Data Visualization Report

MASTER DEGREE PROGRAM IN DATA SCIENCE AND ADVANCED ANALYTICS

Group 19

Celso Endres m20200739
Emanuele Aldera m20210617
Mikala Durham m20210645
Sergio Corral m20211011

April 2022

Introduction

Energy plays a necessary role in our society, being used in every sector, both productive (industrial) and consumer (household, transportation). Commonly, energy sources are divided into two categories: non-renewable ones are all those with limited amount of resource and their energy is extracted through combustion or burning, with gasoline, gas (all types) and coal as the referents; on the other hand, the second major class contains the renewables sources, which contrary to the first one, are all those that come from an unlimited source or large enough to be considered as such. These energy sources are considered clean because they do not generate direct waste.

What is interesting about this topic is that in addition to its inherent importance in daily life, there is currently a very strong debate regarding the use of fossil fuels (non-renewable energies) and investment in other types of 'cleaner' energies due to the high impact caused by the first ones on climate change; however, there is much ignorance of how this market works, who are the main participants and what is the real possibility of substituting the main sources for other alternatives.

It was then decided to explore the subject and create a dashboard containing information to help viewers understand what energy sources countries have used in the past and are using now, as well as which countries are the main producers of certain types of energy. Due to the broad nature of the topic, we chose to focus mainly on oil for several reasons: it is heavily criticized for its environmental impact, dividing public opinion, and it is the most widely used energy source in the world.

Dataset

The dataset used is the annual information published by BP, one of the most important oil producers. The report includes historical production volumes by country, trade information, capacity and consumption of various energy sources, as well as average annual prices of a barrel of oil. In addition to this, to have a better understanding of the topic we integrated the dataset with some world macroeconomic indicators from the WorldBank. Both datasets were open source and their use was allowed.

- Statistical Review of World Energy | Energy economics | Home (bp.com)
- World Bank Open Data | Data

Layout, Visualization and Interaction choices

The main goal of this dashboard is to provide the story of global energy sources and usage by country as well as energy dependency on fossil fuels. The dashboard provides information from a specific perspective, but has available interaction options to explore the energy data used in other areas, as the user desires.

The layout was determined to be simple, minimalistic, and to incorporate all graphs in such a way that the user could simply browse between the visualizations.To achieve that, an external stylesheet (GRID) provided by the library *dash-boostrap-components* and many inline CSS commands that would overwrite the external CSS reference were used. The visualizations are confined within lighter colored boxes, with a light grey background.

A dashboard including numerous graphs with many possibilities for user interaction was designed to offer greater depth to the information. Each graph was created with the goal of explaining each section of the story:

A line chart depicting changes in the average price of a barrel of crude oil over time, including both the current and constant prices in US dollars, where the viewer can interact with it by choosing a historical event from the drop-down menu and seeing how it affected the average price, on the year in which the historical event occurred, a vertical dotted line appears. This is to draw the user's eye to the most relevant information. One important thing to emphasize here is how oil is so globalized that events all over the world have a direct impact on the price, resulting in consequences and increases in production costs for virtually all products all over the world.
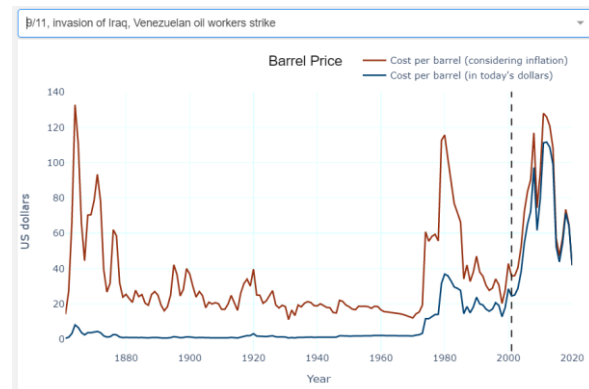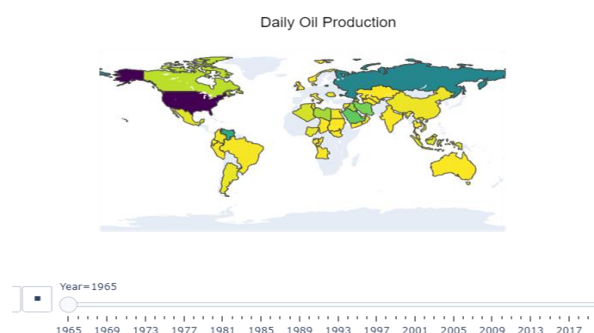

