INTRODUCTION AND PROJECT OVERVIEW

This report details a data science project focused on analyzing the supply and disposition of natural gas in Canada. The project aimed to develop a Power BI dashboard to visualize key trends, providing valuable insights for stakeholders involved in energy planning. By leveraging open-source data, we sought to understand production, consumption, and storage dynamics within Canada's energy sector.

Natural gas plays a crucial role in Canada's energy landscape, making its supply and disposition a vital area of study for energy security, economic resilience, and policy development. This project addresses these aspects by providing a comprehensive analytical tool.

OPEN-SOURCE DATA OF INTEREST: DATASET OVERVIEW

The dataset utilized for this project is sourced from Statistics Canada, specifically Table 25-10-0055-01. This publicly available dataset provides multi-year monthly data on natural gas.

Key characteristics of the dataset include:

- **Source:** Statistics Canada - Table 25-10-0055-01
- **Time Period Covered:** Multi-year monthly data
- **Units Used:** Cubic metres and gigajoules (in thousands)

KEY VARIABLES WITHIN THE DATASET

The Statistics Canada dataset provides a rich set of variables crucial for a comprehensive analysis of natural gas supply and disposition. These variables allow for in-depth exploration of various aspects of the natural gas market in Canada.

The key variables include:

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

WHY THIS DATASET? RELEVANCE AND VALUE

Our selection of this particular dataset was driven by several key factors that align with the goals of this data science project. The inherent characteristics of the data make it exceptionally suitable for our analytical objectives.

Reasons for selecting this dataset:

- **Relevance to Canada's Energy Sector:** The dataset directly pertains to Canada's natural gas industry, a critical component of the national economy and energy infrastructure.
- **Rich, Multi-Dimensional Data:** The inclusion of various variables, from production to consumption and trade, provides a comprehensive view of the natural gas ecosystem, allowing for multi-dimensional analysis.
- **Policy and Planning Value:** The insights derived from this data can directly inform policy decisions and strategic energy planning within Canada.
- **Alignment with Dashboard Goals:** The dataset's structure and content perfectly align with our objective of building a Power BI dashboard to visualize natural gas supply and consumption trends.

PURPOSE AND GOALS OF THE PROJECT

The overarching purpose of this project was to develop a robust Power BI dashboard to show Canada's natural gas supply and consumption trends, helping stakeholders analyze production, use and storage for better energy planning. This dashboard is intended to be a valuable tool for stakeholders, enabling them to analyze production, usage, and storage patterns for more effective energy planning.

Our specific goals for this analysis were to:

- Analyze trends in natural gas.
- Maintain a production-consumption ratio above 1 for energy security.
- Keep export dependency below 50% to support economic resilience.
- Support policy decisions through key production and consumption KPIs.
- Understand sector-wise consumption trends.

EXPECTATIONS AND ANTICIPATED FINDINGS

Before diving into the data analysis, we formed several expectations about the patterns and trends we anticipated finding within the natural gas supply and disposition data. These expectations guided our initial exploration and helped us frame our analytical questions.

What we expected to find:

- **Trend Patterns:** We anticipated observing consistent growth or fluctuations in gross withdrawals and marketable production over time.
- **Sector-Wise Consumption Differences:** Our hypothesis was that the industrial sector would exhibit higher consumption, with residential peaks during winter months.

- **Trade Dynamics:** We expected to confirm Canada as a net exporter of natural gas - tracking export dependency and import volumes.
- **Inventory Movements:** We predicted to identify seasonal buildup and drawdown patterns in natural gas inventory levels.

KEY ANALYTICAL QUESTIONS

To guide our analysis and ensure we addressed the most critical aspects of natural gas supply and disposition, we formulated three key analytical questions. These questions serve as the foundation for the insights derived from our Power BI dashboard.

Our key analytical questions were:

1. How have gross withdrawals and marketable production evolved over time across Canada?
2. How does natural gas consumption differ by sector (residential, industrial, commercial) and province?
3. What is Canada's natural gas trade balance (imports vs. exports), and how do inventory levels change over time?

METRICS AND KPIS: STRATEGIC OBJECTIVES

To effectively monitor and evaluate the natural gas landscape in Canada, we defined several key performance indicators (KPIs) and operational metrics. These measures are crucial for tracking progress towards our strategic and operational objectives.

