DS5110 Project Report

Title: Analyzing Global Electricity Statistics

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Summary:

Electricity is a critical component of modern life, and reliable access to electricity is essential for economic growth and human development. As economies continue to grow and become more industrialized, the demand for electricity is also increasing.

To ensure that electricity is produced efficiently and sustainably, it is crucial to monitor and analyze the trends and patterns of electricity production. By gaining insights into global electricity production, we can make informed decisions to promote a reliable and sustainable energy future.

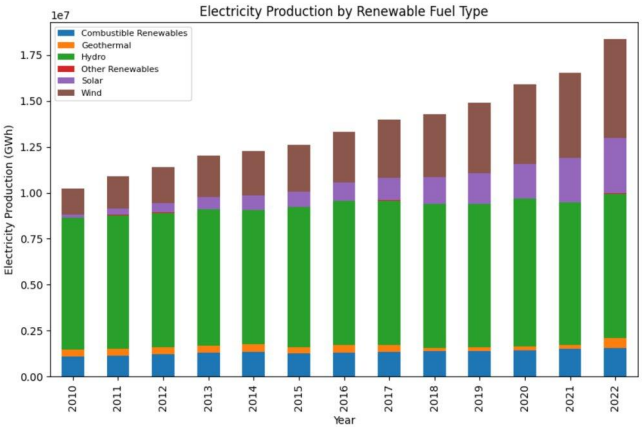
Analyzing the relationship between electricity production and economic growth is crucial for making informed decisions and policies that promote both economic development and environmental sustainability. In this project, we aim to explore the relationship between electricity production and a country's GDP. Specifically, we will analyze the Monthly Electricity Statistics dataset obtained from the International Energy Agency (IEA) website to identify patterns and trends in electricity production worldwide, and examine correlations between electricity production and a country's GDP using dataset obtained from WorldBank.

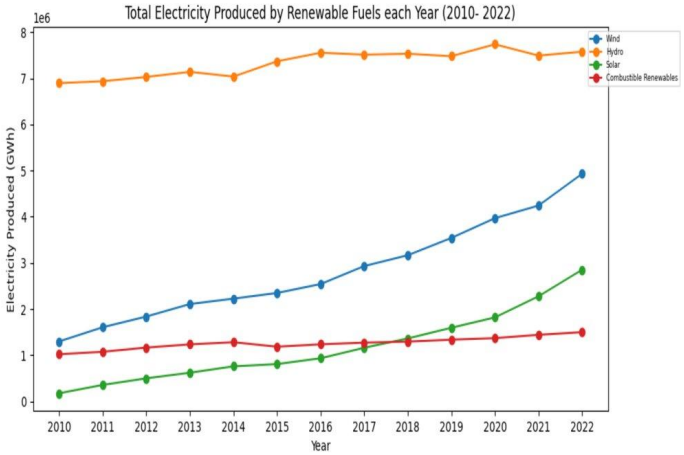
Ultimately, the project seeks to provide a comprehensive analysis of the relationship between electricity production for different fuel types, and contribute to a better understanding of global energy trends and patterns, gain insights into the relationship between electricity production and economic activity and develop an algorithm that can forecast future events or outcomes based on historical data.

Methods: Refer to the Methods pdf.

Results:

ELECTRICITY PRODUCTION BY RENEWABLE FUEL:

