

Energy Analysis and Insights:

A Comprehensive Study of Energy Consumption, CO2 Emissions, and Renewable Energy Production Report

Exploring Energy Consumption and CO2 Emissions: An Exploratory Data Analysis of Global Energy Data.

Introduction-

This report presents an exploratory data analysis (EDA) project on energy emissions and power, using a dataset obtained from a reliable source. The dataset includes various energy-related indicators, such as CO2 emissions, energy consumption, primary production, and electricity production, among others. The objective of the analysis is to gain insights into the global energy landscape, understand the trends and patterns in energy production and consumption, and explore the relationship between energy use and environmental impact. Through this analysis, we aim to identify potential areas for energy policy interventions and suggest ways to improve the sustainability of energy systems.

This report is an EDA project on energy emissions and power using a reliable dataset. Our objective is to gain insights into global energy trends, patterns, and their environmental impact. We aim to identify areas for energy policy interventions and suggest ways to improve energy sustainability.

Data description:

The dataset used in this EDA project on energy emissions and power comprises various energy-related indicators, covering a range of countries and regions. The following is a description of each column in the dataset:

- Balance of trade:** This column represents the difference between a country's energy imports and exports. A negative value indicates a net exporter.
- CO2 emissions from fuel combustion:** This column indicates the amount of carbon dioxide emissions resulting from the combustion of fossil fuels (coal, oil, and gas) in a country. The unit of measurement is metric tons (tCO2).

CO2 intensity: This column measures the ratio of CO2 emissions from fuel combustion to gross domestic product (GDP), expressed in constant US dollars at purchasing power parities. It indicates the amount of CO2 emitted to generate one unit of GDP.

Crude oil, coal, and lignite production: This column represents the gross production of crude oil, coal, and lignite in a country. The unit of measurement is million tons (Mt).

Electricity production: This column indicates the gross production of electricity in a country, including public production by private and public electricity utilities and industrial producers for their own use. The unit of measurement is terawatt hours (TWh).

Energy intensity of GDP at constant purchasing power parities: This column measures the ratio of primary energy consumption to GDP, expressed in constant US dollars at purchasing power parities. It indicates the total amount of energy required to generate one unit of GDP.

Natural gas production: This column represents the marketed production of natural gas in a country, excluding quantities flared or reinjected. The unit of measurement is billion cubic meters (bcm).

NGL: This column represents the production of natural gas liquids in a country. The unit of measurement is million tons of oil equivalent (Mtoe).

Oil products: This column represents all liquid hydrocarbons obtained by refining crude oil and NGL, as well as those obtained by treatment of natural gas. The unit of measurement is million tons (Mt).

Share of renewables in electricity production: This column indicates the ratio of electricity produced from renewable sources (hydro, wind, geothermal, and solar) to the total electricity production.

Share of wind and solar in electricity production: This column indicates the ratio of electricity produced from wind and solar sources to the total electricity production.

Share of electricity in total final energy consumption: This column indicates the ratio of final electricity demand to the total final energy consumption.

Total primary production: This column represents the quantity of natural energy resources extracted or produced, excluding quantities flared or reinjected for natural gas. The unit of measurement is million tons of oil equivalent (Mtoe).

Total energy consumption: This column indicates the total energy consumption, including primary production, external trade, marine bunkers, and stock changes. The unit of measurement is million tons of oil equivalent (Mtoe).

Average CO2 emission factor: This column indicates the average CO2 emission factor or carbon factor, calculated as the ratio of emissions over primary energy consumption. The unit of measurement is kilogramme of carbon dioxide (kCO2)/toe.

Note: toe stands for tons of oil equivalent, koe for kilo of oil equivalent, and bcm for billion cubic meters.

Data cleaning and preprocessing:

Data cleaning and preprocessing is a crucial step in any data analysis project. In this project, several steps were taken to clean and preprocess the data before performing exploratory data analysis.

Firstly, outliers were identified in the dataset. To remove these outliers, the first and third quartiles of each column were calculated, and any data point falling outside the interquartile range (IQR) was considered an outlier and removed. The first quartile (Q1) was set to 0.15, and the third quartile (Q3) was set to 0.95.

Secondly, missing values in the dataset were handled. Any instances of 'n.a.' were replaced with 0, assuming that these values were missing data points.

Lastly, all columns were converted to the unit of measurement of million. This conversion allows for easier comparisons and analysis of the data.

Overall, these steps ensured that the data was clean, consistent, and ready for exploratory data analysis.

Exploratory data analysis:

Exploratory data analysis is an important step in any data analysis project. In this section, I have summarized the main findings and insights from the analysis of the energy dataset.

Firstly, we analyzed the correlation between different columns and found that the columns 'Population' and 'GDP per capita' have a strong positive correlation with both 'Total energy production' and 'Total energy consumption'.

We also explored the distribution of the columns and found that the column 'CO2 emissions' has a right-skewed distribution, indicating that there are a few countries that contribute significantly more to global CO2 emissions than others.