Strategic KPIs:

- **Production-Consumption Ratio (PCR)**
    - **Formula:** Total Consumption/Total Marketable Production

    - **Goal:** Maintain ratio > 1 for energy security, indicating that domestic production meets or exceeds demand.

- **Export Dependency**
    - **Formula:** Total Marketable Production/Gross Exports
    - **Goal:** Keep below 50% to reduce over-reliance on exports and support domestic resilience. A high export dependency can signal an over-reliance on external markets.

METRICS AND KPIS: OPERATIONAL OBJECTIVES

In addition to strategic KPIs, we identified several operational metrics to track the day-to-day and year-to-year performance of Canada's natural gas sector. These metrics provide granular insights into various aspects of supply and demand.

Operational Metrics:

- **Total Production Volume Over Time:** Aggregate marketable production over time. It indicates overall output capacity and growth trends. It helps stakeholders assess supply reliability and make informed decisions on infrastructure and storage.
- **Sectoral Consumption Over Time:** Breakdown by Residential, Industrial, and Commercial use. This helps identify major consumers and monitor seasonal spikes. It is insightful for policy or pricing strategies.
- **Gross Exports Over Time:** Total volume of natural gas exported. It illustrates how much gas is exported from Canada each year and tracks the export trends and fluctuations. It supports analysis of Canada’s role in international energy trade.

CONNECTING AND MODELING IN POWER BI

The foundation of our Power BI dashboard lies in a well-structured data model. We sourced our data as a CSV file from Statistics Canada and then proceeded to model it using a star schema approach, which is ideal for analytical purposes.

Source Format: CSV from Statistics Canada

Data Model Structure:

- **Fact Table:**
    - Fact_Natural_Gas: This central table contains the core quantitative data, such as the Value of natural gas (production, consumption, etc.), linked to various dimensions through their respective keys.
- **Dimension Tables:**
    - Date_Dim: Contains date-related attributes like Date_Key, Month, Quarter, Ref_Date, and Year, allowing for time-based analysis.
    - Geography_Dim: Holds geographical information, including Dguid, Geo, Geo_Id, and Region, enabling analysis by province or region.
    - Supply_and_Disposition_Dim: Describes the type of natural gas activity, with fields like Sd_Id, Sd_Type, and Supply_and_Disposition (e.g., Gross Withdrawals, Marketable Production, etc.).
    - Unit_of_Measure_Dim: Contains information about the units of measurement, such as Scalar_Factor, Unit_of_Measure, and Uom_Id, allowing for flexibility in data presentation.

This star schema ensures efficient querying and clear relationships between data points, facilitating the creation of dynamic and insightful visualizations.

