

A Comparative Analysis of Gas Consumption Demand and Electricity Generation in Ireland Before and After COVID.

Gas Consumption Analysis (Before COVID-19)

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Dataset Description

- ▶ Dataset Used : NGSD02.20251113T141152.json (JSON Line Format) Converted into (JSON Array Format)
- ▶ after cleaning it got (gas_clean) file #cleaned dataset
- ▶ Time Period : Pre-COVID Daily Gas Consumption
- ▶ Attributes includes : date, category, demand, year, month, month name, weekday, week.

Project Overview

- ▶ To analyse the Ireland's daily gas consumption from 2019 to 2020 this project was executed, which focuses on the period before COVID-19 pandemic.
- ▶ The goal is to understand how gas demand varies across different categories and which sector contribute the most to overall consumption before COVID 19.

Research Question

- ▶ "How does Ireland's daily gas consumption vary across different customer types from 2019 to 2020 (before covid), and which sectors contributed the most to overall gas demand?"

Tools and Technologies:

- ▶ Python (pandas, matplotlib, seaborn, statsmodels)
- ▶ MongoDB (NoSQL database)
- ▶ Docker (containerised MongoDB)
- ▶ Jupyter Notebook (development environment)

Database and Docker Architecture

- ▶ MongoDB was deployed using Docker.

Database Connection:

- ▶ The mongoDB database is accessed using MangoClient from python.
- ▶ mongoDB queries like address, database and collection where implemented to extract gas_clean data from the database into pandas' data frame for further analysis.

