Adapting to Climate Change: Power Generation Methods in Alberta

DATA 604

Figure 1: Power lines in Alberta

(2023). https://www.nationalobserver.com/2023/10/03/opinion/alberta-must-modernize-its-electricity-system. photograph. Retrieved December 7, 2023, from https://www.nationalobserver.com/2023/10/03/opinion/alberta-must-modernize-its-electricity-system.

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Introduction

The focus on climate change is becoming increasingly prevalent in the developed countries. All the way from new government policies down to everyday consumer behaviors. We must invest in the future while avoiding sacrificing quality of life and our growing economies. An area in which a large proportion of pollutants are emitted is in the methods of power generation in Canada but more specifically in Alberta as we are more reliant on coal powered plants relative to other provinces. Provinces like British Columbia and Ontario were ahead as they have an abundance of other methods such as hydro and nuclear energy. Our objective with this project is to understand what kind of power generation assets we currently hold and how they have changed over time and how we can adapt going forward to meet our goals of limiting our contribution to climate change. We will explore this issue by diving into types of power generation and the output they provide to our grid, looking into how external factors affect individual types of generation, and how these factors affect the wholesale power generation market.

Individual Datasets

(a) <u>Power Generation in Alberta and CO2 emissions:</u>

It is inevitable to ask the question about power generation and environment in Alberta. To analyze the impact of transition from coal to gas on CO2 emissions, the Government of Canada Greenhouse Gas Reporting Program [4] was selected, which tracks greenhouse gas (GHG) emissions from various industries in Canada, including power generation plants in Alberta. This dataset comprises cumulative yearly CO2 emissions (in tons) from power plants and is categorized by power generated from fossil fuels, hydroelectric plants, and other fuel types. It consists of 14,950 records and 84 columns. It must go through a cleaning process, and filtering process to obtain the CO2 data ready to be merged with the yearly data of the main dataset. The cleaning process consisted mostly of shortening the column names so it could be loaded in SQL and removing unnecessary columns before grouping them by Year and Industry type. The main table provided an excellent year-over-year review of the transformation from coal to gas, showing an astonishing ~90% conversion over the last 8 years. Also, unveiled a rapidly growing solar and wind industry incentivized by deregulated power prices and CO2 credits [5]. The merged table between main Power Generation Dataset and the Emissions dataset, allowed to clearly visualize how the transformation from coal to gas made a significant impact on emissions, reducing them from 48 to 27 million tons of CO2 a year without compromising the power output of ~80 Terawatts of electricity. Amazing accomplishment to be proud of in Alberta.

(b) External Factors on Power Generation

To investigate the external factors that affect the power generation of various fuel types in Alberta, especially renewable energy which relies on mother nature the weather dataset was largely chosen to assist in the analysis of this topic. The weather dataset was originally extracted from ACIS website [7] by picking the weather attributes needed for this topic, including daily data of Maximum Temperature, Minimum Temperature, Precipitation, Incoming Solar Radiation, Wind Speed through weather stations located in different townships in Alberta. The Since no 1-to-1 match can be established from weather stations to power generation stations in the main dataset, a township was picked to represent each of the 6 regions (Calgary, Edmonton, South, Northeast, Northwest, Central) and a township-region dataset was created to bridge the weather dataset to the main dataset later. The primary key in the weather dataset is Date and Township. The expectation is that a strong correlation can be observed between temperature and overall power generation, incoming solar radiation and solar power, precipitation and hydro, wind speed and wind power.

(c) Allocation of Energy:

The choice of the "System_and_regional_load" dataset was driven by the need to analyze the relationship between electricity generation and demand in various regions of Alberta. This dataset provided hourly data on electricity demand for each region, allowing for a direct comparison with the main dataset on power generation. To conduct time zones were standardized during the loading of the csv file to enable seamless alignment between the electricity generation and demand datasets.

```
load data local infile 'C:/Users/Calvin/Downloads/sr_data.csv'
    into table `l02-4`.system_and_regional_load_hourly
    fields terminated by ','
    ignore 1 rows
    (@datetime, @dummy, hourly_profile, season, @dummy, @dummy,
    set datetime = str_to_date(@datetime, '%d-%m-%Y %H:%i:%s');
```

The "System_and_regional_load" dataset was joined with the main dataset on power generation using regions. This facilitated a comparative analysis between the electricity generated by each region and the corresponding demand from each region.

(d) Impact of Covid-19 on Electricity Generation in Alberta

Two datasets were used in answering the guiding question, does covid-19 have an impact on electricity generation in Alberta?

The first is the main dataset from AESO showing the breakdown of electricity generation in Alberta from 2015 to 2023. For this guiding question, the dataset was analyzed from 2019 to 2022 to cover the pre-covid period and post covid period. Another dataset used was the covid-19 which was retrieved from the city of Edmonton open data portal. [2]

This data reported the active covid-19 cases in Alberta based on data, location and other indices in Alberta from 2020 to 2023. Analysis was done to visualize the trend in covid-19 cases in Alberta year on year to further infer possible impact on electricity generation in Alberta.

(e) The Wholesale Pricing Market

I decided to focus on the pricing aspect of the electricity market. For those who don't have slowing climate change at the top of their priorities, most people still care about their electricity bills. For context, pricing in this project is based on the wholesale price in the market. This means that prices here are what the distributors pay per megawatt of electricity. These are not the prices consumers pay directly but are trickled down because of costs incurred by distributors.

The reason we see such variation is due to supply and demand. The main influencers in this market are the fact that electricity is an inelastic good, and that supply is directly correlated with demand. We currently have no economical way of storing electricity. Thus, we only produce what is required. Problems arise when demand exceeds the capability of our power generation sources.

	Timestamp (UTC)	Timestamp (MT)	AIL	Pool Price	Solar	Wind
0	2016-01-01 07:00:00	2016-01-01 00:00:00	9231.996943	13.67	NaN	958.471111
1	2016-01-01 08:00:00	2016-01-01 01:00:00	9082.480132	13.23	NaN	951.242222
2	2016-01-01 09:00:00	2016-01-01 02:00:00	8919.190476	12.53	NaN	913.370556
3	2016-01-01 10:00:00	2016-01-01 03:00:00	8818.941847	11.07	NaN	911.220556
4	2016-01-01 11:00:00	2016-01-01 04:00:00	8779.003740	11.07	NaN	932.833889

Table 1: Overview of Energy Price Dataset

In the chosen table, I have primary keys in the Date columns "Timestamp" and pricing data in the "Pool Price" column. In terms of cleaning, there were a few steps needed to use the date as a primary key with the main dataset. First, was converting to the same datetime format. Choosing one of the columns with the applicable time zone was next which also required dropping the other date column. With this I also dropped the columns that weren't relevant to price including "AIL", "Solar", and "Wind". Lastly, to coincide with the weather data which I would eventually have to join, I decided to create a column for daily pricing data in substitute of hourly pricing data. This was by grouping all rows with the same date and dividing by the number of rows per day resulting in the average daily price. We do lose some accuracy in doing this, but we could not compare pricing to temperature without this step because of the absence of hourly temperature data.