MEASURES DEFINED FOR THE DASHBOARD

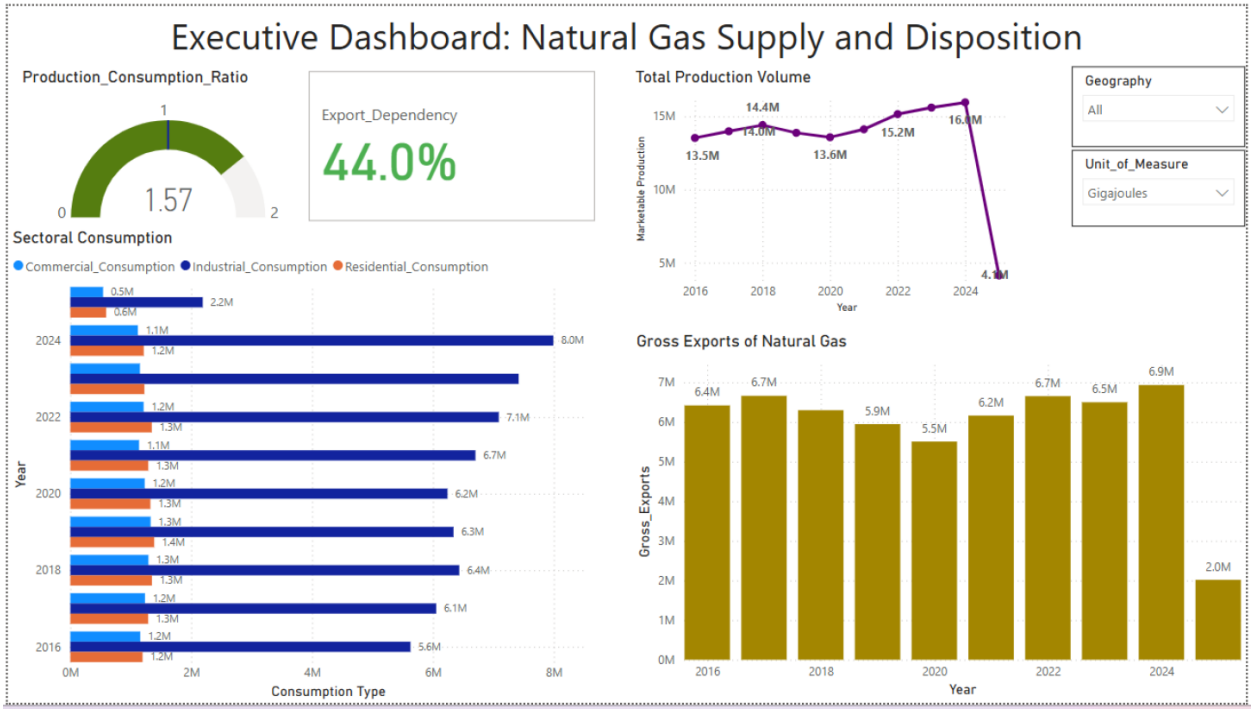
To derive meaningful insights from our data model, we created a series of measures in Power BI. These measures are crucial for calculating and presenting the KPIs and operational metrics on the dashboard.

Measures used to create the dashboard include:

- Marketable_Production
- Total_Consumption
- Gross_Exports
- Export_Dependency
- Export_Dependency_Colour (likely for conditional formatting on the dashboard)
- Production_Consumption_Ratio
- Residential_Consumption
- Industrial_Consumption
- Commercial_Consumption

These measures enable the calculations and aggregations necessary to visualize trends, ratios, and consumption patterns effectively within the Power BI environment.

EXECUTIVE DASHBOARD OVERVIEW



Our Power BI Executive Dashboard for Natural Gas Supply and Disposition provides a comprehensive at-a-glance view of key metrics and trends. It is designed to offer quick insights into Canada's natural gas landscape.

The dashboard prominently displays the following:

KPIs Displayed:

- **Production–Consumption Ratio (PCR)** – Gauge
- **Export Dependency** – KPI Card (%)

Operational Metrics Visuals:

- **Total Production Volume** – Line Chart
- **Sectoral Consumption** – Clustered Column
- **Gross Export** – Column Chart

This arrangement allows stakeholders to quickly grasp the overall status of natural gas supply and disposition, identify areas of concern, and understand underlying trends.

RESULTS: KEY DASHBOARD VISUALIZATIONS

The Power BI dashboard effectively visualizes the defined KPIs and operational metrics, providing a clear representation of Canada's natural gas supply and disposition.

- **Production_Consumption_Ratio:** A gauge showing the current PCR value. As per the dashboard image, it is **1.57**. This value is well above the target of 1, indicating strong self-sufficiency.
- **Export_Dependency:** A KPI card displaying the export dependency as a percentage. As per the dashboard image, it is **44.0%**. This is below the target of 50%, suggesting a healthy balance and reduced over-reliance on exports.
- **Total Production Volume:** A line chart illustrating the trend of total marketable production over time.
- **Sectoral Consumption:** A clustered column chart breaking down natural gas consumption across commercial, industrial, and residential sectors by year.
- **Gross Exports of Natural Gas:** A column chart showing the total volume of natural gas exported each year.

The dashboard also includes slicers for "Geography" and "Unit of Measure," allowing for interactive exploration of the data by province and preferred unit.

RESULTS: PRODUCTION-CONSUMPTION RATIO (PCR) ANALYSIS

The Production-Consumption Ratio (PCR) is a critical strategic KPI displayed on our dashboard. It directly indicates Canada's self-sufficiency in natural gas supply.

