Impact and Evolution of Nuclear Energy Production

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GitHub: github.com/mnpappo/ads-assignment-3

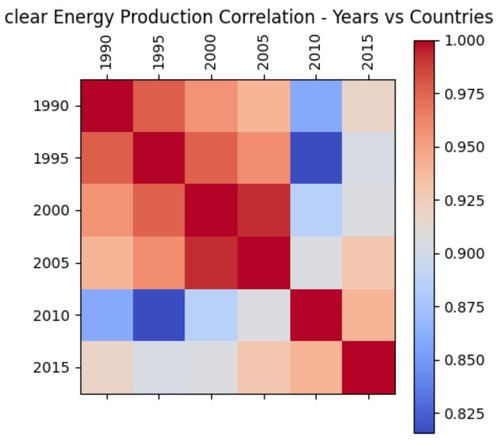
Abstract

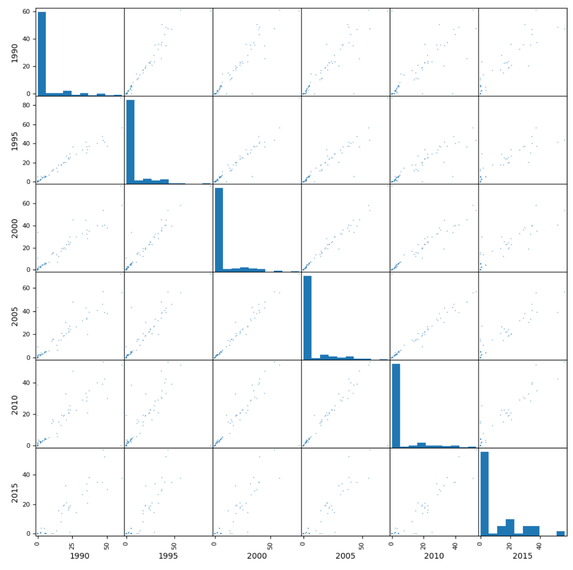
Nuclear energy plays a crucial role in energy production due its low greenhouse gas emission. This poster presents a comprehensive analysis of nuclear energy production from 1990 to 2015, highlighting trends, correlations, clustering and future forecasts across various countries utilizing K-means algorithm using World Bank Data indicator 'Electricity production from nuclear sources (% of total)'.

Introduction

Utilizing K-means clustering techniques, we identify patterns in nuclear energy output, revealing changes in usage and production strategies over the 25-year span. A correlation heatmap provides insights into the interplay between production metrics over the years. Further, predictive model project the future of nuclear energy production for three key nations from three different clusters like Korea, the United Kingdom, and the United States, offering a forecast with confidence margins to gauge the reliability of our predictions. This visual and analytical synthesis not only depicts past and present trends but also fosters a discussion on the future of nuclear energy, its sustainability, and its role in the global energy mix. By analysing complex data into accessible visualizations, the poster serves as a platform for both informed dialogue and educational exploration, targeting both energy sector professionals and the broader public interested in the future of energy production.

Analysis





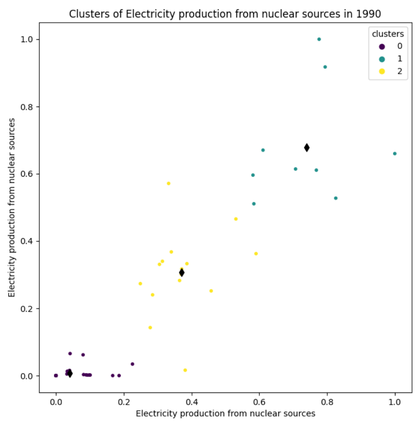
Our data analysis journey begins by exploring the intricate correlations that exist between years and countries in the realm of nuclear energy production.

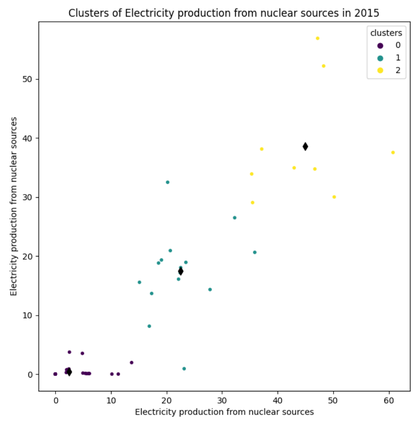
Through a detailed heatmap, we discern patterns of consistency and change, highlighting the interconnected nature of global energy policies and their outcomes. The palette of reds to blues not only paints a picture of the data but also sheds light on the shifting alliances and strategies within the nuclear sector.
Transitioning to the scatter plots, we dissect the inter-country dynamics over the span of a quarter-century. The plots reveal an intriguing dance of data points, where each cluster tells a story of a group of countries with similar nuclear energy trajectories. Some clusters demonstrate rapid growth, indicative of an increased reliance on nuclear power, while others show stagnation or decline, possibly reflecting shifts towards alternative energy sources or changes in national energy policies.

The scatter matrix further enriches our understanding by comparing year-on-year production figures. Each matrix cell captures a slice of history, where the scatter and distribution of points elucidate the ebb and flow of nuclear energy's popularity and usage. The diagonal histograms offer a succinct summary of the distribution of production values within each year, serving as a temporal snapshot of the world's nuclear energy pulse.
Together, these visualizations form a multi-faceted lens through which we observe the complex narrative of nuclear energy. They enable us to not only see the data but also understand the socio-economic, environmental, and political undertones that have influenced nuclear energy production over the years.

