Alberta Grid Balance Predictor

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University of Calgary ML/AI Certificate

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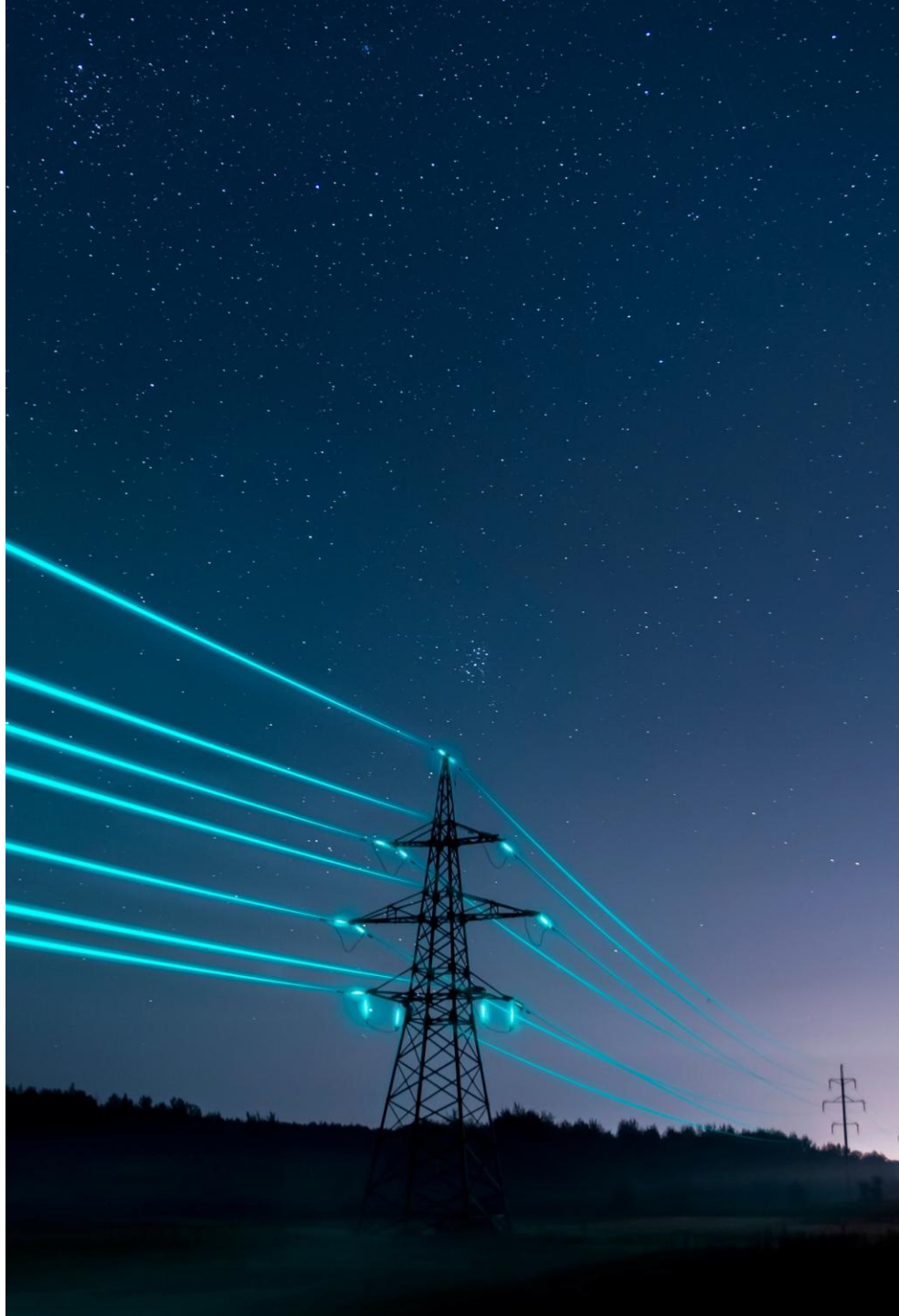
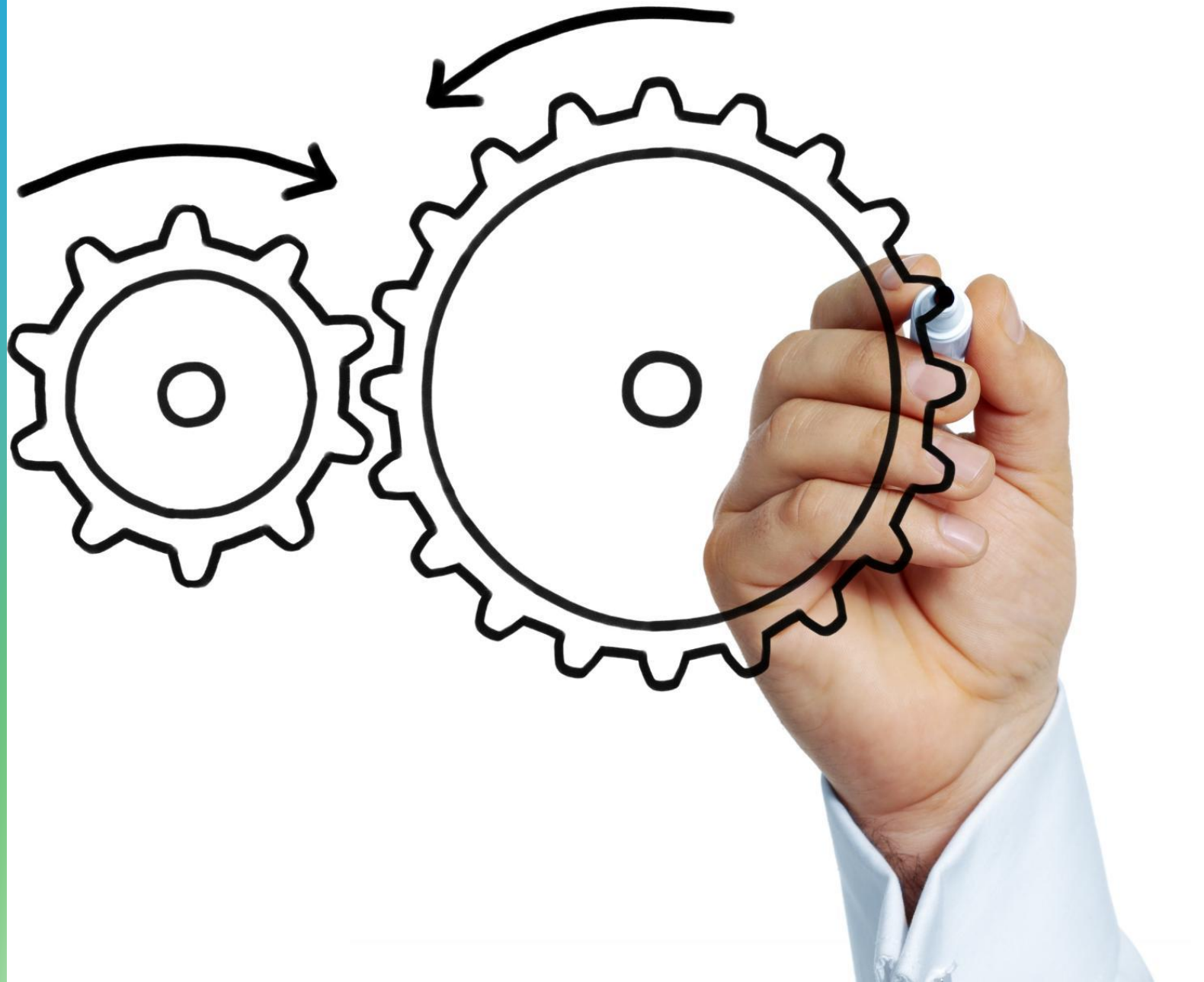


Overview

- Project Overview and Objectives
- Implementation and Tools Utilized
- Data Overview
- Model Selection and Development
- Results
- Challenges
- Marketing and Future Development

Project Overview and Objectives



Problem

Our electrical grid requires stability.

