Ontario Electricity Demand Analysis

Project Overview: Electricity demand forecasting and price analysis are critical for energy providers to ensure reliable supply, manage operational costs, and plan future capacity. This project analyzes Ontario's hourly electricity demand and pricing data from 2002 to 2023. The goal is to identify temporal patterns, hourly, daily, monthly, and seasonal and investigate the relationship between demand and price.

Problem Statement: The main questions addressed:

- Which hours and weekdays have the highest electricity consumption?
- How does demand vary across months and seasons?
- When do electricity prices peak, and in which months/seasons?
- How does electricity demand influence prices?

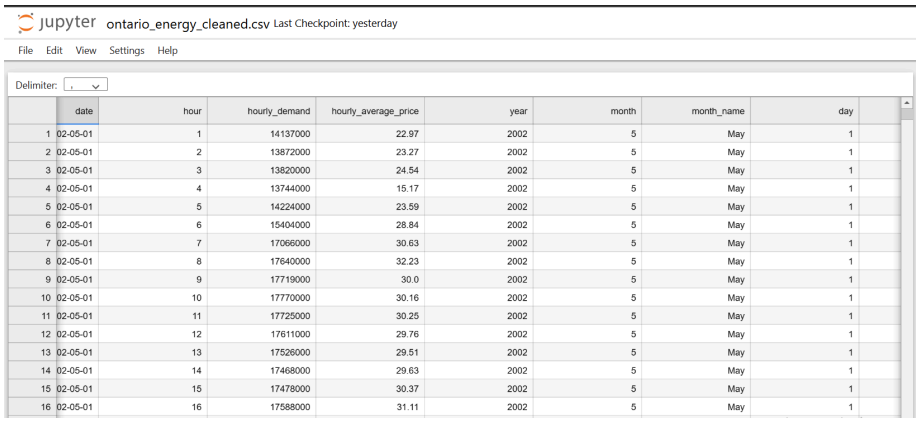
Tools & Libraries:

- Python (pandas, matplotlib)
- SQL (MySQL / PopSQL)
- Tableau
- GitHub

Dataset:

- **Source:** Ontario electricity demand and price data (raw CSV).
- **Duration:** 2002–2023
- **Key columns:**
  - date — date of the measurement
  - hour — hour of the day (0–23)
  - hourly_demand — electricity demand (in MWh)
  - hourly_average_price — price per MWh

Derived features: year, month, month_name, day_name, season, is_weekend



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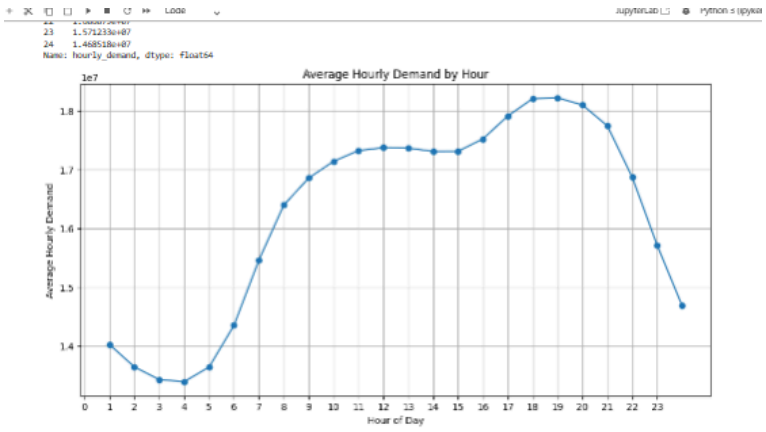
	date	hour	hourly_demand	hourly_average_price	year	month	month_name	day
1	02-05-01	1	14137000	22.97	2002	5	May	1
2	02-05-01	2	13872000	23.27	2002	5	May	1
3	02-05-01	3	13820000	24.54	2002	5	May	1
4	02-05-01	4	13744000	15.17	2002	5	May	1
5	02-05-01	5	14224000	23.59	2002	5	May	1
6	02-05-01	6	15404000	28.84	2002	5	May	1
7	02-05-01	7	17066000	30.63	2002	5	May	1
8	02-05-01	8	17640000	32.23	2002	5	May	1
9	02-05-01	9	17719000	30.0	2002	5	May	1
10	02-05-01	10	17770000	30.16	2002	5	May	1
11	02-05-01	11	17725000	30.25	2002	5	May	1
12	02-05-01	12	17611000	29.76	2002	5	May	1
13	02-05-01	13	17526000	29.51	2002	5	May	1
14	02-05-01	14	17468000	29.63	2002	5	May	1
15	02-05-01	15	17478000	30.37	2002	5	May	1
16	02-05-01	16	17588000	31.11	2002	5	May	1