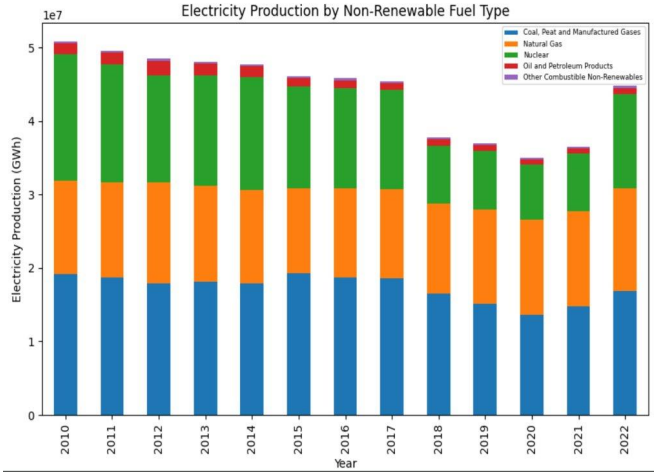


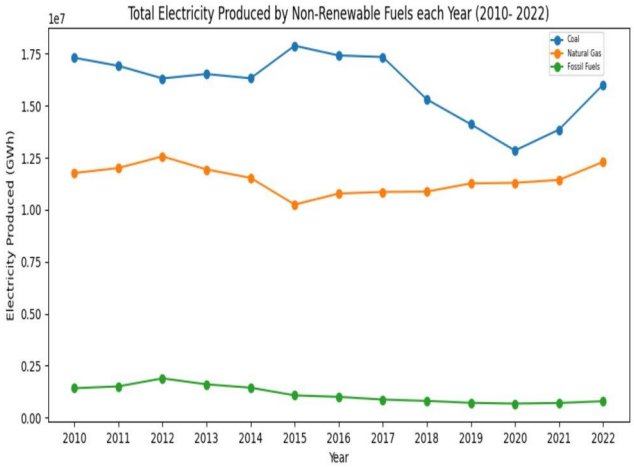


The above charts show the total electricity production in GWh (Gigawatt-hours) by renewable fuel type for each year from 2010 to 2022. One of the key takeaways from the above plots is that hydroelectric power has been the most dominant renewable energy source over the years, indicating that it has consistently produced more electricity than any other renewable fuel type. Another

important trend from the plots is the increase in the production of wind power over time. The electricity produced by wind power was relatively small during the early years but it has grown steadily over time.
A third trend that is apparent from the plots is the rapid increase in the production of solar power from around 2016 onwards. This is consistent with the fact that solar power has become much more affordable in recent years, thanks in part to advances in technology and manufacturing processes. Overall, the plots provide a useful overview of the trends in renewable energy production over time, and allows us to identify which types of renewable energy are becoming more popular over time.

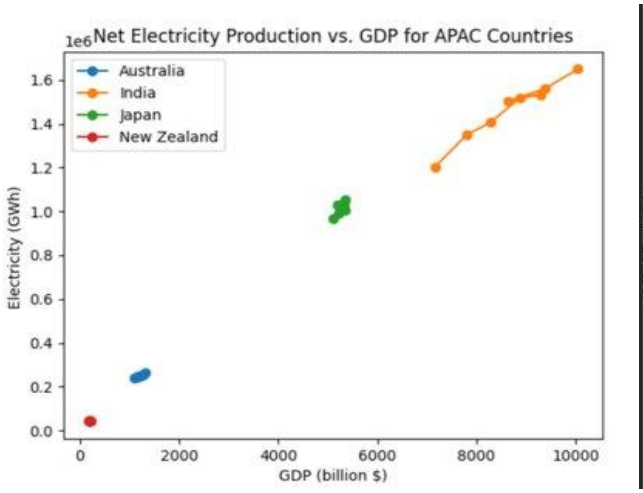
ELECTRICITY PRODUCTION BY NON-RENEWABLE FUEL:

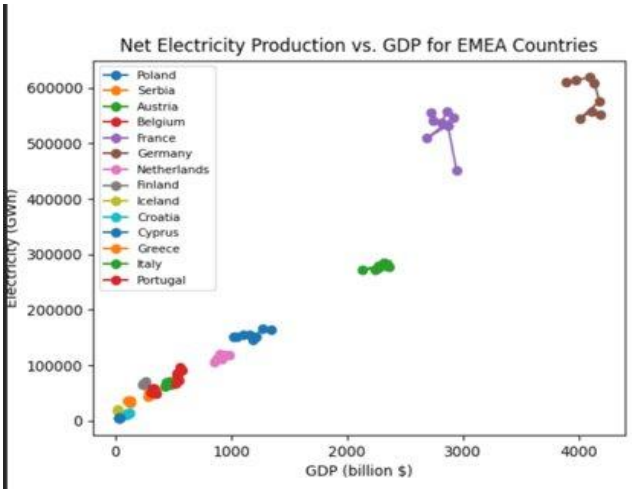




The above charts show the total electricity production in GWh (Gigawatt-hours) by non-renewable fuel type for each year from 2010 to 2022. From the plots, we can see that coal has consistently been the primary source of electricity production, followed by natural gas. There is a slight dip in the electricity produced by coal in 2020 which indicates that it might possibly be due to the COVID-19 pandemic. We can also see that there has been a decrease in electricity production from coal since 2016, while there has been a slight increase in electricity production from natural gas during the same period. This suggests a shift in the use of non-renewable fuels for electricity production towards natural gas.
Another trend that is apparent in the chart is the relatively stable production of oil and petroleum products over time. Electricity produced by fossil fuels has remained relatively consistent throughout the plot, indicating that they have not experienced significant growth or decline over time.