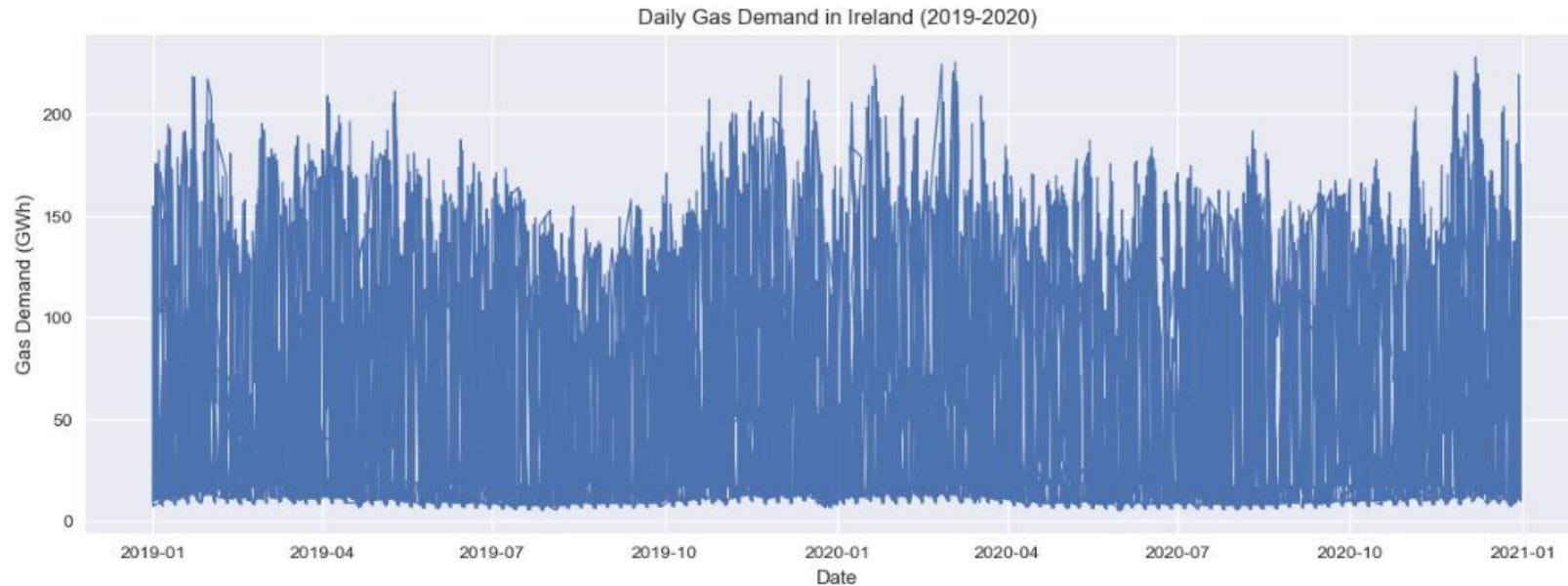
Data Preprocessing steps

- ▶ The following data preprocessing steps were applied:-
- ▶ After successful connection the id was automatically created, as it was unnecessary column so it was removed.
- ▶ Handling missing and duplicate values where required
- ▶ Conversion of date columns into datetime format
- ▶ From 2019 to 2020 the data was used for visualization as per the research question.
- ▶ created columns for more clear understanding of visualization
- ▶ saved the cleaned dataset back to the MongoDB .

Key Analysis and Insights

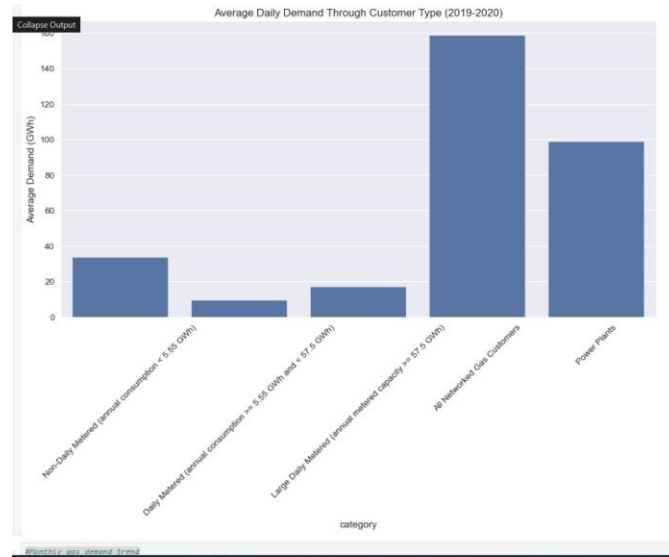
- ▶ Trend of daily gas demand
- ▶ Compare customer type means average demand per customer category
- ▶ Monthly gas demand trend
- ▶ which category contributes the most
- ▶ Heatmap category vs month
- ▶ Gas consumption by weekday
- ▶ Total demand per year
- ▶ Category trend line plot
- ▶ Forecasting for next 30 days was used with the help of ARIMA model.

Trend of daily gas demand (2019-2020)



- Displays Ireland daily gas Demand(GWh) from 2019 to 2020.
- Each and every point represents gas consumption for every single day.
- The output shows :
- Higher demands during winter month (2019-10) & (2020-10)
- Lower demands during Summer month (2019-04) & (2020-04)

Average demand per customer category(2019-2020)



Comparing the average daily gas demand over different customer categories.

The output shows:

