Inside Canada's Natural Gas Economy: Insights from Monthly Supply & Disposition Data

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1. Abstract

This project delves into the monthly historical dataset titled "Supply and Disposition of Natural Gas" provided by Statistics Canada (Table: 25-10-0055-01). The analysis leverages Power BI to explore production, consumption, and trade dynamics within Canada's natural gas sector. With dual-unit measurements (cubic metres and gigajoules), the dataset offers an insightful look at trends over several years. Using diverse visualizations—from gauge charts to line and bar charts—the project uncovers critical insights, including production versus consumption ratios, export dependencies, and seasonal trends. This research is aimed at helping stakeholders, policymakers, and industry analysts grasp the evolving dynamics of the northern energy market.

2. Dataset Overview

- **Title:** Supply and Disposition of Natural Gas, Monthly
- **Source:** Statistics Canada (Table 25-10-0055-01)
- **Period:** Jan 2016 – Mar 2025
- **Frequency:** Multi-year Monthly data
- **Units:** Cubic metres and Gigajoules (in thousands)
- **Variables:**

  - Gross Withdrawals
  - Marketable Production
  - Imports
  - Exports
  - Residential, Industrial, Commercial Consumption
  - Opening & Closing Inventory
  - Inventory Change

3. Key Features of the Data

- **Dual Units**: Enables both volume and energy analyses.
- **Sectoral Breakdown**: Disentangles residential, commercial, industrial demand.
- **Geographic Granularity**: National plus provincial breakdown.
- **Trade & Storage**: Imports/exports and inventory levels.

4. Purpose of the Article

This article serves a dual purpose:
- **Informationa**l: It delivers a clear narrative on natural gas supply and disposition trends to a diverse audience, including industry professionals and policymakers.
- **Methodological**: It demonstrates the practical use of Power BI for in-depth data analysis and visualization. Readers can learn how structured data models and well-designed dashboards can demystify complex energy datasets.

5. Purpose and Goal of the Analytics

Purpose: Build a Power BI dashboard to show Canada's natural gas supply and consumption trends, helping stakeholders analyze production, use and storage for better energy planning.

Goal: The primary objectives of this analysis include:
- **Energy Security**: Assess if Canada produces enough gas for itself.
- **Sector Planning**: Pinpoint high-demand sectors and seasonal peaks.
- **Trade Strategy**: Understand export reliance and opportunities.
- **Inventory Management**: Reveal storage patterns and risks.

6. Key Analytical Questions

To narrow our focus, the study addresses these questions:

- **Production Trends:** How has national natural gas production evolved, and what irregularities exist in its historical data?
- **Sectoral Consumption:** How do natural gas usage patterns differ among residential, industrial, and commercial sectors—and what seasonal variations emerge?
- **Trade Dynamics**: What are the implications of Canada's export dependency, and how do imports complement domestic production?
- **Inventory Patterns:** How do opening and closing inventories, and their variations, serve as indicators of market stability?

7. Data Modeling Approach

The backbone of this analysis lies in a well-structured Power BI data model. Based on the attached data model screenshot, the architecture features a star schema design that consolidates transactional and descriptive data:

- **Central Fact Table:** The Fact_Natural_Gas table is at the core, recording key metrics such as gross withdrawals, marketable production, import/export figures, consumption by sector, and inventory levels.
- **Dimension Tables:**
  - Date_Dim: This table provides comprehensive date-related information including month, quarter, and year values. It facilitates temporal slicing and trend analysis, enabling users to drill down into seasonal and historical trends with ease.
  - Geography_Dim: This dimension stores regional and geographical identifiers, which enrich the fact data and allow for spatial analyses. It enables comparisons across various geographic regions, offering insights into regional differences in natural gas supply and consumption.
  - Supply_and_Disposition_Dim: This table categorizes the key components of natural gas management, such as production, consumption, import/export activities, and inventory changes. It helps to frame the analytical context by clearly distinguishing between different aspects of the supply and disposition process.
  - Unit_of_Measure_Dim: This dimension details the measurement units used in the dataset, specifically the dual representations in cubic metres and gigajoules. It ensures proper unit standardization and supports easy conversion and verification across the dataset.
- **Data Relationships**: Clearly defined one-to-many relationships connect the fact table with various dimensions. These connections ensure referential integrity and enable dynamic filtering across visualizations. The model's design enhances both performance and ease of exploration, allowing users to drill down into granular details without compromising the overarching narrative.
- **Methodology:** Data cleaning and transformation were conducted using Power Query to standardize formats and address missing values. Custom DAX measures were then developed to calculate key ratios (e.g., production vs. consumption) and track trends over time. This robust data model underpins all subsequent dashboards and insights provided in the analysis.
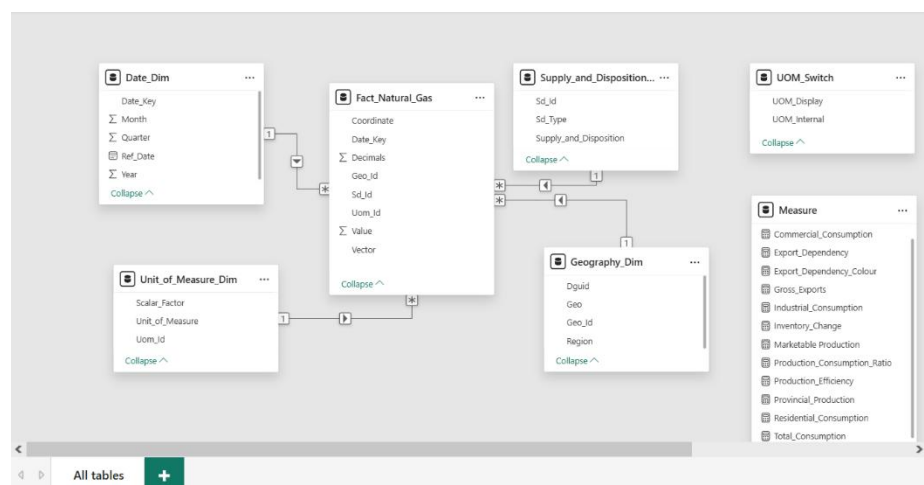
8. Metrics and KPIs