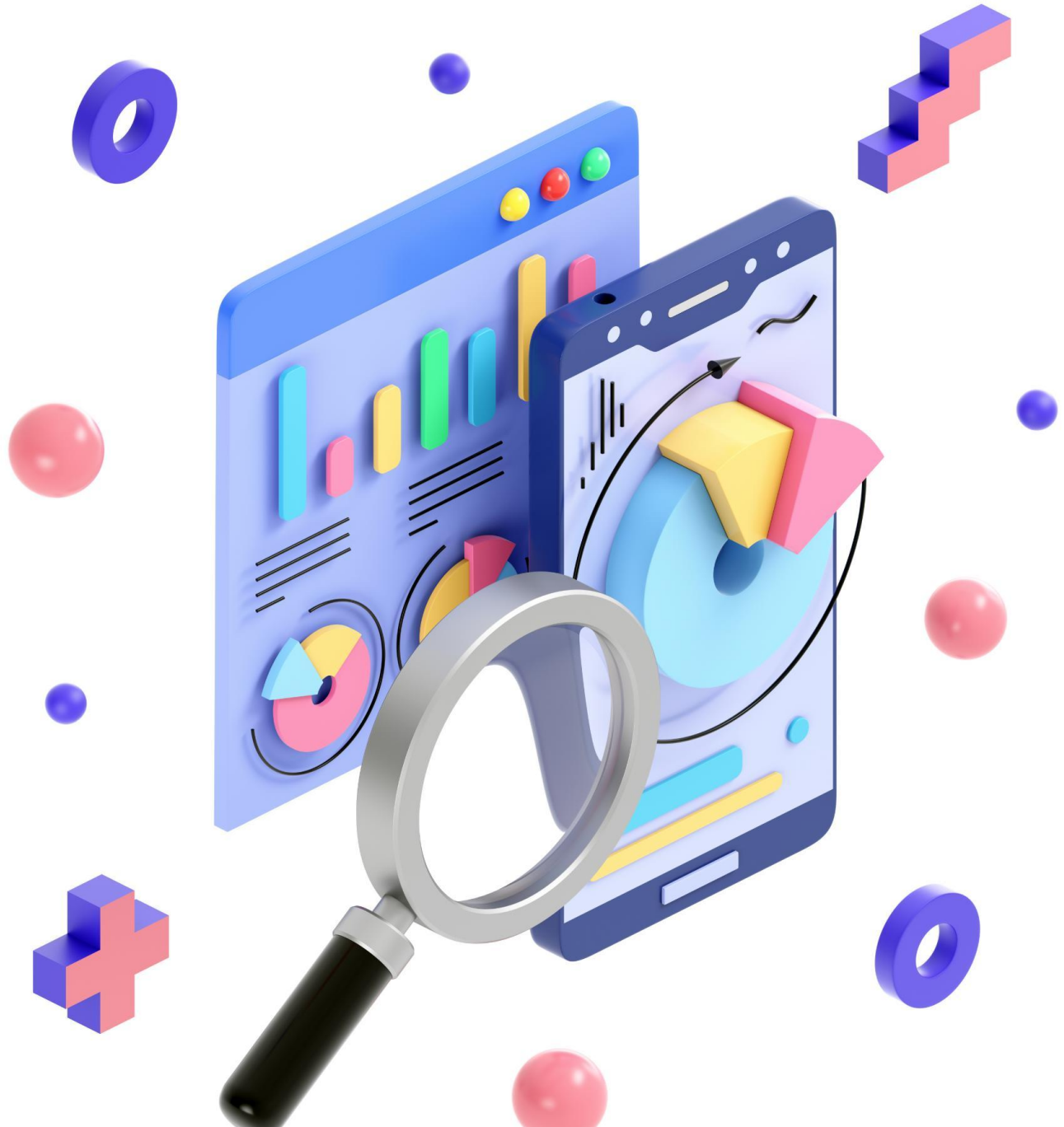
Balancing generation (supply) and demand (load) is essential for maintaining reliable, affordable, sustainable grid operations.