- **Definition:** The PCR shows the ratio of total marketable production to total consumption.
- **Interpretation:** A ratio above 1 indicates self-sufficiency in natural gas supply. It is useful for monitoring energy security.
- **Current Status (as per dashboard):** The dashboard shows a PCR of **1.57**. This is well above our target of greater than 1 (to ensure domestic production meets or exceeds demand), demonstrating Canada's strong position in natural gas self-sufficiency.

RESULTS: EXPORT DEPENDENCY ANALYSIS

Export Dependency is another vital strategic KPI that assesses Canada's reliance on international markets for its natural gas sales.

- **Formula:** Export Dependency is calculated as Gross Exports ÷ Total Marketable Production.
- **Significance:** High export dependency may indicate over-reliance on external markets.
- **Target:** Our target is to keep export dependency below 50% to reduce over-reliance on exports and support domestic resilience.
- **Current Status (as per dashboard):** The dashboard displays an Export Dependency of **44.0%**. This value is below our 50% target, indicating a healthy balance between domestic supply and international trade, thereby supporting domestic resilience.

RESULTS: TOTAL PRODUCTION VOLUME ANALYSIS

The Total Production Volume visual on the dashboard provides a clear trend of Canada's overall natural gas marketable production over time.

- **Purpose:** This visual tracks Canada’s overall natural gas marketable production over time.
- **Insights:** It indicates overall output capacity and growth trends.
- **Decision Support:** It helps stakeholders assess supply reliability and make informed decisions on infrastructure and storage.

The visual shows fluctuations in total production volume over the years, with a notable dip towards the end of the displayed period, which would warrant further investigation.

RESULTS: CONSUMPTION BY SECTOR ANALYSIS

Understanding how natural gas is consumed across different sectors is crucial for targeted policy development and resource allocation. The clustered column chart on the dashboard illustrates this breakdown.

- **Display:** These visual displays natural gas usage across key sectors: Residential, Industrial, and Commercial.
- **Utility:** It helps identify major consumers and monitor seasonal spikes.
- **Policy Implications:** It is insightful for policy or pricing strategies.

The chart allows for a quick comparison of consumption levels between sectors across different years, revealing which sector is the largest consumer and how consumption patterns change over time.

RESULTS: GROSS EXPORTS ANALYSIS

Gross Exports of natural gas represent Canada's contribution to the international energy market and are a significant aspect of its energy economy.

- **Purpose:** This visual illustrates how much gas is exported from Canada each year.
- **Tracking:** It tracks the export trends and fluctuations.
- **Strategic Importance:** It supports analysis of Canada’s role in international energy trade.

The chart shows varying levels of gross exports over the years, indicating the dynamic nature of international natural gas demand and supply.

DASHBOARD INTERACTIVITY: SLICERS

To enhance the user experience and provide dynamic data exploration, our Power BI dashboard incorporates interactive slicers. These tools allow users to filter and view data based on specific criteria.

- **Geography Slicer:** This slicer helps to see the provincial variations across the dashboard.
- **Unit of Measure Slicer:** This slicer helps to switch between two measuring units.

These slicers empower stakeholders to conduct more granular analysis and gain specific insights tailored to their needs.

CONCLUSIONS

This project successfully developed a comprehensive Power BI dashboard for analyzing Canada's natural gas supply and disposition. By focusing on key metrics and visualizations, we aimed to provide actionable insights for energy planning and policy development.

Key conclusions from our analysis and dashboard implementation include:

- **Strong Energy Security:** The consistently high Production-Consumption Ratio (PCR) above 1 demonstrates Canada's self-sufficiency in natural gas, ensuring domestic demand is met by local production.
- **Balanced Export Strategy:** The export dependency remaining below 50% indicates a healthy balance between serving domestic needs and participating in international markets, contributing to economic resilience.
- **Comprehensive Data Insights:** The dashboard effectively displays trends in total production volume, sectoral consumption, and gross exports, offering a multi-faceted view of the natural gas sector.
- **Empowering Stakeholders:** The interactive nature of the dashboard, facilitated by slicers, allows stakeholders to perform detailed analysis by geography and unit of measure, supporting informed decision-making.

Overall, the project has met its goals of providing a valuable tool for understanding and strategizing within Canada's natural gas energy sector. The insights derived can assist in maintaining energy security, fostering economic stability, and guiding future policy decisions.