Image 1. Linechart - Historical oil price

Image 2. Worldplot - Oil production

An interactive globe map is used to help comprehend who the major participants in the oil/energy industry are by illustrating the countries' production through time, the user can choose to have the map play automatically through all years available or select a specific year using the slider. We used darker colors to represent larger numbers.

To understand how energy consumption is divided for each country over time, two visualizations were used: the first, a stacked bar chart, shows the repartition of different energy sources' consumption over time (from 1965 to 2020), and the user can select the country he wants to learn about. The user can select the country of interest from a drop-down list, as well as which energies to display. It can be seen here how, following the ratification of several international treaties aimed at reducing global warming, some countries have been able to lessen their dependence on fossil fuels in favor of renewable energy sources.

The second visualization, a treeplot, shows the distribution of energy sources' consumption for a specific year; the year can be selected using a slider. Because of the effectiveness principle, we wanted a plot that allowed a zoom in on one specific year. The stacked bar does a good job to show the change over time of different sources, but by including a second plot with area as the channel to communicate the different energy uses in one country in one year, we are removing some of the attributes to really emphasize a country's dependency on certain energy sources in the treeplot. While rectangular area is not the most accurate way to

communicate numerical values, we decided it was acceptable as a support visual to the bar plot, which uses a much more effective channel.
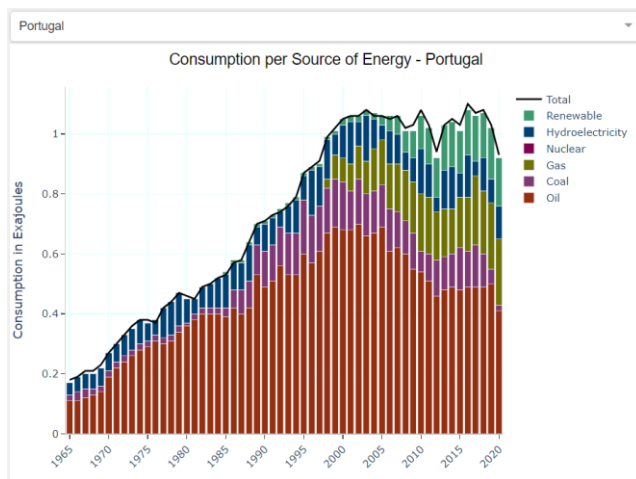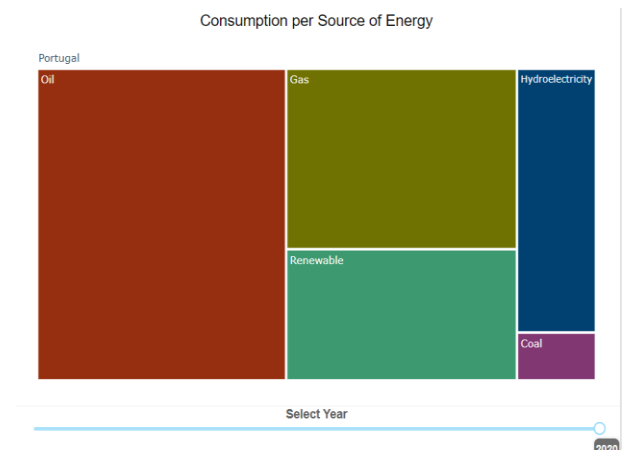