Lack of easy to access information for consumers.

No clear way for consumers to know what to do to help play a role in maintaining grid stability.

Actionable recommendations at any time are missing.

Without a clear, actionable insight to shift behaviours, grid stability is challenged.



Solution

Project Objectives

Predict the grid balance at any given hour of any given day and provide actionable recommendations to users.

Success Criteria

Accurate prediction of grid balance, proper classification of recommendations.

Result

Users have easily accessible information they can act on to ensure grid stability.

Implementation and Technology Stack

Software and Technology Used

Software Tools

Programming language: Python

IDE: PyCharm Community Edition

Python Libraries

Numpy, Pandas: Data cleaning and preprocessing

Matplotlib, Seaborn: Data visualization

Scikit-learn, Tensorflow: Model construction

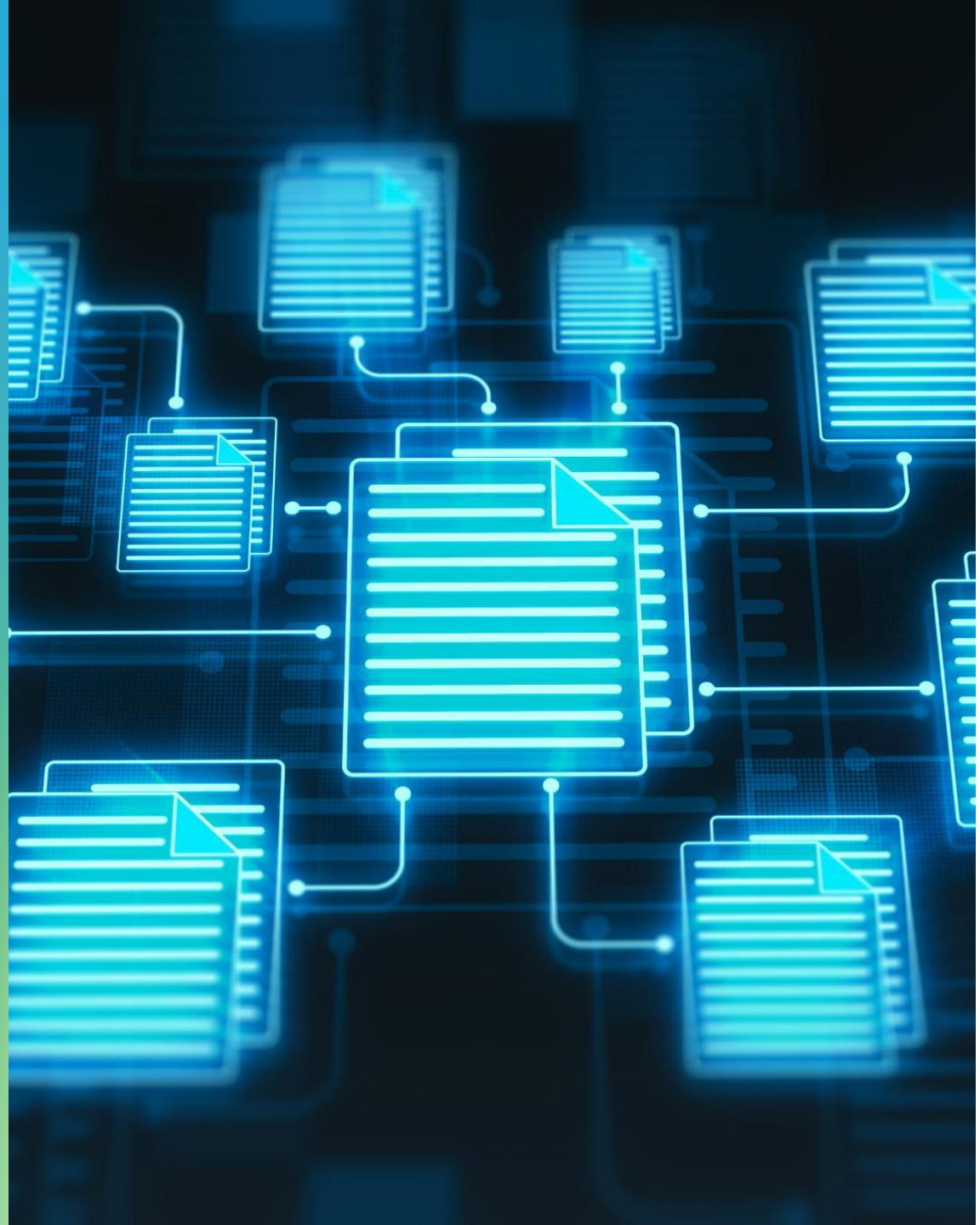
Streamlit: Interactive dashboard

Other Technology

Copilot/ChatGPT for debugging, refactoring, visualization.

Tableau for data collection from the AESO.

Data Overview



Sources and Types of Data Used

Data Sources Overview

Hourly generation and load data from 2022-2025 collected from the Alberta Electric System Operator (AESO) public database.

Types of Data Involved

Generation: All generators (MW)

Renewables share: Solar + wind (MW)

Load: Alberta Internal Load (AIL)

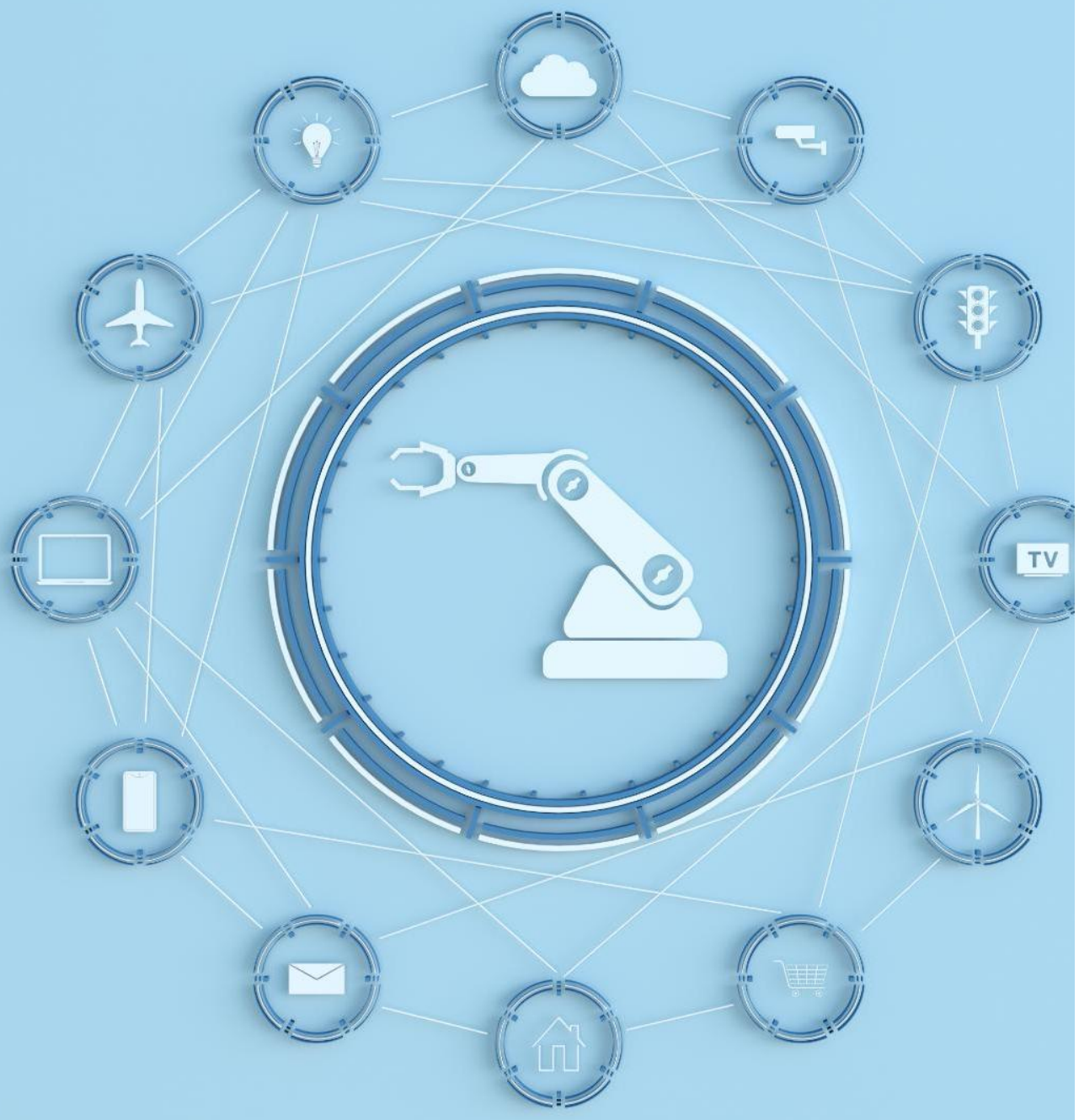
Timestamp: Date, Hour (MST)

