot of opportunities for new technologies and innovation.

***Data processing:*** We used about 704,016 rows of data for energy generation and 78,888 rows for demand/load data, these were unpivoted, and the final rows came to 552,216. Hence, the analysis covered a total of 1,256,232 rows of dataset.

**Data Analysis:** According to the demand trend in figure 1 below,Edmonton has the highest load over the last 5 years, followed by Central. It must be noted that, AESO classification/division of Alberta is different from the standard division by Alberta. This demand could be attributed to the sitting of mining and heavy industries in Edmonton.

A graph of different colored lines

Description automatically generated

Figure 1: Demand trend for Each Region in the last 5 years.

Seasonality also has a huge impact on energy generation and demand. As per the visual below, December normal see a spick in energy consumption till February. However, this trend tends to slows in March as per figure 2 below.

A graph of energy generation

Description automatically generated

Figure 2: Daily energy generation vs demand for the last 2 years.

Alberta is pushing to eliminate coal powered energy generation as per the visual below. Over the years generation capacity for Coal declined sharply. This implies the province’s determination to eliminate the coal system. Which can be attributed to the quest for green energy and environmentally friendly energy generation.

A graph of a graph showing the number of fuel types

Description automatically generated with medium confidence

Figure 3: System generation by Fuel type over the years.

Using SARIMAX in Python, we predicted energy generation and demand for the next three years (2024-2027).

From the figures below, the consumption patterns will remain the same as well demand. However, due to Alberta’s push to attract people from other provinces with tax credits, we expect this to result in high demand.

***A graph of a graph showing the price of a stock market

Description automatically generated with medium confidence***

Figure 4: Demand forecasting with SARIMAX.

***A graph of a graph showing the growth of a stock market

Description automatically generated with medium confidence***

Figure 5: Generation forecasting with SARIMAX.

**Conclusion & Recommendations**

Alberta is pushing to eliminate coal powered energy generation. However, there is no corresponding increase in generation from other fuel types to cater for the energy loss from coal as the figure below.

Energy generation throughput from other fuel types such as Wind and Solar is very low duration the winter season. Demand/load on the other hand increases significantly during the winter and especially during on-peak hours.

We understand the push for green and environmentally friendly energy generation; however, this must be managed such that significant energy is not lost during the coal powered generation phase-out.

More investment should go into wind powered, natural gas and solar energy generation. Lastly, more storage facilities should be established to store energy from these generation mix during Summer for subsequent use in the winter.