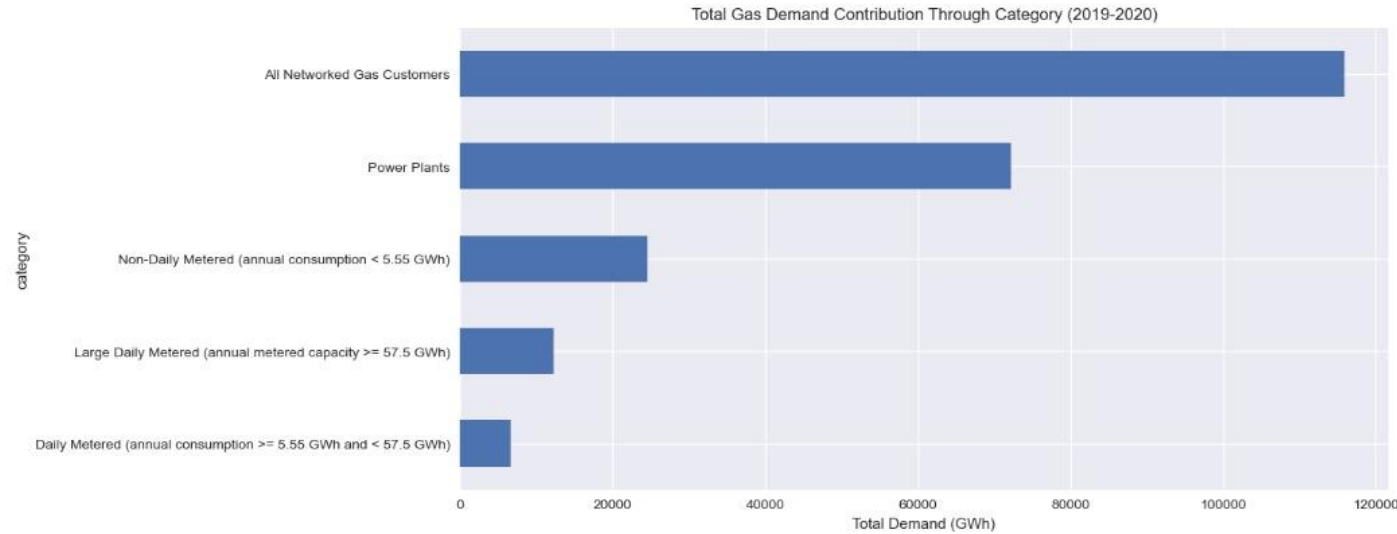
- All Network gas customers shows the highest average demand.
- Power plants are the second largest daily gas consumers.
- Daily and Non-daily metered customers consumes significantly less gas.
- Large daily customers shows moderate but consistent demand.

Monthly gas demand trend(2019 vs 2020)



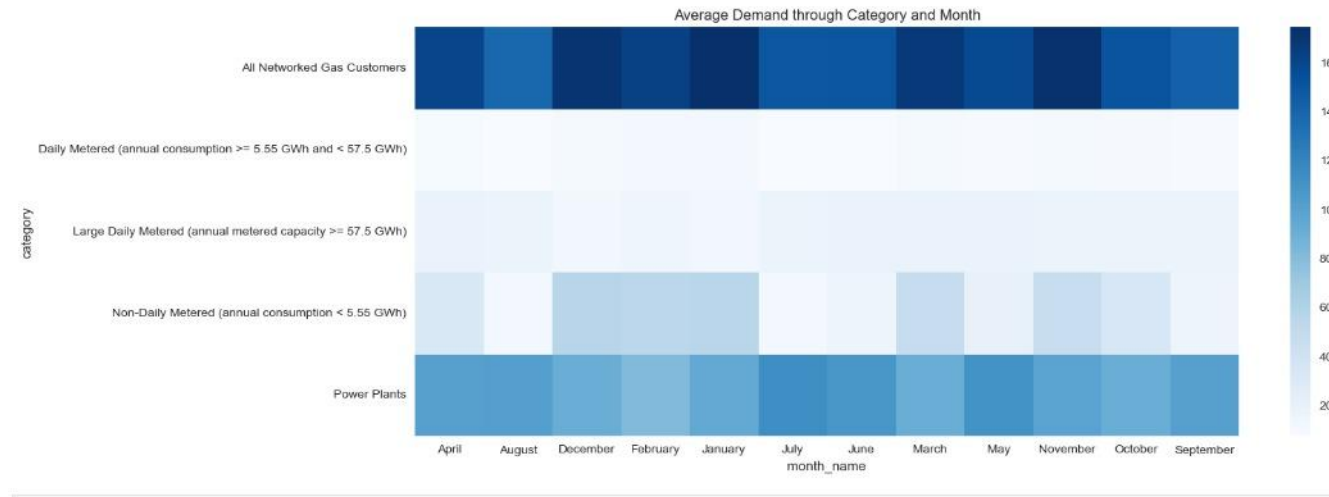
- Compares monthly total gas demand during 2019 to 2020
- The output shows:
- Winter month (January, December) shows the highest demand in both years.
- Summer month shows lower gas usage.
- 2020 follows the similar pattern to 2019 with some variations likely impact by early COVID effects.