Clustering

This clustering analysis serves as a pivotal piece in our narrative, revealing the underlying structure within the global nuclear energy production landscape. By applying advanced clustering algorithms to the data, we have identified distinct groups of countries that share common production patterns over the selected period.
Cluster 0: This cluster represents countries with a nascent or declining nuclear sector, characterized by low production values in both 1990 and 2015. These countries may have faced economic, political, or environmental challenges that hindered the growth or maintenance of their nuclear energy programs.
Cluster 1: Featuring nations with moderate but increasing reliance on nuclear power, this cluster shows a significant rise in production from 1990 to 2015. These countries likely embraced nuclear energy as a strategic asset, possibly to diversify their energy mix or reduce carbon emissions.
Cluster 2: The final cluster comprises countries with high and sustained levels of nuclear energy production. These are the stalwarts of nuclear power, having established and maintained a strong nuclear presence, which underscores their long-term commitment to this energy source.
The strategic grouping of countries into clusters allows us to discern patterns that transcend individual national policies and reflect broader regional and global trends. It also aids in identifying key factors that influence the development or decline of nuclear energy sectors, such as technological advancements, resource availability, public perception, and regulatory landscapes.
The clusters not only narrate the past but also hint at possible futures. They serve as a foundation for policymakers and energy strategists to understand the global nuclear energy tableau and to anticipate the potential movements within this dynamic field.



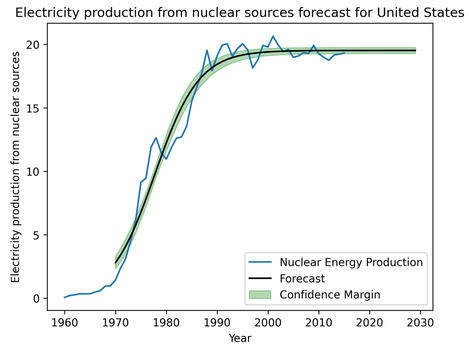


Predictions

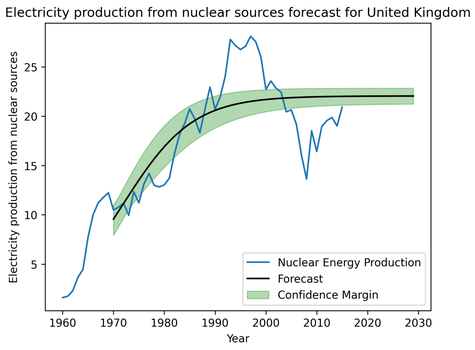
We've looked at the past and present of nuclear power. Now, let's talk about what might happen in the future. We used simple math to guess how much nuclear energy countries might produce. We got 3 clusters and the clusters consists of these countries:

Cluster 0: 'Australia' 'Austria' 'Chile' 'Denmark' 'Early-demographic dividend'
'East Asia & Pacific' 'Europe & Central Asia (excluding high income)'
'Estonia' 'Greece' 'IBRD only' 'IDA & IBRD total' 'Ireland' 'Iceland'
'Israel' 'Italy' 'Latin America & Caribbean (excluding high income)'
'Latin America & Caribbean' 'Low & middle income'
'Late-demographic dividend' 'Luxembourg' 'Middle East & North Africa'
'Mexico' 'Middle income' 'Netherlands' 'Norway' 'New Zealand'
'Other small states' 'Poland' 'Portugal' 'Small states'
'Europe & Central Asia (IDA & IBRD countries)'
'Latin America & the Caribbean (IDA & IBRD countries)' 'Turkiye'
'Upper middle income'
Cluster: 1: 'Belgium' 'Switzerland' 'Euro area' 'Finland' 'Hungary' 'Korea, Rep.'
'Slovak Republic' 'Slovenia' 'Sweden'
Cluster 2: 'Canada' 'Central Europe and the Baltics' 'Czechia' 'Germany'
'Europe & Central Asia' 'Spain' 'European Union' 'United Kingdom'
'High income' 'Japan' 'North America' 'OECD members'
'Post-demographic dividend' 'United States'

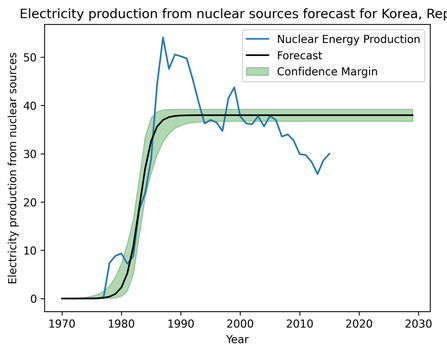
Our prediction shows United States is one of the largest producers of Nuclear energy, United kingdom is in middle, South Korea is in the bottom section.



United States: For the US, we think things will stay pretty much the same. They're not building many new plants, but they're not closing many either. So, their nuclear energy will likely stay steady. USA is in growth rate as always to implement more nuclear energy production source. Prediction show USA will be one of the major producers of Nuclear Energy.



United Kingdom: The UK's future with nuclear energy is a bit up and down. They're not sure how much they want to use nuclear power, which makes it hard to guess what they'll do. It clearly shows a promise for future up trend. In future the amount of nuclear energy production units will increase over the time. The prediction a little bit rough for logistic function but shows a clear prediction.



South Korea: It looks like South Korea will make more nuclear energy as time goes on. They're really into nuclear power and are building more plants to make electricity.

Conclusion

We learned that each country uses nuclear power in its own way; some are increasing it, others are not sure, and some might keep it the same. Nuclear power is important because it doesn't create a lot of pollution, but it also has problems like safety and waste. Our predictions are just good guesses based on what we know today, but things could change with new technology or decisions by leaders. Understanding nuclear power is important because what happens next depends on new ideas, what governments decide, and what people think about it.