Data exploration

What is the power generation rate of transformation from coal to other fuel types in Alberta and what is the impact on Carbon Emissions?

The investigation into power generation in Alberta began with finding the main dataset from the Alberta Electric System Operator (AESO) webpage [1]. This dataset captured the hourly power generated in Alberta for each power plant, including coal, natural gas, hydroelectric power, solar, wind, and biodiesel. The power produced was reported in Energy units of Megawatts * hour in a total of ~14 million records that represented the historical power generation in the province from 2015 until September 2023. The second part of the question required a dataset containing the CO2 emissions for power generation in Alberta [4]. A significant number of columns had to be removed to summarize the CO2 tons per power generation industry and province per year. Here is the SQL code used for the cleaning and joining of the datasets.

<u>Main dataset: AESO – Power Generation</u>

Conversion from daily data to yearly data: Please note that the starting file is called "energy_all_monthly_sorted" but in fact it contains the daily data from the daily file called "energy_all". Both files are in the Schema l02-4 in MySQL.

```
DROP TABLE IF EXISTS `l02-4`.energy_all_yearly_sorted;
CREATE TABLE `l02-4`.energy_all_yearly_sorted AS
SELECT year_data,month_data,Fuel_Type,sum(sum_monthly_volume) AS
acc_monthly_volume FROM `l02-4`.energy_all_monthly_sorted
GROUP BY year_data
ORDER BY year_data;
SELECT * FROM `l02-4`.energy_all_yearly_sorted;
```

<u>Secondary Dataset – CO2 Emissions:</u>

The CSV file containing the dataset was imported into Pandas using 'sqlalchemy'. The information was stored in a table in MySQL using an engine pointing to the group Schema l02-4. The table was manipulated in MySQL, and the columns were reduced from 84 to 5, extracting the CO2 produced by power plants in Alberta from 2004 to 2021.

```
SELECT * FROM `l02-4`.emissions_sql;
DROP TABLE IF EXISTS `l02-4`.emissions_clean;
CREATE TABLE `l02-4`.emissions_clean AS
SELECT
```

```
Reference_Year,
ROUND(SUM(`Total_Emissions_(tonnes_CO2e)`), 2) AS 'Cum_CO2eq_per_year_Tonnes',
ROUND(SUM(`CO2_(tonnes)`), 2) AS 'Cum_CO2_per_year_Tonnes',
ROUND(SUM(`CH4_(tonnes_CO2e`), 2) AS 'Cum_CH4_per_year_Tonnes',
`English_Facility_NAICS_Code_Description`
FROM   `l02-4`.emissions_sql
WHERE
Facility_Province_or_Territory = 'Alberta' AND `English_Facility_NAICS_Code_Description`
IN ('Fossil-Fuel Electric Power Generation', 'Other Electric Power Generation', 'Hydro-Electric
Power Generation')
GROUP BY    Reference_Year;
```

This code was significantly useful, as it not only filtered the columns that are needed from the table but also added the CO2 emissions for the selected Facilities Description, allowing the focalization of data towards the power generation industry in Alberta. The table was named 'emissions_clean' and contained the same yearly-based information required to join the table with the transformed main database.

Join Tables – Yearly Power Generation and CO2 Emissions:

The transformed main database ‘energy_all_yearly_sorted’ Table was joined to the CO2 emissions ‘emissions_clean’ Table using an inner join and a time key.

```
SELECT * FROM `l02-4`. emissions_clean;
DROP TABLE IF EXISTS `l02-4`.emissions_cleanj;
CREATE TABLE `l02-4`.emissions_cleanj AS
SELECT *
FROM `l02-4`.emissions_clean
INNER JOIN `l02-4`.energy_all_yearly_sorted ON `l02-4`.emissions_clean.Reference_Year
=`l02-4`.energy_all_yearly_sorted.year_data;
ALTER TABLE `l02-4`.emissions_cleanj
DROP COLUMN Cum_CO2eq_per_year_Tonnes,
DROP COLUMN Cum_CH4_per_year_Tonnes,
DROP COLUMN English_Facility_NAICS_Code_Description,
DROP COLUMN year_data,
DROP COLUMN month_data,
DROP COLUMN Fuel_Type;
SELECT * FROM `l02-4`.emissions_cleanj;
```

Several columns were deleted to clean the data and facilitate the graphing process with matplotlib.pyplot.

Graphical Analysis:

The main dataset analysis was used to answer the first part of the question. The goal was to visualize the transformation from coal to gas over the last 8 years by plotting the total power generated since 2015.

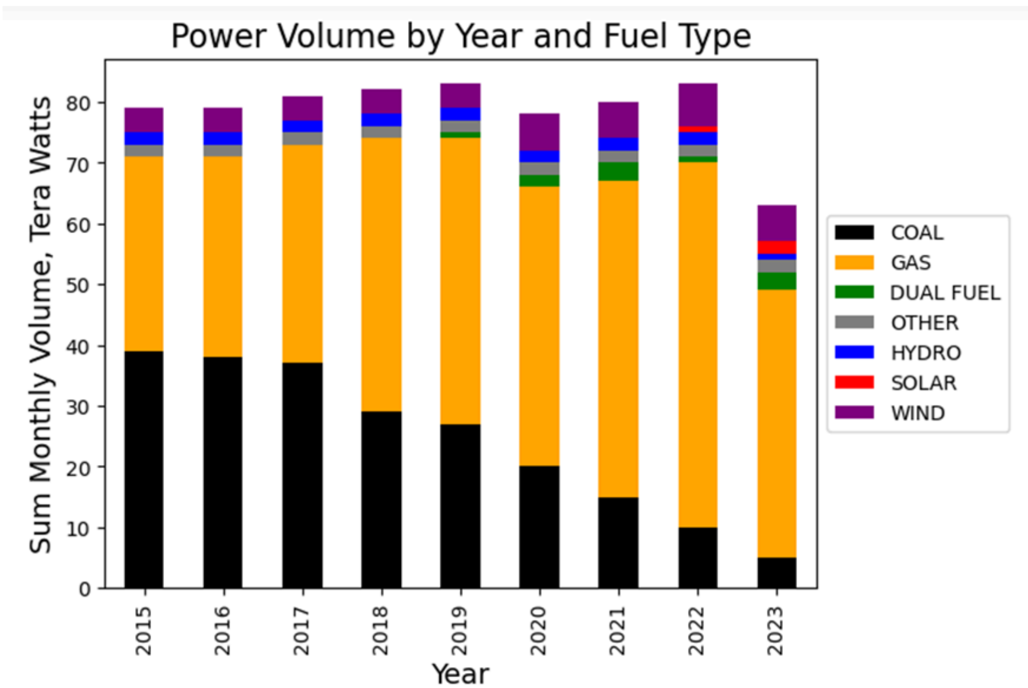

Figure 2: Power Volume by Year and Fuel Type

Figure 2 showed that Alberta has achieved a commendable 87% shift from coal to natural gas. The commitment to complete this transformation from coal to gas is set for 2030. As per September 2023, coal-generated power was only ~8 out of the ~80 Terawatts of annual consumption, representing just 10% of the total production. Noteworthy is the substantial growth in green power generation, particularly over the past three years.