Image 3. Barplot - Energy consumption by country

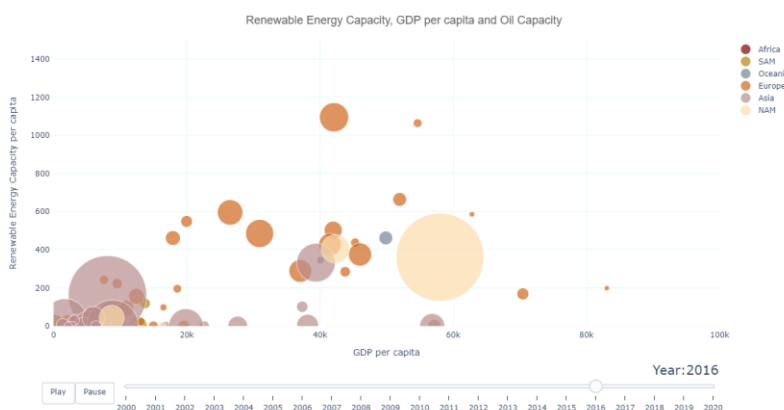Image 4. Tree plot - Energy usage by source.

Image 5. Bubble Chart - Renewable Energy Capacity

A bubble chart is then used to understand the relationship between Renewable Energy Capacity per capita, Oil Capacity, and GDP per capita for each country from the year 2000 to 2020. By playing the animation manually, the user can see the evolution of these relationships, and decide which continents to show. As mentioned in the previous paragraph, some countries have been able to reduce their dirty energy consumption; however, there is much debate in this regard, as shown in this graph, where only countries with certain characteristics have been investing in this issue, with those with the highest GDP per capita being those who have given greater importance, while developing countries continue to use more traditional energies to a greater extent. We thought it interesting to add the hue as a channel representing continents because of the story regarding access to clean energy, but the more important information here is the numerical attributes about clean energy and capacity by country, which is why these are displayed using the position channels, which is the highest ranked channel, according to Munzner (2014).

Finally, to understand by which sectors each energy source is consumed, an interactive pie chart was created to present to the user a simple yet effective communication method; here, the user can select the energy source via a dropdown menu, and the pie chart regarding that source's repartition to the various industry sectors will be shown. Knowing which industries consume the most fossil fuels, as they have the highest opportunity cost, is one of the most important aspects of understanding the energy market, progress toward pollution reduction, and how to reduce dependence on oil.
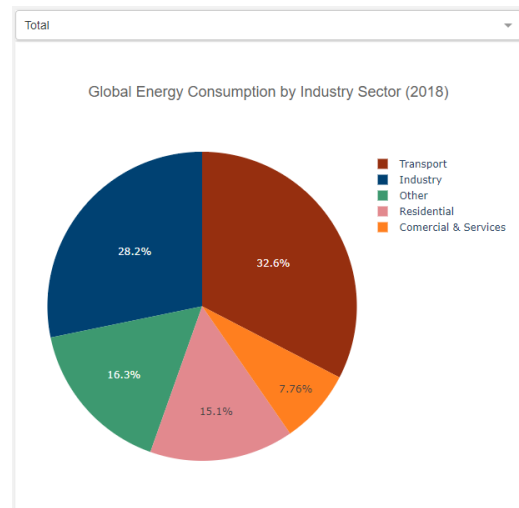
The first draft of this visual was a stacked area chart over time, but the sectors and absolute size of the plot were rather consistent over time, and so the addition of the time attribute was not supporting the information we wanted to communicate in this visual.

Image 6. Pie chart - Energy consumption by sector

By employing the expressiveness principle, we are showing all and *only* the relevant information.

Discussion

The energy topic is very broad, and it must continue to be analyzed and presented in a simple way that can reach the general public, in order to continue encouraging the study of alternative energies and, in the future, to enable mankind to continue reducing its use of pollutant energies as much as possible, thus supporting environmental protection.

Regarding the design of the page itself, the colors identify each topic, the organization of the visuals make good use of storytelling, and interactivity gives the user the freedom to delve deeper into what he considers most relevant. These were the relevant considerations we made as we designed the dashboard.

References

Statistical Review of World Energy. 2022. *Statistical Review of World Energy*. [online] Available at: <https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html> [Accessed 3 April 2022].

Tamara Munzner (2014). Visualization Analysis and Design. CRC Press.

World Bank Open Data. 2022. *World Bank Open Data*. [online] Available at: <https://data.worldbank.org/> [Accessed 3 April 2022].