Feature engineering

Utilization

Generation and load data were downloaded in separate CSV files and processed into a single CSV file, joined by timestamp.

Model Selection and Development



Comparative Analysis of Considered Models

Model Variety

Several machine learning models were evaluated to find the best fit for the project's problem.

Regression (balance value)

Linear regression, ANN, LSTM.

Classification (surplus/deficit)

Logistic regression, random forest, HistGradientBoosting (HGB), ANN.

Model Used (ANN)

ANN for Regression and Classification

Able to learn nonlinear decision boundaries and subtle trends that trees and traditional machine learning regression models struggled with.

Best Performing Metrics

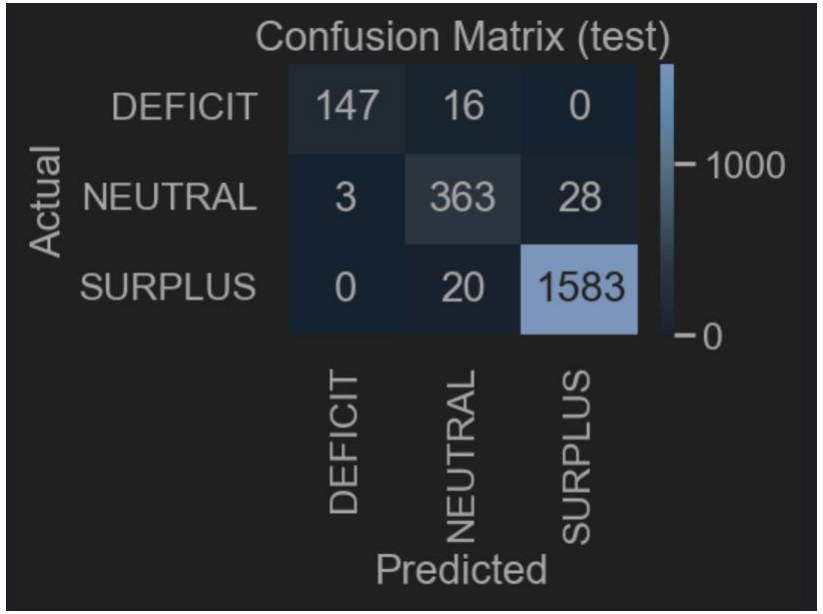
Across the board, the ANN model outperformed on MAE, RMSE, classification, and directionality.