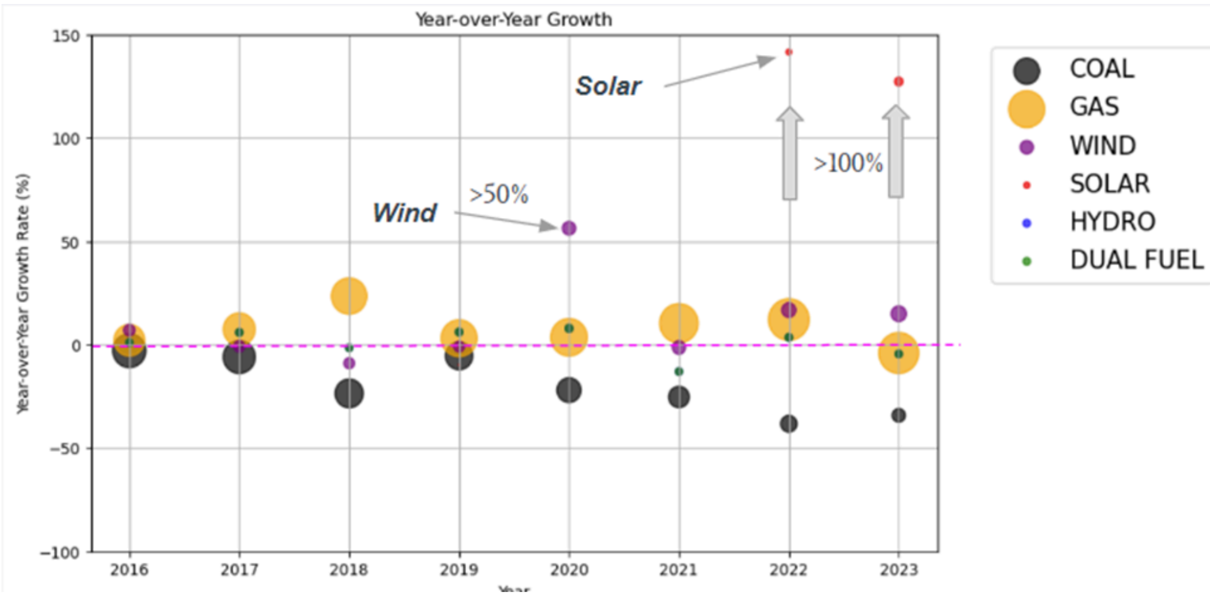

Figure 3: Yearly Power Growth by Fuel Types

From Figure 3, the bubbles on the chart represent various fuel types, and their sizes indicate the percentage of total energy produced. This visual representation helped us to understand the contribution of each fuel type to the overall annual power production. Since 2020, there has been significant growth in both wind and solar power generation. Wind power, for instance, experienced a 50% uptick in 2020, followed by an additional 20% growth in both 2022 and 2023. Solar power exhibited impressive growth rates, surpassing 100% in 2022 and 2023. The surge in power generation can be attributed to the deregulation of prices in Alberta since 2019 and the TIER regulation that provides green power producers with Carbon Credits at ~$25/ton of CO2 not emitted into the atmosphere. The joined data from power generation and CO2 emissions showed how Alberta reduced ~40% of the CO2 emissions (gray bars) between 2015 and 2021 by transforming the fuel from Coal to Gas and increasing the production of Solar and Wind power.

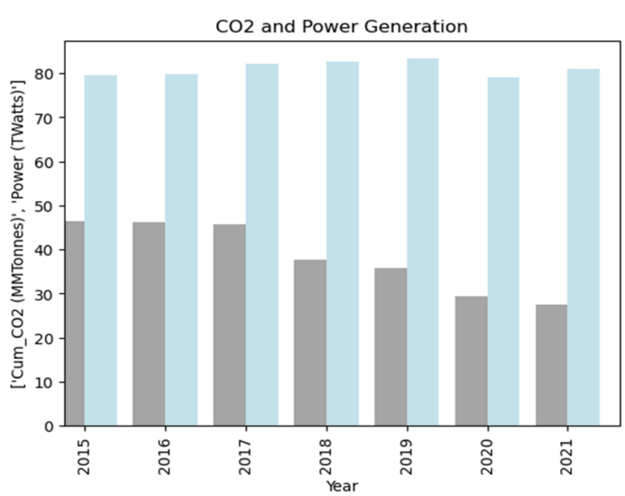

Figure 4: CO2 and Power Generation

From Figure 4, the analyses obtained from these datasets confirm Alberta's commitment to reduce carbon emissions while maintaining a proper power supply.

(b)What are the effects of weather on the volume of power generation? Particularly, on renewable energy.

To investigate this topic, the weather dataset and the main power generation dataset will be joined. To achieve that, weather data will be joined with the township dataset first to map the townships in weather dataset to regions in the main dataset:

```
CREATE TABLE weather_region AS

(SELECT weather.*,

        township.region

FROM township

INNER JOIN

ON weather.township=township.township);
```

From the queries above, a table containing weather data of 6 townships representing each region in the main data is prepared. Then the newly created weather_region is joined with the main dataset to perform further analysis and visualization.

```
pd.read_sql_query("

SELECT energy_all_daily.*,

        energy_all_daily.Volume/energy.Maximum_Capability AS Load_Rate,

        weather_region.Air_Temp_Min,

        weather_region.Air_Temp_Max,

        weather_region.Precipitation,

        weather_region.Solar_Rad,

        weathe_region.Wind_Speed

FROM energy_all_daily

LEFT JOIN weather_region

ON energy_all_daily.Date=weather_region.Date

  AND energy_all_daily.Area=weather_region.Region;", engine)
```

A table is prepared through Sqlalchemy in Python after joining. Tasks such as further grouping, filling missing values and visualizations are completed in Python.