Operational Metrics and Insights:

- **Total Production Volume**

  - o *What:* Aggregate marketable production each month.
  - o *Why:* Indicates overall output capacity and growth trends.
  - o *How:* Line chart plotting monthly totals.
  - o *Insight:* Production climbed from ~167 M m³ in 2016 to ~199 M m³ by 2023, then dipped to ~51 M m³ in early 2024—suggesting seasonal or operational factors. Monthly Production Volume

- **Sectoral Consumption**

  - o *What:* Monthly natural gas use by residential, industrial, and commercial sectors.
  - o *Why:* Reveals which sectors drive demand and highlights seasonal peaks.
  - o *How:* Stacked bar chart, grouped by year and color-coded by sector.
  - o *Insight:* The industrial sector consistently uses the most gas (~60–65%), while residential consumption spikes in winter months

- **Gross Exports of Natural Gas**

  - o *What:* Total volume of natural gas exported each month.
  - o *Why:* Measures Canada's engagement in international trade and export capacity.
  - o *How:* Column chart showing annual export totals, annotated with values.
  - o *Insight:* Exports grew from ~81 M m³ in 2016 to ~87 M m³ in 2023, then fell to ~25 M m³ in early 2024—mirroring production shifts.

Strategic KPIs and Insights:

- **Production-Consumption Ratio (PCR) -** Marketable Production / Total Consumption
  - *Formula:* Total Production ÷ (Residential + Industrial + Commercial Consumption)
  - *Why:* A PCR above 1 means Canada produces more than it uses domestically.
  - *How:* Gauge visual with a target line at 1.0.
  - *Insight:* PCR averaged 1.3 over the period, confirming net self-sufficiency, but dropped to 1.1 in late 2023, signaling tighter domestic supply.

- **Export Dependency**: Gross Exports ÷ Total Marketable Production, measuring reliance on exports (target < 50% for diversification).
  - *Formula:* (Gross Exports ÷ Total Production Volume)*100
  - *Why:* Indicates the proportion of production destined for export (target < 50%).
  - *How:* Card visual formatted as a percentage, with green if below 50% and red if above.
  - *Insight:* Export dependency hovered around 45–50%, balancing revenue from exports against domestic needs.
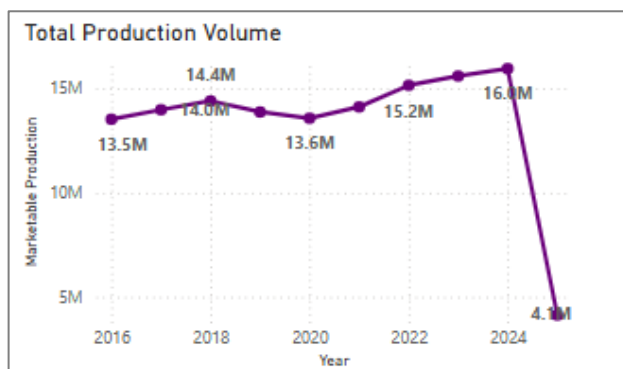
9. Visualization Walkthrough