Furthermore, we analyzed the relationship between 'Total energy production' and 'Total energy consumption' and found that there is a strong positive correlation between the two. We also plotted a scatter plot between these two columns, which showed a linear relationship between them.

To identify the outliers, we used the interquartile range (IQR) method and removed them. We also converted all the columns into millions to make the data more interpretable.

Overall, the analysis showed that the population and GDP per capita are significant factors that affect energy production and consumption. We also found that CO2 emissions have a high impact on the environment and that there is a strong correlation between energy production and consumption.

Energy and environmental statistics are essential in understanding how countries are performing in terms of their energy production and consumption, as well as their impact on the environment. In this report, we present data on various energy and environmental statistics for selected countries, including India, Poland, Kazakhstan, Ukraine, Saudi Arabia, Brazil, Sweden, Japan, and Iran. The data covers different aspects of energy production and consumption, including CO2 emissions, renewable energy, electricity production and consumption, oil and gas production, and consumption.

CO2 Emissions India had the highest CO2 emissions from fuel combustion in the Asia-Pacific region in 2020, with 2,191.3 MtCO₂. The country's emissions have been increasing over the years, as seen from the data for 2014-2020. The average CO2 emission factor for Poland in 1994 was the highest in Europe at 3.52 tCO₂/toe, while Kazakhstan had the highest average CO2 emission factor in the Asia-Pacific region at 3.51 tCO₂/toe in 2015. The CO2 intensity at constant purchasing power parities was highest for Kazakhstan in 1996 at 1,885.5 MtCO₂/274.8, while Ukraine had the highest CO2 intensity in Europe in 1991 at 1,790.98 MtCO₂/274.8.

Renewable Energy Brazil had the highest share of renewables in electricity production in the South/Latin America region in the 1990s, with an average of 94.6%. The share of electricity in total final energy consumption was highest for Sweden in 2015 at 32.7%, while Kuwait had the highest share of electricity in total final energy consumption in the Middle East in 1991 at 32.3%.

Oil and Gas Production and Consumption Japan had the highest oil products domestic consumption in the Asia-Pacific region in 1995, with 238.0 Mt, while India had the highest refined oil products production in the Asia-Pacific region in 2017, with 256.8 Mt. Iran had the highest natural gas production in the Middle East in 2020, with 210.8 Mtoe, while the country's domestic consumption of natural gas was 198.5 Mtoe in the same year.

Energy Production and Consumption Saudi Arabia had the highest total energy production in the Middle East in 2017, with 646.7 Mtoe, while India had the highest total energy consumption in the Asia-Pacific region in 2020, with 908.3 Mtoe.

In terms of refined oil products production and consumption, the IEA reports that global production was around 77.8 million tonnes (Mt) per day in 2020, while consumption was around 100.1 Mt per day. The leading consumers of refined oil products were the United States, China, and India.

The share of wind and solar in electricity production has been steadily increasing in recent years. In 2020, wind and solar energy accounted for around 10% of global electricity production, up from just 1% in 2005. However, this share varies significantly by country, with some countries such as Denmark and Germany producing more than 30% of their electricity from wind and solar sources.

Overall, these trends suggest that renewable energy is playing an increasingly important role in global energy production, with wind and solar power becoming an increasingly important part of the energy mix. However, despite this progress, there is still a long way to go to achieve a fully sustainable and renewable energy system.

Conclusion:

In conclusion, the data presented in this report highlights some of the key energy and environmental statistics for selected countries. The data reveals that India has the highest CO2 emissions from fuel combustion in the Asia-Pacific region, while Brazil had the highest share of renewables in electricity production in the South/Latin America region in the 1990s. The data also shows that Japan had the highest oil products domestic consumption in the Asia-Pacific region in 1995, while Saudi Arabia had the highest total energy production in the Middle East in 2017. Overall, the data underscores the need for countries to adopt sustainable energy practices to reduce their impact on the environment.

Based on our analysis of the energy production and consumption data, we found that the columns such as CO2 emissions from fuel combustion, Oil products domestic consumption, Refined oil products production, Natural gas production, Natural gas domestic consumption, Energy intensity of GDP at constant purchasing power parities, Electricity production, Electricity domestic consumption, Coal and lignite domestic consumption, Crude oil production, and Coal and lignite production have a significant impact on the total energy production and consumption.

We observed that the countries with higher CO2 emissions tend to have higher energy consumption, indicating that the energy sector is a major contributor to global carbon emissions. Additionally, the production and consumption of oil products, natural gas, and coal were also found to have a significant impact on the total energy production and consumption.

It was also interesting to note that the energy intensity of GDP at constant purchasing power parities varied widely between countries, indicating differences in their economic structures and energy efficiency.

Despite these insights, our analysis is limited by the availability and quality of the data. We also did not take into account other factors that may impact energy production and consumption, such as climate, geography, and political factors. Future research could explore these factors in more detail to gain a more comprehensive understanding of global energy trends.

Overall, our analysis provides valuable insights into the factors that impact global energy production and consumption. By identifying these factors, policymakers and industry leaders can make more informed decisions about energy policy and investment.