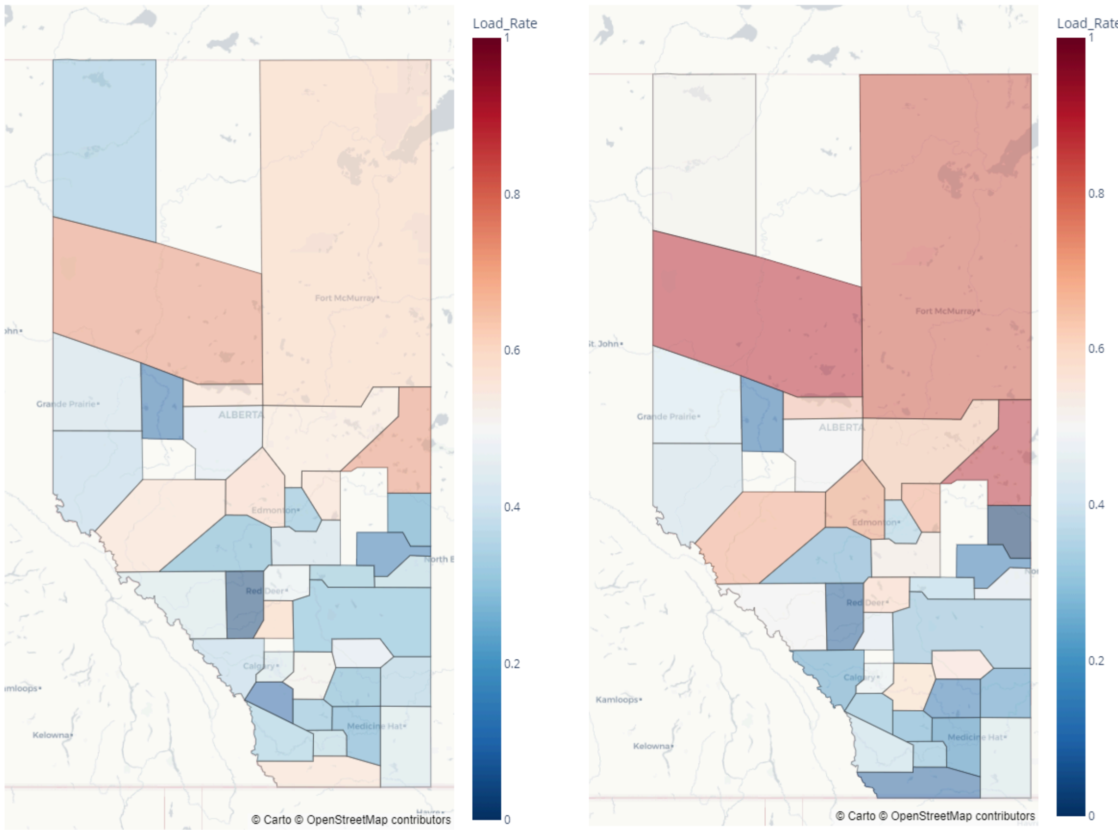

Figure 5: June Average Load Rate and December Average Load Rate

From Figure 5, a drastic increase in load rate can be observed in December compared to June in Edmonton, Central and Northeast regions, where the load rate is calculated as the average volume generated divided by the average maximum capability within each month. The difference in load rate from June to December is due to increased power usage in winter with decreased temperatures.

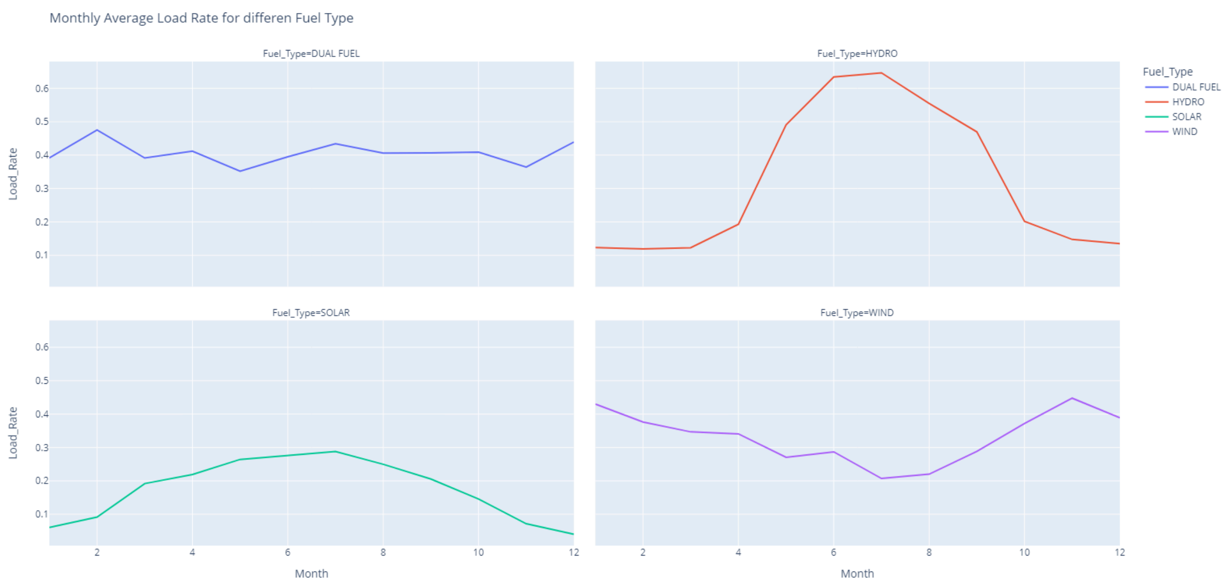

Figure 6: Monthly Average Load Rate by Fuel Types

From Figure 6, a similar pattern can be observed for hydro energy (red line) and solar energy(green line): An increase in generation in warm months and decrease in cold months. The pattern is reversed for wind energy generation.

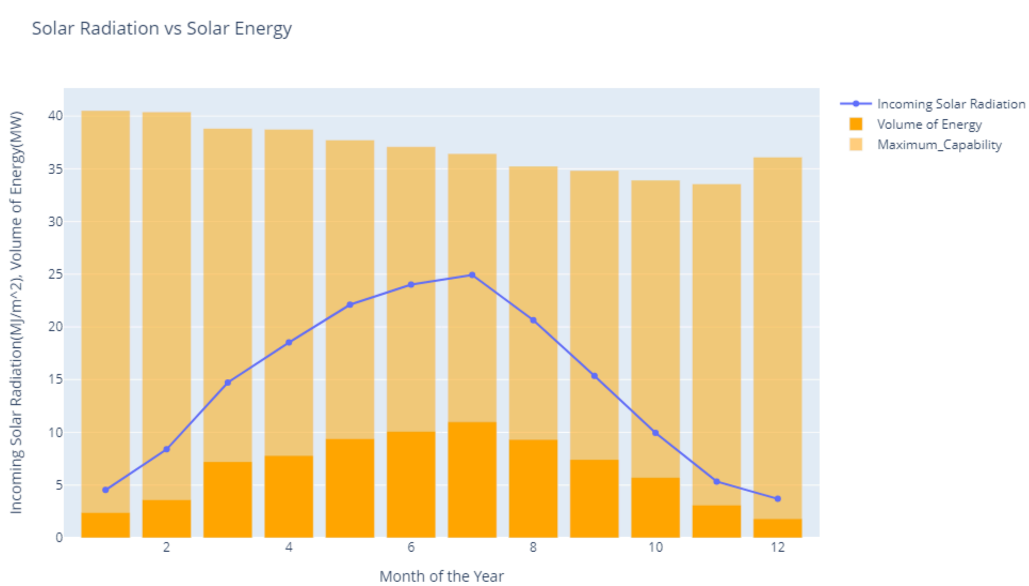

Figure 7: Monthly Incoming Solar Radiation and Solar Energy Generation

From Figure 7, the distribution of solar power generation matches the distribution of solar radiation. In summertime when the surface receives more solar radiation, the solar power generation increases with it. Note that the variance in monthly maximum capability (transparent bars) is due to the constant addition of new solar panels in the Alberta grid.