Methodology

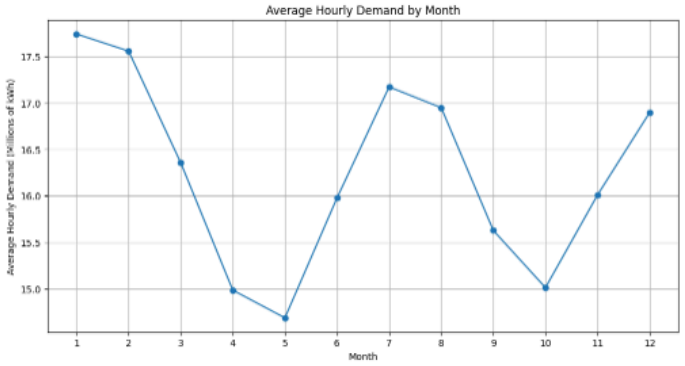
Python Notebook

- Loaded raw CSV, handled missing/duplicate data
- Created derived columns: year, month, month_name, day_name, season, is_weekend
- Performed initial exploratory data analysis (EDA) and visualizations



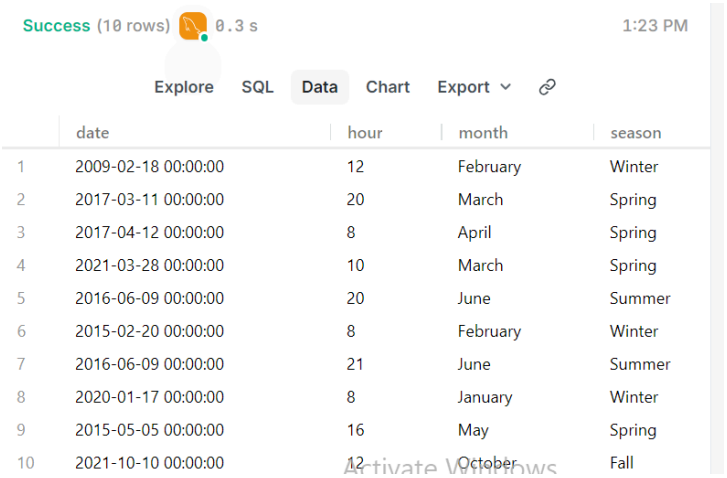

```
[14]: # Group by month number
monthly_avg = df.groupby('month')['hourly_demand'].mean()

# Plot
plt.figure(figsize=(12,6))
plt.plot(monthly_avg.index, monthly_avg.values / 1_000_000, marker='o')  # divide by 1 million for readability
plt.xticks(range(1,13))  # 1 to 12 months
plt.xlabel('Month')
plt.ylabel('Average Hourly Demand (Millions of kWh)')
plt.title('Average Hourly Demand by Month')
plt.grid(True)
plt.show()
```



SQL Queries

- Aggregated hourly, daily, monthly, and seasonal demand
- Identified top 10 peak price event
- Analyzed price vs demand relationship