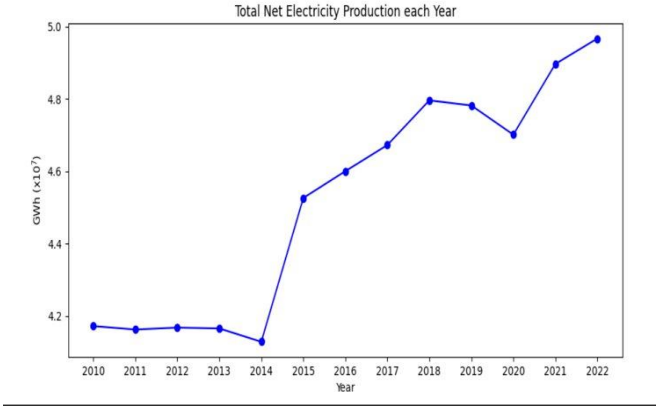
NET ELECTRICITY PRODUCTION V/S GDP:

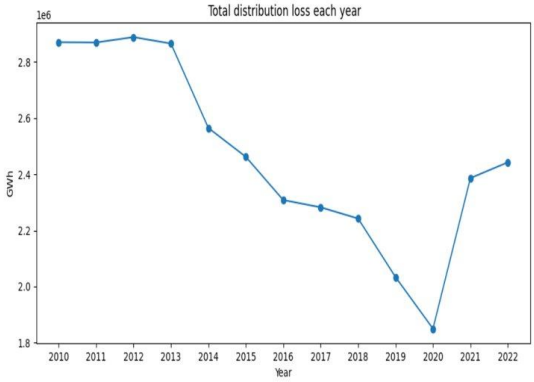




Based on the analysis of the gross domestic product (GDP) and electricity values for the Asia Pacific (APAC) and Europe, Middle East, and Africa (EMEA) regions, a linear relationship has been observed. This indicates that there is a significant correlation between these two variables. The analysis suggests that as GDP increases, so does the demand for electricity, and consequently, electricity consumption increases. The relationship is further strengthened by the fact that industries and businesses, which contribute significantly to the GDP of a country, require a considerable amount of electricity to function. The linear relationship between GDP and electricity consumption highlights the importance of a stable and reliable energy supply in fostering economic growth and development. This information can be valuable in informing policy decisions and investment strategies that aim to promote sustainable economic growth and energy security.

NET ELECTRICITY PRODUCTION VS DISTRIBUTION LOSS:

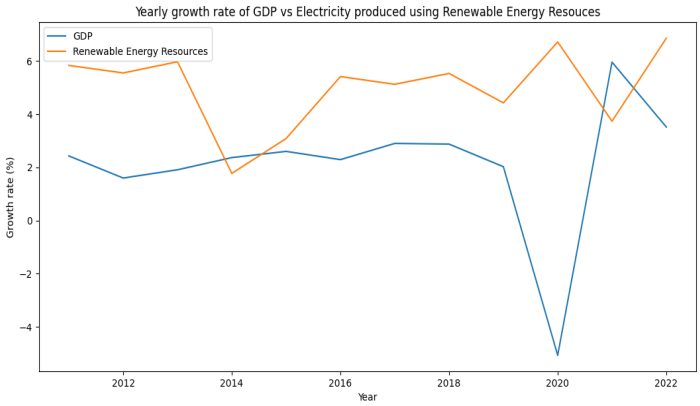


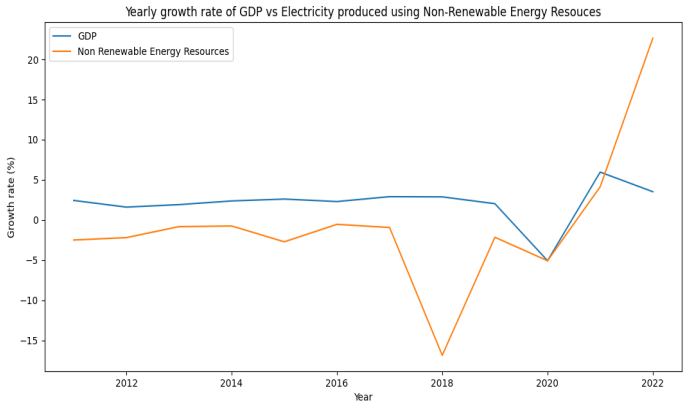


There is an inverse relationship between net electricity production and distribution losses during the initial years, with higher distribution losses observed during the years when net electricity production was lower. This relationship can be attributed to the fact that lower production requires less transmission and distribution infrastructure, resulting in less efficient and less reliable energy supply.

As net electricity production began to increase, we see a decrease in distribution losses, indicating an improvement in the efficiency of the energy system. This trend continued from 2018 to 2022, where we see a similar pattern in the values for both net electricity production and distribution losses, suggesting that the energy system has reached a level of stability in terms of its infrastructure, maintenance, and operational practices.

COMPARISON OF YEARLY GROWTH RATE OF GDP V/S ELECTRICITY PRODUCED USING RENEWABLE AND NONRENEWABLE ENERGY RESOURCES:





From the above graphs we can see that there is a complex relationship between a country's GDP (Gross Domestic Product) and the production of electricity using different energy resources. The graph can be used to analyze the trends in the growth rates of GDP and electricity production over the 10-year period. If the lines slope upwards, it indicates an increase in growth rate, while a downwards sloping line indicates a decrease in growth rate. If the lines are flat, it indicates that the growth rate remained constant over the years.