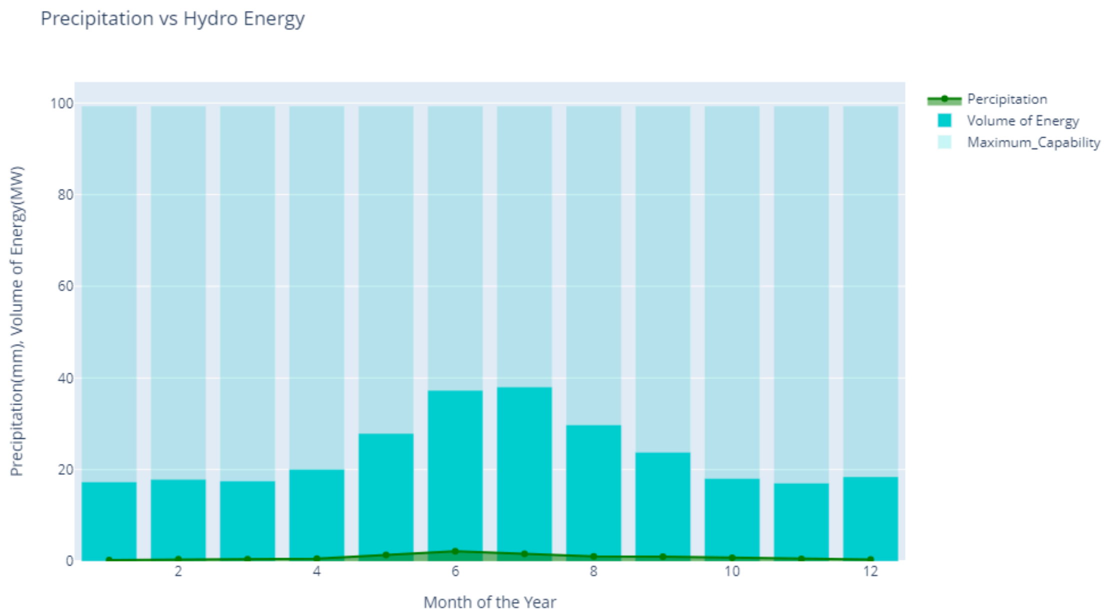

Figure 8: Monthly Precipitation and Hydro Energy Generation

From Figure 8, the distribution of hydro power generation matches the distribution of precipitation(mm). In summertime when more precipitation is received, the hydro power generation increases with it. However, the change in precipitation is not significant in Alberta, and the variance in hydro power generation could be better explained by the water level in rivers and reservoirs. Considering the time limitation of the project and the difficulty of finding water level data that can be joined with the main dataset, the analysis is not performed.

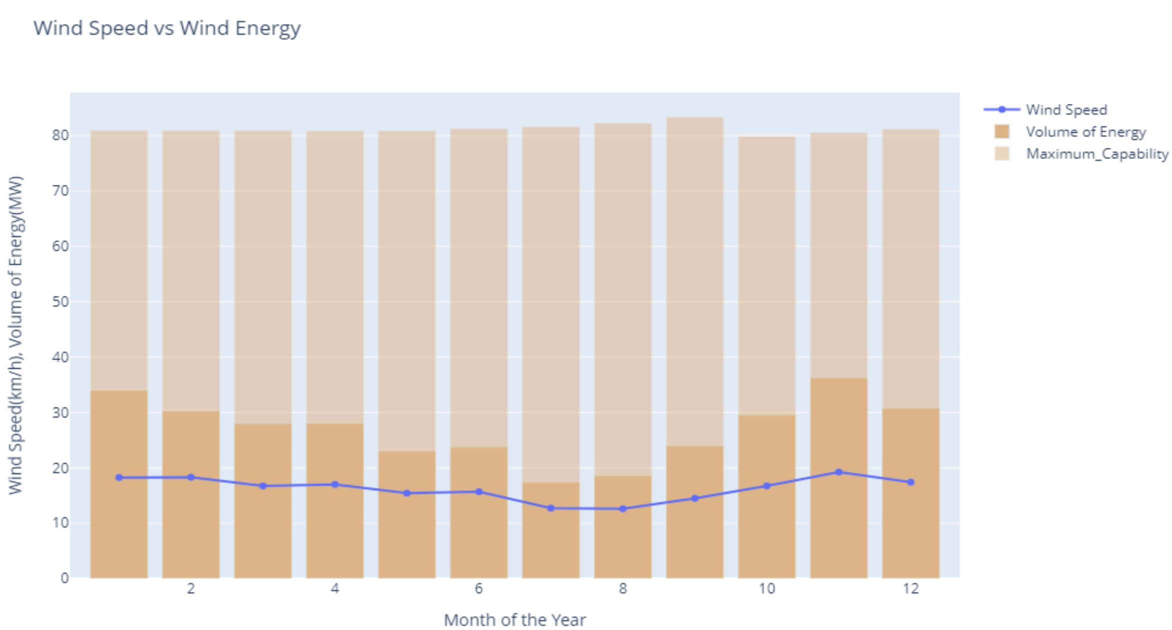

Figure 9: Monthly Wind Speed and Wind Energy Generation

From Figure 9, the distribution of wind power generation matches the distribution of wind speed (km/h - 10m average). There seems to be more windy days in winter months that lead to more wind power generation.

In general, the renewable energy generation pattern matches the pattern of its corresponding weather attribute. However, renewable energy generation is far away from its maximum capability. With Alberta's Net Zero Emission goal in 2050, we would expect to see a slow but steady increase in the load rate of these renewable energy stations.

(c) **Which region/areas in Alberta consumes the most electricity?**

To perform this analysis, we linked the System_and_regional_load dataset to the main dataset on energy_generation to view the differences in electricity demand and electricity generated across the different regions in Alberta.

