Energy Preferences

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1 Introduction and Theme

At this critical time for the global response to climate change, energy choices are crucial to achieving sustainable development goals. Energy consumption not only directly affects greenhouse gas emissions, but also reflects the complex interactions of society, economy, and technology. In particular, renewable energy (such as bioenergy, solar energy, hydropower, and wind energy) is considered one of the core means to mitigate climate change and promote global energy transformation due to its low-carbon, high-efficiency, and sustainable characteristics.

This project aims to explore the relationship between global energy choices and climate change from both macro and micro levels. At the global level, the project analyzes and visualizes energy use in different countries, with a particular focus on the development and application of renewable energy, and provides insights into energy transformation by revealing the energy preferences of various countries and their evolution over time. At the micro level, the project studies the relationship between individual energy consumption preferences and their educational background, income level, and climate concern, and explores the potential factors that affect energy choices. This macro-micro perspective not only helps to understand the differences in energy choices between countries but also provides data support for energy decision-making at the individual level.

The data and visualizations used in this report are available for further exploration. Readers interested in the details of the project or interactive dashboards can visit the following links:

- GitHub Repository: https://github.com/pengningyi/EnergyPreferences
- Tableau Cloud Dashboard: https://public.tableau.com/shared/BDPCNM6GH?:display_count=n&:origin=viz_share_link

1.1 Related Sustainable Development Goals

This project is closely related to several Sustainable Development Goals (SDGs) proposed by the United Nations, especially the following goals:

- Goal 7: Ensure access to affordable, reliable, sustainable, and modern energy for all.

 By studying the preferences of different countries for the use of renewable energy, the project provides insights on how to accelerate the popularization of modern sustainable energy, especially in terms of improving energy efficiency and reducing dependence on fossil energy.
- Goal 13: Take urgent action to combat climate change and its impacts.

 The project reveals the key role of renewable energy in mitigating climate change and provides scientific support for achieving global climate goals.

1.2 Project Motivation

As a graduate student, one of the first tasks I completed after arriving in Finland was to sign an electricity contract for the student apartment I rented. When comparing various electricity contracts, I noticed that the contracts detailed the source of energy, such as hydropower, wind power, or coal power, and that contracts using sustainable energy were usually more expensive. This made me start to think about what the actual impact of different energy types is. What do they mean for personal life and society as a whole?

With these questions, I decided to use this project as an opportunity to delve into the development trends of renewable energy around the world and the multiple impacts of energy choices on individuals and society. By analyzing and visualizing global energy use and combining energy consumption data at the individual level, this project aims to reveal the connection between energy choices and climate change, inspire more people to pay attention to sustainable energy and provide scientific basis and action direction for global energy transformation and sustainable development.

2 Data and Information Usability

This data for this project comes from two sources. The first dataset contains energy usage information for multiple countries from 2000 to 2023 [1]. Data points include total energy consumption and the breakdown of sources such as fossil fuels, bioenergy, solar, wind, and hydropower. The second dataset is survey dataset, which captures information about individuals' preferences for green energy options, their educational background, income levels, and climate change concerns [2]. The dataset includes several categories and variables that provide a comprehensive view of demographic characteristics and their relationship with environmental attitudes.

This project aims to provide policymakers with valuable insights into the role of renewable energy in mitigating climate change. By exploring the visualizations, they can better understand the connection between sustainable energy and its impact on climate. This perspective may offer a fresh angle for shaping future policies.

For individuals and families, the project serves as a tool to uncover the link between household energy costs and energy consumption. The visualized dashboards provide a clear comparison of energy costs, types, and customer preferences, helping users make informed decisions about their energy choices while considering sustainability and affordability.

The estimated time for interacting with this visualization project is around 3 to 5 minutes, depending on how much information the user wishes to extract. The visualization consists of two dashboards.

3 Approach

The visualization consists of two dashboards.

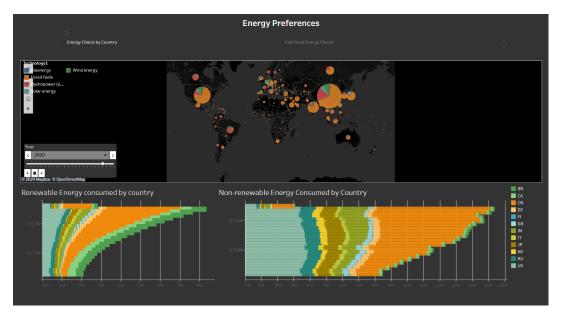


Figure 1: Global Energy Consumption Trends from 2000 to 2023.

