Energy Consumption and Economic Growth Analysis

Project Overview

This project explores the relationship between energy consumption and economic growth across countries using the "Energy Consumption Dataset by Our World in Data" from Kaggle. The analysis focuses on energy consumption per capita and GDP per capita as key indicators, segmented by income levels. Both Python and Power BI were utilized for data transformation, analysis, and visualization, enabling a deeper understanding of global energy trends and their economic implications.

Data Preparation

1. Dataset Description

- The dataset includes key metrics such as energy consumption, GDP, population, and various energy-related statistics segmented by country and year.
- Primary variables analyzed:
    - `gdp_per_capita`: GDP per capita of countries.
    - `energy_per_capita`: Energy consumption per capita.
    - `income_level`: Income classification of countries (low, lower-middle, upper-middle, high).

2. Data Cleaning and Transformation

- Removed rows with missing or incomplete data to ensure accuracy.
- Converted `year` to the correct data type (integer) for consistency.
- Ensured appropriate data types for numerical and categorical fields (e.g., `gdp_per_capita` and `energy_per_capita` as decimal numbers).

3. Tools Used

- *Python*: For initial data cleaning and exploratory analysis.
- *Power BI*: For interactive visualizations and dashboard creation.

Key Findings

1. Overall Trends

- A strong positive correlation was observed between GDP per capita and energy consumption per capita

- High-income countries consistently consume more energy per capita compared to low-income countries.
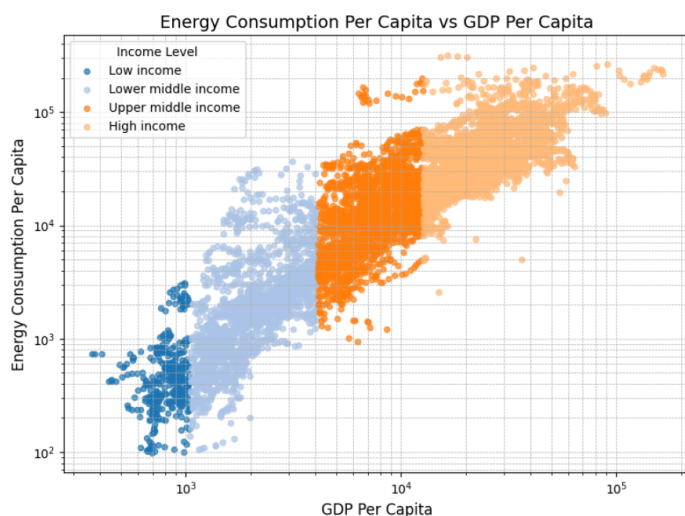
2. Income Level Insights

- *Low-Income Countries*: Concentrated in the lower spectrum of GDP and energy consumption per capita. Limited industrialization and reliance on low-energy activities likely contribute to these patterns.
- *Lower Middle-Income Countries*: Show gradual improvement in both GDP and energy consumption, reflecting economic development and energy access expansion.
- *Upper Middle-Income Countries*: Spread across a wider range, with some countries nearing high-income characteristics.
- High-Income Countries: Represent the highest levels of GDP and energy consumption, driven by industrialization, advanced infrastructure, and high living standards.

3. Energy Efficiency Variability

- The variation in energy consumption within income levels suggests differences in energy efficiency and resource utilization.
- Some high-energy, low-GDP countries likely represent resource-rich economies relying on energy-intensive industries.
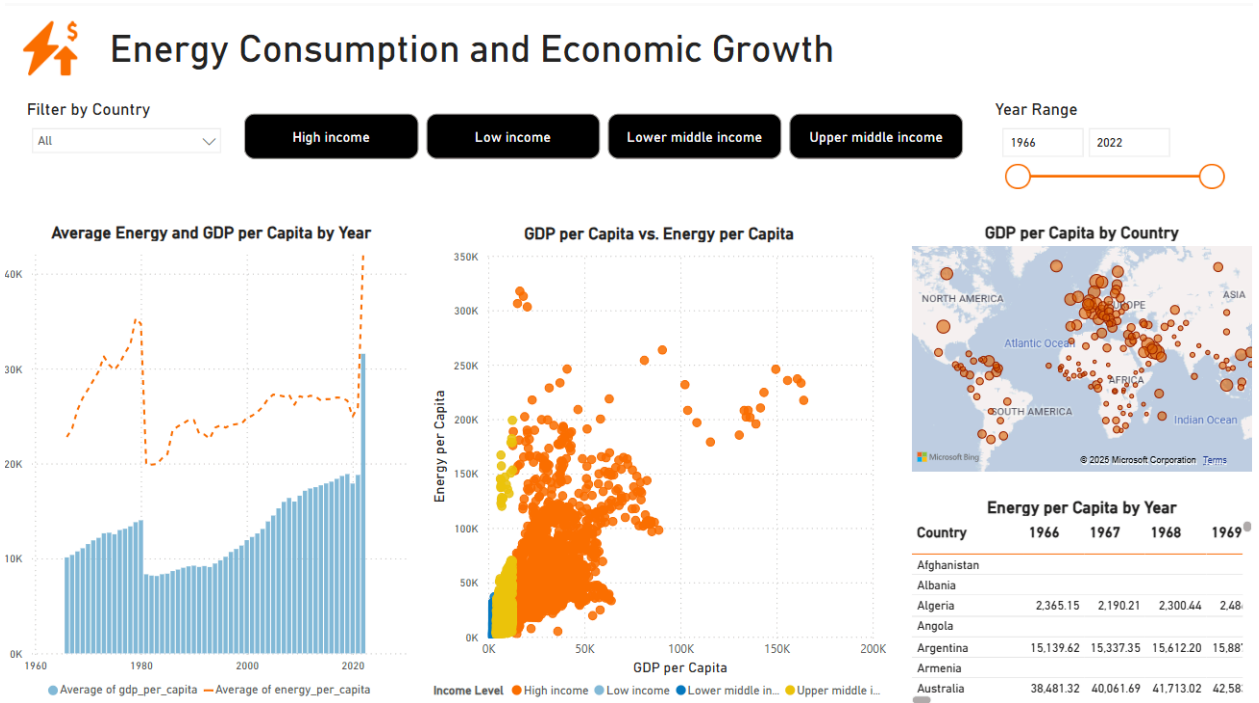
Visualizations and Insights