Executive Dashboard View:
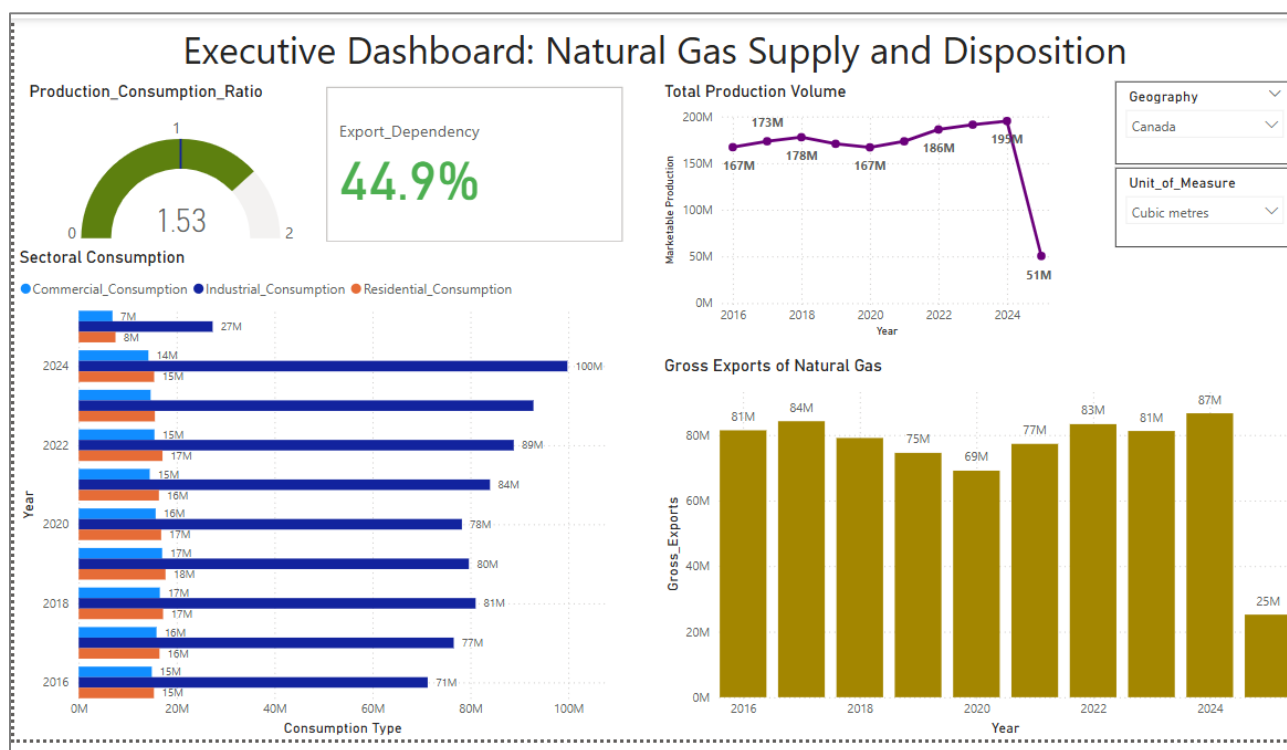
Below is a guided tour of the key dashboard visuals, each tied to our defined metrics and KPIs:

1. **Total Production Volume**
   o Visual: Line chart
   o X Axis: Date (Year)
   o Value: Total Production Volume
   o Interaction: Hover for exact values; use the drill down feature to zoom on specific years.


2. **Sectoral Consumption**
   o Visual: Stacked column chart
   o X Axis: Date (yearly grouping)
   o Legend: Sector (Residential, Industrial, Commercial)
   o Value: Sectoral Consumption volumes
   o Interaction: Click on a sector legend to isolate its trend; filter by province via the geography slicer.
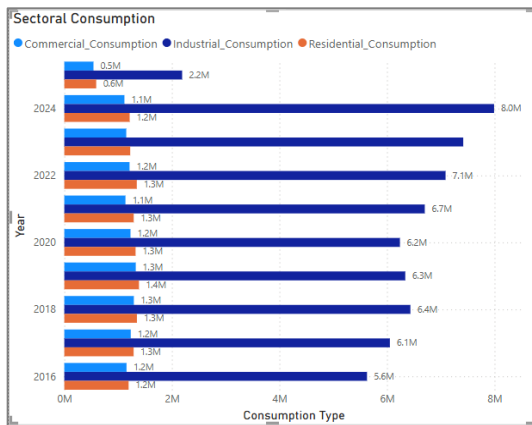
3. **Gross Exports of Natural Gas**
   o   Visual: Column chart
   o   X Axis: Date (Year)
   o   Value: Gross Exports
   o   Interaction: Use the unit-of-measure slicer to switch between m³ and GJ; Drill down to see changes on specific year.
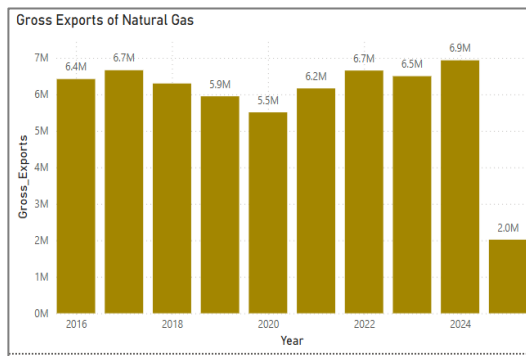