The first dashboard shows the distribution and trends of renewable and non-renewable energy consumption by country through maps and bar charts. The map shows the geographical distribution of energy use, while the bar chart details the consumption of renewable and non-renewable energy by country.

It should be noted that due to the time range of the data, the data for 2023 only includes partial statistics from the first few months, so the total energy consumption cannot be directly compared with the full year.

• Map section:

The interactive map shows the geographical distribution of global energy consumption and the proportion of each energy type. Users can select years through the timeline to dynamically observe the changes in the energy composition of different countries in each year. Different colors represent specific energy types such as bioenergy, wind energy, and solar energy, and the size of the bubble reflects the total energy consumption.

• Bar chart section:

The stacked bar chart below is divided into two parts. The left picture shows the consumption data of renewable energy (renewable energy) in various countries, and the right picture shows the consumption data of non-renewable energy (non-renewable energy). The legend marks the country name, which is convenient for users to intuitively compare the consumption trends of various countries in these two types of energy.

The second dashboard shows data on energy preferences related to climate change, covering different income and education levels.

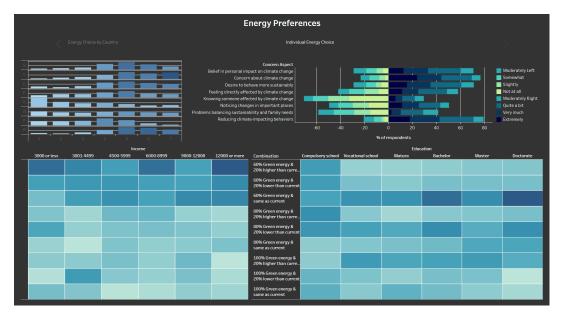


Figure 2: Energy Preferences by Income and Education Levels.

• Heat map section:

The left heat map is of income and green energy preference. The horizontal axis shows the income range, from "3000 and below" to "12000 and above", a total of six intervals; the vertical axis also shows different green energy combinations and price adjustment plans(such as 60% green energy and the same price as the current price, or 100% green energy but 20% lower price, etc.). The depth of the color indicates the preference frequency of choosing a certain combination at each education level, and the darker the color, the stronger the preference for the corresponding combination in this education level.

The right heat map is of education and green energy preference: The horizontal axis represents education background, with six levels from compulsory education to doctoral degree; the vertical axis shows different green energy combinations and price adjustment plans.

- Diverging bar chart section: This divergence bar chart analyzes the respondents' level of concern about climate change and its impact dimensions. The horizontal axis of the chart represents the level of concern, ranging from "not at all" to "extremely"; the vertical axis shows different dimensions of concern, including:
 - Personal perception of impact in climate change;
 - Desire for a sustainable lifestyle;
 - Concerns about the balance between family needs and sustainability, etc.

The different colored bars represent the distribution of respondents' answers on these dimensions, with light colors representing lower concerns and dark colors representing higher concerns.

4 Analysis

4.1 Time

From a time perspective, the proportion of renewable energy use globally increased significantly between 2000 and 2023. 2010 became a watershed in the development of new energy. Since then, the growth of renewable energy has accelerated, gradually replacing some fossil fuel consumption. Several countries have shown clear changes in this trend. For example, China's renewable

energy consumption increased by approximately 1,000% from 2000 to 2023, while non-renewable energy consumption increased by approximately 500%. At the same time, the consumption of non-renewable energy in developed countries such as the United States, Russia, and Germany has basically remained stable, while the consumption of renewable energy has been growing slowly. This shows that there has been some progress in optimizing the energy structure of these countries, but the growth rate Still relatively slow. Special attention needs to be paid to India and China. In the past decade, energy consumption in these two countries has shown a comprehensive and rapid growth trend, which is not only reflected in the growth of fossil fuels, but also includes the rapid rise of new energy sources. This has brought about the transformation of the global energy structure. came an important impact. However, since the data in 2023 only covers some months, it cannot be directly compared with the full-year data in other years. However, it can be seen from the existing data that China and India remain in the lead in promoting the use of new energy.