which category contributes the most



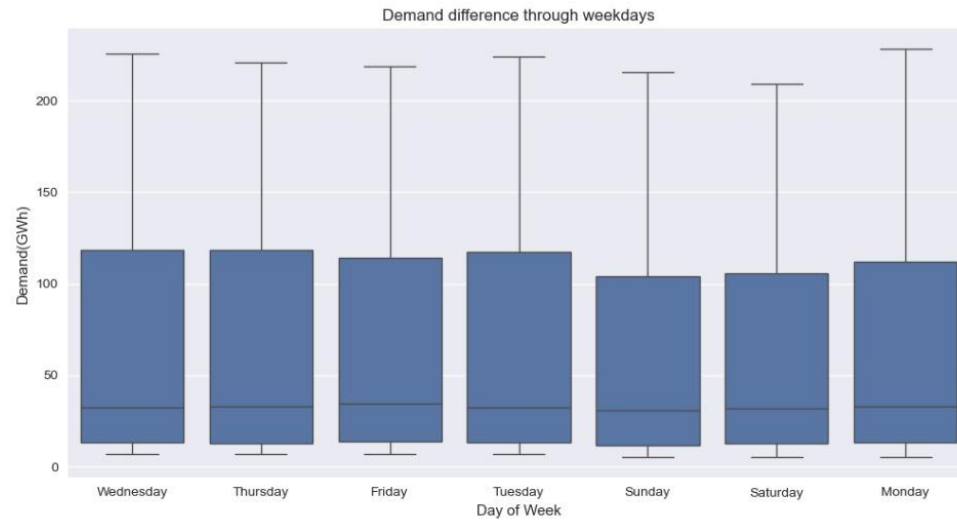
- Total Gas consumption calculated across 2019-2020 for each customer category.
- The output shows:
- All networked gas customers contributes the highest of total demand.
- Power plants are the second largest.
- Another customers categories shares the less amount of total demand of gas consumption.

Heatmap category vs month



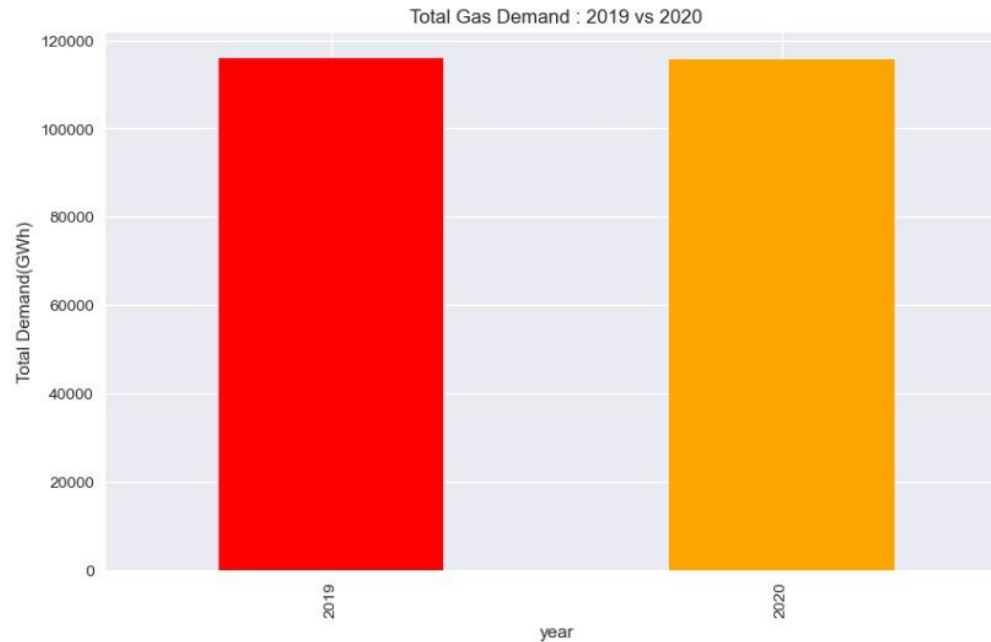
- Average gas Demand by customer category and month
- The output shows:
- Dark colors shows the high demand
- Winter month shows high demand almost for all categories.
- Light colors shows low demand.

