

Bitcoin & Society

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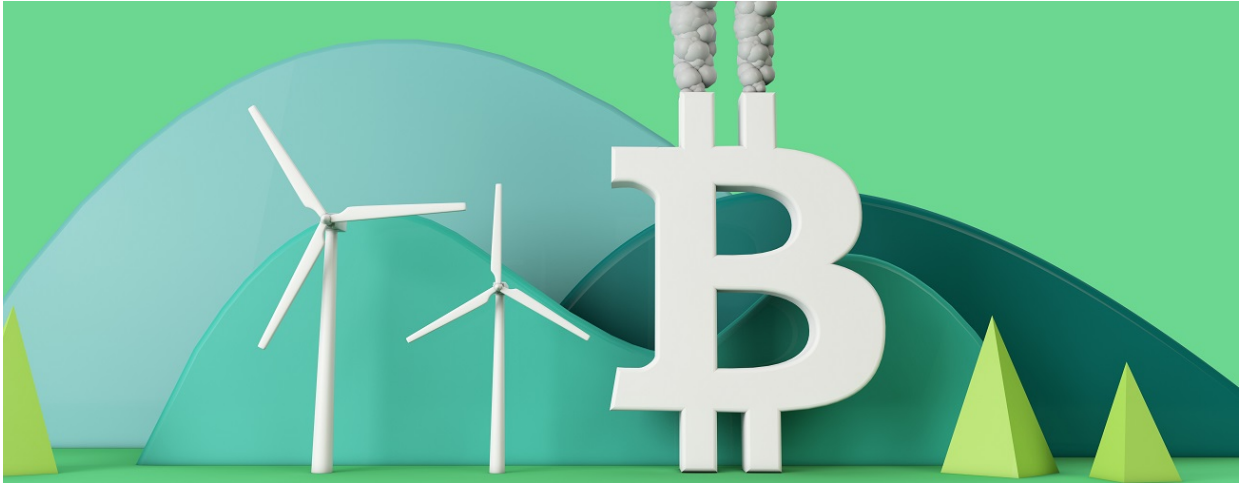


Fig. 1: Bitcoin tries to meet environmental sustainability standards.

Abstract—More than a decade on, it's undeniable that Bitcoin has gone mainstream. However, the digital gold rush has come with a catch, the massive electricity consumption. It is Bitcoin's proof of work consensus mechanism that makes it so energy-intensive. It's estimated that Bitcoin's electricity consumption in 2022 exceeds the entire annual electricity consumption of Norway. The power consumption of Bitcoin is already the same as that of a medium-sized country. In our project, we try to answer this question, is Bitcoin environmentally friendly? The examination of this question requires a thorough assessment of the relative environmental impact of Bitcoin compared to the global market, with a yearly evaluation of changes. The selection of appropriate data to represent the environmental effects presents a challenge. Our analysis focus will be on greenhouse gas emissions and energy consumption. To gain a deeper understanding of the issue, we will further decompose the sources of energy consumption.

Index Terms—Bitcoin, energy consumption, greenhouse gas emissions, environments

1 INTRODUCTION

Our project visualizes the greenhouse gas emissions and energy consumption of Bitcoin compared to those of various countries globally. Additionally, the sources of energy consumption for each country are also depicted. It will be useful for policymakers, researchers, and the general public to assess the relative impact of Bitcoin compared to other countries and to understand the sources of energy consumption in each location.

Bitcoin is frequently viewed as an additional strain on the environment [1]. Nevertheless, if its trend continues to persist, it is crucial to determine the relative volume of its impact and its energy sources' cleanliness. The visual format makes it easier to compare the data, facilitating informed decision-making and promoting awareness of the environmental impact of Bitcoin in a global context.

So our target research question is, **is Bitcoin environmentally friendly?** It will be answered by two main visualization parts, the Bitcoin greenhouse gas emissions by year, and its energy consumption sources compared with nations.

2 TECHNICAL REALIZATION

We mainly used D3 for data visualization in this project, and BS5 for responsive layout of the website. D3 is a JavaScript library used to

create bespoke, interactive charts and maps on the web. Most charting libraries (such as Chart.js and Highcharts) provide ready made charts whereas D3 consists of building blocks with which custom charts or maps can be constructed. D3's approach is much lower level than other charting libraries. Creating a bar chart with Chart.js is just in a fly. D3 allows us to bind arbitrary data to a Document Object Model (DOM), and then apply data-driven transformations to the document. For example, use D3 to generate an HTML table from an array of numbers. Or, use the same data to create an interactive SVG bar chart with smooth transitions and interaction. Bootstrap 5 is the newest version of Bootstrap, which is the most popular HTML, CSS, and JavaScript framework for creating responsive, mobile-first websites. Bootstrap is a free front-end framework for faster and easier web development. It includes HTML and CSS based design templates for typography, forms, buttons, tables, navigation, modals, image carousels and many other, as well as optional JavaScript plugins. It also gives you the ability to easily create responsive designs

3 FEATURE DESCRIPTION

As shown in Figure 2, the world map enables the users to view the country-level greenhouse gas emissions. The darker the colors, the higher the values are. There is no need of the legend, because, when the users apply the mouseover on a country, the exact number will show out. The red color country, Honduras above the South America in the picture, represents the country that has the most similar amount of CO2 emission as Bitcoin for that year. Users are able to click different years to update the map view. The years from 2014 to 2019, denote when Bitcoin experienced rapid growth.