Flexibility for Future Development

Can be upgraded to LSTM or transformer architecture to use more complex data.

Metrics

MAE	RMSE	Dir. Acc	Class Acc
0.81 MW	**1.00 MW**	**1.000**	**0.969**



Results

Python Package + Interactive Dashboard

Main Results Achieved

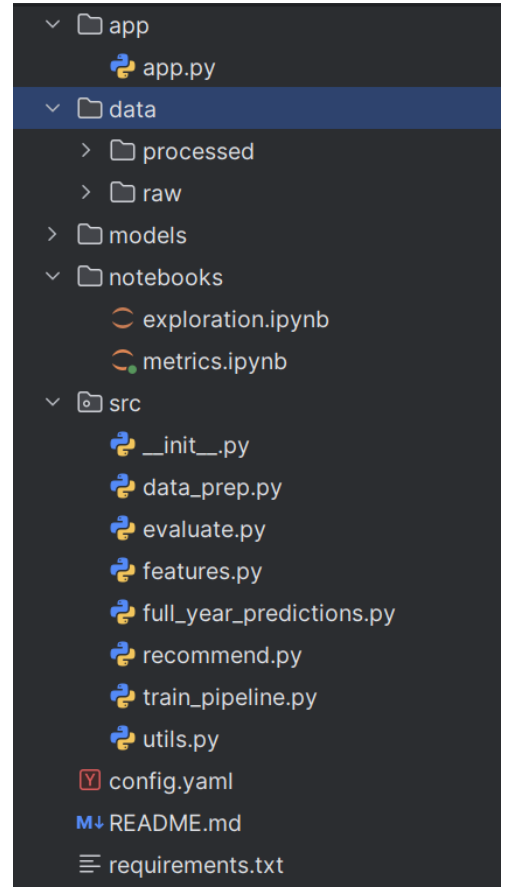
Model successfully predicts grid balance in Alberta and gives recommendations to users.