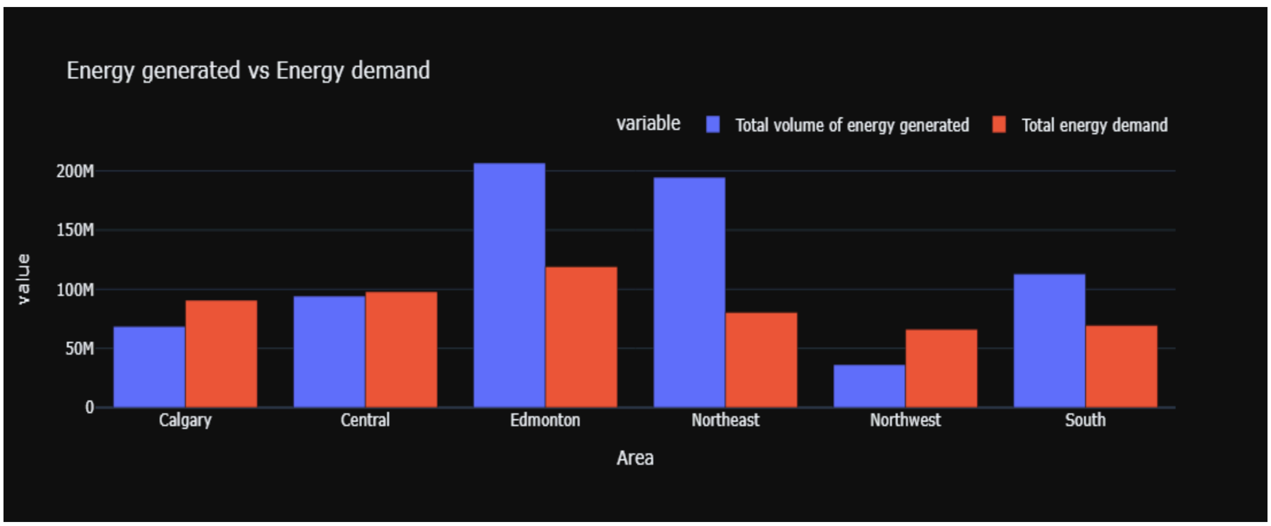

Figure 10: Energy Generation vs. Energy Demand

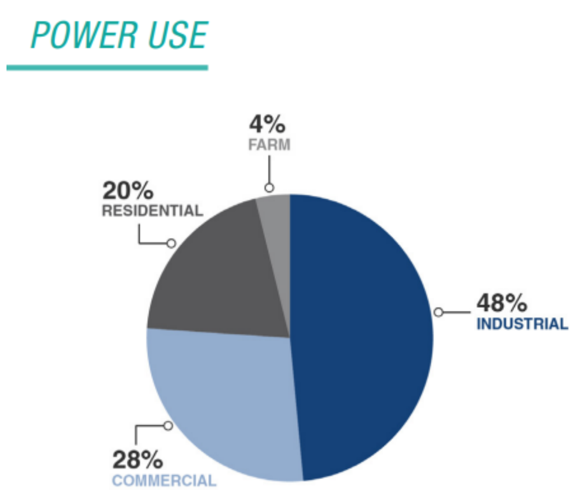

Figure 11: Power Usage by Industries

Our data analysis of electricity consumption unveiled a hierarchy in usage across different regions. Edmonton emerged as the highest consumer, followed by the Northeast region, with Northwest and Calgary trailing behind.

Analyzing this pattern against the backdrop of Alberta's power grid information provided by AESO, it's intriguing to note that industrial activities constitute a staggering 48% of electricity consumption, followed by commercial usage at 28% and residential at 20%.

Edmonton's prominence as the top consumer aligns with its status as a major economic hub for northern and central Alberta. Additionally, being a significant center for the oil and gas industry, it's no surprise that industrial activities, a primary driver of electricity usage, thrive in this area.

The Northeast region's ranking as the second highest consumer correlates with its position as the 2nd largest oil-producing region in Alberta. The intensive energy requirements of oil production contribute substantially to the region's electricity consumption.

Lastly, Calgary's placement as a lower consumer of electricity might be attributed to a combination of factors such as a diversified economy and potentially more efficient consumption practices compared to the high-industrial and energy-intensive areas like Edmonton and the Northeast.

It was also interesting to note that the highest consumers of electricity (Edmonton and Northeast) generate more electricity than their demand. This surplus in electricity generation might stem from the necessity to ensure uninterrupted power supply for critical industrial operations. Regions with major industrial hubs often have robust electricity generation capacities to ensure stability and reliability for these energy-intensive sectors.

On the flip side, low consumers of electricity (Calgary and the Northwest region) do not generate enough electricity to meet their demand. This discrepancy could be attributed to various factors. For instance, Calgary's diversified economy might not be as reliant on heavy industries that demand immense electricity. Hence, its generation capacity might not match the consumption needs.

This analysis underscores the intricate relationship between economic activities, industrial prowess, and electricity consumption patterns in different regions of Alberta.

(d) How has Covid-19 impacted Electricity generation in Alberta?

There was a drop in April 2021 which was after the covid-19 lock down. In April, refinery production was reduced due to scheduled spring maintenance shutdowns at some refineries, while consumption of refined petroleum products continued to be affected by pandemic-related measures which remained in place in most provinces.[4]

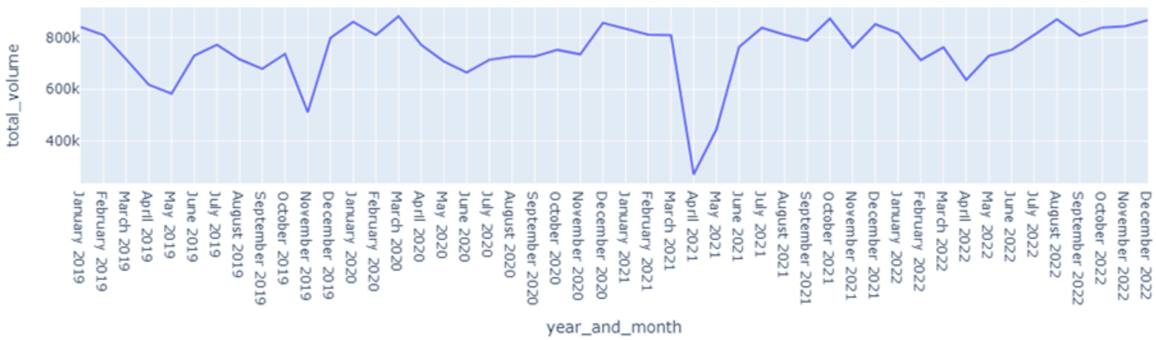

Figure 12: Time Series of Energy Generation

Electricity generation continued a downward trend in April, declining 1.0% year over year to 48.3 million megawatt-hours (MWh). Nuclear generation fell 8.3% year over year to 6.9 million MWh, as maintenance continued at nuclear plants in Ontario and New Brunswick. Electricity generated from combustible fuels was also down 3.8% to 8.5 million MWh, mostly because of lower quantities produced in Alberta. This overall decrease was partially offset by renewable energy generation (including hydro, wind, solar and other sources of energy).[4]

The impact of covid-19 was also viewed across the provinces, and it was observed as shown on the graph that there was a steady increase in covid-19 infection from 2019-2022. This increase in infection as shown in the graph below can also be attributed to the possible reason why routine refinery maintenance in 2020 could not be conducted.