4.2 Space

From a spatial perspective, the center of global energy consumption is mainly concentrated in countries with rapid economic development, such as China, India and the United States. These countries not only have high total energy consumption, but also gradually show the characteristics of energy structure optimization. In particular, China has rapidly developed from an ordinary energy power in 2000 to the world's largest energy consumer in 2023. Its rapid increase in energy demand has made it the key to global energy transformation. At the same time, the differences in energy structure between different countries are also very significant. Brazil is particularly outstanding in the use of renewable energy. Its proportion of renewable energy consumption in 2023 has exceeded fossil fuels, becoming a model of energy transformation. Countries dominated by traditional fossil fuels, such as the United States and Russia, although still highly dependent on non-renewable energy, are gradually increasing the use of renewable energy. This also illustrates the significant imbalance in the progress of energy transformation in various countries.

4.3 Interaction of Time and Space

Interactive analysis of time and space reveals the rise of China and India in the energy sector over the past two decades. From a time point of view, the energy demand of these two countries is growing rapidly; from a spatial point of view, China has shown a strong ability to adjust its energy structure, and its renewable energy growth rate far exceeds that of other countries. In 2023, renewable energy has accounted for It accounts for about 50% of total energy consumption. India has experienced rapid growth in both non-renewable energy and renewable energy, showing the characteristics of energy demand expansion and structural transformation advancing in parallel. In addition, since 2010, the proportion of renewable energy has gradually increased globally, but the growth rates vary significantly in different regions. Brazil will account for more than 50% of renewable energy in 2023, and China has also achieved significant progress. In comparison, the proportion of new energy in the United States and Russia is relatively low, indicating the progress of energy transformation in developed and developing countries. There are significant differences. Generally speaking, non-renewable energy consumption in developed countries is stable and new energy growth is slow, while in developing countries, while energy demand is increasing, the pace of energy structure optimization has accelerated significantly.

Through the above comprehensive analysis of time and space, it can not only clearly display the dynamics of global energy consumption and structural changes, but also provide valuable data support for customized energy policies in different countries. These findings also provide new perspectives for further promoting global energy transition and combating climate change.

4.4 Individual Energy Preferences

In the personal perception dimension, the data reveals that respondents are most concerned about "behaviors to reduce climate impact," with a significant portion expressing strong worry. This highlights a clear focus on individual actions to address climate change. On the other hand, concerns about "balancing family needs and sustainability" vary across different groups, suggesting that financial constraints may influence how people prioritize sustainability. While concerns about the "impact of climate change on important locations" are also common, they are slightly less concentrated compared to the direct impact of climate change on individuals' lives, which tends to generate stronger reactions.

Regarding preferences for green energy choices, the data reveals that highly educated individuals, such as those with Master's or Doctorate degrees, as well as higher-income respondents, tend to favor products offering 60% green energy at the same price, rather than opting for products with a higher proportion of green energy that may come with a higher or lower price. This trend reflects a preference for economic stability and balance in energy choices, especially among those with greater financial means or educational backgrounds. However, it's important to remember that these insights are derived from survey data, which might not fully represent the behavior of the entire population. In practice, we encourage individuals to make more sustainable choices when circumstances allow, and believe that with increased awareness and supportive policies, more people will begin to make green energy choices in the future.

5 Conclusion and Discussion

The data visualizations from both dashboards offer a comprehensive view of global and individual preferences related to climate change and green energy, revealing important trends across countries, income groups, education levels, and energy choices. From a global perspective, China and India stand out as major drivers of energy consumption, with China emerging as the world's largest energy consumer and India following closely behind. The data also shows a significant shift toward renewable energy, particularly in countries like China, where the share of fossil fuels has decreased, and Brazil, where renewable energy now dominates. These global patterns are mirrored in the individual data, where respondents with higher education and income levels showed a preference for green energy options, especially when the price remained the same. Despite this, the data indicates that these preferences vary significantly depending on personal circumstances, with lower-income households often more concerned about balancing immediate financial needs with sustainable choices.

While these visualizations offer a valuable understanding of the evolving global and individual energy preferences, it is important to recognize that these findings are based on survey data, which may not fully reflect the broader population's behaviors. The results highlight the importance of accessibility to green energy options, as higher-income and more educated groups tend to make more sustainable energy choices when financially feasible. However, these preferences underscore a broader issue: the need to make green energy choices more accessible and affordable for a wider population. In global terms, the increasing focus on renewable energy in countries like China and Brazil, alongside the steady growth of renewable energy consumption in the U.S. and Europe, points to a future where green energy adoption will become increasingly widespread. Policies, technological advancements, and global collaboration will be key in ensuring that the transition to sustainable energy is inclusive, enabling people from all backgrounds to participate in the global effort to combat climate change.

References

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