Gas consumption by weekday



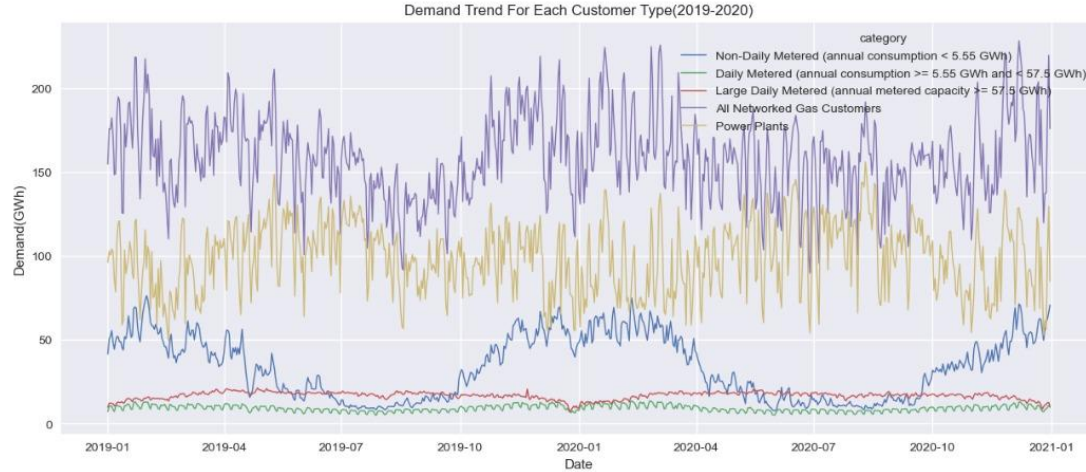
- Distribution of Gas Demand over different days of the week.
- The output shows:
- The gas consumption shows consistent demand over weekdays.
- Slightly lower demand on weekends specially for Sunday.

Total demand per year (2019 vs 2020)