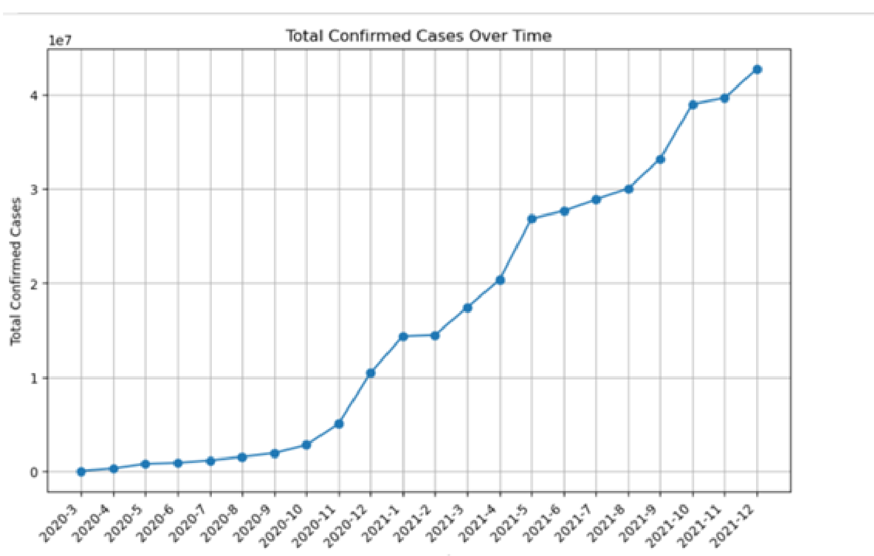

Figure 13: Time Series of Confirmed COVID Cases

(e) What are the major causes of spikes in electricity prices and how can they be mitigated?

I found that joining pricing data with both the weather dataset and the main dataset would yield the best results when it comes to determining causes for price volatility in the market. This was accomplished by joining using the date columns as the primary key. By doing this, we would be able to analyze the time series data to compare effects on prices from both weather and exportation data.

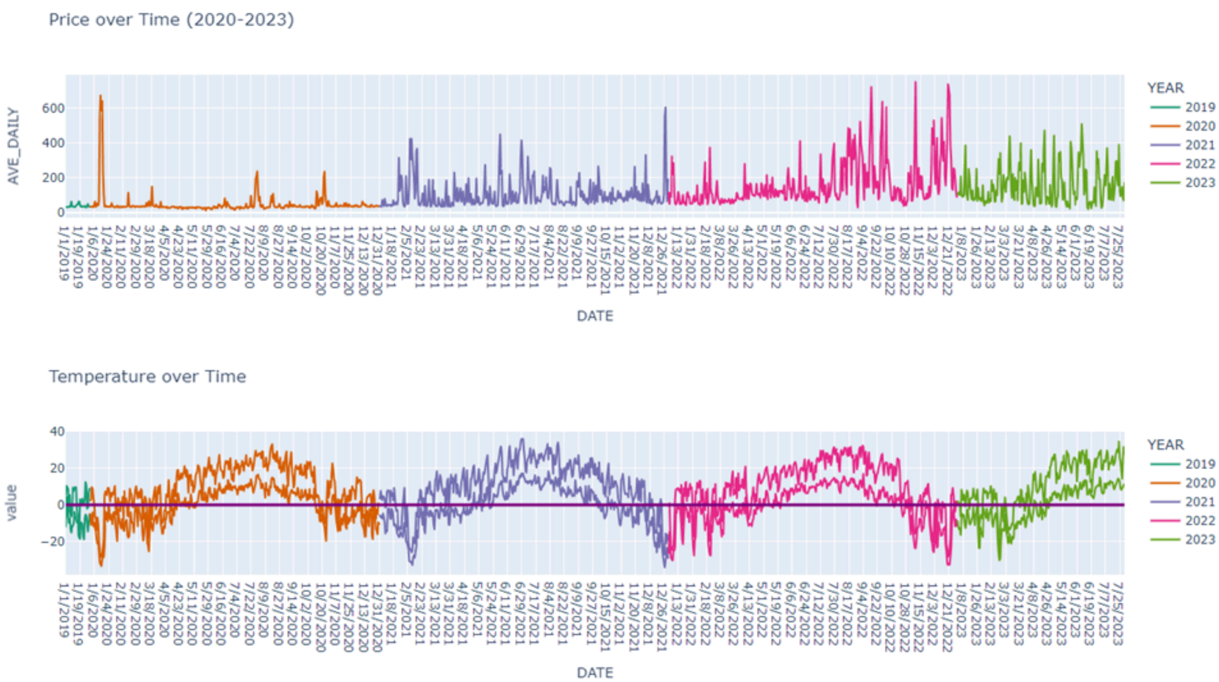

Figure 14: Pricing and Temperature averages

Plotting the weather and price data over the span of our dataset was not indicative of a relationship between the tables. While aggregating the temperatures, there weren't any obvious outliers to suggest prices were subject to extreme temperatures.

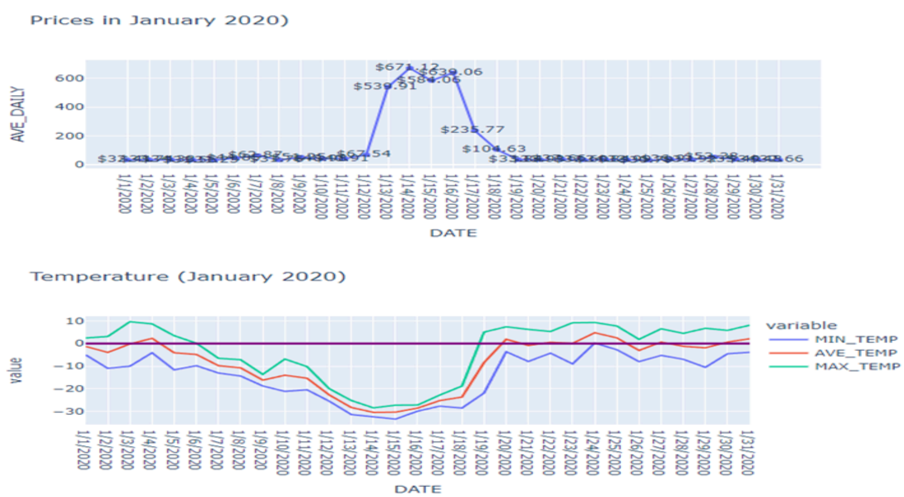

Figure 15: Pricing and Temperature in January 2020

Looking at a specific month, a swing in temperature can have a significant impact on the market in each hour. The load on the grid becomes significant enough to cause prices to jump to historic highs. Highs that are much more common now that we are transitioning to renewable generation sources.