4. **Production-Consumption Ratio (PCR)**
   o   Visual: Gauge chart
   o   Value: PCR measure
   o   Target: 1.0 (self-sufficiency threshold)
   o   Interaction: Adjust date or province to see how PCR shifts; gauge color gradient indicates performance versus target
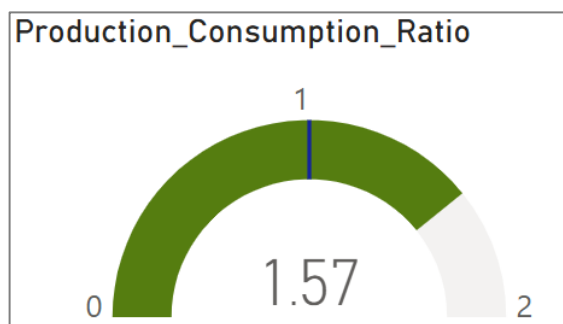
5. **Export Dependency**
   o Visual: KPI card
   o Value: Export Dependency %
   o Formatting: Green if < 50%, red if ≥ 50%
   o Interaction: Filter by province to track how export reliance changes. Also, filtering by time shows the trend evolves.
   o Each visual updates automatically when you interact with the Date, Geography, or Unit of Measure slicers, enabling a dynamic, multi-dimensional exploration of Canada's natural gas landscape.
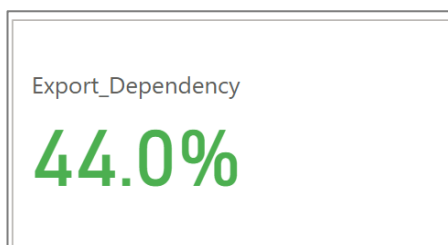
10.   Interactive Features

- **Unit Switching**: Slicer toggles between m³ and GJ.
- **Geography Selection**: Slicer toggles between Provinces and Canada.
- **Drill-through**: Click a province bar to view detailed monthly trends.
- **Tooltips**: Hover for exact values and comparison to prior period.

11.   Major Findings

- **Stable production** till 2023; **recent dip** needs investigation.
- **Industrial users** are the biggest consumers; **residential** is highly seasonal.
- **Exports** form ~half of production—high revenue but a potential vulnerability.
- **Inventory cycles** align with climate-driven demand.

12.   Challenges and Limitations

Every data analysis project comes with its unique set of challenges:

- **Data Completeness and Reliability:** Although Statistics Canada is a reputable source, the historical breadth of data may contain periods with gaps or inconsistencies. Interpreting sharp changes might require caution, as they could stem from reporting practices rather than actual market shifts.
- **Dynamic Market Influences**: The natural gas market is subject to volatile geopolitical, economic, and seasonal factors. While the historical analysis is robust, real-time dynamics may not be fully captured without supplemental data sources.
- **Visual Representation Constraints:** Although Power BI's dashboards provide valuable high-level insights, some of the subtle nuances inherent in the data might require deeper narrative explanations to fully appreciate the context.
- **Technical and Model Complexity**: Building a multifaceted data model (as confirmed by the attached screenshot) can introduce performance challenges. The complexity of relationships and calculations sometimes necessitates trade-offs between comprehensive analysis and dashboard responsiveness.

13.   Conclusions and Future Scope

Conclusion

This analysis provides a comprehensive exploration of Canada's natural gas supply and disposition landscape, revealing key trends and nuances that are critical in today's energy market. By integrating a structured data model with powerful visualizations in Power BI, the study illuminates vital metrics such as production-to-consumption ratios, export dependencies, and sectoral consumption changes. These insights not only inform stakeholders about current market conditions but also lay the groundwork for more sophisticated, forward-looking analyses.

Future Scope

- **Predictive Analytics**: Future efforts could integrate real-time data feeds and advanced forecasting models (e.g., time-series analysis) to predict shifts in production, consumption, and export trends—enabling proactive energy management.

- **External Data Integration**: Incorporating additional data points—such as economic indicators, weather patterns, and geopolitical events—could enhance the model and provide a more dynamic forecasting capability.
- **User-Centric Dashboard Design**: Creating specialized dashboards tailored to different audience segments (industry analysts, policymakers, investors) would ensure that the insights are directly applicable to diverse decision-making contexts.

14.　　References

- Statistics Canada: Table 25-10-0055-01
- Energy Canada Reports

- GitHub: https://raw.githubusercontent.com/nabde/sait-proj-pbi-1/refs/heads/main/natural_gas_s_and_d_stat_can_25100055.csv