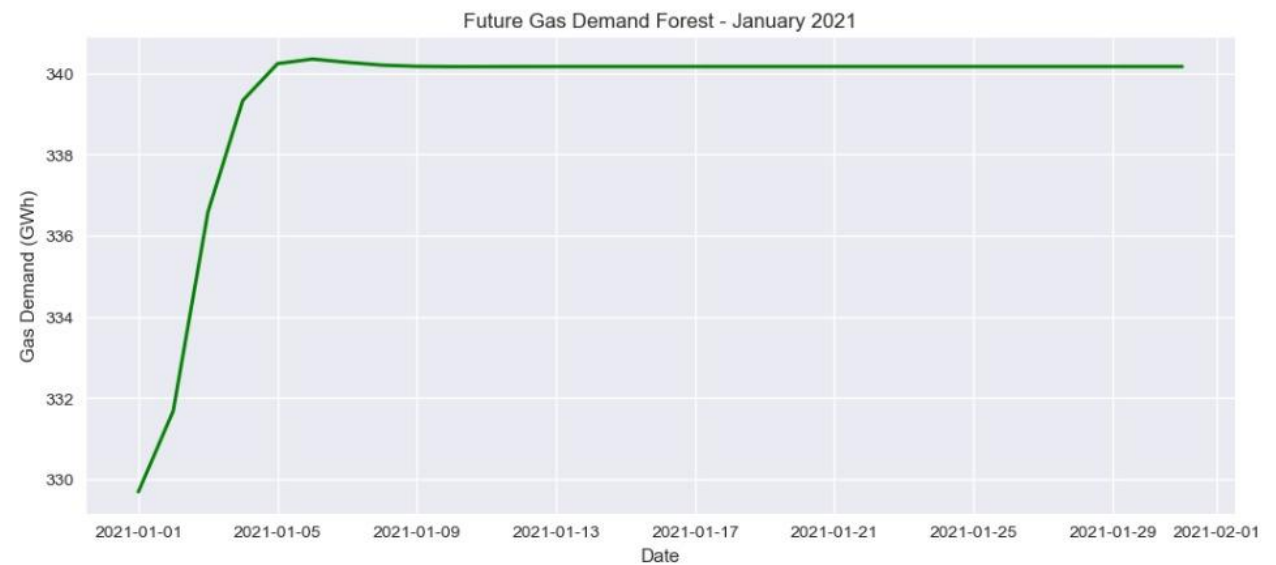
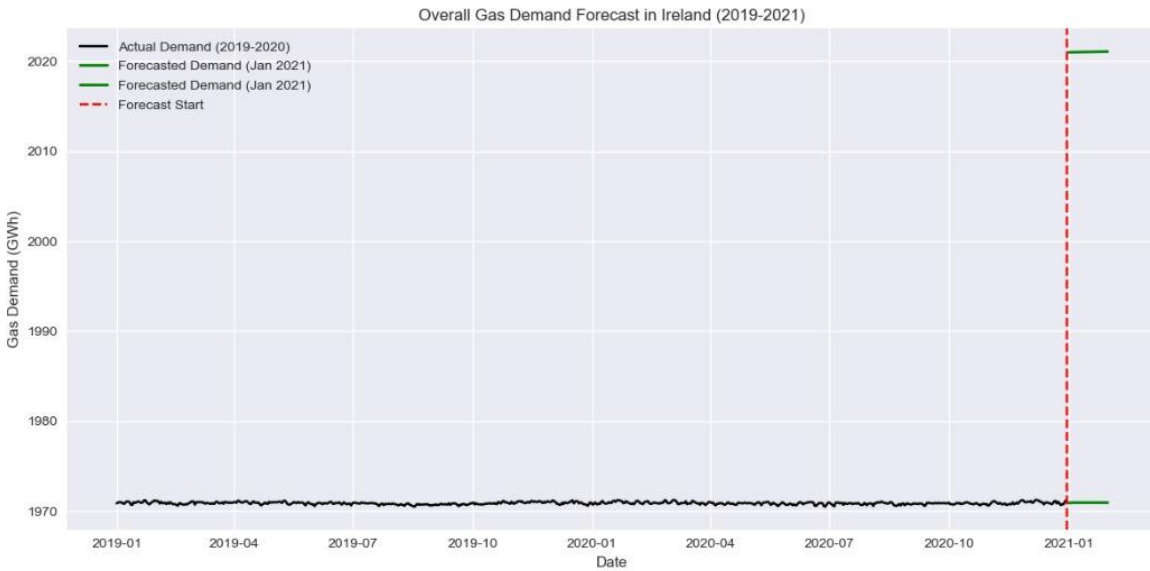
- Total annual gas demand comparison during 2019 and 2020
- The output shows:
- Total gas demand is similar over both years
- It shows gas use stable before covid disturbance.

Demand trend for each category type(2019-2020)



- Daily demand trend separated by customer category
- The output shows:
- All Network customers dominate throughout the year.
- Daily metered and Non-daily metered customer category shows the stable and low demand.

Future Gas Demand Forecast(January 2021)



- It shows the Forecasted demand for January 2021
- The output shows :
- Forecast stable after initial days.
- Arima focus on trend and seasonality.

Challenges & Learnings

► **Challenges :**

- Raw dataset was in JSON line format not in JSON Array
- Managing Docker & MongoDB setup and connectivity issues
- Matching dates across datasets and filtering
- Handling time-series data

► **Learning:**

- Learned how to store JSON data using MongoDB
- Gain hands on experience with docker based database environment.
- Learned Feature Engineering techniques for real world dataset.
- Gained practical coding knowledge
- Understand seasonality and demand patterns in energy datasets
- Learned practical Time series knowledge for forecasting using ARIMA

Conclusion

- ▶ Gas daily demand consumption in Ireland varies essentially over customer category type through all network gas customers and power plants contributing the most demand.
- ▶ This project shows clear shows seasonal and time-scale patterns were observed in daily and monthly gas used during both years
- ▶ The study successfully implement's a full data analytics pipeline from MongoDB storage to visualization and Arima forecasting.

Future Work

- ▶ Applying advanced forecasting models like SARIMA ,LSTM for improving the prediction accuracy.
- ▶ Integrate weather and temperature data to improve demand prediction accuracy.