Exploring Global Energy Transition Trends

Group 6
Team Members: Dylan Kayyem
Github: https://github.com/dylankayyem/4502-Project-06

Project Description

Our project aims to analyze the "World Energy Consumption" dataset to uncover key insights into the dynamic landscape of global energy consumption and production. We will address five specific questions:

✓ **Renewable Energy Adoption Trends:** We will investigate how the annual changes in electricity generation from wind and solar sources have evolved over time, shedding light on countries at the forefront of renewable energy adoption.

✓ **Fossil Fuel Dependency and Electricity Generation:** Our analysis will focus on the annual changes in electricity generation from fossil fuels, allowing us to identify regions experiencing a notable shift away from fossil fuel-based electricity production.

✓ **Per Capita Energy Consumption and Economic Growth:** By examining the correlation between a country's per capita energy consumption and GDP, we aim to identify nations achieving remarkable economic growth while maintaining low energy intensity.

✓ **Carbon Intensity of Electricity Production:** We will explore the changing global trends in carbon intensity of electricity production, aiming to pinpoint countries leading in clean energy generation and those facing environmental challenges.

✓ **Hydropower and Wind Energy Growth:** Our analysis will track the annual changes in electricity generation from hydropower and wind energy sources, revealing countries that exhibit significant growth in these vital renewable energy sectors.

Through data analysis and visualization, we will provide valuable insights into the ongoing energy transition, environmental sustainability, and the economic implications of energy consumption patterns worldwide.

Prior Work

- ✓ **Energy Reports and Publications:** Numerous international organizations, such as the International Energy Agency (IEA), the World Energy Council, and the U.S. Energy Information Administration (EIA), regularly publish reports and data related to global energy consumption, production, and trends. These reports often include analyses, projections, and policy recommendations.
- ✓ **Academic Research:** Researchers in fields like energy economics, environmental science, and sustainability have conducted extensive studies on energy consumption patterns, the impact of renewable energy adoption, and the transition away from fossil fuels. Academic journals feature a wealth of peer-reviewed research on these topics.
- ✓ **Government and Policy Studies:** Many governments and policy institutions conduct studies on energy consumption to inform energy policies. These studies often assess the environmental and economic implications of energy choices and evaluate the progress toward sustainability goals.
- ✓ **Data Repositories:** Organizations like the World Bank, NASA, and the U.S. National Renewable Energy Laboratory (NREL) maintain data repositories and provide access to datasets related to energy consumption, production, and environmental factors. Researchers use these datasets for various analyses.

Given the wealth of prior work in this area, our project can benefit from building upon existing research, using the "World Energy Consumption" dataset to provide new insights or perspectives, and potentially contributing to the ongoing discussion on global energy transition and sustainability.

Datasets

✓ Data on Energy by Our World in Data

  ➤ https://www.kaggle.com/datasets/pralabhpoudel/world-energy-consumption/data

✓ This dataset consists of energy consumption and production of each country in respective years.

  ➤ **Energy consumption** (primary energy, energy mix and energy intensity): this data is sourced from a combination of two sources—the BP Statistical Review of World Energy and SHIFT Data Portal.

  ➤ **Electricity consumption** (electricity consumption, and electricity mix): this data is sourced from a combination of two sources—the BP Statistical Review of World Energy and EMBER – Global Electricity Dashboard.

  ➤ **Other variables:** this data is collected from a variety of sources (United Nations, World Bank, Gapminder, Maddison Project Database, etc.).

✓ Downloaded on Dylan Kayyem's local machine.

Proposed Work

Data Cleaning
- ✓ **Data Quality Check:** Begin by conducting a thorough data quality check. Identifying missing values, outliers, and any inconsistencies in the dataset and addressing them. Check for missing values in columns like "biofuel_cons_change_pct" or "greenhouse_gas_emissions" for example.

Data Preprocessing
- ✓ **Data Transformation:** Convert columns to appropriate data types if necessary. For instance, ensure that numeric columns are in numeric formats and date-related columns like "year" are in a consistent date format.
- ✓ **Feature Engineering:** Create derived features if they provide valuable insights. We can calculate the percentage of renewable
- ✓ energy consumption based on "renewables_consumption" and "energy_cons_change_twh" for example.
- ✓ **Normalization/Scaling:** Normalize or scale numeric features to ensure they are on the same scale, which can be important for certain machine learning algorithms.

Data Integration
- ✓ **Data Aggregation:** Aggregate data at different levels (e.g., yearly totals, regional aggregates) for a higher-level analysis.
- ✓ **Data Transformation:** Apply any transformation required for specific analysis, such as calculating percentage changes or shares of total energy consumption.
- ✓ **Merging with External Data:** Potential to integrate external datasets that may provide additional context or variables related to energy consumption and environmental factors.

List of Tools

✓ Cleaning and Preprocessing:

  - Python

  - Pandas

  - NumPy

✓ Data Integration and Analysis:

  - Matplotlib

  - Seaborn

  - Plotly

✓ If needed:

  - SQL databases like MySQL or PostgreSQL

Evaluation

✓ **Descriptive Statistics:** Calculate summary statistics (mean, median, standard deviation, etc.) for key variables to understand the central tendencies and variations in the data.

✓ **Data Visualization:** Create visualizations such as histograms, box plots, scatter plots, and time series plots to explore the data visually and identify any trends or anomalies.

✓ **Correlation Analysis:** Calculate correlations between variables to identify relationships between different energy consumption metrics and environmental factors.

✓ **Regression Analysis:** Perform regression analysis to model relationships between dependent and independent variables.

✓ **Comparative Analysis:** Compare energy consumption trends over different years, countries, or regions to identify insights and patterns.

✓ **Data Validation:** Validate the integrated dataset against external sources or historical records to ensure accuracy.

✓ **Documentation:** Document data cleaning, preprocessing, and integration steps thoroughly to ensure transparency and reproducibility.