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Global Greenhouse Gas Emissions (MtCO₂e)

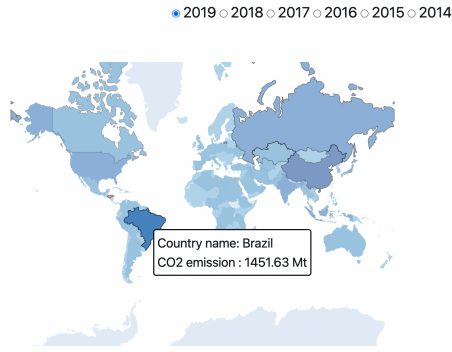


Fig. 2: Global Greenhouse Gas Emissions (MtCO₂e)

As shown in Figure 3, The bubble chart shows the energy consumption sources for the year 2019. Each pie chart represents a country or Bitcoin. The legend divides the sources into three categories: yellow for nuclear, blue for renewable, and violet for fossil sources. The size of the bubble represents the energy consumption value, but the data is logged mathematically first to make the bubbles more manageable and visually appealing.

Two countries with equal energy consumption can still have varying greenhouse gas emissions based on the proportion of energy sources they use. To better compare these emissions, we created an outer circle on the chart that displays the logged value of CO₂ emissions. The two numbers on the Bitcoin pie chart highlight this comparison.

The interactions are designed in an engaging way. For example, by dragging one pie chart over another, you can see the differences in energy sources. For example, you can place the chart for Estonia over the chart for the US and easily compare their energy sources because the charts are transparent. Additionally, to offer a personalized experience, we provide the option for users to select countries that consume less or more x times energy than Bitcoin, where x is a typed-in value. The system will then generate continuous or discrete ranges based on the numbers entered by the user.

Electricity Consumptions & Greenhouse Gas Emissions in 2019*

Show countries whose total electricity consumptions are > 30 times < 0.25 times of Bitcoin's. Confirm

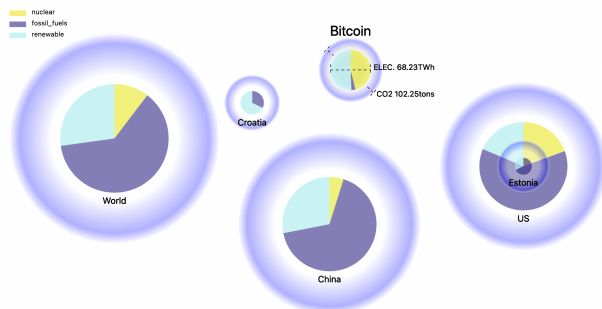


Fig. 3: Electricity Consumptions & Greenhouse Gas Emissions in 2019

4 INTERESTING FINDINGS

Regarding the world map, we discovered that Bitcoin's CO₂ emissions in the last 3 years rank in the middle among all countries in the world. The volume accounts for 1 percent of the emissions of the top emitting country. This confirms that the emissions are on a country level, as previously assumed.

The bubble chart reveals a surprising fact about Bitcoin's energy sources: they are primarily made up of clean sources such as renewable

and nuclear energy. This challenges previous misunderstandings about the harm Bitcoin poses to the environment, as shown in Figure 3.

After examining the countries that consumed 10 percent more or less energy than Bitcoin in 2019, we found that while their pie charts are similarly sized, their CO₂ emissions (represented by the outer circles) vary greatly. Uzbekistan has the highest CO₂ emissions due to its reliance on traditional energy sources, as shown in its pie chart composition. Conversely, Bitcoin has the smallest CO₂ emissions circle because it primarily uses clean energy sources.

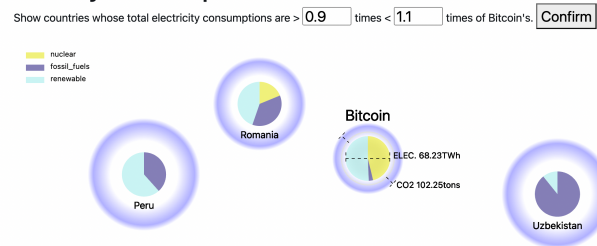


Fig. 4: Countries with Energy Consumption 10% Above or Below Bitcoin in 2019

5 REFLECTION

Our project is limited to showing only Bitcoin data before 2020 as some up-to-date information is not available. Also, in the future, we plan to create an interactive experience by linking the world map and bubble chart. When clicking on a country on the world map, the pie chart will display the corresponding data, making the analysis more intuitive and user-friendly.

6 TEAM WORK

Zhiyang Guo programmed the world map, while Yi Wu programmed the bubble chart. Zhiyang Guo got the website published, and Yi Wu modified the explanation words on the website. Our teamwork has been excellent from the beginning, as we strive to find common ground while recognizing our differences.

ACKNOWLEDGMENTS

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- [1] A. N. Q. Huynh, D. Duong, T. Burggraf, H. T. T. Luong, and N. H. Bui. Energy consumption and bitcoin market. *Asia-Pacific Financial Markets*, 29(1):79–93, 2022. 1