DSAN 5550

Data Science & Climate Change

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<div align="center">**Rising Global Temperatures Impact on Energy Poverty**</div>

Problem Detection

The ongoing rise in global temperatures has led to significant environmental impacts, from severe weather events to energy surplus and poverty. One notable consequence is the increase in energy poverty– a lack of access to modern, reliable, and affordable energy services, including electricity and clean cooking facilities. This issue disproportionately affects low-income and rural communities and exacerbates existing inequalities. This project aims to establish the correlation between rising global temperatures and energy poverty while predicting future energy poverty indexes based on temperature projections. Understanding this relationship is crucial in anticipating how energy poverty may increase in response to global temperatures, thereby informing policy decisions and targeting interventions for vulnerable populations.

Data Collection & Refinement.

The data used in this project will be from various sources: The World Bank, The Intergovernmental Panel on Climate Change (IPCC), CEIC Data, the National Oceanic and Atmospheric Administration (NOAA), and Enerdata.

Access to Electricity / % Population: This dataset, provided by the World Bank Group, will be utilized to identify indicators of energy poverty and pinpoint countries most affected. The data will be refined by focusing on key columns such as "Access to electricity, urban (% of urban population)" and "Access to electricity, rural (% of rural population)," allowing for targeted analysis of energy poverty hotspots. [1]

IPCC AR5 Seasonal Temperature & Precipitation Extremes: The dataset IPCC will be used to analyze average seasonal and annual temperature and precipitation extremes across three periods: 2016-2035, 2046-2065, and 2081-2100. This data will used to assist in predicting energy poverty indexes in relation to temperature forecasts. The dataset will be refined by focusing on the predictions for the next 11 years, ending in 2035, rather than encompassing the entire dataset.

N.B: Should a more comprehensive dataset become available that allows for a deeper analysis, this dataset may be changed or added onto. [2]

Global Land and Ocean Average Temperature Anomalies: This dataset from the National Oceanic and Atmospheric Administration (NOAA) illustrates the rise in global temperatures from 1900 to the present day. It will be analyzed alongside the World Bank dataset to establish a correlation between increasing global temperatures and energy poverty. For this analysis, the dataset will be refined to include only the years after 1998, aligning with the start date of the Access to Electricity dataset. [3]

Energy Prices per Country: This dataset from the World Bank includes energy prices from 2013 to 2019 and will be used alongside the additional datasets to create an *additional poverty index*. This new index will be compared with the initial poverty index from the Access to Electricity dataset and used to establish a correlation between energy poverty and global temperatures. For analysis, the dataset will be refined to focus on the top 20 countries with the highest poverty indexes from the initial Access to Electricity dataset. [4]

Energy Consumption Index: This dataset from Enerdata offers a time series of energy consumption indices per country. It will be used in combination with the Energy Prices per Country dataset to create the *additional poverty index*. To ensure consistency with the Energy Prices dataset, this dataset will be narrowed down to include only consumption data from 2013 - 2019 and the unit of measurement will be converted from Mtoe to kWh. [5]

Annual Household Income per Capita: This dataset from CEIC data provides household income per country, it will used in conjunction with the previously mentioned datasets to create an *additional poverty index*. The datasets will be truncated to include only the years 2013 to 2019. Additionally, since many units are expressed in the local currency of each country, they will be converted to USD to ensure consistency with the other datasets. *N.B: This dataset may be replaced with another economic index if significant inconsistencies arise with the datasets used in the project.* [6]

Implementation:

To identify the correlation between energy poverty and global temperatures, a correlation matrix will be generated with a focused analysis of the correlation coefficients. To support the initial analysis, an *additional energy poverty index* will be derived using three key indicators: household income, energy prices, and average energy consumption (kWh). This will provide an energy affordability ratio, representing a measure of energy accessibility relative to income. A threshold value will be established to classify countries based on energy poverty status, where those surpassing this threshold are identified as experiencing energy poverty. Multiple regression will be used to analyze how global temperatures affect both the initial energy poverty

index and the *additional energy poverty index*. Once the model has been trained, predictions for future energy poverty indexes (initial and additional) will be made based on the 2035 global temperature projections.

Evaluation:

To evaluate the success of the model, different metrics will be used to assess the predictions made on both known and projected data points. For the known data points, R-squared and Root Mean Square Error will measure the model's performance by computing the variance of the energy poverty index and evaluating the average error of predictions. Confidence intervals will be used to calculate the reliability of future predictions based on global temperature projections to analyze the model's accuracy. In addition to evaluating model performance, the carbon emissions generated by the code's execution will be quantified through CodeCarbon, to ensure assessment of its environmental impact.

References

1. https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?end=2006&start=1990

2. https://ipcc-browser.ipcc-data.org/browser/dataset/651/0

3. https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/global/time-series

4. https://databank.worldbank.org/source/doing-business/Series/IC.ELC.PRI.KH.DB1619

5. https://yearbook.enerdata.net/total-energy/world-consumption-statistics.html

6. https://www.ceicdata.com/en/indicator/annual-household-income-per-capita