Interactivity

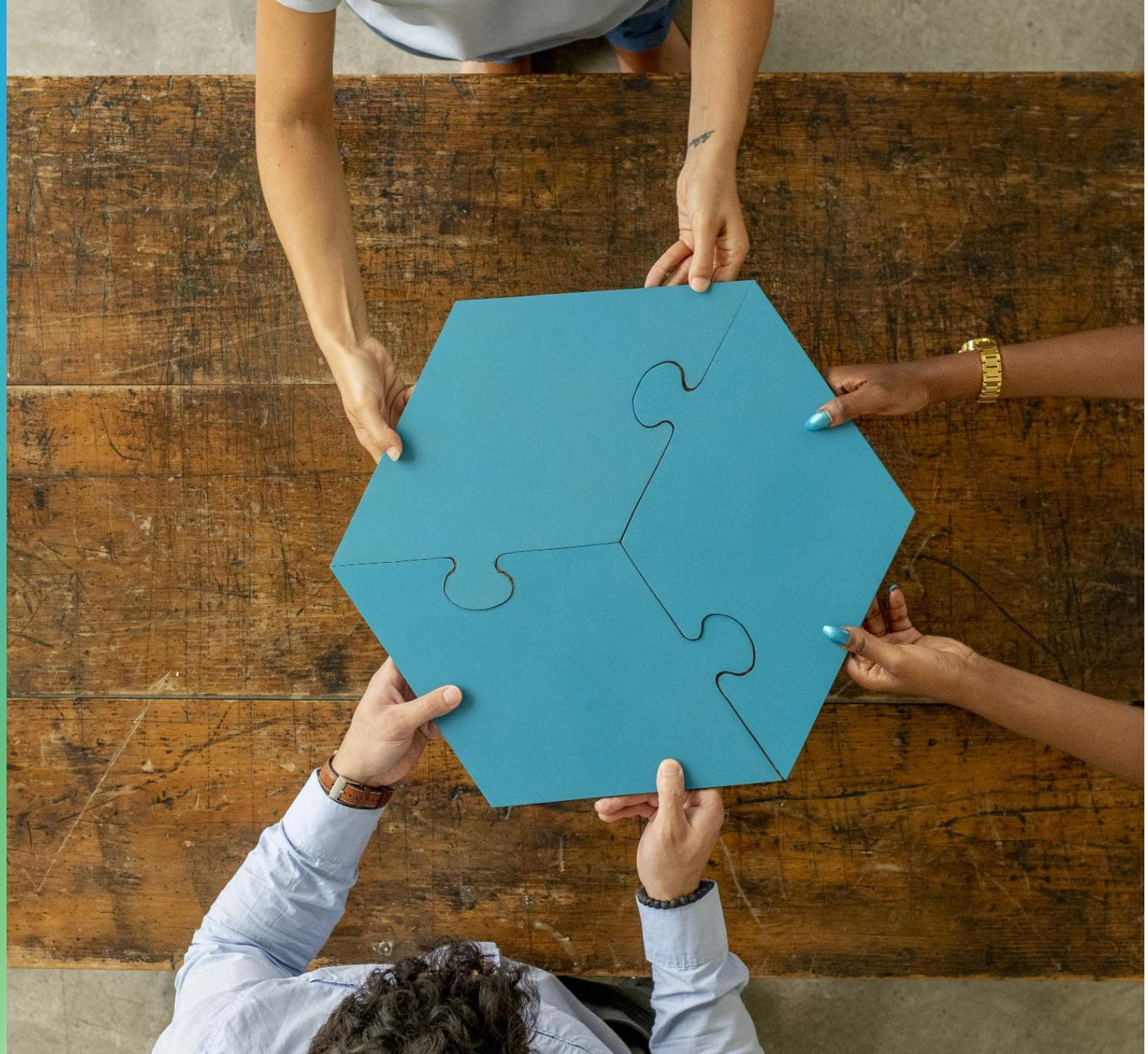
User can choose the date and time they wish to check through an interactive dashboard.

Project Goal Completion

Code is clean, modular, and in a package format ready to be marketed and shipped.



Challenges and Future Development



Challenges

Missing data to capture complexity

Weather, import, export, and many other variables affect the balance.

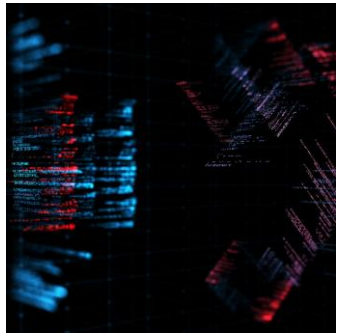
Data either not available or not regularized to be hourly, limiting usage.

Long training times

GPU not recognized by Tensorflow, only trained using CPU.

Led to long training times, particularly for the ANN.

Marketing and Future Development



Technical Skill Development

Learn transformer architecture.

Learn generative and agentic AI.

Learn about Python and Excel integration.

Marketing to Users

Consumers/prosumers who are sustainability-oriented and want to ensure grid operations.

Grid operators seeking to implement AI solutions.

Battery storage (BESS) and other electricity storage providers.

Future Project Directions

Gather more data, implement LSTM and eventually transformer models to capture complexity.

Implement a generative AI chatbot for personalized recommendations.

Conclusion

Comprehensive Problem Solving

The project applies a thorough method to solve a complex real-world issue in the energy sector using AI and machine learning techniques.

Insights and Skills Gained

The project provided valuable experience and understanding of AI concepts that enhance my ability to solve energy challenges for a more sustainable and resilient energy future.

Thank you!

Live Demo and Q&A

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