1. Python Visualizations

- *Scatter Plot*: Showed the relationship between `gdp_per_capita` and `energy_per_capita`, segmented by income level with a log–log scale.

  Insight: Confirmed the positive correlation and highlighted clusters by income group.

2. Power BI Interactive Dashboard

Average Energy and GDP Per Capita by Year (Bar and Line Chart):

- The bar chart shows the **average GDP per capita** over time, while the line chart represents **average energy consumption per capita**.
- **Key Insight**: While GDP per capita demonstrates steady growth over the decades, energy consumption per capita shows a fluctuating trend, with a sharp rise in the late 2020s. This could indicate economic resilience combined with periods of varying energy efficiency or consumption practices.
- **Recommendation**: Investigate periods of fluctuation (e.g., significant dips or spikes in energy consumption) to determine the causes, such as technological advancements, economic crises, or policy changes.

GDP Per Capita vs. Energy Per Capita (Scatter Plot):

- This scatter plot reinforces the relationship between energy consumption and GDP, segmented by income levels.

- **Key Insight:** High-income countries have significantly higher energy and GDP per capita compared to lower-income groups. However, lower-income countries display clustering at lower values, highlighting inequalities in energy access and economic output.
- **Recommendation:** Encourage sustainable energy investments in lower-income countries to reduce disparities and drive economic growth.

GDP Per Capita by Country (Map Visualization):

- The map visual highlights GDP per capita distribution across different regions.
- **Key Insight**: The highest GDP per capita values are concentrated in regions like **North America, Europe, and parts of Asia**, while African countries and parts of South Asia show lower GDP levels.
- **Recommendation**: Regional policies should focus on improving infrastructure and energy accessibility in underdeveloped regions to bridge economic gaps.

Energy Per Capita by Year and Country (Table Visualization):

- This table provides granular data on energy consumption per capita by country and year.
- **Key Insight:** The table format allows users to compare individual country trends over time. For instance, developed countries like Australia demonstrate consistently high energy consumption compared to developing nations.
- **Recommendation:** Use this table to identify outliers or patterns (e.g., sudden increases in energy usage) for deeper country-specific analysis.

Challenges and Limitations

- *Data Gaps*: Missing data for certain countries and years limited the scope of analysis.
- *Simplistic Aggregation*: Using average as the aggregation measure may oversimplify patterns; median or weighted averages could be explored in future iterations.
- *Income Classification*: Broad income categories may obscure within-group variations (e.g., disparities within "high-income" countries).

Conclusion and Recommendations

Energy vs. GDP Relationship: The strong correlation between GDP per capita and energy consumption suggests that economic growth is often accompanied by increased energy demand. However, the wide disparities across income levels indicate the need for sustainable energy strategies in lower-income regions.

Income Level Disparities: High-income countries dominate both GDP and energy consumption per capita metrics. Policies encouraging renewable energy adoption and economic aid for low- and middle-income countries could help achieve a more balanced global growth.

Future Analysis: Incorporate additional metrics like carbon emissions or renewable energy usage to understand the environmental impact of increasing energy consumption.

Next Steps

1. **Deep Dive into Energy Sources**
   - Analyze the role of renewable vs. non-renewable energy in economic growth.
2. **Regional Analysis**
   - Explore trends by continent or region for more granular insights.
3. **Advanced Metrics**
   - Include additional indicators like carbon intensity and energy access rates.

Appendices

- Dataset Link: [Kaggle – Energy Consumption Dataset]
- Code Repository: [GitHub Repository]
- Power BI Dashboard: Embedded visuals available upon request.