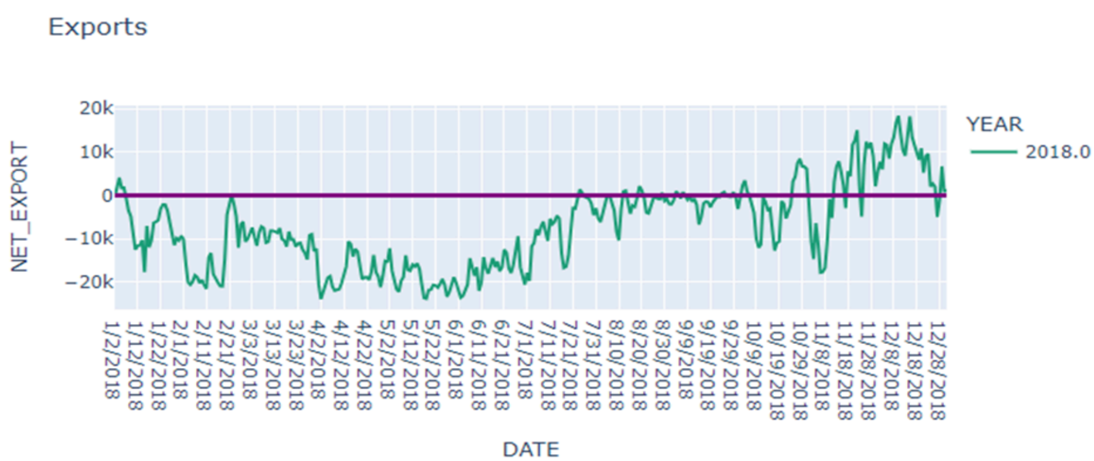

Figure 16: Net Exports in 2018

The import and export market also has a role to play in electricity prices but may not be as obvious as those shown above. The province is a net negative exporter of electricity. Per megawatt of electricity, it is often more expensive to bring in power from neighboring states and provinces. This is required when the assets in Alberta do not have the capability to meet demand at a given time. As we progress with the transition, the province we become increasingly less reliant on power from other areas. This will result in a lower energy bill.

Discussion

Javier	This project allowed working with databases that contained hundreds of thousands of records. I noticed that CSV files are no longer suitable to contain that volume of data. For instance, AESO supplied data in chunks of 6 months to comply with CSV data restrictions. In the same way, we needed to learn techniques to extract this data in Pandas, working with zip files and folders. I appreciate the value of MySQL in transforming the data with simple commands. Filtering the data becomes much faster in MySQL than doing it in Pandas. However, it is not very flexible with the order of commands. I learned that joining tables in SQL usually duplicates columns that need to be filtered afterward. However, data aggregation with commands such as SUM() and AVG() is easy to implement, and the results are generated quickly despite the volume. In some cases, the use of subqueries creates complications. I worked around these difficulties by creating intermediate tables that allowed me to get to the final answer. In terms of project results, Alberta is well on its way to transitioning from coal to other greener fuels for power generation. That was confirmed when correlating with CO2 emissions in power plants. For future work, I would be interested in reviewing which other environmental impacts would result from the use of green energy such as windmills and solar power.
Calvin	This project has increased my understanding of the discrepancies in generation and consumption across different regions, and how crucial it is for efficient energy distribution and allocation. It emphasizes the necessity for interconnected and flexible power systems to ensure a balanced and reliable supply of electricity across Alberta. Due to this project, I am now more comfortable with working with datasets in SQL which contain a very huge number of records. This project required extensive exploration of the data in SQL, and this has increased my proficiency in the language. To extend this project, I would have liked to have more data on other factors that affect electricity demand and generation such as power plant costs, and data associated with the transmission and distribution system. .
Yao	From the project I developed a deeper understanding of Alberta's power grid, power generation distribution and geographic attributes. Now I understand the meaning of "be a part of the energy", which is written on the Calgary welcome signs. I was surprised to see Alberta is net-negative in power (import

	more than export) despite being an energy province. In the technical aspect, this project allows me to practice a lot more on queries. Joining tables were tricky at first since the queries always gave me duplicate columns. I was not aware of the fundamental differences between merging in pandas and joining in MariaDB. I later learned that I only need to select the primary key once in one dataset to avoid the duplicated column problem. Database design is another valuable lesson I learned from the process. Initially I tried to upload a 1.3GB dataset into the database without considering uploading time and query processing time. I later learned to keep each file in a moderate size before uploading, which optimized running time a lot. I also learned to be careful playing with SQL alchemy connection and session. From watching other groups' presentations, I want to try designing a dashboard visualization that draws data directly from the database. I also want to include more dataset (i.e., water level, power transition lines) into the project to make the analysis more robust.
Yinka	Based on the impact of Covid-19 on electricity generation, a couple of things were observed and learned from this topic. First was to see that there was an aftermath effect of covid-19 on electricity generation in Alberta as seen in the decline observed in April 2021. Although the province has experienced a gradual and significant shift from coal to natural gas in recent years, there is still room for improvement for electricity generation with renewable energy. The drop in Oil prices during the covid-19 lockdown across the world indirectly influences gas production in most provinces. This still makes natural gas unreliable in the event of any global pandemic hence the need for more focus on renewable energy.
Jaden	After watching presentations from our peers, I think a dashboard would be a very effective medium in presenting our findings. Loading our main dataset into Tableau or PowerBI along with some of our associated tables would provide those interested with a more immersive look into our findings. To extend this project, I would have liked to bring in data regarding more factors that affect the electricity market because there are many variables besides the weather. For example, wildfire/natural disaster data which may have affected solar energy generation, or droughts affecting hydro. Commodity prices may also have an impact on generation methods such as coal and natural gas.

Conclusion. Summarize the project, especially the parts you feel were most noteworthy. Remember to cite your sources properly, as required.

In conclusion, Alberta's ambitious goal of phasing out coal from power plants by 2030 [6] is well on track, with coal now contributing only ~10% to the province's power generation. The remarkable growth of wind and solar power exceeding 100% year over year, combined with the utilization of natural gas as a fuel source, has led to a substantial reduction in CO_2 emissions by almost 45%, demonstrating the success of the transition. While solar and wind play crucial roles, their weather-dependent nature highlights the necessity of a diversified energy mix. Recognizing the importance of reliability, particularly underscored during external disruptions like the Covid-19 pandemic, reinforces the significance of maintaining gas power plants alongside green energy sources. This dual approach ensures not only environmental sustainability but also establishes a resilient and reliable energy infrastructure for the province.

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