Powering the Future: An Interactive Tool for U.S. Electricity Trends

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Introduction

Electricity forecasting plays a crucial role in ensuring electricity reliability. We developed an interactive tool that visualizes the trend of electricity demand and generation across the United States. The tool also provides forecasts for electricity demand and generation. The tool also evaluates the vulnerability of each balancing authority (an entity responsible for maintaining the balance between electricity generation and demand within a specific geographic area).

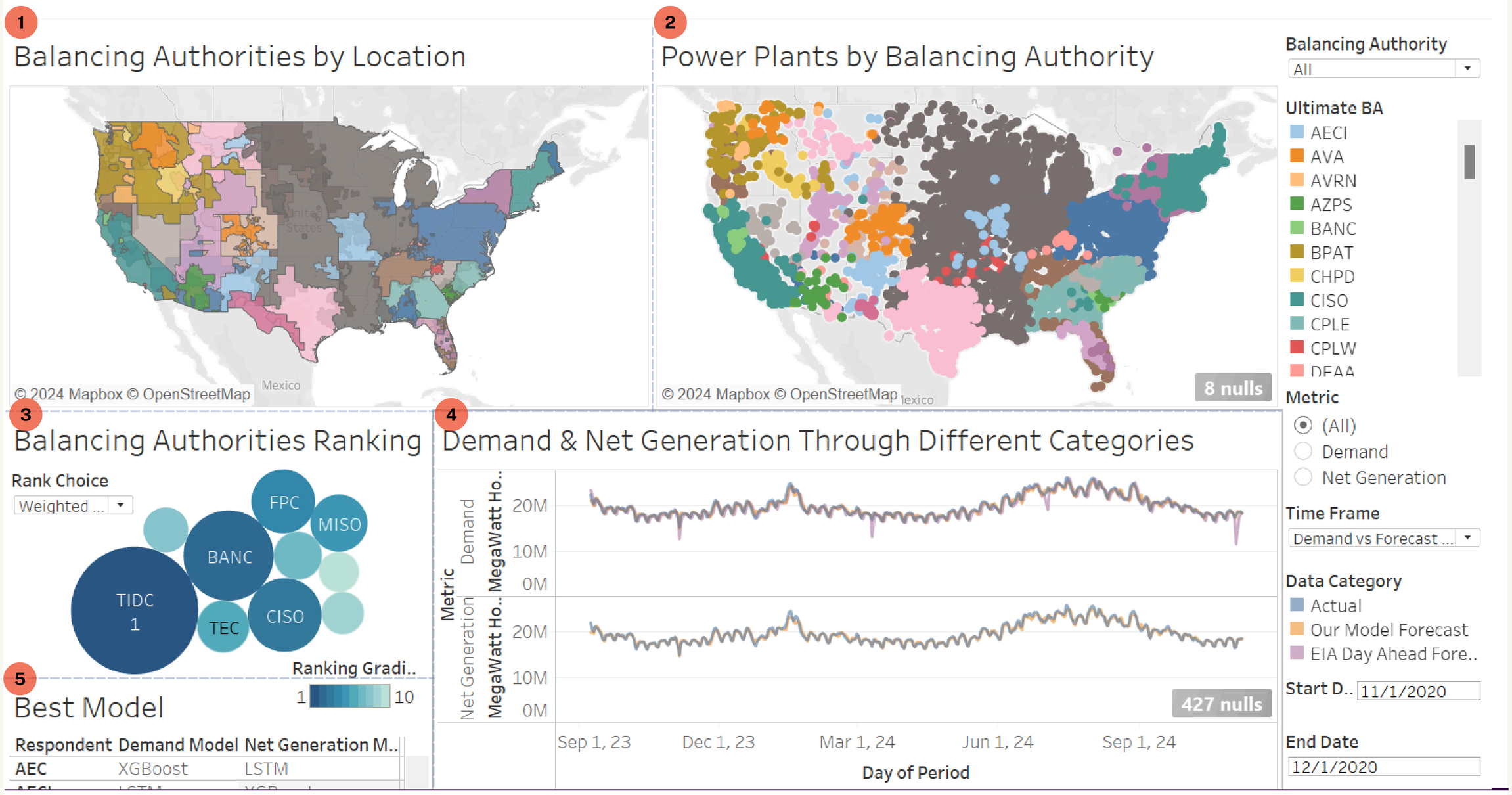
Methods

1. **Energy forecast:** We developed time series models to predict energy demand and generation for each balancing authority. We used SARIMA-X, LSTM Neural Network and XGBoost models for each authority and selecting the one with the lowest RMSE.
2. **Balancing authority vulnerability index:** We used the PageRank algorithm to identify the most vulnerable balancing authorities based on their capacity to fulfill energy demand.

Data

1. **Acquisition:** Collected data from multiple EIA API endpoints (www.eia.gov) and stored datasets in JSON format with a documented data dictionary.
2. **Database:** Set up a Google Cloud Platform MySQL server to host and manage the data.
3. **Loading:** Used Python scripts to batch upload JSON data to the SQL server.
4. **Processing:** Integrated and processed key datasets into pre-forecasting views for analysis and visualization.

Results



Users can gain several insights from the visualizations. **1. Map of balancing authorities and their service areas:** Users can explore an interactive map that highlights each balancing authority and its corresponding service area. A filtering option allows users to focus on specific balancing authorities to examine their service areas in detail. **2. Power plant locations:** Users can view the locations of power plants across different regions of the United States, providing insights into the geographic distribution of energy generation facilities. **3. Balancing authorities ranking:** Users can view the top 10 most vulnerable balancing authorities based on the PageRank method. They can filter the rankings by either PageRank or weighted PageRank. **4. Forecasting results:** Users can explore forecasting results for energy demand and generation, with options to filter by specific balancing authorities and time frames. They can also compare the forecasts with actual data and EIA forecasts for better analysis.

Experiments

We evaluated our forecasting models using RMSE to select the best model for each balancing authority. We built SARIMA-X, LSTM and XGBoost models, choosing the one with the lowest RMSE. Users can view which model was selected for each balancing authority (Figure **5**). The energy trend chart (Figure **3**) shows that our best model accurately predicts energy demand and generation, outperforming EIA forecasts.

Conclusion

Our interactive tool provides valuable insights into electricity demand and generation forecasts, enabling users to assess the vulnerability of balancing authorities and make data-driven decisions. This tool enhances the understanding of energy dynamics and supports more informed decisions for optimizing grid management and improving energy resilience.