One key insight that can be gleaned from these charts is that there is a strong positive correlation between electricity demand and real GDP growth in emerging and developing economies. This means that as electricity demand increases in these countries, their economies tend to grow as well. Another insight that can be derived from the chart is that the growth in electricity demand tends to lead the growth in real GDP. This is indicated by the fact that the line for electricity demand is generally steeper than the line for real GDP growth, indicating that the former tends to increase more rapidly than the latter. Additionally, the chart shows that there was a significant dip in both electricity demand and real GDP growth in emerging and developing economies in 2020, likely due to the COVID-19 pandemic and the resulting economic slowdown.

Discussion:

What is the meaning and impact of the results?

- The fuel mix of electricity production can change due to various factors such as the availability of resources, policy changes, or technological advancements. Visualizing the trends in the dataset can help to identify such shifts and provide insights into the drivers behind them. This information can be valuable for forecasting future energy scenarios and planning for the transition to cleaner or more sustainable energy sources.
- Visualizing data on electricity production by fuel type can be an effective tool for decision-makers in identifying the most efficient and sustainable energy sources for a particular region or country. This can inform policy decisions related to energy production and lead to a more reliable and sustainable energy future.
- Understanding the relationship between electricity production and economic growth can inform policies related to energy investment and infrastructure development. By identifying the factors that influence electricity production, we can develop strategies to accelerate economic growth and promote sustainable energy practices.
- Time series forecasting can help energy producers plan and allocate resources more effectively, leading to reduced greenhouse gas emissions and a smaller carbon footprint.

Who is able to benefit from this project? How can the results be used to make better-informed decisions?

- Energy companies may use the insights to make decisions related to investments in new power plants or fuel sources.
- Researchers and academics can use these results to better understand trends in energy production and consumption, and to develop new models for forecasting future electricity demand and production.
- Policymakers and government agencies responsible for developing energy policies and regulating the energy sector can benefit from the findings of our project. They can use the results to design policies and regulations that promote sustainable and efficient electricity production, which can in turn drive economic growth.

What could be improved about the project in future work?

- Developing more advanced visualizations that allow for more nuanced insights and comparisons between different fuel types or regions.
- Incorporating data from additional sources to provide a more comprehensive view of electricity production and consumption.

Statement of contributions:

Karthik Chintamani Dileep: I made valuable contributions to all stages of the data analysis pipeline, including data collection, preprocessing, and modeling. To start, I conducted an extensive search for relevant data sources and identified the most reliable and informative datasets. Next, I performed various data preprocessing tasks, such as cleaning, feature selection, and data transformation, to ensure the data was suitable for analysis. Additionally, I applied linear regression and ARIMA modeling techniques to the data to generate accurate and robust predictions. My modeling work also involved rigorous evaluation of the models' performance, which helped identify areas for improvement and fine-tuning. Overall, my contributions were critical to the success of the project and helped deliver insights and predictions that will be valuable.

Shrada Chellasami: Conducted research on global electricity statistics and identified relevant datasets for analysis. Developed data visualizations and analyzed trends between GDP and global electricity production using different energy resources such as Renewable and Non-Renewable energy resources and consumption. Collaborated with team members to identify key findings and insights from the data analysis. Co-authored the final report and presentation, which highlighted the team's findings and recommendations based on the data analysis.

Shreya Nelakonda: Analyzed data for electricity statistics from various countries around the world and helped in identifying relevant datasets. Developed data visualizations to help uncover patterns and trends in electricity production for different fuel types. Worked closely with my team members to interpret the results, derive meaningful insights from the data and to co-author the final report and presentation.

Sumayya Naseem: I played a pivotal role in our team's analysis of electricity statistics by proposing the inclusion of GDP data to better understand their interdependence. By creating two critical plots - "Net Electricity Production vs Distribution Loss" and "Net Electricity Production vs GDP" - I helped analyze and interpret the data, leading to valuable conclusions. Beyond these contributions, I also collaborated with the team to analyze the data and formulate conclusions for the project report and presentation.

References:

Monthly Electricity Statistics obtained from IEA:

- Dataset: https://www.iea.org/data-and-statistics/data-product/monthly-electricity-statistic
- Documentation:https://iea.blob.core.windows.net/assets/18d269a6-777a-4368-b073-c407a2b8e44c/Monthlyelectricitystatistics_Documentation.pdf

GDP Dataset obtained from WorldBank:

- https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?end=2021&start=1960&view=chart

Appendix:

Code: https://github.com/karthikcd7/Analyzing-Global-Electricity-Statistics-IDMP