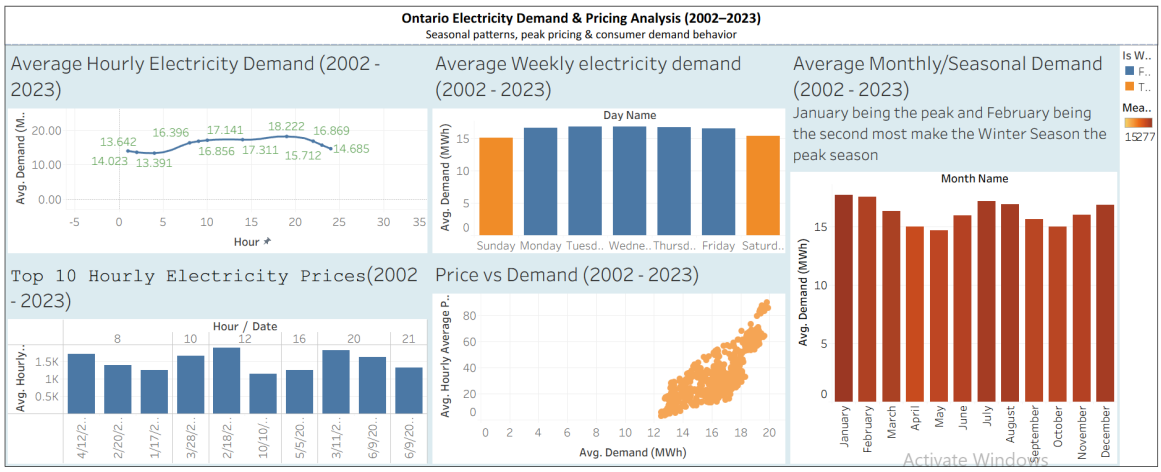
	date	hour	month	season
1	2009-02-18 00:00:00	12	February	Winter
2	2017-03-11 00:00:00	20	March	Spring
3	2017-04-12 00:00:00	8	April	Spring
4	2021-03-28 00:00:00	10	March	Spring
5	2016-06-09 00:00:00	20	June	Summer
6	2015-02-20 00:00:00	8	February	Winter
7	2016-06-09 00:00:00	21	June	Summer
8	2020-01-17 00:00:00	8	January	Winter
9	2015-05-05 00:00:00	16	May	Spring
10	2021-10-10 00:00:00	12	October	Fall

Tableau Dashboard

Created interactive dashboards:

- Hourly demand
- Weekly demand
- Monthly & seasonal demand
- Top 10 peak prices
- Price vs demand scatter plot

Applied color-coding for weekdays/weekends



Analysis & Findings

Hourly Demand Patterns

- **Observation:** Peak demand occurs between **16:00–19:00**, indicating late afternoon/evening are busiest hours.
- **Insight:** Useful for energy providers to schedule generation and reduce peak load risks.

	hour	avg_demand_mwh
1	1	14.02
2	2	13.64
3	3	13.43
4	4	13.39
5	5	13.64
6	6	14.35
7	7	15.46
8	8	16.40
9	9	16.86
10	10	17.14

Weekly Demand Patterns

- **Observation:** Weekdays consistently show higher demand than weekends.
- **Insight:** Industrial and commercial activity drives weekday demand, while weekends are comparatively lower.

	weekday	avg_demand_mwh
1	Monday	16.54
2	Tuesday	16.80
3	Wednesday	16.78
4	Thursday	16.73
5	Friday	16.49
6	Saturday	15.34
7	Sunday	15.06

Monthly & Seasonal Demand

- **Observation:** Winter months (especially January and December) have the highest demand, while summer and spring are lower.
- **Insight:** Seasonal variation impacts energy supply planning and pricing strategies.

	month	avg_demand_mwh
1	1	17.74
2	2	17.56
3	3	16.36
4	4	14.98
5	5	14.69
6	6	15.98
7	7	17.17
8	8	16.95
9	9	15.63
10	10	15.01

	season	avg_demand_mwh
1	Spring	15.35
2	Summer	16.71
3	Fall	15.54
4	Winter	17.39

Top 10 Peak Prices

- **Observation:** Most extreme price spikes occur during winter months, aligning with high demand periods.
- **Insight:** Highlights periods of potential stress on the electricity grid.

	date	hour	month	season
1	2009-02-18 00:00:00	12	February	Winter
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Price vs Demand Analysis

- **Observation:** Positive correlation between demand and electricity price.

- **Insight:** Higher demand drives higher prices, important for pricing models and forecasting.

	demand_million_kWh	avg_price
1	2	60.02
2	3	44.83
3	4	24.62
4	5	31.35
5	6	80.56
6	7	37.17
7	8	35.86
8	9	5.21
9	10	0.18
10	11	4.79

Conclusion

This project demonstrates **end-to-end analytics skills**:

- **Python:** Data cleaning and feature engineering
- **SQL:** Aggregation, insights, and peak analysis
- **Tableau:** Visualization and interactive dashboards

Key takeaways:

- Late afternoon/early evening is the peak electricity demand period
- Weekdays and winter months have the highest consumption
- Extreme price spikes are aligned with high demand periods
- Price and demand are positively correlated

The analysis can help energy planners and utilities make **data-driven decisions** regarding supply, load balancing, and pricing.